Compost Toilets as an Alternative to the Honeybucket in a Rural Alaska Native Village

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## ABSTRACT

In rural Alaska Native Villages, approximately one-third of households are not served by piped water and sewer systems and must rely on five-gallon plastic buckets (called honeybuckets) for collection and disposal of human waste. Households that use honeybuckets can be at increased risk for fecal-oral diseases. Many of these households may never be served by piped or flush-haul systems and few alternatives have been tested in rural Alaska. Compost toilets have been suggested as an alternative technology, but comprehensive testing of modern composting systems in Alaska Village households has not been carried out. This project tested state-of-the-art commercially available compost toilets (Envirolet MS10 self-contained units) as an alternative to honeybuckets in a self-identified rural Alaska Native Village that predominantly uses honeybuckets for human waste disposal. The toilets were installed in three different households and one commercial setting (the community store) and were monitored for a ten-month period. The toilets were evaluated on system performance, user perspectives and opinions, and capital and annual costs. A local operator was hired to assist with monitoring and maintaining the toilets, and carrying out an educational component for users and the community. Remote sensing equipment was used on the first toilet installed for real-time monitoring of temperature, toilet use, and waste moisture in the toilet, and was also used for troubleshooting problems and tracking operations. A power meter was also used to measure electricity use of the toilets. Envirolet MS10 compost toilets were found to be capable of providing economical management of human waste as an alternative to honeybuckets and can be successful with the following considerations:

- A local operator position, with an initial training component, is needed to assist the households with at least the emptying of the toilets, and possibly other maintenance required for the successful operation of the toilets;
- Education is necessary for users to understand the limitations of the toilets and how to operate them;
- Two toilets are needed to meet capacity in larger households (four or more people).

Compost toilets were preferred to honeybuckets by the majority of users for the reasons that compost toilets have less odors than honeybuckets and do not have to be emptied as often as honeybuckets. During the 10-month test period that the toilets were monitored, the toilet installed in the two to three person household performed the best in terms of user satisfaction, frequency of emptying, and transfer of maintenance tasks (the household successfully took over all maintenance tasks including emptying the toilet). Methodology and lessons learned from the project can be used to carry out further compost toilet testing and/or testing of other alternative sanitation technology.

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# 1.0 INTRODUCTION AND BACKGROUND

## *1.1 Introduction*

Approximately one-third of homes in rural Alaska do not have piped water and sewer systems. Honeybuckets (five-gallon plastic buckets) are used for human-waste collection and disposal in these cases, and increases the risks of direct exposure to human waste and possible infection from diseases such as Hepatitis A, gastroenteritis, and skin and eye infections. Due to financial, climatic, and geographical challenges, some households may never be served with piped systems. The most common alternative to a piped system in Alaska villages is the flush-haul system, which uses holding tanks for water and wastewater in homes, but these systems also have limitations for some households and communities, and operation and maintenance (O&M) costs can be high. Few alternative sanitation technologies have been comprehensively tested in rural Alaska and a need exists to research, test, and evaluate potentially feasible and sustainable systems to manage and improve sanitation in Alaska villages. Compost toilets have been suggested as a possible technology, but comprehensive testing of modern systems in Alaska village households has not been carried out. The purpose of this study is to test the feasibility of compost toilets as an alternative to honeybuckets in a rural Alaska Native Village, from a technical, economic, and user-feedback perspective. The research goals are to carry out a first-phase demonstration project over several months with state-of-the-art commercially available compost toilets, with an educational and monitoring component and using participatory methods, report findings, and make recommendations for next phase or further testing based on lessons learned from the project.

## *1.2 Background - Overview of Rural Alaska Water and Sanitation*

Approximately 12 percent of the population of Alaska (mostly Alaska Natives) live in over 200 remote villages around the state, far from road systems, and often far from other villages, where small planes and occasional barges provide the only access in and out of the communities (Haley 2000). The population size of each of the villages range from a few dozen to over 1000 people with many villages under 500 people. Constructing and operating sanitation systems in these remote communities can be expensive and complex due to a number of issues. Because of the remote locations and extreme climate, it can be difficult and expensive to get supplies and equipment in and out of the communities. In many communities, barge access is limited to a short window in the summer when the rivers aren't frozen, and the small planes that come in have limited space. The permanently frozen soil (permafrost) found in most of the villages makes construction and operation of sanitation systems difficult, expensive, and restrictive. The installation of septic tanks in rural Alaska is often impractical because of the ice-rich soil and limited soil drainage/percolation (the permafrost layer forms a barrier that prevents drainage). Permafrost can also restrict the drilling of wells for groundwater, and may also prevent the installation of sewer pipes underground. River water is usually used in areas where groundwater is inaccessible but high turbidity and piping issues in the winter can be a problem. When sewer pipes need to be built above ground, the construction and maintenance is usually more expensive than standard below ground systems. The extreme climate can also limit the construction season in villages to a three-to-four month period, which often must also coincide with the barge schedules, which can extend the timeline of a project and increase the costs.

When sanitation systems are constructed in villages, capital costs are usually paid for with federal and State funds, but ongoing O&M costs need to be covered by the communities. Due to small population sizes, communities can not take advantage of economies of scale and the high annual O&M costs are spread across a small number of households. The average per capita income in rural Alaska villages is also significantly lower than the statewide average (between 30 and 40 percent lower) (Colt 2003). Residents in rural Alaska also spend more of their income for sanitation service than Anchorage or other US residents (Colt 2003). According to a Rural Utility Business Advisor (RUBA) survey carried out in 1999 with villages that had piped water and sewer systems, households in rural Alaska spend 1.5% of their incomes, on average, for sanitation service compared to Anchorage residents at 1% and other US residents at 0.5% (Haley 2000). Even with the higher than US-average outlays, the fees collected for sanitation service in villages often do not cover the operating costs. This can lead to a cyclical problem of villages not having enough money to cover required maintenance (parts, chemicals, etc.), which can cause breakdowns or malfunctions of the technology costing the village more money in repairs. Table

1.21 is from the document *Sustainable Utilities in Rural Alaska, 2003* (Colt 2003) and compares income and utility consumption between rural Alaska villages, Anchorage, and the US.

**Table 1.1 Income and utility consumption comparisons** (from Sustainable Utilities in Rural Alaska, 2003 (Colt 2003))

| | **Rural AK** | **Anchorage** | **US** |
|---|---|---|---|
| Per Capita Income 1999 | 13,000 | 30,000 | 28,500 |
| Residential Electric Consumption (kWh/yr) | 4,000 | 10,500 | 10,100 |
| Percent of Household Income Spent on electric/water/sewer | 3.2 - 5.1% | 1.6% | N/A |

Sources: Calculations based on PCE data, BEA Local Area Personal Income, Energy Information Administration  Notes: Rural Alaska per capita income based on VSW-eligible communities (Colt & Hill 2000)

The economies of many Alaska Native Villages rely on a combination of subsistence and cash (Haley 2000). Subsistence is the top priority for Alaska Native Villages. According to the Alaska Department of Fish and Game, rural Alaska residents depend on subsistence foods for 35% of their calories and 100% of their protein (ADF&G 1998). But subsistence is a priority for more than just nutritional needs. The Alaska Commission on Rural Governance and Empowerment writes about subsistence:

> "Protecting subsistence is the top priority of rural Alaskans. Harvesting and consuming fish, game and other natural foods and resources for subsistence is the cornerstone of life in rural Alaska. These resources have great nutritional, economic, cultural and spiritual importance" (ACRG 1999, p.12)

Subsistence often must take priority over other schedules, including paid jobs.

Another financial issue for villages is the ever increasing cost of electricity and fuel which affects operation of sanitation systems and transportation of equipment, parts etc. Villages are not connected to regional electrical grids. Electricity is generated by individual diesel generators and the price per kWh is several times the national average. Fuel is typically brought into the community by barge and prices have skyrocketed in recent years. Most sanitation systems require a substantial amount of electricity/fuel for operation and although the state provides some relief through the power cost equalization program (PCE), the amount of the economic assistance can vary each year.

Currently, about one third of homes in rural Alaska do not have piped water and sewer systems. Honeybuckets (plastic 5-gallon buckets) are used for human-waste disposal in these cases. Village residents that must still rely on using honeybuckets face risks of disease from accidental contact with the untreated waste, when residents have to carry their own honeybuckets to a disposal site, or spillage/leakage occurring on community roads and boardwalks during transportation to disposal sites. Honeybuckets were the historical method of collecting sewage in Alaska Villages. In the late 1980s, water and wastewater systems for homes started being built and in the early 1990s, piped water/sewer systems were being installed and the main alternative to piped systems, the flush-haul system, was developed (Eddy 2004). State and federal agencies have been working for many years to provide adequate sanitation facilities to Alaska Villages but there are still many homes in villages that must haul their own water and waste, which agencies and villages alike agree is an inadequate and unsanitary level of service.

To determine the status of water and wastewater service in homes across rural Alaska communities, the Governor's Council on Rural Sanitation implemented the Rural Alaska Housing Sanitation Inventory (RAHSI) project, which was carried out in 2004. The project involved surveying individual households in Alaska communities and recording the type of water and sanitation system for each household into a database. In 2006, the Alaska Native Tribal Health Consortium (ANTHC) updated the RAHSI database with information gathered from community visits and other resources. ANTHC is equivalent to the Indian Health Service agency for Alaska Tribes and is one of the primary agencies responsible for carrying out sanitation projects in Alaska communities. Statistics from ANTHCs updated database for water and sanitation service in Alaska communities follow.

- 66% of Alaska communities are considered served but in these served communities, up to 49% of homes may use honeybuckets;
- 34% of Alaska communities are considered not served (a minimum of 51% of homes in the community don’t have either a piped water/sewer or flush-haul system);
- 22% of Alaska communities are 100% served (100% of homes in the village are served by either a piped water and sewer system or a flush-haul system);
- 18% of Alaska communities have 0% of homes served by either a piped water/sewer or flush-haul system.

Note that ANTHC considers a community "served" if 50% or more of the homes in the community have either piped water/sewer or flush-haul systems installed.

As noted in the statistics, even in communities that are considered served with piped water/sewer or flush-haul units, there could be several households in that community where no system was installed due to their location in the community, seasonal access issues, or other reasons, and must still rely on honeybuckets and hauling water. It is possible that these households may never be able to be connected to a piped system or have flush-haul units installed. Piped water and sewer systems are considered the highest level of sanitation service for Alaska Native Villages, and a description of the systems and their variations are given in further detail in section 1.24. Flush-haul systems (also discussed in further detail in section 1.24) are the most common alternative to piped systems, and basically use holding tanks for water and waste in individual homes instead of a linked piping network through the community. Communities that aren't served or are only partially served, can apply to the State's Capital Improvement Project (CIP) program to get on a priority list for funding. The CIP program is managed through the Alaska Department of Environmental Conservation's Village Safe Water (VSW) program which is the primary State agency involved in the construction of village water and sewer projects. The financial requests to this program from villages each year are far greater than the amount that can be appropriated in any given fiscal year, so a ranking system is used and the highest priority projects are the ones funded on a year to year basis (Sanitation 1998). The priority ranking system includes factors such as public health hazards, local priorities, federal assistance, project status, economic development potential, and current operation and maintenance capabilities. Even if a village ranks high on the priority list, funding for construction of sanitation facilities can be years away. Depending on the situation, a feasibility study may need to be carried out, a selection process must take place, and a design and permit phase must be completed before any construction can take place.

Since the funding agencies give priority in the ranking system to communities which can prove to have the financial, technical, and managerial capability to operate and maintain a completed sanitation facility, many villages which have honey buckets or other systems which do not provide a satisfactory level of service, will have difficulty qualifying for piped or flush-haul systems (USEPA 1995). Hence funding is not necessarily focused on villages with the most serious public health problems since many villages cannot meet the agency O&M requirements (USEPA 1995). Beyond funding, other factors such as an adequate supply of potable water may preclude the construction of piped systems in communities. In these cases, a village may select the flush-haul system as an alternative, however, there are basic requirements for the flush-haul system that a village must have such as roads or boardwalks with a bearing capacity adequate to handle transportation vehicles (i.e. trucks or All Terrain Vehicles (ATV's)), and in several villages, this type of infrastructure is missing or inadequate (USEPA 1995). Flush-haul systems may also be a more attractive alternative for communities with challenging topographic and climatic situations which would require expensive adaptations of conventional piped systems (e.g., installing pipes above ground, using vacuum rather than gravity systems, extra installation etc.). However, while the capital costs of constructing flush-haul systems can be significantly less than constructing even conventional piped systems, the O&M costs of flush-haul systems can be up to twice as high (USEPA 1995; Haley 2000), and since the village must cover the O&M costs of a system, even flush-haul systems may not be a feasible option. The O&M costs of piped systems may also be unaffordable to some villages, which may perpetuate the use of honeybuckets indefinitely for some villages and/or households.

### 1.2.1 Health and Sanitation

A relatively small number of health studies have been carried out in rural Alaska over the years to determine the health benefits and disease risk reduction from improved sanitation services. One study that was carried out recently by the State found respiratory infection (LRI) hospitalization rates that were five times higher than national rates in the Yukon-Kuskokwim region of Alaska, a region in the state where the majority of villages aren't served by piped water and sewer services (Alaska 2007). Diseases such as respiratory illnesses and skin infections and, often spread by contaminated hands, are thought to be perpetuated by insufficient quantities of water to allow adequate hygiene (Alaska 2007). In a study carried out by the Indian Health Service (IHS), the gastrointestinal death rate for the Alaska IHS area was found to be more than twice that of the US rate between 1994 and 1996 (IHS 2004). In the same study digestive system diseases ranked fourth in cause of hospitalization in FY 1997, accounting for 9.6% of hospital discharges, following obstetric deliveries and complications of pregnancy (ranked 1), respiratory system diseases (ranked 2), and injury and poisoning (ranked 3) (IHS 2004). Gastrointestinal illness is affecting Alaska Natives even if it's not reported as the highest cause of hospitalization or the most serious problem with which they have to deal. A common situation in rural Alaska however with illnesses like gastroenteritis, diarrhea related diseases, and skin infections, is that people often may not receive medical treatment beyond their village clinic due to the cost and distance of traveling to a regional hospital. Many cases of these illnesses therefore go unreported because people are not seen by doctors in facilities that regularly record and report health data to the State or other sources for statewide analysis. The Alaska Governor's Council on Rural Sanitation in the *Rural Sanitation 2005 Action Plan* further comments on this issue from interviews with Alaska health professionals:

> "Many Alaska health professionals believe that most afflictions resulting from poor water and sewer conditions reside in this (gastroenteritis and diarrhea-related illness) category. Usually death does not result, and a large majority of the sick recover on their own without hospitalization. These factors further complicate the ability to collect and analyze health data. It should be noted however, that several health professionals commented that while gastroenteritis and diarrhea related illnesses do not alone cause death, they may debilitate weaker individuals such as children and the elderly to the point where they are susceptible to fatal illness" (Sanitation 1998, p.26).

Hepatitis A used to be the biggest health concern for rural villages in Alaska with inadequate sanitation systems. Hepatitis A is spread through personal contact or fecal oral contact from an infected person. In 1998, an evaluation of epidemiological data carried out by the Congressional Office of Technology Assessment (OTA) for *An Alaskan Challenge: Native Village Sanitation,* showed that Native Villages with honey bucket systems accounted for 72 percent of the reported cases of Hepatitis A in Alaska (OTA 1994). The OTA also reported that Hepatitis A and B cases were most widespread in the Yukon-Kuskokwim Delta region of southwestern Alaska and at a rate of incidence that was one of the highest in the United States (OTA 1994). Fortunately, a vaccination for Hepatitis A was successfully tested on two outbreaks in 1993 and a statewide vaccination of all children has been promoted by the State of Alaska Public Health ever since (Sanitation 1998). As noted by the Alaska Governor's Council on Rural Sanitation in the *Rural*

*Sanitation 2005 Action Plan*, State health officials have a high confidence that the Hepatitis A vaccine will eliminate epidemics in Alaska, but officials (interviewed) were also quick to reiterate the importance of adequate water and sewer as a preventative measure against Hepatitis A and other intestinal diseases" (Sanitation 1998, p.26).

The use of honeybuckets increases risks of direct exposure to human waste particularly when buckets are hand carried to disposal sites: when wastes are transported on sled or cart pulled by an ATV or snowmobile and spill on roads or boardwalks: and when wastes spill on the ground from overflowing hoppers or bins located through the community. When potential disease containing waste is on the ground, a few factors can increase the likelihood of people coming into contact with it: people and pets can track waste-contaminated mud into homes and onto the floors where children play, people may carry out subsistence activities (e.g. cleaning fish or game) near where waste spilled or was tracked, and disease vectors such as insects, birds, or rodents, can make contact with the waste and spread it to food sources (USEPA 1995; Sanitation 1998). A study carried out by the University of Alaska Fairbanks in 2005 looked at the transport of fecal bacteria and the pathways of contamination in a rural Alaska community that uses honeybuckets. Results of the study (Chambers 2005) demonstrated that levels of fecal bacteria were found at some points within the community that were higher than background levels and that human fecal contamination was present in the village likely from honeybucket spills, contamination tracked back from the honeybucket dumpsite, or from gray water dumped within the community. (Chambers 2005) Results also showed that all-terrain-vehicle (ATV) use and foot traffic transported bacteria from the honeybucket dumpsite to the village and into homes. (Chambers 2005) Based on results of this study, it was suggested that care taken with honeybucket and gray water disposal might reduce the human fecal load within the community.

### 1.2.2 Benefits of Improving Sanitation Systems

Beyond health reasons, there are other direct and indirect benefits to improving sanitation in rural communities. In 1998, the Alaska Governor's Council on Rural Sanitation developed the Rural Sanitation 2005 Action Plan, which outlined a strategy to enable all Alaskans to have access to safe drinking water and sanitary sewage disposal by 2005. As part of the action plan, a review was carried out to identify the benefits which result from improving water and sewer systems in rural Alaskan communities. Sanitation agency staff, officials, health professionals, and other Alaskans across the State were interviewed and five benefits were repeatedly identified that result from improving water and sewer systems, which are listed below: (Sanitation 1998)

1) **Improvement to public health** – Government officials stress that improving the health of Alaskans is the number one reason for constructing water and sewer facilities in rural Alaska. Health officials were unanimous in their opinion that there is a strong correlation between the health of a population and the level of sanitation that good water and sewer facilities provide.
2) **Economic development** – Enabling long term expansion of a village's economic base, for example starting or expanding tourism markets through the creation of cottage businesses such as bed and breakfast accommodations. The existence of improved water and sewer systems in rural Alaska may capture lodging and meal revenues from government and other workers traveling to village on business. With added conveniences and lodging facilities these workers may be compelled to stay in the village (rather than a hub city) allowing the local economy to capture some of the revenues associate with government travel.
3) **Economic growth** – Influx of cash into the local economy from construction activity from water and sewer projects and using village residents as the primary labor force for the construction.
4) **Improvement to quality of life** – Improving poor water and sewer conditions in rural Alaska improves the daily living experience for people.
5) **Indirect benefits** - Reduction of medical costs as a result of a decrease in disease prevalence, increased school attendance and improved adult productivity resulting from reduction in illnesses, and improved environmental conditions associated with better sewage disposal techniques.

In addition to the benefits noted by agencies, organizations, and other parts of the public sector, such as those just listed, there may be additional benefits to improving sanitation from the perspective of the individual households where systems have been, or need to be, installed that may not have been noted. Table 1.221 is from the document "Rethinking Sanitation – Lessons and Innovation for Sustainability and Success in the New Millennium" by Dr Mimi Jenkins and Steven Sugden, and presents benefits of improved sanitation from two different perspectives – the private household and the public societal perspective. The information was compiled from several case studies and project reports from rural communities around the world. So although the information is not Alaska specific, it is still relevant and gives insight to additional benefits that may be overlooked by society and offers additional good reasons to improve sanitation.

**Table 1.2 Inventory of stated benefits of improved sanitation from the private vs. public perspectives** (From Jenkins and Sugden's *Rethinking Sanitation – Lessons and Innovation for Sustainability and Success in the New Millennium, 2006*) (Jenkins 2006)

| Household Perspective [a] | Society-Public Perspective [b] |
|---|---|
| - increa sed comfort | - reduced excreta-related disease burden |

| Household Perspective [a] | Society-Public Perspective [b] |
|---|---|
| - increa sed privacy<br>- increa sed convenience<br>- increased safety, for women, especially at night, and for children<br>- dignity and social status<br>- being modern or more urbanized<br>- clea nliness<br>- lack of smell and flies<br>- less embarrassment with visitors<br>- reduced illness and accidents<br>- reduced conflict with neighbours<br>- good health in a very broad cultural sense, often linked to disgust and avoidance of faeces<br>- increased property value<br>- increa sed rental income<br>- eased restricted mobility due to illness, old age<br>- reduced fertilizer costs (ecological sanitation)<br>- manure for crop production (ecological sanitation) | (morbidity and mortality) leading to:<br>• reduced public health care costs<br>• increased economic productivity<br>- increased attendance by girls at school (for school sanitation) leading to broad development gains associated with female education<br>- reduced contamination of ground water and surface water resources<br>- reduced environmental damage to ecosystems<br>- increased safety of agricultural and food products leading to more exports<br>- increased nutrient recovery and reduced waste generation and disposal costs (for ecological sanitation)<br>- clea ner neighbourhoods<br>- less smell and flies in public places<br>- more tourism<br>- national or community pride |

[a] Compiled from the following case studies and project reports based on household interviews, surveys and group discussions in many different settings:(Jenkins 1999; Jenkins 2004);(Jenkins 2005);(Obika 2002);(Mukherjee 2000);(Allan 2003); (Elmendorf 1980);(D'Sousa 2005);(WSP-EAP 2002);(WSP 2004).
[b] Reasons for public action stated in studies and documents but rarely quantified or ranked, for example, see (Evans et al 2004)

### 1.2.3 Sanitation Issues in the Yukon Kuskokwim Area

The majority of communities in Alaska that do not have piped water/sewer or flush-haul service, or are only partially served, are located in western Alaska and the Yukon-Kuskokwim area. Most or all of the residents in at least 18 villages in this area use honeybuckets and must haul their own water (Chambers 2005). A list of these villages is shown in Table 1.231 (Chambers 2005). As noted in USEPA's *Federal Field Workgroup Report to Congress on Alaska Rural Sanitation (1995),* certain challenges and characteristics of this region make the problem of finding sanitation solutions particularly difficult:

- Very small populations so that economies of scale cannot be realized and per household system costs are very high;
- Extremely limited cash economies resulting in no or low funding to pay utility technicians and system operational and management costs (villages which are cash short may still have strong subsistence economies);
- Village governments have limited resources and technical assistance available to them to ensure adequate operation and management of sanitation systems;
- Remote locations, permafrost soils, harsh climates, and high energy costs all contributing to high construction and operation costs;
- Linguistic and cultural differences which complicate communication between agency staff and Alaska Native Village residents and village councils (USEPA 1995).

Some of these challenges may restrict the possibility of piped or flush-haul systems ever being installed in villages in this region, or at least it may take many years to put systems in place. There also may be a larger number of individual households that are not able to be connected or served in a village that does eventually get "served." Alternative sanitation solutions may be the most relevant and needed for villages in this region.

**Table 1.3 Yukon-Kuskokwim Delta villages lacking fully piped water and sewer** (from *Transport Of Fecal Bacteria In A Rural Alaskan Community* 2005 (Chambers 2005))*

| | | |
|---|---|---|
| ***Most or all residents haul water and use honeybuckets or pit privies*** | | |
| Akiachak | Kasigluk | Nunam Iqua |
| Atmautluak | Kipnuk | Pitka's Point |
| Raven | Kongiganak | Quinhagak |
| Chuathbaluk | Kwethluk | Shageluk |
| Crooked Creek | Kwigillingok | Tuluksak |
| Eek | Newtok | Tununak |
| ***Partial improvements, some haul water and use honeybuckets or pit privies*** | | |
| Akiak | Marshall | Nunapitchuk |
| Kotlik | Napaskiak | |
| ***Large portion of community served or full service coming soon*** | | |
| Napakiak | Tuntutuliak | |

* All villages listed had population estimates of 100-700 residents in 2004 and per capita income between $6495 and $10,487 in 2000. Sources: (Chambers 2005) (RUBA 2005) (ADCA 2005) (VSW 2000)

### 1.2.4 Description of Sanitation Systems Used in Alaska Native Villages

This section contains further information about the various types of sanitation systems used for waste handling and disposal in Alaska Native Villages (honeybuckets, piped systems, flush-haul, electric toilets, and septic tanks), as well as general information about water supply in villages.

**<u>Honeybuckets</u>**

Honeybuckets are five-gallon plastic buckets that are placed in the bathroom of a home or business for human waste. Some users attach a plastic seat to the buckets, some build a wooden bench with a seat where the bucket sits below the bench, and others just use the bucket as-is. Some households also line the buckets with plastic trash bags and may add some Lysol (or other sanitizer) to the bottom of the bucket before use. When the bucket is full, the contents are dumped and then the bucket is returned for continued use. Methods

Figure 1: A typical honeybucket in a home. Source: Clark Mishler.

for disposing honeybucket waste vary depending on the facilities available in each village. Some villages have a honeybucket haul service where households can choose to pay for an operator to pickup and dispose of honeybuckets on a regular basis from their home, or household residents can haul the waste themselves for free. Transport of the waste is either by hand (the case for many residents hauling their own) or by sled or cart pulled behind a snowmobile or ATV. Some villages have hoppers located around the community where residents can dump their honeybucket waste, and when the hoppers are full, an operator hooks them to an ATV or snowmobile and empties them. During the wintertime, the hoppers often need to be flipped over and pounded to release the frozen contents. The type of disposal area for honeybucket wastes also varies among villages. Most villages have some sort of lagoon (unlined) but the size, access, and distance from houses varies greatly. In some villages, honeybucket wastes are disposed of alongside trash at the landfill, and some households may dump honeybucket waste on the ground near houses, in the river, tidal plains, ocean, or in lakes or tundra ponds. In villages that use liners in their honeybuckets, lagoons will often fill up with plastic bags which impede any kind of natural treatment of the wastes. Direct contact with honeybucket wastes for someone that is hand carrying the buckets to the disposal area is highly likely given the uneven terrain and site access in most villages (e.g. dilapidated boardwalks, muddy foot paths on the tundra, ice and snow, etc.). Spillage of raw wastes in town during transport by ATV or snowmobile can also be a common occurrence with full honeybuckets and hoppers. Raw waste can seep onto the ground in town from overflowing hoppers and during snowmelt or seasonal flooding, sewage contaminated water can flow through town and other areas of the community.

Figure 2: Honeybucket hoppers for communal dumping

## Piped systems

On the other end of the spectrum, piped water and sewer systems provide the highest level of sanitation service for Alaska Native Villages. Gravity, vacuum, and pressure sewage are generally the types of piped systems installed in villages. The gravity piped system is the preferred type of technology, but building gravity systems in rural Alaska is not always possible because of the harsh soil conditions, permafrost, rocks, and flat surfaces found throughout the State. Technologies such as pressure and vacuum sewers are considered the next feasible alternative to gravity piped systems. Below are basic descriptions of pressure and vacuum systems from the document, *An Alaskan Challenge: Native Village Sanitation 1994* (OTA 1994).

Figure 3: Above ground piping structure passing through the center of a community

**Pressure sewage systems**
"Pressure sewage systems, so called because of their reliance on pressure provided by pumps, are considered highly efficient in removing sewage through smaller pipelines. Although essentially similar to gravity piped systems, the pressure-type technology requires a power source to heat service lines and maintain the pressure needed to ensure transport of sewage through the pipes. The use of specialized plumbing fixtures in homes connected to this type of sewer system is also necessary" (OTA 1994, p.8).

**Vacuum sewer collection**
"Vacuum sewer collection technology is designed to use a central vacuum to draw raw sewage from connected homes into a central unit or facility. The use of a vacuum environment not only permits the use of smaller water volumes compared to gravity and pressure piped systems, but also enables the placement of service lines on any type of terrain with little concern for slope. The installation and operation of vacuum systems is generally more expensive than for gravity and pressure sewer services" (OTA 1994, p.8).

In areas of permafrost, piped systems need to be installed above ground, and require insulation, heating, and water circulation to prevent freezing. These modifications add to the already high initial capital and annual costs to install and maintain piped systems in villages, and can also have a negative effect on community aesthetics – many villages feel that above ground piping structure ruins the visual landscape of their community and environment. Piped systems also require an adequate supply of water which can be an issue for some villages. Due to environmental logistics, high capital costs, and more importantly high monthly/annual costs to households, there are several villages that may never be able to be provided with piped systems. Some villages that already have piped systems installed currently have trouble paying the monthly/annual costs (Colt 2003).

## Flush-haul systems

Figure 4: Above: Flush-haul wastewater tank outside a home.
Figure 5: Below: Vacuum tanker used for removing wastewater from flush-haul systems

The most common alternative to a piped system in Alaska Villages is the flush-haul system, also referred to as closed-haul or tank-haul. There are a few different variations of the flush-haul system, but in general, separate holding tanks for water and sewer are used in individual homes instead of a community connected piping network. Water is delivered by an operator/utility worker to homes using a potable water tanker pulled by an ATV or snowmobile, and a plastic tank inside the home is filled on an as-needed basis for a fee. Water from the tank is generally pressurized and piped to a low-flush toilet, and in some cases, to sinks in the bathroom and kitchen. Black and gray water flow via insulated pipes to an insulated tank outside the home and when filled, an operator pumps out the tank with a small vacuum tanker pulled by an ATV or snowmobile, also on an as-needed basis and for a fee. The operator then takes the filled tanker to the lagoon or disposal area and empties the contents. The size of the water and wastewater tanks vary depending on the system installed and the size and transport logistics of the village, but can range from 100-500 gallons. The transport tankers are sized to fit the specific system and usually hold the same amount of liquid that the water and wastewater tanks hold. Since households pay for service based on usage, some people will fill their own water tanks with water hauled from non-treated sources to reduce costs. Due to the size of the tanks and the cost to fill them, it is generally not economical to connect bathing or laundry units to the system so washeterias, or a single building in town that generally has laundry machines, a toilet, shower, and a drinking-water spigot ,must still be relied on with flush-haul systems. Although the initial capital costs for installing flush-haul systems in villages are lower than the costs to install piped systems, flush-haul systems typically have higher operating costs due to the operation, maintenance, and replacement of the vacuum tankers and haul vehicles, electricity and part replacement costs for the in-house systems, and the pay-per-haul fees paid by the household based on usage of the system (Colt 2003). A company that produces and sells many of the flush-haul systems (e.g., equipment, parts, etc.) in Alaska is Cowater Alaska and further information about the systems can be viewed at http://www.cowateralaska.com/.

## Septic systems

As mentioned previously, the installation of septic tanks in rural Alaska is often impractical because of the ice-rich soil, limited soil drainage/percolation (the permafrost layer forms a barrier that prevents drainage), and occasional flooding seen in many parts of the state. In addition, warm wastewater from septic tanks can melt the ice (permafrost) and create large sinkholes in the ground. Septic tanks are generally only used in a handful of villages in the southwest coastal regions of Alaska.

## Electric toilet systems (Incinolet)

Incinolet toilets have been installed in a few homes in rural Alaska. The Incinolet toilet uses electric heat to reduce human waste (urine, feces, and toilet paper) to a small amount of ash. Before each use of the toilet, a paper insert is placed in the metal bowl of the toilet to capture the incoming waste or urine. Once use is completed, a foot pedal is pressed which opens the metal bowl, and the paper insert and contents drop into an incinerating chamber at the bottom of the toilet. An incineration cycle is started after each use by pushing a button on the toilet. Ash then can be removed from the bottom chamber on a regular basis. Although comprehensive testing of these toilets has not been carried out in a village, electricity use is high (2kWh per cycle) which limits their use as an economical alternative. For more information about Incinolet electric toilets see http://www.incinolet.com/

## Water supply

Although Alaska is rich in hydrologic resources such as rivers, lakes, and tundra ponds, obtaining water for drinking and sanitation can often be challenging. Permafrost can hinder groundwater as an option, or require deep drilling, and groundwater in coastal areas can be brackish. River intake systems are a popular surface water option but can be problematic because of ice jams and flooding, and are not an option when turbidity is high. (Colt 2003) Some households, particularly in villages without piped service, may use gutters or drains to collect rainwater or may chop ice chunks from lakes and rivers and transport them back home to melt in a container. In villages without piped sanitation systems, coin operated community watering points are common which require hand hauling water, usually in five-gallon buckets. Watering points can be spigots located throughout a village connected by pipes from a treatment building or can be a single building where water is dispensed. Households that haul their own water generally use a small amount per person per day and the graywater is generally discarded just outside homes. Even households with flush-haul systems installed tend to use a small amount, often less than six gallons per person per day, since the households are charged for hauling and discharging the water used (Colt 2003). Some villages may also have a washeteria.

Figure 6: Coin operated community watering point

### 1.2.5 Alternative Sanitation Technologies

Several of the major reports on rural Alaska sanitation that have been developed over the past decade and a half by various government agencies and organizations have proposed or recommended the need to test alternative sanitation technologies to piped and/or flush-haul systems. However, few if any, comprehensive field-demonstration projects have been carried out. Statements from the following reports regarding alternative sanitation technologies are listed in Appendix A:

- Recommendations of the Alaska Sanitation Task Force, A Commitment to Alaskans, Executive Summary (1992).
- An Alaska Challenge: Native Village Sanitation, U.S. Congress, Office of Technology Assessment (1994).
- Federal Field Workgroup Report to Congress on Alaska Rural Sanitation, U.S. Environmental Protection Agency, Water Division (1995).

- Alaska Governor's Council on Rural Sanitation, Rural Sanitation 2005 Action Plan (1998).
- Institute of Social and Economic Research: Financing Water and Sewer Operations and Maintenance in Rural Alaska (2000).

The individual statements from each report vary, but they all promote and recommend the research, testing, and evaluation of alternative sanitation technologies in an effort to improve sanitation in rural Alaska. Many of the reports specifically note that little information exists on the application of alternative sanitation technologies in rural Alaska, and several of the reports specifically mention compost toilets as a technology that could/should be tested. The report with the most numerous statements presented in Appendix A is the US Congressional document *An Alaska Challenge: Native Village Sanitation* since it was one of the first governmental documents to thoroughly review the status of efforts to provide safe sanitation to Alaskan Natives and the technologies that had been used or proposed for this purpose, and it examines the criteria that need to be applied in selecting and implementing new technologies (OTA 1994).

## *1.3 Overview of Compost Toilets*

Compost toilets of various kinds have been used successfully throughout the world for more than 30 years. Compost toilets are biological systems that use little to no water and breakdown human waste to 10 to 30% of the original volume -- when sized and operated correctly -- with a resulting soil-like end product called humus (USEPA 1999). The rate at which the material (waste) in a compost toilet will breakdown depends on the type and composition of the materials being composted, the number and health of the microorganisms using the materials as a food source, the way the toilet is being operated, and the environmental factors in the composting chamber (Del Porto and Steinfeld 1998). Although the operating requirements may vary for different types of compost toilets, the general concepts of composting and necessary environmental factors apply to all of them. The primary environmental factors include the following:

*Aeration*

An aerobic environment in the composting chamber is important for the growth of microorganisms. The material in the chamber should ideally have a loose texture, rather than being compacted, to allow air circulation. Bulking agents such as wood chips, cocoa shells, or popped popcorn etc. can be used with some systems to add pore spaces and help airflow to the material (Del Porto and Steinfeld 1998). Mechanical and other mixers are built into some systems to help expose the material to air.

*Moisture Content*

Maintaining a certain level of moisture is important for microbes to thrive. An environment that is too saturated can create anaerobic conditions and odor issues, and when moisture levels are too low, microbial processes slow down and the composting process is inhibited (Del Porto and Steinfeld 1998). The general consensus in compost literature for the range of moisture content for composting to take place is 45-70% with 50-60% being optimal.

*Temperature*

The temperature needed for effective biological decomposition is between 68 and 112 degrees Fahrenheit, and is known as the mesophilic phase (where mesophilic microorganisms are dominant) (Jenkins 2005). Most compost toilet systems, particularly the self-contained manufactured units, operate in this mesophilic phase (Del Porto and Steinfeld 1998). Although maximum pathogen destruction occurs in the thermophilic phase (113 to 160 degrees Fahrenheit) these high temperatures are rarely reached in manufactured compost toilets, because any heat generated is usually lost through the vent pipes (Pace 1995; Del Porto and Steinfeld 1998). Toilets operating in the psychrophilic phase (42 to 67 degrees Fahrenheit) have a significantly reduced processing time, and below 41 degrees Fahrenheit (biological zero) little to no processing takes place as most microbes can't metabolize nutrients at this temperature (Del Porto and Steinfeld 1998). In general, as the temperature increases, so does the capacity in the composter. And vice versa, with lower temperatures, more time and capacity (volume) may be needed to process the waste (Del Porto and Steinfeld 1998).

*Carbon to nitrogen ratio (C/N)*

Although a carbon-to-nitrogen ratio is important for aerobic bacteria, its significance in compost toilet operations is less of an issue. Microorganisms require carbon as an energy source to grow, and nitrogen and other nutrients for protein synthesis; as a general rule, an optimum carbon-to-nitrogen ratio is 25-30 parts carbon to 1 part nitrogen (Jenkins 2005). In many compost toilets however, the urine (which contains most of the nitrogen) drains to the bottom or is evaporated from the system thus adding the exact amount of carbon to help process the nitrogen is not crucial (Del Porto and Steinfeld 1998). The more important use of the carbon is as a bulking agent as previously mentioned or to help absorb liquid.

### 1.3.1 Types of Compost Toilet Systems and Features

There are several different types of compost toilets ranging from site-built to commercially manufactured systems. As summarized by David Del Porto in the *Composting Toilet System Book* (Del Porto and Steinfeld 1998), compost toilets can be classified in a few different ways as shown in Table 1.311:

**Table 1.4 Compost toilet classifications**

| Types of compost toilet systems | Description |
|---|---|
| Self-contained vs. centralized | Self-contained units are "all in one" systems with a composting chamber underneath a toilet seat, and the whole unit fits in the bathroom. Centralized units are also called "remote" units and have a regular sized toilet that sits in the bathroom which connects to a larger composting chamber underneath the bathroom. |
| Manufactured vs. site-built | Manufactured units are commercially produced "off the shelf" systems that are generally ready to install, come with a warranty or customer service, and often are certified by National Sanitation Foundation (NSF) or other standards. Site-built units vary in design and are self- or contractor-built for the specific situation. |
| Batch (multiple chamber) vs. continuous (single-chamber) | A batch composter has two or more chambers which are filled one at a time and then left to compost while the next chamber is put into operation. A continuous composter has a single chamber where waste enters through the top, and end-product is emptied from the bottom. |
| Active vs. passive | Active systems utilize features that speed up the process of composting such as heaters, fans, mixers, tumblers etc. Passive systems don't use any mechanical features and just rely on the shape of the composting chamber, ambient temperature, gravity, and time to breakdown the waste. Passive composters are often called "moldering" toilets and take a longer time to breakdown waste. |

Although there are a variety compost toilets types, most systems will have these basic components: (Del Porto and Steinfeld 1998)

- A composting chamber connected to a toilet/seat
- An exhaust system to vent odors, carbon dioxide and water vapor
- A ventilation system or method to add oxygen to the aerobic organisms
- A drainage system for excess liquid
- Access to remove the end-product

Some level of operation and maintenance (O&M) is a requirement for all types of compost toilets. Although the O&M tasks do not require extensively trained technicians or treatment plant operators, regularly carrying out the tasks is crucial for toilet performance. Most compost toilets require regular addition of an organic bulking agent (e.g., peat moss, sawdust, cocoa shells, straw) to provide a source of carbon for the bacteria, to keep the pile porous for proper air distribution, and to help absorb any liquids. Most toilets also require some sort of periodic mixing to add oxygen to the system, and also require the removal of the finished end-product, which can occur anywhere from every three months for a self-contained system to every two years for a large central system) (USEPA 1999).

A general advantage of compost toilets compared to piped water and sewer systems is that they don't require water so water isn't wasted as a transport medium (for flushing). Compost toilets also turn waste into a potentially valuable end-product. A general disadvantage of compost toilets is that they require a level of responsibility and commitment by users and owners for ongoing maintenance.

A reasonable amount of literature and resources has been generated over the years listing specific types and brands of compost toilets. Del Porto and Steinfeld (1998) in particular present a comprehensive description of various manufactured and site-built compost toilet systems including photos, sizes, and contact information for each type, and is a recommended resource for anyone reviewing the variety of compost toilets that can be purchased or built. An assortment of information about compost toilets can also be found on the internet. Table 1.312 summarizes several of the more popular commercially manufactured compost toilet systems but is not necessarily a comprehensive list of all manufactured units.

**Table 1.5 Commercially manufactured compost toilet systems**

| Company | Website |
|---|---|
| Alascan | http://www.alascanofmn.com/ |
| Biolet | http://www.biolet.com/ |
| Bio-Sun | http://www.best-composting-toilet.com/ |
| Clivus Multrum | http://www.clivusmultrum.com/ |
| EcoTech Carousel | http://www.ecological-engineering.com/carousel.html |
| Ekolet | http://www.ekolet.com/ekolet-eng/index.htm |

| | |
|---|---|
| Envirolet | http://www.envirolet.com/ |
| Phoenix | http://www.compostingtoilet.com/ |
| Sun-Mar | http://www.sun-mar.com/ |
| Vera Miljo | http://www.vera.no/ |

A variety of designs also exist for building compost toilets using local materials and labor and these types of toilets can be tailored to a particular situation and house/bathroom design. Although it is unknown if one has over been built or tested in Alaska, a popular design for a site-built compost toilet is the Hinged-Top Humanure Toilet which is detailed in the *Humanure Handbook* by Joseph Jenkins (2005) (see http://www.jenkinspublishing.com/sawdustoilet.html for further information). An owner-designed system that was built in a home just outside Anchorage, Alaska, but not tested in a rural village, is the Biorealis system (see http://biorealis.com/composter/rotating/ for details). Further designs of site-built systems can be found on the internet and in books such Del Porto and Steinfeld's (1998) *The Composting Toilet System Book* discussed previously. For this project it was desired to test commercially available compost toilets, and thus various units were reviewed, which are described further in section 2.21. Three units were chosen—Envirolet, Biolet, and Sun-Mar—and each unit was further analyzed and compared in terms of such traits as models available, size, operation requirements, and electricity use. Appendices B and C present summary comparisons for each of these units.

### 1.3.2 Compost Toilet Installations in Alaska

There have been compost toilets installed in various parts of Alaska over the years, but little information/documentation exists on the types of toilets, their location, and their performance. According to manufacturer's that sell compost toilets to locations in Alaska, few have been sold for installation in rural Alaska Native Villages (Interviews 2006). The vast majority have been sold for installation in non-Native communities, and for vacation/cottage homes that get seasonal rather than year round use (Interviews 2006).

In the 1994 government document *An Alaskan Challenge: Native Village Sanitation,* reference was made to the planning of a possible field test of compost toilets in Alaska by the University of Alaska Anchorage. However, no documentation of such a test could be found and it is unknown if the test was ever carried out. In the same document, brief reference was also made to compost toilet installations in a few rural Alaska communities two to three decades ago where older designs were tried out. It was noted that the systems had little success due to design flaws, and that the lack of a participatory approach to the projects resulted in indifference and rejection of the technology in the homes where they were tested. No documentation, written or verbal, was found for the outcome of these installations. The report emphasized the need for formal field testing of modern compost toilets since testing documentation did not exist.

A few compost toilets known to have been installed in Alaska Native Villages in recent times were not installed in Native households, but in school-staff housing, which tends to have seasonal occupancy and not year-round use, and they were ordered and installed by the individual school-staff members themselves. These toilets were purchased for personal use and were not installed to be formally tested or evaluated. Table 1.321 lists these and other known installations of compost toilets in Alaska Native Villages. Note that there could be other installations of compost toilets throughout the State, initiated by individual homeowners, but information about them is unknown.

**Table 1.6 Known compost toilet installations in Alaska**

| Installation location | Description | Timeframe of installation |
|---|---|---|
| Kongiganak | One Envirolet installed in the School Principal's home, and one Envirolet installed in a teacher's home. Both installations are self-contained units and both do not have year round use (i.e. not used during the summer). | Within the last five years. |
| Kwigillingok | One Envirolet installed in the School Principal's home (self-contained unit). This installation also does not get year round use (not used during the summer). | Within the last five years. |
| Naknek | One Clivus Multrum installed in a household. The remote composting chamber is set up in a (heated) garage underneath the household. Unknown if the unit is still installed and in use. | Within the last 10-15 years. |
| Buckland | One AlasCan installed in a household. The remote composting chamber is set up in a (heated) basement underneath the household. Unknown if the unit is still installed and in use. | Within the last 10-15 years. |
| Selawik | Two decades ago, 20 self-contained toilets were donated to the Village but without preparatory community education, follow-up education, or technical assistance. In some homes, the units were never installed and in other homes the toilets were removed not long after installation because residents were never shown how to operate the toilets. | Within the last 20 years. |
| Vacation/ | Garness Industries in Anchorage, AK has sold several self- | Within the last five |

| | | |
|---|---|---|
| cottage home installations | contained Sun-Mar systems for installation in seasonal vacation homes/cottages in various parts of the State, but none for installation in households in rural Alaska Villages. | years. |

## *1.4 Overview of Participatory Approaches for Rural Sanitation Projects*

Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) (also referred to as Rapid Rural Assessment), are both proven methods for collecting and evaluating qualitative information on rural projects and in particular, for assessing sanitation planning and operation in Alaska Native Villages. The methodology used to gather information on user perspectives and opinion about the compost toilets for this project was based in part on PRA and RRA. An overview of PRA and RRA concepts and methodology is given in this section.

### 1.4.1 Overview of RRA (Rapid Rural Appraisal)

Rapid Rural Appraisal (RRA) which has also been called “rapid appraisal” and “rapid assessment” has been used as an evaluation methodology for rural development projects since at least the mid-1970s (Beebe 1995). RRA is a process of learning that is characterized by “the production of quick results and the simultaneous use of research techniques associated with concepts such as (1) a system perspective, (2) triangulation of data collection, and (3) iterative data collection and analysis which provide a flexible but rigorous approach to the collection and analysis of qualitative research data” (Beebe 1995, p.42). Other descriptions of RRA include: “survey undertaken without questionnaires” (Schmehl 1982, p.73); “informal, exploratory, largely unstructured interviews combined with observation” (Honadle 1979, p.2); “a bridge between formal surveys and unstructured research methods such as depth interviews, focus groups and observation studies” (Crawford 1997, p1, c8): and “learning from and with rural people, directly face-to-face; from indigenous physical, technical, and social knowledge” (Crawford 1997, p.1, c8). Techniques used to carry out RRA include semi-structured interviews, triangulation, use of indigenous knowledge, and direct observation and are described further below.

**<u>Semi-Structured Interviews</u>**

Semi-structured interviews are a key component to RRA based on a systems perspective (Beebe 1995). One of the most important ways to learn about local conditions is to ask local people what they know (Beebe 1995). When carrying out semi-structured interviews, the idea is “to get people to talk on a subject and not just answer direct questions” (Beebe 1995, p.42) and to “talk with people and listen to their concerns and views” (Rhoades 1982, p.17). Semi-structured interviewing has also been called “unstructured interviewing,” “conversation” (Burgess 1982, p.107), and “conversation with a purpose” (Webb 1932, 130). Burgess notes that researchers need to listen carefully to the person they are interviewing so they know what direction to take the interview, and to “share the culture” of the person they’re interviewing (Burgess 1982, p.108)(Burgess 1982). Culturally appropriate gestures such as “nods of the head, smiles, and facial expressions that reflect the emotions narrated” can be used to keep the conversation flowing (Beebe 1995, p.44). Focus group interviews can also be a useful way for collecting certain types of information: “Group interviews where individuals are free to correct each other and discuss issues, can identify variability within the community and prevent an atypical situation from being confused with the average” (Beebe 1995, p.45). (Beebe 1995)

## Triangulation

When applied to RRA, triangulation simply means “gathering information about a particular topic from a variety of different sources, using a variety of data-gathering methods” (Crawford 1997, p.1, c8). Triangulation has also been defined as “the process of cross-checking data by collecting it from more than one source” (Dunn 1994, p.1). The assumption for RRA is that there is no one perfect way to obtain information for the majority of situations and even if there was one, it couldn’t be predicted in advance (Beebe 1995). According to Beebe (1995), “Triangulation involves conscious, non-random selection of research methods based on the resources available and the system being investigated. Triangulation of individuals and methods improves the quality of information and provides crosschecks.”

## Use of Indigenous Knowledge and Systems Perspective

The RRA process is intended to “contribute to an insider’s perspective of the system” and should focus on “what the participants in the system believe to be the critical elements, their relative importance, and how they relate to each other” (Beebe 1995, p.42). RRA should be carried out in a way that local people understand it, such as using locally defined categories of a system for descriptive or comparative purposes (Beebe 1995). Further, using indigenous knowledge involves agreement on the most important components in the system and the most important problems or constraints faced by the local participants" (Galt 1985, p.14).

**Direct Observation**

For RRA, direct observation is an important and useful tool for "validating data collected in advance, providing multiple checks on data collected from interviews, and suggesting additional topics for interviews" (Beebe 1995, p.44). Through direct observation, many variables can be observed and recorded, such as physical surroundings, project participants' and general resident's behaviors and actions, or the way services (e.g., sanitation) are carried out or operated in the community (Carroll 2004). One way direct observation can be carried out is by using a field notebook to record the actual local environment and/or behaviors. Photos can also be used to document the initial stages of the projects as well as progress throughout. "Direct observations used in combination with other quantitative data … can provide a vivid picture of community strengths as well as problems and needs" (Carroll 2004, p.2).

### 1.4.2 Overview of PRA (Participatory Rural Appraisal)

Participatory research methods have been used for planning and evaluating projects in rural settings worldwide, including Alaska, for the past decade and a half. A commonly used label for participatory research is Participatory Rural Appraisal (PRA). PRA evolved from Rural Rapid Appraisal and is generally considered to differ in that, "when properly applied, it is a part of the development process itself" (Chambers 1997). PRA has been described as "an approach for shared learning between local people and outsiders" (World Bank 1994, p.1), "an exercise in communication and transfer of knowledge" (World Bank 1994, p.1), and is "intended to complement quantitative engineering, economic, or similar data" (Berardi 1998, p.4). PRA and RRA share a few basic principles which include:

- using triangulation for cross-checking information;
- promoting learning that is rapid, flexible, exploratory, and interactive; and,
- using local criteria and categories (G. Berardi 1999).

PRA has also been defined as “a semi- structured process of learning from, with and by rural people about rural conditions” (Chambers 1997, p1, c8). Chambers suggests that researchers carrying out PRA should have “appropriate attitudes, demeanor and behavior which include:

- participation by the outsider
- respect for rural people
- interest in what they know, say and show
- patience, wandering around, not rushing, and not interrupting
- humility
- materials and methods which empower villagers to express, share, enhance and analyze their knowledge.”

## PRA in Alaska Native Villages

The importance of community support and participation at the start and throughout projects that are carried out in Alaska Villages is becoming more and more recognized (Joint Federal-State Commission on Policy and Programs Affecting Alaska Natives 1994; OTA 1994; US Congress 1994; Ashton 1996; Olofsson 1996). As noted by the Alaska Natives Commission, “Community members are more invested in the success of a project having been part of it from the start, and community participation in research and project development also can contribute to more fundamental cultural and social renewal in villages.” (ANC 1994; Berardi 1998). Further comments about participatory approaches and carrying out PRA in Alaska Native Villages are as follows:

- “PRA can produce better community support for ongoing program or project implementation, and, therefore, better project success” (Berardi 1998, p.4).
- “PRA encourages villagers to present and analyze what they know, which amplifies the sharing of information” (Gigi Berardi 1999, p.9).
- As noted by the Alaska Federation of Natives, “Such collaborative research behavior is appropriate for villages in Alaska, and further, it (PRA) provides the opportunity for a deeper understanding of rural problems and solutions. It uncovers information quickly, and encourages villagers to present and analyze what they know” (AFN 1989, p.59).
- “A participatory approach may be especially important in cultures that have an oral tradition, such as the Athabaskan, Inuit, and Yup’ik cultures in most of Village Alaska because it accommodates a way of communicating that allows researchers and community members to recognize the cultural lenses through which both groups filter information and possibly misinterpret terms or unintentionally trivialize topics” (Berardi 1998, p.4).

There have been several documented cases of participatory research projects carried out in Alaska. Three of them are described here. One of the earliest participatory projects in Alaska was carried out by Nancy Yaw Davis in 1976 and 1978, and involved participation of local individuals in developing study questions and being involved in the information gathering process.

Gigi Berardi wrote the following about Davis's study: "The design of Davis's study allowed individuals to participate in a variety of ways, including completing either long or short form surveys or giving open-ended written responses, which illustrates a flexibility in research methods designed to accommodate villagers' preferences and concerns. Davis carefully formulated research questions with community input to try to ensure that the information collected during the relatively few days she was in the village would answer the research questions" (Berardi 1998, p.3). Davis found from the study that "it is possible to collect meaningful and reliable information in the Alaska village setting in a brief period of time if the information collection process is collaborative" (Davis 1976; Berardi 1998, p.3).

Another project that used a participatory approach in Alaska was the ANHB Rural Sanitation Facilities O&M Project, which was carried out with several Alaska communities over several years in the late 1990's. The purpose of the project was to "identify ways to better assist rural communities in meeting their sewer and water system management, operation and maintenance needs" (ANHB 2000, p.4). The approach to the project encouraged villages to identify their own solutions to management, operation and maintenance needs and acknowledged that people in the village know best what it takes to get things done where they live. The evaluation of the project drew on multiple sources of information including project documents, field notes from frequent village visits, phone logs from regular phone contact, closeout interviews with community administrators, overall evaluation interviews with community administrators, community self evaluation questionnaires and interviews, and pre- and post-project mentor interviews. Final close out interviews were conducted over the telephone and were recorded and transcribed. The interviews took the place of a final written project report and were "rich in detail and consistent with the oral tradition of the people participating in the O&M projects" (ANHB 2000, p. 6). Observations, findings and results of the project, as direct quotes, are listed as follows:

- "Visits to the villages and frequent telephone contact helped to establish rapport and trust between the villages and ANHB.
- The participatory process of villages identifying needs and solutions increased community understanding of the causes that lead to particular sanitation problems.
- A village-identified starting point is more likely to lead to a sustainable outcome.
- Sustainability is enhanced by doing projects with a village, rather than for or to them.

- Socioeconomic and sociocultural factors influence how the sanitation facilities are ultimately used, managed, operated and maintained.
- Working with villages using an approach (participatory) provides more opportunity to further build self-governance and local leadership and contributes to the likelihood of sustainable outcomes.
- Mailed forms, such as the O&M project application, were not the best survey instrument for requesting information from villages. The ANHB visits to project villages elicited a clearer identification of need and expression of solutions from the villages.
- The commitment to truly empower requires individual and institutions to work with rural communities in a way that demonstrates trust, flexibility, patience, and deference" (ANHB 2000).

Based on the results of the project, it was noted that "the current shift to incorporate participatory process into the provision of a broad range of services in rural Alaska also represents an important shift to 'healthier and more sustainable' communities" (ANHB 2000, p.3).

Another participatory project was carried out in 1999 by Gigi Berardi and Shannon Donnelly to study the usefulness of PRA for sanitation research projects in Village Alaska. The findings of the study confirmed that "flexible and personalized research approaches can reveal a body of local knowledge that exists regarding how best to address and evaluate sanitation issues" (Berardi and Donnelly 1999, p.1). Features of participatory research that were identified to be relevant to Village Alaska sanitation research as found by this study included:

- facilitating group interviews;
- carrying out walking and driving (car, truck, and snow machine) transects;
- looking at community and individual household sanitation and other facilities, and observing operation of sanitation systems;
- using triangulation of information; and,
- reviewing secondary sources (master plans, reports, maps, and other historical records).

The main research techniques that were used for the study were "numerous informal conversations with village residents and representatives of various groups" (Berardi and Donnelly 1999). Interviews also were completed with City and Native Village staff, with representatives of state agencies, and with a sanitation consulting firm active in the village. Further findings, results, and methods of the study, listed as direct quotes are given as follows:

- "Keeping a flexible schedule was noted to be essential during the field visit.

- Interviews were conducted and discussions were facilitated with no preset agenda in mind, allowing for wide-ranging conversations.
- When villagers were interested in information we had or could find, it was provided.
- Individuals answered questions during their work routines (operating a water plant, working at a construction site, teaching, managing a project), which itself provided considerable information on daily activities and concerns, without placing a demand on their free time.
- The material collected from interviews augmented survey-generated information focused on technical aspects of sanitation and operator training, and provided a richer narrative.
- Having information from a variety of sources and participatory collection methods generated a richer picture of what was happening, a hologram, perhaps, rather than a simpler two-dimensional picture.
- Establishing contacts early in the project ensured that a network of support was in place prior to the field visit to the village. This was critical to the successful and timely completion of the field visit.
- Other methods used in gaining information included reviewing city, agency, and school district documents, pertinent regional newspaper articles, and posted materials.
- Participation in opportunistic activities such as a walking tour of the town with a community member led to unanticipated learning about aspects of village sanitation.
- The narrative responses were compiled from diverse sources to develop a meaningful composite" (Berardi and Donnelly 1999).

## *1.5 Overview of Demonstration Project Community and Their Sanitation Situation*

The Native Village of Raven (Raven) was the self-identified community in which the project was carried out in. Raven residents had been looking for an alternative to using honeybuckets and specifically wanted to test compost toilets in their community. For a description of how the project was initiated, see sections 2.1 and 2.2 of this document.

### 1.5.1 Community Background

Much of the community background information in this section is from the Alaska Commerce, Community, and Economic Development database (ADCCED 2007).

**<u>Location and Climate</u>**

Raven is located in western Alaska on the Yukon-Kuskokwim Delta. The 2006 population was 460. The community area encompasses 5.7 sq. miles of land and 0.8 sq. miles of water. The developed portion of the community is generally flat, but nearby plateaus and knolls rise as high as 35 feet above surrounding lakes. The area is underlain by continuous permafrost and in upland areas, the vegetation is characteristic of arctic tundra. Moss and lichen mats superimposed with other plant species create an insulating mat that protects the permanently frozen ground. The mat also acts as a sponge holding many times its dry weight in water. Minor changes in exposure, drainage, or disturbance easily alter the species composition in this area. Vegetation surrounding lakes and ponds is somewhat marshy (Zender 2002; ADCCED 2007). Raven has a marine or maritime climate which has an ameliorating affect on temperature and precipitation. Precipitation averages 22 inches, with 43 inches of snowfall annually. Summer temperatures range from 41 to 57 degrees Fahrenheit and winter temperatures range from 6 to 24 degrees Fahrenheit  (ADCCED 2007).

Figure 7: Photo of Raven in the summertime

## History, Culture and Demographics

The area of Raven has historically been occupied by Yup'ik Eskimos (Fienup-Riordan 2000). In the early 1950s, Alexie Amagiqchik founded a small general store at the site. He had moved from a village on the Bering Sea to the new location one mile inland to escape potential floodwaters. Others from the original village followed and settled in Raven. The City was incorporated in 1974.  A federally-recognized tribe is located in the community – the Village of Raven; Raven Traditional Elder's Council (not recognized). The population of the community consists of 98% Alaska Native or part Native.  A traditional Yup'ik Eskimo community, Raven residents practice a subsistence lifestyle with some commercial fishing (ADCCED 2007). During the 2000 U.S. Census, total housing units numbered 82, and vacant housing units numbered seven.  Note that 2005 census data are not available for Raven.  These same U.S. Census data for 2000 indicated 118 residents as employed. The unemployment rate at that time was 11.94 percent, although 41.58 percent of all adults were not in the work force. The median household income was $35,556, per capita income was $8,474, and 25.07 percent of residents were living below the poverty level (ADCCED 2007).

Figure 8: Photo of Raven in the summertime

**Economy and Transportation**

Other than government positions, most employment in Raven is seasonal, supplemented by subsistence activities. Twenty-seven residents hold commercial fishing permits for herring roe and salmon fisheries. Coastal Villages Seafood, Inc., processes halibut and salmon in Raven and trapping is also a source of income (ADCCED 2007).

Figure 9: Photo of Raven in the wintertime

A State-owned 2,500’ long by 35’ wide gravel airstrip provides chartered and private air access year-round, and a seaplane base is available. A new airport is currently under development. Although there are no docking facilities at this time, a number of fishing boats and skiffs are used for local travel. Snowmobiles are relied on during the winter, and trails are marked to Kipnuk (20 mi.) and Kasigluk (83 mi.) (ADCCED 2007).

During the non-winter months, the community is connected by a wooden boardwalk system. For years the majority of the boardwalk has been in a degraded state due to rot and heavy ATV traffic (Zender 2002). Recently however, approximately 80-85% of the boardwalk was replaced with new material in various areas around the community, through a state-funded project. Fifteen to twenty percent of the boardwalk remains in a degraded condition, most notably, the boardwalk that accesses the honeybucket disposal site and the dumpsite.

**Facilities, Utilities, Schools and Health Care**

Electricity is provided by Naterkaq Light Plant. There is one school located in the community, attended by 147 students. The Raven Health Clinic is a Primary Health Care facility. Raven is classified as an isolated village, it is found in EMS Region 7A in the Yukon/Kuskokwim Region. Emergency Services have floatplane and air access and are provided by a health aide (ADCCED 2007).

### 1.5.2 Overview of Sanitation Facilities

Facilities for water, wastewater and solid waste are described in this section.

**Water**

A well and water treatment plant were built in 1983 and are owned by the Traditional Council. The water treatment plant connects to fourteen watering points around the community through an above ground insulated duct. To use the watering points, a 25 cents token (sold at the main store in town) is inserted which returns five gallons of water. The majority of Raven residents collect rainwater in barrels (via a string drip system from roofs) or collect riverwater or pond ice for drinking, cooking, and bathing, despite the local water treatment plant, and its public watering points from which residents can haul from. Many residents do not like the taste of the water (too brackish as well as chlorinated) from the public watering points (Zender 2002). The only “in-house plumbing” systems that exist in Raven are in the twelve households (two of which are teacher households) and two businesses that have the flush-haul systems installed. The flush-haul system (also called closed-haul or small-vehicle haul system) includes a 100-gallon plastic water tank in the home. People can choose to pay $10 (each time) for an operator from the Utility Office to fill their tank using water from the watering point. The flush-haul water tanks are hooked up to a low flush toilet, and a bathroom and kitchen sink. Some households with the flush-haul system choose to fill the water tanks themselves with water from the watering points or from traditional sources. The school is the only entity in Raven that is fully plumbed and receives piped water from the circulating mains that supply the watering points. The school has one shower that is available for school staff to use and six showers available for students to use. The majority of Raven residents use steamhouses for bathing.

Figure 10: Public water dispensing location in Raven

Figure 11: Household rain catchment system

The Alaska Village Safe Water (VSW) Program has been working with Raven over the past several years to find a better solution for their water source. In the 1990's twelve wells were drilled to depths of 115 to 140 ft in the area of the Bureau of Indian Affairs school complex along the riverbank (CE2 Engineers 2000). All of the wells delivered water high in TDS (375-400 mg/l) and sodium (140 mg/l) and the sustainable production rate from each was low (less than 8gpm) (DNR 1995). It was determined that the Bureau of Indian Affairs (BIA) school well field would not produce enough water to supply a piped utility system (CE2 Engineers 2000). However, one observation from the tests showed that as the pumping rate decreased, the TDS levels equally decreased (i.e. as pumping rates halved, the TDS levels also halved) which indicate that the aquifer is continuously recharging (Burleigh 2007). One possibility for an alternative system to a full piped system may be to tap several wells at a lower production rate for better quality water (Burleigh 2007). In 2006, VSW drilled wells at the end of the new part of town to test the water quality and production rate, but the results were not yet available (Burleigh 2007). Once VSW has the results, they will produce a report with the recommended water system design and costs, based on results from all tests, and present it to Raven.

## Wastewater

Overview and History

Out of the 82 households in Raven, 72 households use honeybuckets for human waste disposal. Electric incinerator toilets ("Incinolets") are used in one or two of the teacher housing units. The Alaska Village Safe Water (VSW) Program has been working with Raven over the past several years to try to improve their sanitation facilities. In 1996, VSW developed a Sanitation Facilities Study for Raven to review options of a full, piped water and sewer system, and an alternative flush-haul (closed-tank and haul) system. The piped system proposed would involve installing above-ground water and vacuum sewer lines (due to Raven's geology and terrain) which would lead to a disposal lagoon. A flush-haul system would involve

Figure 12: Full honeybuckets lined up waiting for collection

installation of a 100-250 gallon plastic tank for potable water inside the homes and a 150-500 gallon insulated tank outside the homes for wastewater. Water from the tank inside the homes would be pressurized and piped to a low-flush toilet and a bathroom and kitchen sink. Black and gray water would flow to the outside tank where it would be pumped out by a small vacuum tanker, pulled by an ATV or snowmobile, and taken to a disposal area. The in-home water tank would be filled, when needed, by a potable water tanker pulled by an ATV or snowmobile. Note: for a full explanation and description of a flush-haul system, see section 1.24.

Figure 13: Flush-haul wastewater tank outside a home

Based on the VSW study, Raven chose to explore the flush-haul system over piped water and sewer "because of its simplicity, and the problem of finding enough water of suitable quality to supply a piped system" (CE2 Engineers 2000, p.5). From 1997 to 1999, CE2 Engineers, Inc. designed and constructed the first phase of the flush-haul system which included 12 household and 2 business installations. After the flush-haul systems were operating for a year, "some residents of the Community felt it was time to reexamine the decision to install the flush tank and haul system (throughout the community) in light of its relatively high operating cost and the higher level of service offered by piped utilities" (CE2 Engineers 2000, p.1). Raven requested CE2 to develop a new report which comprehensively compared the piped water/sewer system to the flush-haul system (including technical and financial feasibility) based on the results of operating the 14 flush-haul units for one year. The report was completed in 2000. Results of the report showed that the capital costs required for the flush haul system would be almost $13 million and the average monthly O&M cost per households would be $171. For a piped system, the capital costs required would be almost $15 million and the average monthly O&M cost per households would be $216.

Since the report was written, VSW has been running tests on potential water sources as described in the water section previously. Results of these tests will determine if a piped system is even possible for Raven. Also since the report was written, at least two households have either stopped using or have taken out their flush-haul systems because of problems with the systems or the associated high costs to operate them. Based on resident feedback from site visits and Council meetings, the community has mixed feelings about the flush-haul system and many people feel that the monthly costs of both the piped and flush-haul systems are too high for the majority of households to afford.

Once VSW has the latest water test results, they will produce a report with the recommended water/sanitation system design and costs, based on results from all tests and prior reports, and present it to Raven for review. If a piped system is not possible due to low water production, VSW may suggest the option of continued use of watering points for potable water, constructing a washeteria that would have laundry facilities and one or two showers available for public use, and the installation of flush-haul systems or continued use of honeybuckets for wastewater (Burleigh 2007). Even if the piped system is feasible however, it would likely take at least 5-6 years before funding is secured and construction starts (Burleigh 2007). And even if Raven wants to go with the flush-haul system for all households, it would similarly be several years away before funding is secured and construction starts (Burleigh 2007).

<u>Collection and Disposal</u>

Figure 14: Vacuum tanker used for removing wastewater from flush-haul

The City Utility Office in Raven currently operates a honeybucket waste and flush-haul collection program. Most of the flush-haul households regularly subscribe to the collection service and pay $30 each time to empty their outside wastewater tank, and $10 each time to fill their water tank. (Note that these are costs for operator service only and don't include other costs that the household pays for the system such as electricity, parts replacement, etc.) The number of times each household requests hauling or filling varies each month. The wastewater tank is emptied by the Utility employed operator with a small vacuum tanker which is pulled by an ATV or snowmobile, and then taken to a disposal area for emptying. The in-home water tank can be filled by the operator, when needed, by a potable water tanker (100 gallons) pulled by an ATV or snowmobile.

Problems are often reported with the collection/disposal service for the flush-haul system. In the winter-time, there are often issues with the operator being able to access the outside tanks with the vacuum tanker due to heavy snow and snow drifts, and also problems with the equipment freezing and not working for a period of time. In the spring-time, the operator and backup operators are often away from town on subsistence and thus it can be weeks before there is someone available to fill/haul the tanks. There can also be access issues in the spring during breakup due to the muddy/wet ground. There are also frequent problems reported with the tanker equipment breaking down throughout the year. There is no "backup" equipment, so it can take weeks to order parts and get the equipment fixed. If a household's wastewater tank is full, and there is no operator or equipment to empty it, the household will usually start using a honeybucket until the tank can be emptied. There are often complaints of "bad odor" in the house from the tank when it's full. With several of the older version flush-haul systems in Raven, if the tank is full and the toilet continues to be used, wastewater will leak out of an "overflow" valve at the top of the outside tank onto the ground (Raven 2006).

Figure 15: A resident dumping honeybuckets at the lagoon

Figure 16: Raven honeybucket lagoon with mixed trash piled up

Several households pay for the honeybucket collection service each month. The number of households subscribing to the service varies each month as some households intermittently drop their service, while others might sign on. The cost for the service is $35/month. Honeybucket wastes are picked up by the Utility operator and dumped into a honeybucket hopper on wheels attached to an ATV. The hopper is then taken to the disposal site and emptied out.

The remaining households (around 60) self-haul their waste to the honeybucket lagoon by hand, ATV, or snowmobile. Sometimes honeybucket waste is discarded in the Kinia River or elsewhere, although this practice is not authorized. This practice is most likely carried out by households who do not own operating ATV's or snowmobiles to carry the buckets to the dumpsite. Other households may resort to this practice when the weather is particularly extreme.

Honeybucket Lagoon

The honeybucket disposal lagoon is an old tundra pond located about 1000 feet southwest of the community, adjacent to the solid waste disposal site. A 12 ft wide boardwalk path leads from the airstrip to the honeybucket lagoon dumping area and the boardwalk is in a dilapidated state. The lagoon is brimming with bagged honeybucket wastes and is substantially under-sized to effectively treat the human wastes that are dumped there. The drop-off area is often soaked from honeybucket bag leakage and breakage and users are at serious risk of falling into the lagoon, because there is no railing and the drop-off dock is slippery. In late 2005, the lagoon was measured to be approximately 615 ft in perimeter and 21,000 sq ft in area, and has been growing ever since. Drainage from the lagoon goes directly to the Kinia River where people carry out their subsistence. With plastic honeybucket bags covering an increasing area in and around the lagoon, more and more residents have been discarding mixed solid wastes at the lagoon, treating it like another dumpsite. These solid wastes, including household hazardous wastes, add additional heavy metals and other contaminants to the lagoon flow. The community is very concerned about risk of contamination to the water and food supply (local fish and wildlife) that the honeybucket lagoon poses and they want to dike it off and close it down.

Figure 17: Honeybucket bunker being emptied into the lagoon

Figure 18: Another angle of the overflowing honeybucket lagoon and dilapidated boardwalk

In July 2000, as part of a solid waste project through the Central Council Tlingit and Haida Indian Tribes of Alaska, surface water samples were collected near the dumpsite and honeybucket lagoon to determine the impacts of runoff on surface water quality. Results for fecal coliform demonstrated that near the honeybucket lagoon (Site A listed in the table below), fecal coliforms were extremely high (too numerous to count) (Zender 2002). Samples collected further away from the lagoon (Site B) had lower numbers of fecal coliforms, and samples collected near the outlet of the creek (Site C – where it drains into the river) had no fecal coliforms (Zender 2002). Results are shown in Table 1.521. As noted in the final report, “this situation strongly suggests that the wetland area (located between the honeybucket lagoon and the creek drainage area) is helping to remove the bacteria as the lagoon runoff passes through the wetland” (Zender 2002, p.8). However the report also states that “sampling during the assessment was limited, and not carried out during a period of high water flow, when contamination is expected to be at its maximum” and further recommends to “test for bacteria (fecal coliform or *E. coli*) levels at the outlet of the dumpsite creek during both high and low flow conditions, and during tide rise and fall” (Zender 2002, p.8). The report also advised that since fecal coliform levels were so high at Site A, “residents should not wade in the creek, fish from it, or gather berries that grow in and around it” (Zender 2002, p.8).

**Table 1.7 Surface water sampling results for fecal coliform (FC) concentration**

| What was tested for | Test Method | Units | MCL* | Site A | Site B | Site C | Site D | Site E | Site F |
|---|---|---|---|---|---|---|---|---|---|
| Fecal Coliform | Microbial assay | FC/ 100ml | 10 | >10,000 | 1,100 | 70 | -- | -- | 8 |

(Zender 2002) * Maximum Contaminant Level (drinking water sources should not exceed this amount).

The school operates its own separate wastewater treatment and disposal system. There are approximately 14 flush toilets throughout the school. Wastewater from the school is piped to an unfenced single cell treatment lagoon (totally separate from the honeybucket lagoon) approximately 800 ft west of the school.

Figure 19: Wastewater piping from the school to the separate school lagoon


Figure 20: Aerial view of the Raven honeybucket lagoon and solid waste site, and distance to the community (Zender 2002)


Figure 21: Another aerial view of the Raven honeybucket lagoon and solid waste site from a different perspective (town in the background). (Zender 2002)

## Solid Waste

Figure 22: Raven solid waste site

The disposal area for solid waste in Raven is southwest of the community, approximately 1500 feet from the north side of town and 800 feet from the south side of town, and sits less than 100 feet away from the honeybucket lagoon. The site is unlined and unfenced with trash spreading over a 1 acre area.  A few households pay for trash collection service but the majority of residents self-haul to the site.  A wooden boardwalk continues from the honeybucket lagoon to the edge of dumpsite but accessing the majority of the site requires stepping over trash. Occasionally, honeybucket wastes are dumped at the site alongside other trash, causing people to walk over spilled raw sewage. In 2005, a burn unit was purchased and set up at the dumpsite for burning trash. Operation of the site has been off and on over the years but recently a cleanup of the dumpsite was carried out where trash was consolidated and buried where possible, and a portion of the remaining trash was burned in the burnbox. Trash continues to pile up around the burnbox where self-haulers drop off, and an operator burns bags of trash in the burnbox on a weekly or monthly basis to keep the pile down.

# 2.0 METHODS AND MATERIALS FOR THE COMMUNITY DEMONSTRATION PROJECT

## *2.1 How the Community Demonstration Project Started*

The Native Village of Raven (Raven) was the self-identified community where the project was carried out. The majority of residents in Raven (over 85%) use honeybuckets for human waste disposal. The Raven environmental staff and the community store owner were seeking alternatives to honeybuckets and specifically wanted to test compost toilets in their community. Assistance was requested to find funding to test several compost toilets in the community. The Central Council of Tlingit and Haida Indian Tribes of Alaska, though an EPA Indian General Assistance Program grant, funded the equipment, supplies, author's travel (partially), local personnel, and a portion of the author's field and research time through Zender Environmental, which applied for the grant, and where the author is employed as a researcher. The project commenced in Spring 2006.

## *2.2 How the Project Was Carried Out*

Before the project started, the Alaska Federation of Natives "Guidelines for Research" was reviewed as a standard protocol for scientists and outsiders conducting research among Alaska Natives (AFN 1996). Several trips had been taken to Raven prior to the project starting and relationships had been built with Raven Environmental staff, Council members, and various residents over several years. During the visits, Raven's sanitation system was observed first-hand and updates were given by the environmental staff. A participatory approach was taken throughout the project based in part on methodology such as Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) which is further described in sections 1.4 and 3.9. Community involvement and an educational component were key aspects of the project.

### 2.2.1 Selection of the Compost Toilet

Meetings took place by phone and in person at the beginning of the project to discuss compost toilet technology and the layout of the project. The different types and brands of compost toilets were initially discussed with the environmental staff, Corporation store owner, and some members of the Traditional Council. Manufactured compost toilets (as opposed to site-built) were desired to be tested for this project. Since most of the houses in Raven are built on small pilings and the space beneath the houses is not insulated, it was decided that the best type of compost toilets to test would be the self-contained “all-in-one” units where the whole toilet fits in the bathroom, as opposed to the centralized remote units where the main waste chamber is located below the bathroom, underneath the house. (See photos to the right of typical houses in Raven). Since homes in Raven are fully heated in the winter (including the bathroom area), the self-contained units would be able to take advantage of the heat for more efficient operation. The remote unit toilets, on the other hand, would require building a fully insulated box outside with some sort of heat source, and for the majority of houses, the remote unit may not fit directly underneath the bathroom because the space is too small. After going through the various brands of self-contained compost toilets, the decision was narrowed down to the largest capacity toilets from the companies Sun-Mar, BioLet, and Envirolet. The Envirolet MS-10 model was chosen because it had the greatest capacity (up to 18-20 uses per day) compared to the other models/brands, it did not require sitting or leaning on the toilet seat for the toilet to “open”, it allowed for flexibility in the type of carbon source added, and it had a more normal toilet seat height that didn't require a “step-up” to sit down. See Appendices B and C for a comparison table of capacity and electricity usage between Envirolet, BioLet, and Sun-Mar models, as well as a full comparison table of operational and other differences between the brands (both tables were produced for the project). Also see Appendix D for the installation and operation instructions for the Envriolet Self-Contained System.

Figure 23: Typical housing structures in Raven

Figure 24: Typical housing structures in Raven

### 2.2.2 Hiring the Local Operator

Funding for the project covered the purchase of five toilets and supplies, technical assistance for the duration of the project (one year), travel costs to Raven, and most importantly, a part-time one-year position for a local village operator to monitor and maintain the toilets and assist with the community education aspect of the project. Aside from the selection of the type of compost toilet to test the hiring of a local operator was one of the first major tasks of the project. A job flyer was developed and posted throughout the community and interested parties applied for the position to the Raven Environmental Department. Interviews were held in May, 2006 with two applicants that had prior sanitation experience, and one was selected. Results of the interview are in Appendix E. The operator position started in mid-June 2006 and the overall goals and tasks of the position were to conduct operation and maintenance on the toilets, carry out daily and weekly inspections, report problems and assist with troubleshooting, distribute educational materials about the toilets and project, give talks to the community about the project, and answer any questions from the community about the toilets and project. Yup'ik and English fluency were requirements for the job.

### 2.2.3 Toilet Installation Schedule

The owner of the main store in Raven expressed specific interest in testing a compost toilet in the bathroom of his store, so it was decided to install the first toilet at the store and test its operation for a period of time as the first phase before household toilets were installed. Installation in a public environment would also allow community members to try the toilet out and learn more about how they work. The main store is heavily trafficked by the majority of residents in Raven because it is the chief place in town to purchase hardware goods, supplies, clothes, and food items, and is open seven days a week (a smaller store exists, but is not open all the time and only stocks a small amount of food and beverages). So installing the first toilet in the store would receive a great deal of exposure in the community and give the operator an opportunity to educate people about the project and how the toilets worked.

It was decided that it would also be beneficial to fine tune the operations of the store toilet through monitoring and experimentation before the remaining toilets were installed in households.

Maintaining and monitoring the store toilet would give the operator a great deal of experience with how the toilets work and the best way to operate them so the household toilets could be operated in the most efficient way, given Raven's specific environment and conditions. The store toilet was set to be installed in June, 2006 and the household toilets installed a month or more later, and all installed before winter weather arrived.

### 2.2.4 Development of Project Materials

Reporting forms and inspection sheets were developed for the project for maintenance recordkeeping and potential troubleshooting for the operator and users. Instruction guides were also developed for the operator and users to complement the hands-on training for general toilet operation and maintenance information. The reporting forms and instruction guides developed are described in detail in the next section. All of the forms and instructions were complied into a binder with marked tabs and a table of contents for the operator to reference throughout the project.

### 2.2.5 Socio-Cultural Assessment

User perspectives and opinions about the compost toilets which were gathered throughout the project used participatory methods based in part on Participatory Rural Appraisal and Rapid Rural Assessment. Lessons learned from prior participatory based Alaska sanitation projects were also taken into consideration. Tools such as feedback forms and semi-structured interviews were used. An overview of the methodology is described in section 1.4 and the application and results are given in section 3.9.

## *2.3 Reporting Forms*

The various reporting forms and inspection sheets developed for the project for operator and user based reporting are described in this section by form/sheet.

### 2.3.1 Daily Inspection Sheets

Daily inspection sheets were filled out by the operator for all the toilets at the beginning of each install, and then switched to a schedule of filling them out on Monday's, Wednesday's, and Friday's. Separate sheets were designed for the store and household toilets and both were adjusted a few times during the project to incorporate any operational changes to the toilets.

Table 2.311 shows the questions asked in the inspection forms and the reasons for asking them.

See Appendix F for the actual inspection sheets used.

**Table 2.1 Description of daily inspection sheets**

| **Question asked on daily inspection form** | **Reason for collecting the information** |
|---|---|
| How many times was the toilet used today? | Noted by the operator from the door "use" checklist or the remote sensing device. This number can be used to determine the amount of peat moss to add for the day and also stands as a record for future troubleshooting. |
| How much peat moss and cocoa shell was added today? | Reporting this amount provides a check that the operator has added the correct amount of peat moss and also stands as a record for future troubleshooting. |
| Is there any odor in the bathroom? | Reporting this provides a secondary check to the user-reported odor sheets. |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Reporting this can help determine odor issues (if the toilet bowl is left open, there could be odor) |
| Was the "number of uses" sheet taken down today and replaced with a blank one? | This is a reminder for the operator. |
| Record "watts", "kilowatt-hours", and "hours" readings from power meter (to do this, press the "mode" button on the *Watt's Up* power meter. | This is for the power meter further described in section 2.61 which records electricity use of the toilet. Reporting these numbers provides a secondary check and backup to the meter readings which were downloaded every month or so in the beginning of the project. |
| Do you see anything in the toilet besides human waste and peat moss? (such as garbage, toys, etc.) | Reporting this can help potential troubleshooting (if there is a problem with the toilet, and something was put in the toilet that wasn't supposed to be there, it could be the source of the problem). |
| Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? | This provides a daily check for the operator to ensure the right amount of peat moss is being added. |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | This question was added partway into the project since there were some issues with leakage of the excess liquid line. If leakage occurs, it's important that it's fixed right away or there could be odor issues. |
| Is the wind turbine on the roof moving or is it blocked? | The wind turbine helps draw air out of the toilet and vents outside. Ensuring that the wind turbine is moving and not blocked helps prevent odors, so this question could be used for troubleshooting for odor issues. This question was more important in the winter months when ice and snow can build up on the roof near the turbine. |

| | |
|---|---|
| Are there any flies in the toilet? | Although flies weren't expected with this type of toilet, this question was included in case any were noticed. |
| If the urine container has liquid in it, note how much and empty if it is full. | Reporting the amount of urine in the excess liquid container can help determine if the right amount of peat moss was being added or if the toilet was being overused. (If the container was filling up often, it could be a sign of overuse and/or not enough peat moss being added). |
| Empty can of used toilet paper if full. | This is a reminder for the operator. |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge. | This is a reminder for the operator. |
| If there were any problems with the toilet today, note them here: | Space was given for the operator to report any other issues or problems with the toilet, outside of the previous questions asked. A record of any problems by date can help with potential troubleshooting. |

### 2.3.2 Weekly inspection sheets

Weekly inspection sheets were filled out by the operator for the store toilet only for the first few weeks of the project. This inspection sheet was mostly used as a reminder task list for the operator in the beginning of the project and after awhile wasn't needed as the operator became familiar with the tasks. Table 2.321 shows the questions asked in the inspection form and the reasons for asking them. See Appendix F for the actual inspection sheet used.

**Table 2.2 Description of weekly inspection sheets**

| Question asked on weekly inspection form | Reason for collecting the information |
|---|---|
| Replace weekly "odor sheets" with blank ones in the bathroom. Fax each week. | This is a reminder for the operator. |
| Fax daily inspection and maintenance sheets from last week. | This is a reminder for the operator. |
| Fax "number of uses" sheets from the last week. | This is a reminder for the operator. |
| Fill the 'Warm Water Cup" provided to the 500 ml line with warm (but not hot) water. Sprinkle the warm water around the edges of the waste pile (but not in the middle of the toilet). Note that it was done on the calendar form. | This was carried out in the beginning of the project to avoid the waste mass in the toilet drying out around the outlets of the aerator and rake bars, to reduce any difficulty of moving the bars during operation and cleaning. (This was found to be a problem by other Envirolet compost toilet owners (nation-wide) contacted in the research phase). |

### 2.3.3 Odor Tracking Sheets (User Based Reporting)

The odor tracking sheets were posted in all the bathrooms with compost toilets, for users to mark either “smells okay” or “smells bad” on the day and time the toilet was used. This provided a record of any odors for potential troubleshooting. See Appendix F to view a blank odor tracking sheet. Note that the odor tracking sheets were based on the design of odor detection forms developed for CIER’s Northern Canadian First Nation In-Building Compost Technology project (CIER 2001).

### 2.3.4 Toilet Use Tracking Sheets (User Based Reporting)

The toilet use tracking sheets were used both to track the number of daily uses of the toilets and to ensure the toilets weren’t overused when the toilets were first put into operation. The suggested maximum daily use of the Envirolet MS10 models is 18-22 uses, so the toilet use tracking sheets had 18 check boxes for people to check each time the toilet was used. Instructions were included at the top of the page explaining that once the 18 boxes were checked, the toilet shouldn’t be used for the rest of the day, and a honeybucket should be brought in for the remainder of the day. This was also explained to the store staff and all household members. It was important to operate the toilets under the suggested maximum use, so in terms of troubleshooting, if there were any other issues with the toilets, you could assume that overuse wasn’t the problem. It was also important to track the number of times the toilet was used so the operator knew how much peat moss to add and to also get a feel of the average daily use for each of the toilet installations. The tracking sheets used for the households had slightly different wording from the one used for the store. All were posted on the doors of the bathrooms with a pen attached for ease of marking by the users. See Appendix F for blank tracking sheets used.

### 2.3.5 Calendar Maintenance Reporting Sheets

Monthly calendar reporting sheets were designed for the operator to note when maintenance activities were carried out on a daily and weekly basis. The maintenance activities were letter coded for ease of use (P= Peat moss/cocoa shells added, A=Aerator bar moved back and forth, M=Microbe accelerator added, W=Warm Water added around the edges of the waste pile, E=Emptied compost from bottom of the toilet). The monthly layout made it easier to check if maintenance was being carried out when it should. See Appendix F for a blank calendar reporting sheet.

## *2.4 Instruction Guides*

The various instruction guides, forms, and educational signage developed for the project for the operator and store/household users are described in this section.

### 2.4.1 Maintenance Checklist

A maintenance checklist was developed for the operator to follow as a simple summary to complement the inspection sheets, and as an extra reference to ensure the tasks were carried out when they should be. A blank checklist can be viewed in Appendix F. A separate but similar maintenance checklist was developed for the households later in the project and can also be viewed in Appendix F.

### 2.4.2 Form for Emptying/Cleaning the Toilet

A form was developed for the operator to follow and fill out when each of the toilets was emptied, so a record could be kept of the dates and what the compost was like. The forms included step-by-step instructions of how to empty the toilet, including the manufacturer's detailed instructions of how remove and reattach the bottom panel, and also included some questions to gauge the amount and quality of compost produced and to record information for potential troubleshooting. Photos were also requested to be taken, where possible by the operator, of the compost in the tray for a visual record. It was noted in the maintenance checklist, that the operator and household users shouldn't empty the toilet until the waste in the toilet reached the aerator bar. Before the toilet was cleaned, it was also noted to let the toilet sit unused for at least 1-3 days before cleaning (a honeybucket can be used during this time), to allow for more liquid to evaporate or be absorbed by the peat moss, for more odors to be vented out of the toilet, and for more time for the compost process to take place. A slightly different form was used for the store toilet and the household toilets since the store toilet was

Figure 25:Photo showing bottom panel and tray removal for emptying the compost

used as a reference for compost comparison. Table 2.421 shows the questions asked in the form and the reasons for asking them. A blank form can be viewed in Appendix F.

**Table 2.3 Description of toilet emptying form**

| Question | Reason for collecting information |
|---|---|
| How full is the tray?<br>Over 100% 100% 75% 50% 25% Less than 25% | To note how much waste naturally fell down into the tray over time from the main chamber. |
| How does the material in the tray compare to the bag of **premix starter** (the bag of dirt) that comes with the toilet? Is it wetter, dryer, or about the same? Is it lighter or darker than the bag of dirt? | To get a relative idea of the color and moisture of the compost. |
| How does the material in the tray compare to the material emptied from the **store toilet**?<br>**Circle one:** More composted Less composted Can't tell<br>**Circle one:** Wetter Dryer About the same<br>**Circle one:** Lighter Darker | Since the store toilet was the most monitored and the toilet fully maintained by the operator, the compost produced from it was used as a comparison to the household toilets. |
| Is there liquid in the tray?<br>**Circle one:** A lot A little bit None | If there was a lot of liquid in the tray, it could be used as an indication that the toilet was being overused, or not enough peat moss being added. |
| Is there liquid outside of the tray on the bottom of the toilet?<br>**Circle one:** A lot A little bit None | If there was a lot of liquid outside the tray, it could be used again as an indication that the toilet was being overused, or not enough peat moss being added, or that there might be a leak in the tray which would need to be fixed. |
| How does the odor compare to when you emptied the store's toilet?<br>**Circle one:** Better Worse About the same<br>How would you describe the odor?<br>**Circle one:** Extremely strong Not too bad Barely noticeable | Odor is an indication of how well the waste composted – a strong odor would indicate that the waste wasn't composted enough and should be left for a longer period of time before the toilet is emptied. It could also mean that the toilet isn't being operated correctly. |
| Can you see anything but human waste and peat moss and cocoa shells in the material? (such as cigarette butts, toilet paper, objects etc.) | This was used as a double check to see if users were throwing things into the toilet that shouldn't be there. Foreign objects could disrupt the compost process, so this information could be used for troubleshooting if a problem arose with the toilets. |
| How many days was the toilet NOT in use before it was emptied? | The manufacturer recommends waiting 24 hours after the toilet was last used to empty it out. The |

| | |
|---|---|
| | longer the toilet is allowed to sit unused before emptying, the more time there is for liquid to evaporate or be absorbed by the peat moss, for odors to be vented out of the toilet, and for the compost process to take place. The operator was told to wait at least 1-3 days after the toilets last use before it was emptied, and to tape the toilet off with a "Don't Use" sign on it during that period.<br>This question on the form was used to see if there was a difference in the compost and odor if the toilet was unused for different periods of time, and also as a check to ensure that the toilet was unused for at least 24 hours before it was cleaned. |
| Once the rake bar has been pulled several times to drop the waste down into the tray note how full the tray is: (circle one)<br>Over 100% 100% 75% 50% 25% Less than 25% | To note how much more waste dropped down from the main chamber. |

### 2.4.3 Peat moss and Microbe Accelerator Instructions

Additional simple instructions were developed for the operator on how much peat moss and cocoa shell to add to the toilet, and how to add it. This was a tool for the operator to use, mostly in the beginning of the project when the store toilet was being tested, to ensure the proper amount was being added based on the number of times the toilet was being used each day (as determined by the "tracking uses" sheet and the remote sensing data). The idea was to add a set amount of material (as determined by the number of uses) and gauge how the toilet was operating based on that amount, and to then vary the amount to find the ideal operating circumstances. The amounts listed in the instructions are shown in Table 2.314.

**Table 2.4 Peat moss addition based on toilet use**

| Number of times the toilet was used | Amount of peat moss to add | Amount of cocoa shells to add |
|---|---|---|
| 16-20 | 1 cup | 1 cup |
| 11-15 | ¾ cup | ¾ cup |
| 6-10 | ½ cup | ½ cup |
| 1-5 | ¼ cup | ¼ cup |

Also listed for the operator were detailed instructions on the amount of microbe accelerator to add, and how and when to add it. The microbe accelerator is a product sold by Envirolet to help accelerate the composting process and is added to the toilets every other week. See Appendix F for the actual instruction page. The brand of peat moss used for this project was Black Gold (2.2

cu ft bags) and the Brand of cocoa shells used was Blommer (2.0 cu ft bags). Photos are shown below.


Figure 26: Photos of the type of peat moss and cocoa shells used for the project.

The purpose of adding peat moss to the toilets is to help absorb urine, provide porosity to improve aeration, and provide microorganisms an energy source for growth. In addition to peat moss, Envirolet suggests adding cocoa shells as a further bulking agent to create more air pockets in the waste mass, although it isn't mandatory for operation of the toilets. Cocoa shells were added by the operator to some of the toilets in the beginning of the project, but didn't continue when the users starting adding their own peat moss, in an effort to reduce the time and burden to the users (i.e. adding just the peat moss would take less time and be easier for people). Several users however did note that the cocoa shells provided a pleasant chocolaty smell.

### 2.4.4 Community Education Flyer

An important aspect of this project was the educational component. It was important to educate not only the users but the whole community about the project, about how compost toilets work, and about the compost process in general. A four page educational flyer was developed and copies were posted outside the bathroom where the store toilet was installed, and also distributed at community meetings. Other methods of community education were also carried out throughout the project and are described in section 2.7. The flyers included the following information and a copy of the flyer can be viewed in Appendix F.

- Overview of the compost toilet project
- Overview of the composting process
- How to operate the compost toilets

- How the toilets work
- How they are installed
- Contact information for people that have questions

### 2.4.5 Bathroom Signs for Using the Toilets

Simple instructions for using the toilets were posted on the bathroom walls by the toilets, in both Yup'ik and English, for all the installations, and can be viewed in Appendix F. Information about the instructions and their development are further described in section 2.63.

### 2.4.6 Instructions for the Households

After the store toilet was operated for a period of time, a simplified one-page operation and maintenance instruction guide was developed for the households based on operations of the store toilet. Step-by-step instructions for emptying the toilet, as well a four page educational overview about the project and composting in general, were also given to the households with toilets installed. The one page operation guide can be viewed in Appendix F.

## *2.5 Training the Operator*

Once the operator was hired and the reporting forms and instruction guides were developed, a trip was made to Raven to train the operator in-person on how the toilets work, how to install them, and how to carry out the monitoring and maintenance duties. Prior to the trip, the operator was given the report forms, instruction guides, and the Envirolet installation instructions to review and become familiar with. The operator was also given the community education flyer to review for cultural appropriateness. Once in Raven, the operator was shown all aspects of how the toilets worked using a new Envirolet compost toilet before it was installed (so the internal mechanical and electrical parts of the toilet could be viewed). The bottom panel was removed to show how the toilet should be emptied and the operator got to practice how to properly reattach the panel. Full installation of the first toilet was carried out together so the operator was trained to install future toilets. After the toilet was installed, hands-on training for exact operations was also carried out together for practice, and potential troubleshooting was reviewed. All of the reporting forms were also filled out together so each question was understood by the operator and the instruction guides were explained in detail. The reporting forms and instructions were all complied into a binder with marked tabs and a table of contents for the operator to reference and use throughout the project. The specific duties that the operator was taught to carry out on a regular basis included:

- Adding peat moss and cocoa shells to the store toilet
- Pulling the aerator bar and adding the microbe accelerator
- Filling out all inspection sheets
- Cleaning the toilets
- Troubleshooting any problems that come up
- Filling up household and store supplies of peat moss and cocoa shells
- Replenishing educational materials on display when needed
- Replenishing “Number of Uses” and “Odor” tracking sheets on the doors of the store and household bathrooms
- Ordering more peat moss when necessary
- Cleaning the bathrooms, emptying cans of used toilet paper, emptying excess liquid containers when necessary.
- Checking odor levels in the bathroom
- Reporting any problems with the toilets
- Carrying out operational “tests” with the toilets
- Answering questions from the community about the project and the toilets
- Making announcements on the community-wide CB system about the project and the toilet installations

Operator training continued throughout the first few months of the project over the phone and by email, and regular contact was kept (every few days, if not every day). Filled out reporting forms were sent on a daily/weekly basis, by the operator as requested.

## *2.6 Phase 1 – Compost Toilet Tested in a Public Building (Store)*

As previously mentioned, the owner of the main store in Raven expressed specific interest in testing a compost toilet in the bathroom of the store, so it was decided to install the first toilet at the store and test its operation for a period of time before the household toilets were installed.

Installation in a public environment would also allow community members to try out the toilet and learn more about how they work and give the operator an opportunity to educate people about the project. It was decided that it would also be beneficial to fine tune the operations of the store toilet through monitoring and experimentation before the remaining toilets were installed in households. Maintaining and monitoring the store toilet would give the operator a great deal of experience for how the toilets work and the best way to operate them so the household toilets could be operated in the most efficient way given Raven's specific environmental conditions.

### 2.6.1 Toilet Monitoring

To assist the monitoring effort and to help fine tune operations of the store toilet for Raven's environment, various sensors were installed in the store toilet which connected to a data logger and satellite system for real-time data collection on-line. A brief description of the data collection equipment used is listed in Table 2.611. Detailed information about how the equipment was used to collect data, and what the data were used for, follows Table 2.611 on the next few pages.

**Table 2.5 Data collection equipment used on the store toilet**

| Item | What it was used for |
|---|---|
| Microstation Logger | Central data logging equipment for four sensors |
| Hoboware software | Computer interface software to launch microstation logger, download data, and stop logger. |
| Spring tip limit switch | Used with the pulse input adapter to count the number of times the toilet handle was moved (used to measure number of daily uses) |
| Pulse Input Adapter Contact Closure Version | Sensor that plugged into the microstation to count the number of times the toilet handle was moved (used to measure number of daily uses) |
| Temperature sensor 12-bit with 6m cable (two) | Two sensors that plugged into the microstation to record the (air) temperature in the toilet and the temperature in the bathroom where the toilet was installed. |
| Soil Moisture sensor with 3m cable | Sensor that plugged into the microstation to record relative moisture of the waste mass |
| Stowaway tidbit temperature logger | Self-contained temperature logger used to record temperature in the toilet as backup to the temperature sensor. |
| Microstation adapter cable | To connect the microstation to the computer |
| Solar Stream Satellite | Data transmitting device with an antenna attached that connects to the microstation and sends data to a secure website for real time downloading |

The first Envirolet toilet was ordered and worked on in the UCD Engineering lab before it was sent to Raven. The sensors were installed and the logging/satellite systems were tested to ensure that everything was set-up correctly and worked as intended. Modifications were also made to the drain pipe before shipping the whole unit to Raven. Information about the types of data collected, equipment installed, and modifications made to the toilet follows on the next few pages.

**Measuring toilet use**

Since overuse is one of the most common problems with compost toilets, it was important to find a way to track the number of times the toilet was being used each day. To use the Envirolet MS-10 toilet, a handle is turned which moves a plastic disk over to the side which "opens" the toilet for use. See the photos below.

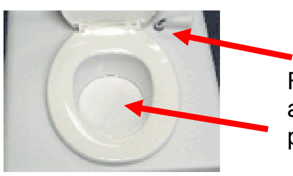


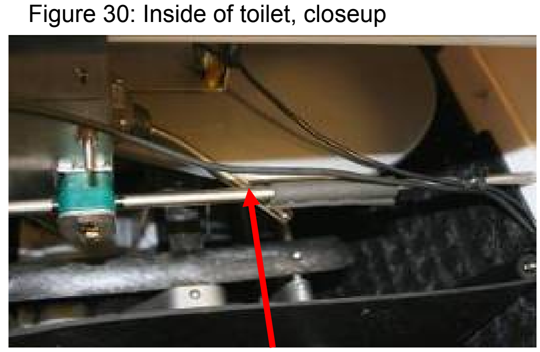
Figure 27: Handle and disk in closed position

Figure 28: Handle and disk in (almost) open position

To measure the number of times the handle was turned (i.e. the disk moved over) in a day, a stainless steal bracket with vibration damping hydraulic line clamps was attached to the back of the toilet (inside) with a corrosion resistant spring tip limit switch attached. A pulse input adapter sensor (contact closure) was connected to the switch on one end, and the microstation logger on the other, so every time the plastic disk hit the spring tip switch, a "pulse" was counted by the sensor/logger. The number of counts in a 24 hour period would approximate the number of times the toilet was used. See photos below of the set-up inside the toilet.

Figure 29: Inside of toilet, closeup


Figure 30: Inside of toilet, closeup



Plastic disk hitting the spring tip switch

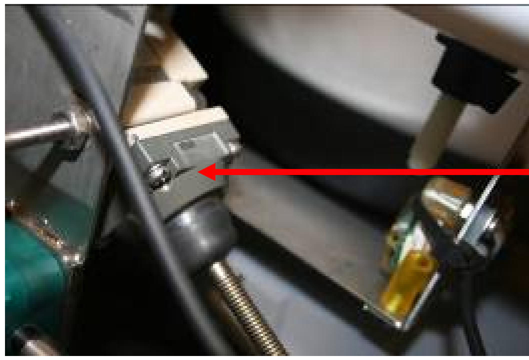



Figure 31: Inside of toilet, closeup

Knowing the number of uses in a day would allow the operator to double check the “number of uses” tracking sheet posted on the bathroom, to properly determine the amount of peat moss to add to the toilet on a daily basis, and to know when the toilet reached maximum capacity (18 uses of either urination or defecation) at which time the toilet would be “closed” and a honeybucket put in the bathroom for the remainder of the day. Tracking the number of times the toilet is used daily can also help troubleshoot potential problems related to overuse, and can help determine how best to operate the toilet.

## Measuring temperature in the bathroom

It was known that the store, and the bathroom in the store, was heated year round (except for the warmer summer months), but it wasn’t known what the average inside temperature was. Since compost toilet operations can be affected by the temperature of the toilet’s environment, the temperature in the room was tracked throughout the duration of the project. Potential variations in room temperature could also be used to help troubleshoot any problems. The temperature sensor was taped to the wall at the same height as the toilet, slightly behind the toilet so it was out of view to the public. The sensor was connected to the microstation which logged temperature readings at regular intervals.

## Measuring temperature in the toilet

It was known that the air temperature in the toilet would be different to the ambient temperature in the bathroom because the toilet has a heater and two fans that operate some or all of the time. Also, because the toilet remains closed at all times (except when being used or cleaned out), heat can build up from the compost process itself. Tracking the temperature inside the toilet would give insight to the compost conditions and would also indicate when the heater in the toilet was on and off (note that when the heater switch is turned on, it operates thermostatically when needed). Experimenting with turning the heater on and off was planned, so the effects of doing this, especially effects to the temperature in the toilet, were desired. It was also desired to know the air temperature where the composting process was taking place and to see how changing toilet operations affected the temperature.

The temperature sensor was attached to the steel bracket (used for the spring tip limit switch) at the back of the toilet, directly above the waste mass, fully inside the toilet. This temperature sensor would measure air temperature in the toilet, not waste temperature. The sensor was connected to the microstation which logged temperature readings at regular intervals. Note that the location of the sensor in the toilet made it difficult to photograph.

There was an additional temperature sensor installed that didn't have a wire attached and didn't connect to the microstation. This was a "Stowaway Tidbit" self-contained sensor that was also attached to the steel bracket close to the other temperature sensor (see photo to the right) and was used as a backup in case there was a problem with the main temperature sensor. The Tidbit sensor could be removed and data downloaded by plugging it into a computer at the end of the project if backup data were needed. The Tidbit sensor logged at the same interval as the main sensor and was programmed with a start date that matched the start date that the main sensor started logging.

Figure 32: Tidbit backup temperature sensor

## Measuring waste moisture

Relative moisture of the waste pile was tracked using a sensor in the toilet as a tool for guiding operations of the toilet. Relative changes in moisture content could help determine if the right amount of peat moss was being added or if the toilet was being overused. The sensor could also be used to see if temperature changes (e.g. from experimenting with the heater) affected moisture of the waste pile. The moisture sensor was installed vertically on its side between two brackets which were attached to the manifold grid. The manifold grid is where the waste sits before dropping down into the bottom tray and is where the majority of the compost process takes place. Vertical placement on the manifold grid was chosen because it would allow maximum contact of the waste on the sensor and is in the area of the toilet where moisture of the waste pile is most critical.

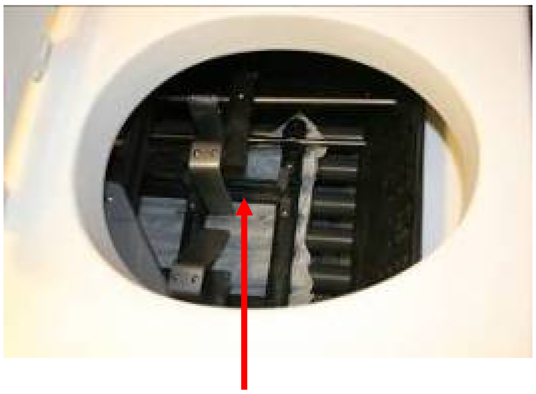


Figure 33: Moisture sensor

Figure 34: Moisture sensor close-up

## Microstation data logger

As described further in the next section (2.62), the microstation was housed in the attic space directly above the bathroom so it was not accessible by the public. The sensor wires (which plug into the microstation) were long enough to reach the attic and were taped behind the vertical vent pipe of the toilet, mostly out of view. The sensor wires for the pulse input adapter, waste moisture, and toilet temperature, all exited the toilet out of a purposely drilled hole high up on the side of the toilet. The photo to the right shows the back of the toilet with the electrical component box removed, and the area where the sensor wires were gathered and threaded through the hole. Clay was used to fill the hole to keep the toilet a closed system for air circulation once the electrical component box was set back in place.

Figure 35: Microstation with four sensor ports

Figure 36: Hole drilled for sensor wires to exit toilet, filled with clay

**Satellite System**

The Solar Stream satellite system consisted of a data transceiver box, which plugged into the microstation on one end, and was connected to an antenna on the other end. It was crucial for the antenna to be installed on the roof of the store so there was a clear line of sight for satellite communications. The antenna was drilled to the side of the roof, on the same side of the building as the attic, as can be seen in the photos below. The antenna wire connected to the transceiver box in the attic through a hole in the side of the building.

Figure 37: Solar Stream data transceiver box

Figure 38: Installing the antenna to the roof of the store

Figure 39: Close-up of the installed antenna on the roof

**System test and start up**

Once the toilet was installed and all the sensor wires were plugged into the microstation, the Hoboware software was launched on a laptop and the laptop plugged in to the microstation via the adapter cable. Data logging time increments of 20 minutes for each sensor were chosen ahead of time and selected for each sensor through the Hoboware software. The microstation was then launched and plugged into the Solar Stream transceiver, and the DataGarrison on-line data center was checked to ensure that data transmission to the satellite was taking place. See photos to the right of the equipment launch and storage area in the attic above the bathroom.

Figure 40 and 41: Launching the microstation and Solar Stream transceiver in the attic space above the bathroom

## Modifications made to the toilet

Modifications made to the toilet for sensor installation were described in the previous pages. Care was taken to install the sensors in a way that wouldn't affect toilet operations. Other modifications were needed in order for the Envirolet toilets to work properly, given the limitations of the bathroom space and general housing structures in Raven. The Envirolet toilet has a filtered drain system at the bottom of the toilet for any excess liquid which drains to one side. See photo below for location of the drain outlet. The toilet comes with a drain kit which includes a quick connect "T" (which connects to the drain outlet) and a 5' nylon drain tube which is designed to gravity flow to a container or leachpit underneath the bathroom. Since the houses in Raven have no insulated area underneath them, a gravity drain system underneath the bathroom would freeze in the winter and not work. So a pipe/container system was developed that would fit in the bathroom by the side of the toilet. Flexible pvc tubing, with a snap valve in the middle, was connected to the toilet drain outlet with a pipe fitting, and on the other end was connected to the spigot on a narrow plastic water container which fit between the toilet and the bathroom wall. The snap valve in the center of the tubing allowed the container to be disconnected when full, without leaking any liquid on either side of the disconnect.

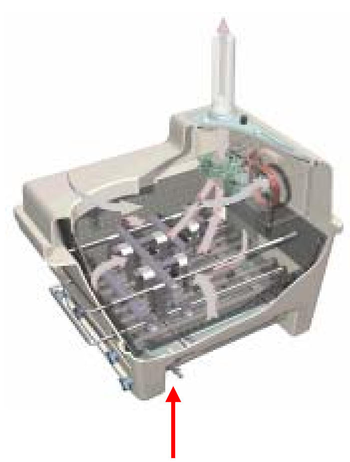


Figure 42: Excess liquid drain port on the side of the Envirolet

Figure 43: Flexible pvc piping and water container modified for the Envirolet

Figure 44: Water container and modified drain pipe connected to the Envirolet

Figure 45: Close-up of pipe fitting which attaches to the drain outlet on the toilet

Figure 46: Close-up of the snap valve for leak-free disconnect

Figure 47: Close-up of the snap valve disconnected

**<u>Measuring toilet power use</u>**

The Envirolet MS10 toilet uses electricity for the internal heater and two fans. Since the heater is thermostatically controlled, it was uncertain how much electricity the toilet would use and since electricity prices are high in Raven, and in Alaska Villages in general, it was important to know the ongoing costs of operating the toilet. The Envirolet toilet has a control switch that allows you to choose between operating the toilet with the heater and fans or just the fans, so a device to measure power was also desired to know the power difference between the two modes and with experimental operations of the toilet.

A Watt's Up? power meter device was purchased to record wattage of the toilet at regular intervals. The Watt's Up? device was purchased separately from the other sensor devices and was not compatible for connection to the microstation or satellite system for real time download. The particular model purchased (the Pro ES) records and stores up to 13,000 data points which can be downloaded from the device using software which comes with the equipment. The store toilet was plugged into the Watt's Up? meter and the meter plugged into the electrical outlet in the bathroom, and the meter was attached to the wall above the toilet with a sign for the public which described what it was and what it was doing (see photos on the next page). A second meter was also used on one of the household toilets (Tundra's) and the meters were set to record data at five or ten minute intervals (which allowed for approximately 45 days of data storage). Data were downloaded before the storage was filled and the meters cleared and restarted again. The types of data recorded by the meters included date/time, watts, volts, amps, watt hours, and max and min watts, volts and amps.


Figure 48: Photo of the Watt's Up meter on the wall above the toilet, with sign for the public


Figure 49: Close-up of the Watt's Up meter

## 2.6.2 Toilet Installation

As mentioned previously, the toilet in the store bathroom was the first to be installed. The location of the bathroom is in the back of the store by the office and is used by staff and customers. Before the installation, there was a honeybucket underneath a wooden bench and toilet seat in the bathroom, and a 4" pvc vent pipe was in place which ran from underneath the wooden bench, through the attic above the bathroom and out the roof. See photos on page 65 of the honeybucket/bench. The compost toilet arrived in Raven fully assembled and ready for installation (as all Envirolet's do). To install the compost toilet, the whole bathroom was first cleared and cleaned out, and then the compost toilet was set in place in a position that would take advantage of the existing vent pipe outlets in the bathroom ceiling and attic roof. It was important that the vent pipe attached to the compost toilet be installed as straight as possible without any bends or angles so proper ventilation would take place (recommended by Envirolet) Four 3.3' pvc vent pipe sections (3" diameter) with 3" couplings between each one were attached to the toilet and continued into the attic space above the bathroom. Half way up the vent pipe (in the attic section), a turbo fan (with 3" couplings on either end of it) was positioned – the turbo fan (an extra attachment ordered from Envirolet) helps draw air up and out of the toilet, increasing evaporation of liquid from the system and increasing performance. Above the roofline, a 2' section of aluminum insulated vent pipe was added by sliding it over the pvc vent pipe. This insulated section is recommended by Envirolet to be used on any exposed area of the vent pipe to help provide proper evaporation. A sheet of rubber roof flashing was placed over the insulated vent pipe section to lay flat on the roof for sealing. A 4" wind turbine was then connected to the top of the insulated vent pipe (since the wind turbine helps draw air up through the vent pipe, it is supposed to add performance to the system by increasing evaporation of liquid from the toilet). While on the roof, as described previously, the antenna for the satellite system was mounted to the side edge of the roof for a clear line of sight for satellite communications. The connecting wire for the antenna was brought down the side of the building and into the attic space where it was plugged into the transceiver. Since all the data collecting systems were housed in the attic, away from the public, the sensor wires from the toilet were taped along the backside of the vent pipe in the bathroom and continued up through the outlet in the ceiling where they were plugged into the microstation.

Once the toilet, vent pipe, and wind turbine were all set in place, a rubber coupling (which connected the toilet to the vent pipe) was tightened, and all of the outlets for the piping were sealed with silicone. The rubber coupling was used for vent pipe flexibility, in case the toilet needed to be moved slightly in any direction or for ease of vent pipe disconnection in case the electrical box needed to be removed. The sealant was important for preventing any air leakage and water intrusion. Silicone sealant, which came with the toilet, was used all around the vent pipe outlets in the bathroom and attic ceiling to fill any air gaps. Sealant was also used underneath the rubber flashing on the roof for weatherproofing.

### 2.6.3 Bathroom Set-Up and Signage

After the toilet was installed, a shelving structure was put up on one end of the bathroom to hold supplies for the toilet and the buckets of peat moss and cocoa shells, and a plastic trash can was set out with a sign on it reminding people to throw toilet paper into the can and not the toilet. Simple instructions for using the toilet were developed in both Yup'ik and English with the help of the operator. The instructions explained how to open and close the toilet, to throw toilet paper in the designed can and not the toilet, and listed a variety of items that shouldn't be thrown in the toilet. These instructions were posted on the bathroom wall by the toilet, (the wall that is first seen when entering the bathroom), and large red font was used to draw attention to them. See Appendix F to view the instructions developed. Small signs were also secured to the toilet by the handle and on the inside of the toilet seat lid explaining the direction to turn the handle to open and close the toilet. Since turning the handle moves a plastic disk (which covers the opening of the toilet) to the side, this instruction was important so the toilet would only be used when it was “open”, and then closed after use for proper air circulation and reduction of odors.

Blank feedback forms, and a folder to put the filled out forms in, were also posted on the wall to encourage users to fill out a form after using the toilet. Content and results of the feedback forms are further described in section 3.9. Copies of blank feedback forms can be viewed in Appendix F. Copies of the four page community education flyer containing information about the project and general information about the compost toilets (described previously in section 2.44), were posted to the wall by the feedback forms for people to take, and were also posted outside the bathroom door. A sign was also posted to the wall underneath the power meter explaining to the public what it was for and what it was doing. Hand sanitizer was also put out on a shelf by the toilet for bathroom users to use since there was no running water in the bathroom to wash hands with.

## 2.6.4 Toilet Start-Up

To “start” toilet operations, the bag of pre-mix starter (special soil mixture, approximately one cubic foot) that came with the Envirolet was added to the main chamber of the toilet and spread evenly across the paper mat which came installed under the manifold grid. (See photos to the right of the premix starter and microbe accelerator that come with the toilet). As instructed by Envirolet, one pint of water was added to the toilet over the pre-mix starter. The switch on the back of the toilet was positioned to “Fans and Heater” and the toilet was plugged in. The modified drain pipe and container were also fitted to for collecting any potential excess liquid during use.

Envirolet’s pre-mix starter used to start up toilet operations


Envirolet’s microbe accelerator powder used once every two weeks to accelerate the compost

Fig 52: Honeybucket under a wooden bench and toilet seat in the store bathroom prior to compost toilet installation

Fig 53: Taking out the existing (black) vent pipe in the store bathroom for compost toilet installation preparation

Fig 54: Fully dismantled store bathroom for compost toilet installation preparation

Fig 55: Compost toilet positioned in bathroom with (white) vent pipe and sensor wires in place

Fig 56: Vent pipe exiting through the bathroom ceiling into the attic with sensor wires running by the side of the pipe


Fig 57: Vent pipe coming up from the bathroom in the attic space with the turbo fan attached with a 3” coupling

Fig 58 & 59: (Left and right) Making a slight adjustment to the attic roof outlet for the vent pipe

**Figures 52-59 Photos of the store toilet**

Fig 60: Aluminum insulated vent pipe section above the roof line, and rubber flashing being sealed to the roof


Fig 61: Wind turbine being placed on top of the aluminum insulated vent pipe for the store toilet

Fig 62: Close-up of the satellite antenna mounted to the roof

Fig 63: Mounting the satellite antenna to the roof


Fig 64: Satellite antenna with the connection wire leading down to the attic space where the data transceiver was located

Fig 65: Sealing the air gaps at the vent pipe outlet in the bathroom ceiling with silicone sealant

**Figures 60-65: Photos of the store toilet**


Fig 66: Basic instructions for using the toilet, in Yup'ik and English, posted on the wall of the store bathroom

Fig 67: Feedback forms for toilet users and educational flyer about the project posted on the wall of the store bathroom

Fig 68: Instructions on the plastic bin (lower left of photo) for people to throw toilet paper in the bin and not the toilet. Also, hand sanitizer for hand washing on the shelf by the toilet.

Fig 69: Shelving in the bathroom with toilet supplies and sign which reminds users not to add any chemical products to the toilet


Fig 70: Labeled buckets for peat moss and cocoa shells in the store bathroom

Fig 71: Sign explaining to the public about the power meter attached to the wall

**Figures 66-71 Photos of the store toilet**

## *2.7 Community Presentation and Education*

After the store toilet was installed and the operator was trained on-site, a community meeting was held at the end of June, 2006 to announce the installation of the store toilet, to introduce the operator, and to educate people about the toilets and the project in general. The meeting was led by the operator and facilitated by the Raven Environmental department and was carried out in Yup'ik.

Figure 72 (above) & Figure 73 (below) Photos from the first community meeting/presentation. The operator explains how the toilets work and how to operate them. (Above and below photo)

A second Envirolet toilet which hadn't been installed or used yet, was brought to the meeting so that it could be used to demonstrate how the toilets worked and how to carry out operations and maintenance on them. The major parts of the toilet and their purpose were pointed out such as the vent pipe, the aerator and rake bars, the bottom panel and tray that comes out, the handle to open the bowl and the bowl removal, the turbo fan, the wind turbine, the excess liquid drain pipe, and the electrics in a box at the back of the toilet. The operator went over specifics about the frequency and amount of peat moss, cocoa shells, and microbe accelerator to add, and also showed people how to take the bottom panel off and reattach it. He also talked about the importance of keeping the toilet bowl closed when not in use (for odor reduction), throwing toilet paper in the designated can and not in the toilet, not using any chemical cleaners to clean the toilet, and not putting anything in the toilet except human waste and the peat moss/cocoa shells.

Figure 74: Second community meeting/presentation to educate the community about the compost toilets

The operator went through the instructions listed in the store bathroom and the specific do's and don'ts of using the toilet, and also handed out community education flyers about the toilets and the project. People were able to walk up to the toilet after the meeting and move the parts to see how it worked (e.g., move the handle to open and close the toilet, check out the main and underneath chamber, move the aerator and rake bars, etc.), and ask the operator any questions. At the end of the meeting, people were encouraged to go try out the toilet at the store and to contact the operator at any time if they had any questions about the toilets or the project.

A second community presentation about the compost toilets and project was carried by the operator at the end of July, just before the first household toilet was installed. Much of the same information was given at this second presentation as the first presentation, and an unused Envirolet toilet was also made available again for a hands-on demonstration of how to carry out the operations and maintenance. There were more people present at the second presentation and an announcement was made that the first household toilet was going to be installed the next day. The operator was also able to answer more questions about the toilets after some people had had a chance to check out the toilet installed in the store.

### 2.7.1 Other Educational Efforts

In addition to the community presentations, there were other educational efforts made throughout the project to keep people informed about the toilets. These efforts were mostly carried out by the operator and Raven Environmental Staff and included:

- Making announcements on the community-wide CB system about the project and the toilet installations
- Working with the store staff and household members one-on-one to teach them about how the toilets work and how to operate and maintain them
- Answering questions from the community about the project and the toilets
- Posting flyers and making announcements about the community presentations
- Distribution of the four page community education flyer
- Giving talks at the Raven school about compost toilets, the project, honeybuckets, and the composting process in general.

## *2.8 Phase 2 – Household Toilet Testing*

It was decided at the beginning of the project to wait to install the household toilets until the store toilet had been operating for a period of time so any "lessons learned" could be carried over to the household toilets. The remote sensing equipment on the store toilet would also help fine tune operations to Raven's specific environment, before full implementation in the households and installing the toilet at the store first would give households a chance to try out the toilet before having one installed in their home. Working on the store toilet first would also allow the operator to fine tune the monitoring program and adjust the instruction and inspection forms as needed.

### 2.8.1 Selection of the Households

The main selection criteria used to decide which households the four toilets would be installed in were willingness of the household to participate in the data collection effort (tracking use and odor), feeling comfortable with the operator spending time in the household monitoring and working on the toilets, and the operator feeling comfortable working with and in the household. The first household toilet was installed at the end of July 2006 in the Snow's household because it was the family of the Environmental Coordinator (who worked in the Raven Environmental Department) and they were already familiar with the compost toilet project, the operator felt comfortable with the family and vice versa, and the household was located next door to the Environmental Department office which would make accessibility easy for the operator from the office base. The Environmental Coordinator would also be able to help provide direct communication about any problems or issues that might come up, so they could be addressed right away, since it was her family's household.

Testing the toilets in a range of household sizes was also desired, especially in larger households since larger household sizes are common in Raven as well as in other Villages throughout Alaska. The Snow's represented a medium to large household size (5-7 people). The second household toilet was installed in September 2006 in a smaller household, to represent the other end of spectrum, and was the Tundra's household with 2-3 people in it. The Tundra's expressed great interest in testing the toilet, had no problems with participating with the data collection, felt comfortable with the operator making frequent visits, and the operator equally felt comfortable working with the household.

Based on results of the operation of the store toilet and the first two households, it was decided to install two toilets in the third household. Note that the full results and reasoning of the two toilet installation are given and discussed in the Results and Discussion Chapter. The third household was chosen because it was a larger family (7+ people), the Environmental Technician (who worked in the Raven Environmental Department) lived there so the family was already familiar with the compost toilet project, and the operator felt comfortable working with the family and vice versa. Similar to the first household (the Snows), the Environmental Technician would also be able to help provide direct communication about any problems or issues that might come up, so they could be addressed right away, since she lived there. The name of this third household was the Moss's and the two toilets were installed in their bathroom in October 2006. Table 2.811 lists all the compost toilets installed in Raven and their reference name used throughout the project and report.

**Table 2.6 Name used to reference each toilet installation for the project and report**

| **Name** | **Where the toilet is installed** |
|---|---|
| Store | In the bathroom in the community Corporation store |
| Snow | In the bathroom in the Snow's household |
| Tundra | In the bathroom in the Tundra's household |
| Moss A | In the bathroom in the Moss's household next to toilet "Moss B" |
| Moss B | In the bathroom in the Moss's household next to toilet "Moss A" |

### 2.8.2 Individual Household Toilet Installation

A brief description and photos of each of the household toilet installations are given in the next few pages. The household toilets were installed at different times (within a month or so of each other), but all were installed before the winter season of 2006. Unlike the store installation where hand and power tools were brought in, tools needed for the household installations were borrowed or rented from the Raven Corporation office. Note that no remote sensing equipment was installed on any of the household toilets; however, a power meter was used to monitor electricity use data on one of the household toilets.

Four sets of modified drain pipes and containers (for excess liquid) were ordered and put together based on the dimensions of the drain pipe outlet on the first toilet ordered (the store toilet). However, when the four household toilets arrived in Raven, the dimensions of the drain pipe were different from the first toilet even though they were the exact same model (the manufacturer had suddenly changed the dimensions of the drain pipe between orders for some reason). Further modifications of the configured drain pipes had to be made on the spot for the household toilets.

**Installation of the Snow's toilet**

Positioning the compost toilet in the Snow's bathroom was straightforward. Although a platform still existed from their old flush haul system in one corner of the bathroom and a self standing vanity was set in another corner, the toilet was positioned in the back corner as you entered the bathroom, with room to spare on all sides. The Snow's were one of 12 households that had a flush-haul system installed around 1998, but they stopped using it several years back because of the noise, smell, and cost to operate it. They removed the flush-haul toilet awhile back, but they still needed to remove the platform, the electrical panel in the next room, and the tank outside. The household had been using a honeybucket since the flush-haul toilet was removed.

The operator and a member of the Snow household carried out the majority of the compost toilet installation. Once the toilet was set in place, the vent pipe was attached to the toilet and a hole was drilled in the roof for the vent pipe to exit. The ceiling height in the Snow's household was much shorter than the ceiling height (and attic) in the store, so only one and a half 3.3' pvc vent pipe sections (3" diameter) were needed along with the turbo fan (which comes with couplings on either side of it) and a 2' section of aluminum insulated vent pipe was attached to the outside portion of the vent pipe. A sheet of rubber roof flashing was placed over the insulated vent pipe section, to lay on the roof for sealing, and a 4" wind turbine was then connected to the top of the insulated vent pipe. The roof material on the top of the house was made of corrugated metal, so extra silicone sealant was used around the ventpipe outlet (on the ceiling of the bathroom and on the roof) and underneath the rubber flashing to prevent any air leakage and water intrusion.

Having had experience with installing the toilet at the store, the first household installation went quite quickly. Once the toilet was installed, signs were put up on the wall and on the toilet, the bag of pre-mix starter was added along with a pint of water, the toilet and turbo fan were plugged in (to an outlet in the bathroom), and the switch on the back of the toilet was moved to heater and fan mode.

**Installation of the Tundra's toilet**

The Tundra's household had always used a honeybucket in their bathroom and the honeybucket was the only item in their bathroom. When installing the compost toilet, the bucket was moved out of the way and the toilet fit without any problems and had room to spare on all sides. Although there was no door on their bathroom, a curtain hung by a rod closed off the bathroom for privacy. No electrical outlet existed in the bathroom, but an extension cord was dropped down over one of the bathroom side walls, since that wall didn't quite reach all the way to the ceiling. A hole in the ceiling/roof was drilled to fit the ventpipe once the toilet was positioned into place. Similar to the Snow's household, the ceiling height was short so only one and one half sections of 3.3' pvc vent pipe was needed, along with the turbo fan and a 2' section of aluminum insulated vent pipe. Rubber roof flashing was used over the ventpipe and a 4" wind turbine was also installed at the top of the ventpipe. The roof on the Tundra's house was also made of corrugated metal, so extra silicone sealant was used around the ventpipe outlets and underneath the roof flashing for weatherproofing. The operator carried out the majority of the installation himself and this toilet took the least amount of time to install. Once the toilet was installed, signs were put up on the wall and on the toilet, the bag of pre-mix starter was added along with a pint of water, the toilet and turbo fan were plugged in (to the extension cord), and the switch on the back of the toilet was moved to Fans Only mode. A drain pipe was modified to fit the drain outlet at the bottom of the toilet and the connected container was placed to the side of the toilet for collecting any potential excess liquid during use. A Watt's Up power meter was also plugged in to measure power usage of the toilet during the first month of operation (see section 3.6 for further details).

## Installation of the Moss's toilets

As mentioned earlier, based on results of the operation of the store toilet and the first two households, it was decided to install two toilets in the third household (see the Results and Discussion Chapter for further information). The layout of the Moss's bathroom was a little longer than the Snow's bathroom and included a vanity on the left side of the wall with a mirror on the wall above it, and a honeybucket towards the back of the bathroom. Measurements of the bathroom were taken to determine whether the two toilets should be placed side-by-side next to the vanity, or on the back wall of the bathroom. It was decided to place them on the back wall because that configuration allowed the most room for users and for the operator to empty out the toilets, and for the drain pipe containers to fit by the side of each toilet. Once the toilets were set in position, installation of the first toilet commenced and a hole was drilled in the ceiling/roof for the vent pipe. The ceiling height of the Moss's was a little taller than the Snows and the Tundras households, so two full 3.3' pvc vent pipe sections were used, with turbo fans installed between the two sections and a 2' section of aluminum insulated vent pipe added above the roofline of the vent pipes. Heavy rains halfway through the installation had caused some delay in the installation of the second toilet, as well as the operator being out sick for a few days, but when the weather cleared and the roof was dry, the installation of the second toilet was completed. Roof flashing and wind turbines were installed on the vent pipes of both toilets, and all outlets and the flashing were sealed with silicone sealant. The toilets were each labeled with a sign (toilet A and toilet B) for reference when carrying out monitoring and maintenance on each toilet. Signs were put up on the walls, pre-mix starter and water were added to each toilet, the turbo fans and toilets were plugged in (to existing outlets in the bathroom), the switches were moved to Fans Only mode, and modified drain pipes were attached to the drain outlets and connected containers set to the side of each toilet. Before installation of the second toilet was completed, there was staff turnover with the operator position. The first operator was training the second operator during this time, so both operators were involved in the installation of the second toilet, and the new (second) operator was trained in toilet installation.

### 2.8.3 Materials and Signage for the Household Toilets

Once the toilets were installed, each household was given the following: labeled buckets of peat moss and cocoa shells, quarter cup scoopers for the buckets, a jar of microbe accelerator, a cup and tablespoon for mixing the accelerator, a pair of gloves, and a plastic bin for disposal of toilet paper. In all the household bathrooms, simple instructions for using the toilet in both Yup'ik and English were posted to the bathroom walls. The instructions were the same as the ones used in the store bathroom and explained how to open and close the toilet, to throw toilet paper in the designated can and not the toilet, and listed a variety of items that shouldn't be thrown in the toilet. Similar to the store bathroom, the instructions were posted on walls that were first seen when you stepped into the bathrooms, and were all printed in large red font to bring attention to them. Also similar to the store toilet, small signs were secured to the toilets by the handles and on the inside of the toilet seat lids explaining the direction to turn the handle to open and close the toilet. "No chemical" reminder signs were also posted to the walls to remind users not to add any chemical products to the toilet for cleaning or deodorizing.

### 2.8.4 Training the Households

After each installation, the households were shown how the toilets worked and how they needed to be maintained. Household members were walked through each component of the toilet and explained its purpose. They were shown how to add the peat moss, cocoa shells, and microbe accelerator, and the reasons they were necessary for toilet operation. Household members were also shown how the compost is emptied and the steps that need to be taken to properly open and close the bottom panel of the toilet. The instructions posted on the bathroom walls were discussed, and the important points emphasized such as throwing toilet paper in the bin and not in the toilet, opening and closing the toilet before and after each use, and not putting anything in the toilet besides human waste peat moss and cocoa shells. The general concept of the composting process was explained as well as what compost is and what can be done with it.

A one page, easy-to-read, operation and maintenance instruction guide was developed for the households and distributed to household members for reference, with the operators phone number listed in large font at the bottom of the page for the household to call if they had any questions or problems with the toilets. Step-by-step instructions, including details of how to properly remove and reattach the bottom panel for emptying the toilet, and the four page educational overview about the project were also given to the household members to read through.

At first, the operator made daily visits to the households to perform the daily/weekly maintenance duties to ensure the toilets were operated correctly from the start. The operator was able to gauge the correct amount of peat moss to add to the toilets based on the number of times the toilets were being used each day by the households and the operator was also able to look out for any problems with the toilets and correct them right away and further educated the household members if needed. The operator also kept a close eye on the number of times the toilet was being used daily and reminded the household to switch to a honeybucket after 18 daily uses. After several weeks of operation, the households took over basic maintenance duties of the toilets. Household members started adding their own peat moss after every use of the toilet and later in the project a designated person was given responsibility to move the aerator bar and add the microbe accelerator at the required intervals. The operator, however, continued to regularly visit the households and ensure that the maintenance duties were being carried out and filled out inspection sheets. The operator also emptied the toilets when needed in two of the three households.

### 2.8.5 Household Toilet Monitoring and Data Collection

The data collection carried out by household members included tracking number of daily uses and odor detection. Similar “daily use” checklist sheets to the ones used in the store bathroom were posted on the front of the bathroom door in the Snow’s and Moss’s households, and on the bathroom wall in the Tundra’s household. The sheets had 18 checkboxes underneath each day of the week (Monday through Sunday) for the household to check each time the toilet was used. Instructions were included at the top of the page explaining that once the 18 boxes were checked, the toilet shouldn’t be used for the rest of the day, and a honeybucket should be brought in for the remainder of the day. The sheets and the reasons for them were explained to the household members, and the operator replaced the sheets each week with new ones. A pen was attached to the door or wall by a string for ease of marking by the users. The odor detection forms were identical to the ones used in the store bathroom which asked people to mark either “smells okay” or “smells bad” on the day and time the toilet was used and were posted on the either the back of the bathroom doors on or on the walls to the side of the toilet. The operator replaced the forms each week with new ones.

The daily inspection sheets used to monitor the store toilet were adjusted for the households and the operator filled these out during monitoring visits to the households. Inspections were carried out on a daily basis by the operator for all of the households for the first few weeks after installation, and then dropped to three times per week (Monday, Wednesday, and Friday). Forms for emptying the toilets were also filled out by the operator, as the toilets were emptied in each household. Household members weren’t asked to fill out either the inspection sheets or emptying forms – both were filled out by the operator only.

**Figures 75-80: Photos of the household toilet installations**

Fig 75: Installation of the Snow's toilet.

Fig 76: Lining up the vent pipe for the Snow's toilet.

Fig 77: Snow's toilet installed with signs put up on the bathroom wall, door and toilet.

Fig 78: Close-up of the signs on the Snow's toilet.

Fig 79: Close-up of the check-list "number of uses" sheet on front of the door of the Snow's bathroom.

Fig 80: Close-up of the "No chemicals" sign and the odor detection sheet on the back of the door of the Snow's bathroom.

Fig 81: Working on the roof above the Snow's bathroom.

Fig 82: Fitting the aluminum insulated section to the top of the vent pipe.

Fig 83: Using silicone sealant to fill any gaps at the vent pipe outlet.

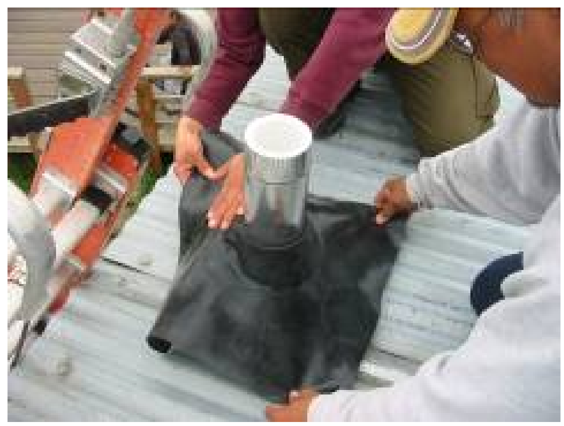


Fig 84: Placing the rubber roof flashing over the insulated section of vent pipe.

Fig 85: Setting the roof flashing to lie flat and secure on the roof.

Fig 86: Using silicone sealant to secure the roof flashing to the corrugated metal roof for weatherproofing.

**Figures 81-86 Photos of the household toilet installations,**

Fig 87: The operator and member of the Tundra household, setting the toilet in place in the Tundra's bathroom.

Fig 88: Installed toilet at the Tundra's with signs up on the back bathroom wall.

Fig 89: Close up of signs on the installed toilet at the Tundra's.

Fig 90: Modified drain pipe with container placed to the right of the Tundra's toilet.

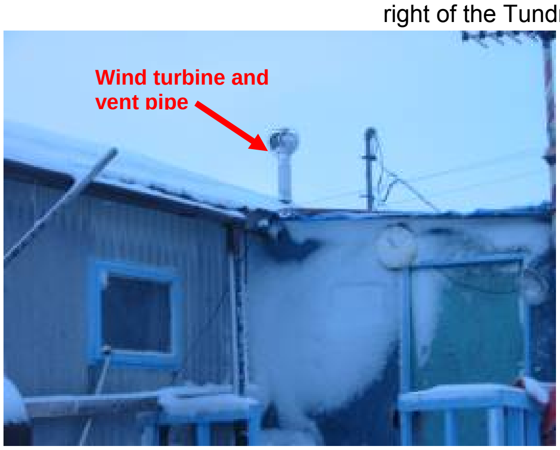



Fig 91: Wind turbine and vent pipe above the bathroom at the Tundra's household. Photo taken in the winter, four months after the Tundra's toilet was installed.

**Figures 87-91 Photos of the household toilet installations, continued**

**Figures 92-95 Photos of the household toilet installations,**


Fig 92: Signs placed on “Toilet A” (one of two toilets) before installation in the Moss’s bathroom.

Fig 93: Toilets A and B set in place in the Moss’s bathroom, against the back wall, for installation.

Fig 94: Vent pipes with turbo fans being set into holes drilled in the ceiling for Toilets A and B in the Moss’s bathroom.

Fig 95: Toilets A and B installed and plugged in the Moss’s bathroom.

# 3.0 RESULTS AND DISCUSSION

In this chapter is a presentation and discussion of the results from the project including system performance results for all the toilets (i.e., remote sensing data for the store toilet, and results from operator reports and inspection sheets for all the installations), a discussion about the operator position, electricity usage results, cost estimates (capital and O&M) of the toilets, user and operator feedback results, and a summary of technical and user issues. An overall timeline of events was developed which presents a chronological listing of major and minor events throughout the project period and can be viewed in Appendix G.

## *3.1 System Performance – Store Toilet*

This section presents results of the data collected by the four sensors in the store toilet and also the results of the inspection sheets and operator reported issues for the store toilet.

### 3.1.2 Results of Remote Sensing Data

As outlined in the previous Methods and Materials chapter, various sensors were installed in the store toilet, which connected to a data logger and satellite system for real-time data collection on-line, for monitoring toilet use, room and toilet temperature, and waste moisture. Data collection from the sensors started on 6/23/06. The microstation was set to log at 20 minute intervals for all four sensors and the satellite system transmitted the data to a pre-set website for real time viewing and administration control. Data collection stopped on 5/2/07 when the store toilet was taken out, and from 10/19/06 to 5/2/07, the data logger was (remotely) changed to log at 30 minute intervals (instead of 20) to reduce satellite data transmission costs.

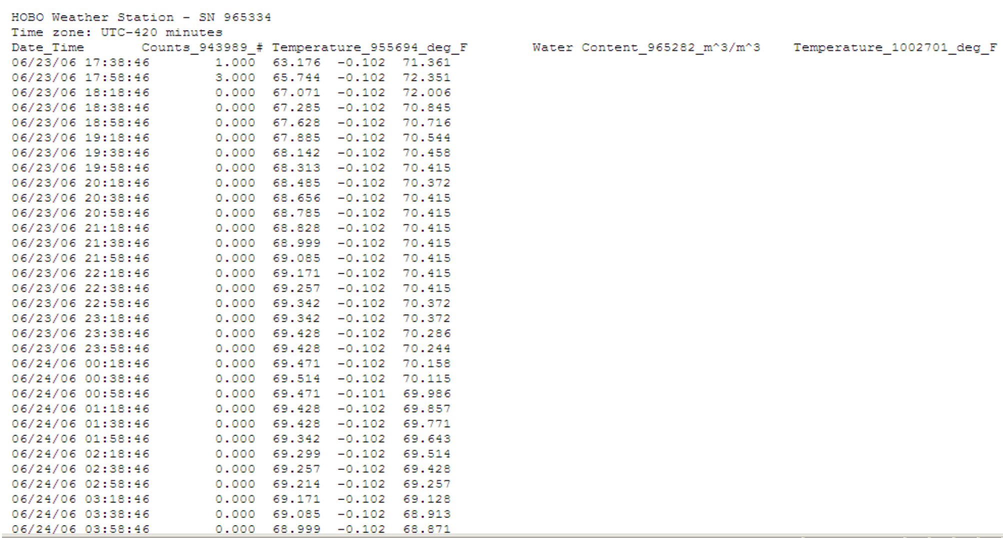
Real time data from the sensors were able to be viewed at a website set up by the satellite company. The company, Upward Innovations, issued a username and password for their Data Garrison™ on-line data center, and logging-on gave access to the sensor data, status of the sensors and microstation, and control panel for making changes to the transmission rate or launching the logger remotely. Sample screen shots of the on-line data access are provided on the next page. Throughout the project, the sensor data were downloaded for backup on a weekly basis. The real time data were accessed frequently (on a daily to weekly basis) for tracking toilet operation and for troubleshooting when needed; and basic statistics were generated on the data set for some of the sensors. Results for each of the sensors (toilet use, temperature, and waste moisture) are presented and discussed in the next few pages.

**Measuring daily toilet use (number of times the toilet bowl was opened)**

Since overuse is one of the most common problems with compost toilets, it was important to find a way to track the number of times the toilet was being used each day. To use the Envirolet toilet, a handle is turned which moves a plastic disk over to the side which "opens" the toilet for use. See section 2.61 for photos. To measure the number of times the handle was turned (i.e. the disk moved over) in a day on the store toilet, a spring tip limit switch was attached to the inside of the toilet which would be triggered when the disk hit the spring. A pulse input adapter sensor (contact closure) was connected to the switch so every time the plastic disk hit the spring tip, a "pulse" was counted by the sensor/logger. The data for this sensor were displayed as counts in the 20 (or 30) minute logging period that the switch was triggered by the disk, which approximated the number of times the toilet was used in that period. The total counts were tallied for each day and are displayed in Appendix H. Note that the first few days of data were thrown out because the toilet installation was being finished and the operator was being trained during those days -- the handle was turned numerous times during those days to show the operator the internal components of the toilet and how to carry out the maintenance -- so the data used for statistics started on 6/26/06. Also note that in order for the operator to carry out daily inspection and maintenance on the toilet, such as adding peat moss, checking that nothing was thrown in the toilet that shouldn't be, and noting how the waste mass looked, the handle would need to be turned by the operator once each day (to move the disk over so the toilet would be "open"). So as shown in Appendix H, one count was subtracted from the total number of counts for each

**Figure 96 Four screen shots of the on-line data access site**

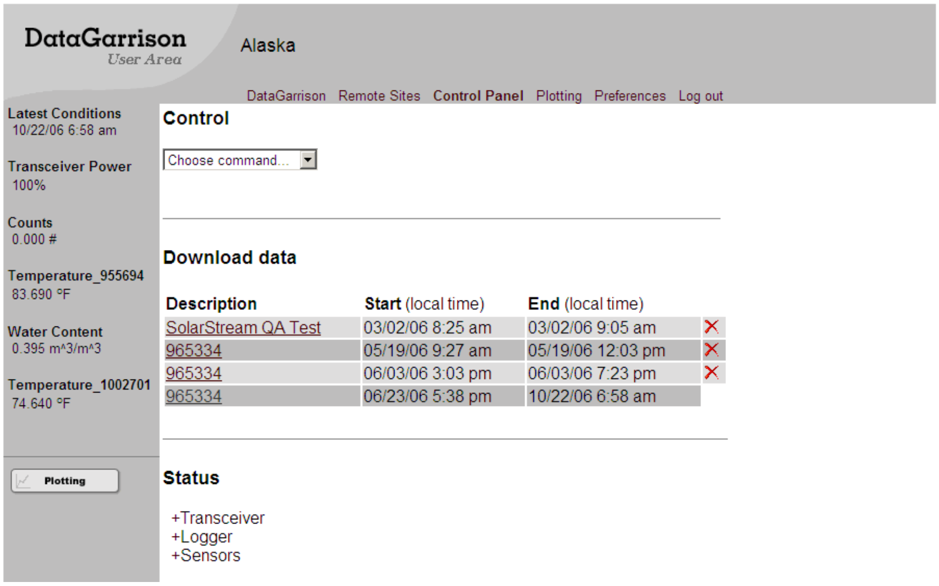

Entry page for viewing individual sensors



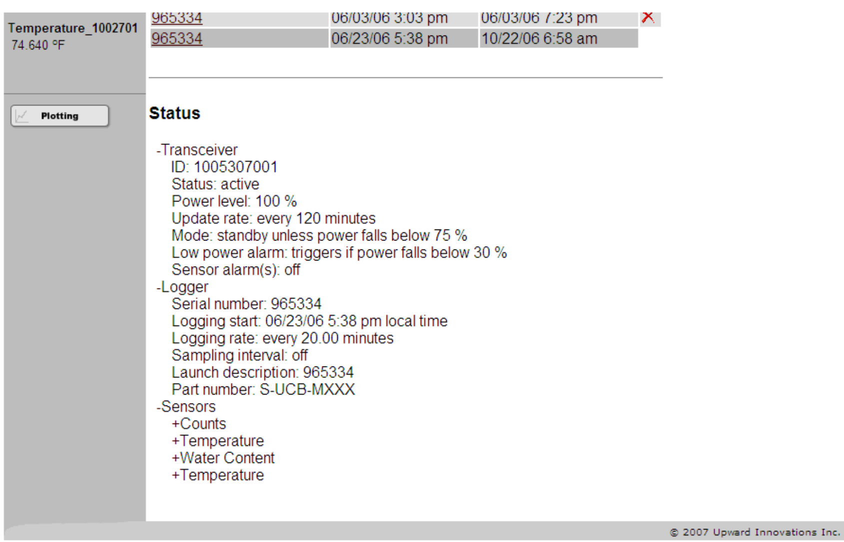
```
HOBO Weather Station - SN 965334
Time zone: UTC-420 minutes
Date_Time         Counts_943989_# Temperature_955694_deg_F        Water Content_965282_m^3/m^3    Temperature_1002701_deg_F
06/23/06 17:38:46        1.000  63.176  -0.102  71.361
06/23/06 17:58:46        3.000  65.744  -0.102  72.351
06/23/06 18:18:46        0.000  67.071  -0.102  72.006
06/23/06 18:38:46        0.000  67.285  -0.102  70.845
06/23/06 18:58:46        0.000  67.628  -0.102  70.716
06/23/06 19:18:46        0.000  67.885  -0.102  70.544
06/23/06 19:38:46        0.000  68.142  -0.102  70.458
06/23/06 19:58:46        0.000  68.313  -0.102  70.415
06/23/06 20:18:46        0.000  68.485  -0.102  70.372
06/23/06 20:38:46        0.000  68.656  -0.102  70.415
06/23/06 20:58:46        0.000  68.785  -0.102  70.415
06/23/06 21:18:46        0.000  68.828  -0.102  70.415
06/23/06 21:38:46        0.000  68.999  -0.102  70.415
06/23/06 21:58:46        0.000  69.085  -0.102  70.415
06/23/06 22:18:46        0.000  69.171  -0.102  70.415
06/23/06 22:38:46        0.000  69.257  -0.102  70.415
06/23/06 22:58:46        0.000  69.342  -0.102  70.372
06/23/06 23:18:46        0.000  69.342  -0.102  70.372
06/23/06 23:38:46        0.000  69.428  -0.102  70.286
06/23/06 23:58:46        0.000  69.428  -0.102  70.244
06/24/06 00:18:46        0.000  69.471  -0.102  70.158
06/24/06 00:38:46        0.000  69.514  -0.102  70.115
06/24/06 00:58:46        0.000  69.471  -0.101  69.986
06/24/06 01:18:46        0.000  69.428  -0.102  69.857
06/24/06 01:38:46        0.000  69.428  -0.102  69.771
06/24/06 01:58:46        0.000  69.342  -0.102  69.643
06/24/06 02:18:46        0.000  69.299  -0.102  69.514
06/24/06 02:38:46        0.000  69.257  -0.102  69.428
06/24/06 02:58:46        0.000  69.214  -0.102  69.257
06/24/06 03:18:46        0.000  69.171  -0.102  69.128
06/24/06 03:38:46        0.000  69.085  -0.102  68.913
06/24/06 03:58:46        0.000  68.999  -0.102  68.871
```

Exported text file of data from four sensors

**Figure 96 continued**




Control panel for making changes (remotely) to the microstation or satellite transceiver




Status page for viewing equipment details

day so the operator's maintenance wouldn't show in the total number of uses. There are other events that could have added inaccuracy to the estimated number of daily counts, such as: someone curious about the toilet could move the handle to look into the toilet to check it out (without actually using it), someone could have used the toilet without moving the handle at all, and someone could have forgotten to move the handle back to the closed position before it was used again. However, a few measures were taken to minimize these incidents, such as, the model toilet provided at the community meetings gave new users the opportunity to check out the toilets and practice opening and closing the bowl with the handle before using the one at the store, the operator educated each of the store staff on how to use the toilet and the importance of opening and closing the bowl, and signs posted in the bathroom and on the toilet (right by the handle) explained to users that the handle needed to be turned to open the toilet before using and closed after finishing. Also, the operator was asked if the toilet bowl was closed when he first saw the toilet each day (noted on the daily inspection forms), and the results showed that the bowl was closed 96% of the time, so it appears that the toilet was rarely being left open.

Table 3.121 lists statistics carried out with the toilet use data in Appendix H. Note that on New Year's Day, all the store staff members (plus temporary workers) were working at the store for a 15+ hour period, for the store's end-of-the-year inventory. The toilet was overused during this period due to the large number of people working, and the number of counts logged from the sensor this day was vastly greater than any other day, so this is noted in Table 3.121.

**Table 3.1 Statistics from toilet use sensor data**

| | |
|---|---|
| Average counts per day | 6.09 |
| Average counts per day with New Year's Day not included | 5.95 |
| Maximum counts in one day (New Year's Day) | 44 |
| Maximum with New Year's Day not included | 25 |
| Minimum counts in one day | 0 |
| Number of days the toilet was used over 18 times | 7 (or 2% of total) |
| Number of days the toilet was used less than 10 times | 226 (73% of total) |
| Number of days the toilet was used less than 5 times | 153 (or 49% of total) |

The results from the self-reported "toilet use tracking sheets," which are further described later in this section, can also be used as a check or comparison to the sensor data. The toilet use tracking sheets were posted on the bathroom door and were filled out by people before they used the toilet (there were instructions asking people to check a box before using the toilet so the daily use could be tracked). The results from the tracking sheets can be viewed in Appendix I. The average number of daily uses from the tracking sheets was 5.29 which is comparable to the average number of uses from the sensor data (6.09 uses per day or 5.95 if New Year's Day isn't included). The similarity of the averages of the tracking sheet data and the sensor data, indicates that between five and six uses is accurate for an overall daily average for the store toilet. The similarity of the numbers also indicates that the self reporting toilet use tracking sheets can be an accurate method to collect data on daily use.

An average daily use of five to six times is a very reasonable rate of use for the Envirolet MS-10 model. The average daily use rate did vary each month however during the project period. For example August 2006 had the highest average daily use rate (12 to 13 times per day), and September and July 2006 had the next highest use rate (8 to 9 times per day). Twelve-to-thirteen uses per day is also still a reasonable rate of use, and overall, the toilet was used less than 10 times per day for the majority of the time (73%). In terms of overuse, the toilet reached maximum daily capacity (18 uses) 7 times during the project period, but the times that it occurred were intermittent and not over several days in a row. The toilets can handle a maximum load as long as there is time for the composting to “catch up” (e.g., no use overnight or less use for a day or two after). So consistent overuse of the store toilet did not seem to be a problem, and the results from the inspection/tracking sheets (described in the next section) also seemed to reflect this. Note that when the toilet did reach maximum use (18 times), the operator was instructed to close off the toilet for the remainder of the day, and to put a honeybucket in place until the next morning.

It was noted however by the store staff, that more “outsiders” (i.e. non-store staff) started coming to the store to use the toilet during events such as Bingo in Spring 2007 which was causing the toilet to fill up faster (further described in section 3.922). According to the sensor data, March 2007 had an above average daily use rate, but wasn’t as high as August 2006. The operator was off work for a period of time in the Spring, so education to new users (during events like Bingo), and/or sign replacement in the bathroom (if needed) may not have occurred. The toilet use tracking sheets weren’t filled out during the spring, so a data check for that period cannot be carried out. If there were indeed significantly more users in the Spring but the sensor data didn’t necessarily reflect that, it could be that the new users weren’t adequately educated on how to use the toilet (i.e., opening and closing the toilet before and after use) during the time that the operator wasn't around, which would stress the need for an ongoing educational component for potential new users, as well as regular attention and monitoring by the operator for toilets installed in a public location.

The sensor device did prove to be a useful tool for assisting with monitoring and maintenance of the toilet. The operator was able to check the sensor data on the web and compare numbers to the self reported tracking sheets to make sure the correct amount of peat moss was being added to the toilet and also to check when and if the toilet reached maximum daily capacity. Based on the performance from this project, it is recommended that this type of sensor be used on any compost toilet installed if possible, along with a continued educational component for using the toilet, to help track the usage and determine if the toilet is meeting the capacity needed where it's installed.

## Measuring temperature in the toilet and in the bathroom

The temperature needed for effective biological decomposition is between 68 and 112 degrees Fahrenheit, and is known as the mesophilic phase (where mesophilic microorganisms are dominant). (Jenkins 2005) Most compost toilet systems, particularly the self-contained manufactured units, operate in this mesophilic phase. (Del Porto and Steinfeld 1998) Although maximum pathogen destruction occurs in the thermophilic phase (113 to 160 degrees Fahrenheit) these high temperatures are rarely reached in manufactured compost toilets, because heat generated is usually lost through the vent pipes. (Pace 1995; Del Porto and Steinfeld 1998) Toilets operating in the psychrophilic phase (42 to 67 degrees Fahrenheit) have a significantly reduced processing rate, and below 41 degrees Fahrenheit (biological zero) little to no processing takes place (most microbes can't metabolize nutrients). (Del Porto and Steinfeld 1998) Since temperature affects composting processes, and hence toilet operations, it was desired to monitor the ambient temperature in both the toilet and the bathroom on a regular basis at the store installation. Two 12-bit temperature sensors were used to gather temperature data on the store toilet -- one sensor was taped to the wall behind the toilet, at the same height as the toilet, and measured the bathroom air temperature, and the other sensor was installed inside the toilet directly above the waste mass and measured the air temperature inside the toilet. (See section

2.61 for further details on installations of the sensors). Both sensors logged at the same interval as the other sensors (i.e. every 20 minutes until 10/19/06 and every 30 minutes thereafter). The temperature data were displayed in degrees Fahrenheit and the sensors had a reported accuracy of ±0.45° at 68° and a range from -40 F to 185 F. Temperature data for both sensors were averaged for each month (June 2006 to April 2007) and are displayed in Table 3.122.

The average temperature in the toilet during the months of data collection was 76.72 degrees F and the average temperature in the bathroom was 71.31 degrees F. It was expected that the temperature in the toilet would be different from the ambient temperature in the bathroom because the toilet has a heater and two fans that operate some or all of the time, and also, since the toilet remains closed at all times (except when being used or cleaned out), some heat can build up from the compost process itself. The temperature in the toilet was indeed higher than the ambient room temperature every month except for March when the room temperature was a half of a degree higher than the toilet. The average temperature difference between the toilet and the bathroom was 5.40 degrees F but it varied each month. In September, the temperature difference was half of what it was in June and July, but this makes sense because the experimentation with the heater and fans was carried out in September (detailed in section 3.6) -- the heater in the toilet was off half or more of the time in September. February and March had the lowest temperature differences, and the temperatures in March were drastically different compared to any other month. For example the monthly maximum for temperature in the toilet in March was in the 60's where every other month was at least 80 degrees F. The temperature maximum and minimums for both inside and outside the toilet were also close to the same in March. It is not known why the March temperatures were so different than the other months, but it is possible that there could have been several power outages at the store during that month, or that the toilet was left open frequently (i.e., the bowl not closed by the handle after use), or that the store didn't have the heater on as much for some reason. The store toilet was emptied by the operator on February 13th, 2007 so perhaps the toilet being less full during later Feb/early March influenced the temperature; however, the toilet was also emptied on November 29th, and there was not a noticeable temperature difference in December. Unfortunately there were no operator inspection sheets filled out in March and few for February as the operator was on and off work during that time, so specific troubleshooting during that period was difficult. The self-reporting odor sheets were also not filled out at the store toilet past August, so odor issues, as a result of the temperature difference during that time, are unknown. During interviews with store staff toward the end of the project (see section 3.9), it was brought up that the toilet wasn't working as well in the Spring (2007) because the operator wasn't coming around as much and more outsiders were coming to use the toilet during events such as Bingo. If the outsiders using the toilet (i.e., non-store staff) weren't educated by the operator on how to use the toilet, the toilet bowl may not have been closed after use and was perhaps left open more of the time which would've equalized the temperature in the toilet and the bathroom. Based on the average temperature in the toilet, psychrophillic composting (42 to 67 degrees F) was taking place in March so the overall processing rate was reduced during that time. However, even during that time, the minimal temperature never dropped below biological zero (below 41 degrees F). In every month besides March (based on the average temperature in the toilet), mesophillic composting (68 to 112 degrees F) was taking place. The toilet never reached thermophillic rates (113 to 160 degrees F), but, as mentioned previously, it is rare for that to happen with these types of compost toilets,

Being able to track the temperature in the toilet on a daily, weekly, or monthly basis was a useful tool for monitoring toilet operations. The data were also particularly useful when experimenting with using the heaters less often to reduce electricity usage. Also, since the data can be viewed remotely, looking out for variations in the temperature can help indicate that there may be a problem with the toilet and that it needs to be checked. The sensors could also be used on different types of compost toilets, along with power meters, to compare operating temperatures as well as relative power usage. Also, knowing the temperature in the toilet can help to gauge the relative rate of composting and hence the capacity of the toilet -- the warmer the temperature, the faster the rate of composting and the less volume capacity needed for processing. If possible, it would be helpful to use a temperature sensor in any compost toilet installed to assist monitoring or troubleshooting either on-site or remotely.

**Table 3.2 Results from store toilet temperature sensor data**

| | **Monthly Temp. Averages (F)** | | | **Monthly Maximum Temperature (F)** | | **Monthly Minimum Temperature (F)** | |
|---|---|---|---|---|---|---|---|
| **Date** | **Temperature in Toilet** | **Temperature in Room** | **Temperature difference between the toilet and room (F)** | **Temperature in Toilet** | **Temperature in Room** | **Temperature in Toilet** | **Temperature in Room** |
| June, 2006 | 82.01 | 73.22 | 8.79 | 88.40 | 75.99 | 63.18 | 67.16 |
| July, 2006 | 84.41 | 76.43 | 7.98 | 92.15 | 83.78 | 72.26 | 66.09 |
| August, 2006 | 79.55 | 72.72 | 6.84 | 88.35 | 78.65 | 64.89 | 65.32 |
| September, 2006 | 74.42 | 70.31 | 4.11 | 85.98 | 79.92 | 62.11 | 62.23 |
| October, 2006 | 81.83 | 74.78 | 7.05 | 89.59 | 78.87 | 65.02 | 61.08 |
| November, 2006 | 78.23 | 72.22 | 6.01 | 86.44 | 80.98 | 65.83 | 63.60 |
| December, 2006 | 78.94 | 71.88 | 7.06 | 84.18 | 77.38 | 61.38 | 51.11 |
| January, 2007 | 75.12 | 70.07 | 5.05 | 85.17 | 82.13 | 59.10 | 50.89 |
| February, 2007 | 70.97 | 67.68 | 3.28 | 82.93 | 77.90 | 50.40 | 50.00 |
| March, 2007 | 63.47 | 63.97 | -0.49 | 68.01 | 68.23 | 46.97 | 46.75 |
| April, 2007 | 78.26 | 72.21 | 6.05 | 86.62 | 78.34 | 64.07 | 63.99 |
| | | | | | | | |
| **Average of monthly averages** | **77.02** | **71.41** | **5.61** | | | | |
| **Average of all sensor data** | **76.72** | **71.31** | **5.40** | | | | |

## Measuring waste moisture

Management of moisture in compost toilets is important for the overall composting process. When moisture levels are too low, microbial processes slow down and the composting process is inhibited (Pace 1995). On the other hand, if moisture levels are too high, microbial processes can become anaerobic and odor producing and also slow decomposition (Del Porto and Steinfeld 1998). The general consensus in compost literature for the range of moisture content for composting to take place is 45-70% with 50-60% being optimal. However it is never specified whether the moisture content is based on volume or mass basis (i.e. volumetric or gravimetric) or whether on a wet or dry basis (Decagon 2007). In 2007, Decagon Devices (a sensing device company) carried out sample calculations which indicated that the 50-60% ideal moisture content guidelines for compost are reported as wet basis gravimetric water content (mass of water divided by mass of wet compost) (Decagon 2007). Soil moisture sensors like the one installed in the store toilet for this project, measure volumetric water content and to convert from volumetric to gravimetric water content, the wet density of the compost must be known. Obtaining the wet density of the compost on a regular basis was beyond the scope of the local operator's duties for this project, so the volumetric water content data from the sensor in the store toilet was used to track relative moisture of the waste pile in the toilet as a tool for guiding operations of the toilet (as opposed to monitoring the actual gravimetric water content of the waste pile on a regular basis). The soil moisture sensor in the store toilet measured volumetric water content from 0 to 0.461 $m^3/m^3$ (0 to 46.1%) with 0 being dry and 46.1% being saturated. As mentioned in further detail in section 2.61, the sensor was installed vertically on its side between two brackets which were attached to the manifold grid (where the waste sits before dropping down into the bottom tray and is where the majority of the compost process takes place). Vertical placement of the sensor on the manifold grid was chosen because it would allow maximum contact of the waste on the sensor and is in the area of the toilet where moisture of the waste pile is most critical. Data readings for volumetric water content in the store toilet were numerous (over 22,000 data points) and therefore are not included in this report. The real time data, viewed by logging into the website provided by the satellite company, were used to monitor the relative moisture of the waste pile. The operator was able to see when the waste (compost) in the toilet was more dry or more wet, and how adding peat moss affected the moisture. A loose scale of 0 to 0.46 was used to gauge the moisture -- 0 being totally dry, and 0.46 being totally saturated.

There were two time periods in the project where the sensor readings were high (i.e., the waste pile was saturated or close to saturation) – August/September 2006 and March/April 2007. August and September had some of the highest daily usage of the toilet as noted by the “use” sensor and the tracking sheets, which could have contributed or caused the readings to be high. The electricity tests were also carried out during this time (using the heaters less as described in section 3.6); however, the moisture readings were high even before the tests were carried out. Looking at the results of the operator and self-reported inspection sheets (detailed in the next section) for this time period, there were no odor issues reported, visual inspections of the waste in the toilet were reported as looking normal and not too wet or too dry, and there was no reporting of leaking or liquid in the excess liquid tube off the side of the toilet. So there seemed to be few, if any, issues during this time that the readings were high. In March, the temperature in the toilet was at an all-time low as noted in the previous section, which meant that the least amount of liquid was being evaporated from the system, which could have contributed or caused the readings to be high. Also during this time, it was noted by store staff that more “outsiders” (non-store staff) were using the toilet during events such as Bingo, and the operator was also on and off work during this time, so users and the operator may not have been adding enough peat moss, leaving the toilet more wet than dry. Inspection sheets weren’t filled out during this period so it is difficult to comment on any odor issues, visual inspections, or if there was any excess liquid coming off the toilet at this time.

There were also a few times in the project when the sensor readings were very low (i.e. the waste pile was dry or close to dry) which was in early December 2006, early to mid February 2007, and late April to May 2007. In early December, it was noted by the operator that the toilet looked dry. The toilet had been emptied out on 11/29/06, and the operator was told to add some extra peat moss to the toilet after emptying to help provide a startup base for resuming use of the toilet. Toilet use for a few days after the toilet was emptied was also low (shown by the “number of uses" sensor data) so there was very little waste going into the toilet at that time. Both of these likely caused the low (dry) sensor readings. In early/mid February, the toilet was likely dry because it had been shut down for a few days by the operator who left on heater/fans mode to dry it out before cleaning on 2/13/07. Similarly in late April, the toilet was shut down and drying out because it was full, which may have caused the low readings.

The moisture sensor was probably the least used and least helpful of all the sensors installed. Based on discussions with the operator, the moisture was best gauged by visually inspecting the waste/compost in the toilet. Aside from a percentage range for moisture content, a general rule for determining ideal compost moisture is as follows: "the material is too wet if water can be squeezed out of a handful and too dry if the handful does not feel moist to the touch" (Pace 1995). This was explained to the operator early on in the project to help visual inspections of the moisture of the waste. As a future recommendation, the moisture sensor could be used to augment visual inspections for tracking moisture, but if cost was an issue in deciding which sensors to install in future toilets, the moisture sensor could be eliminated. Another tool that could be used for gauging overall moisture of the system is if (and how much) liquid is filling the excess liquid line/container. If this occurs regularly, and in large amounts, it could mean that more peat moss needs to be added to the system to absorb liquid, or it could indicate a problem with the heater/fans because less liquid is being evaporated from the system.

## 3.13 Results of the Inspection Sheets and Operator Reported Issues

The inspection sheets for the store toilet were filled out by the operators from 6/26/06 to 2/5/07. Inspection sheets were filled out most days, but not everyday since the operator mostly worked on Mondays through Fridays. Store staff were trained to carry out toilet operation and maintenance on days that the operator wasn't working or was off sick or on travel; however, inspection sheets weren't filled out on those days. The operators kept in contact with the store staff on a regular basis to inform them of their schedule.

Starting on 11/13/06, the new (second) operator was filing out the inspection sheets. The first operator showed the new operator how to fill them out and what each question meant and the new operator was also trained over the phone on how to fill out the forms. Note that no inspection sheets are available for the month of October. Although operation and maintenance took place on the store toilet during the month of October (as verified through daily/weekly phone contact), over a week's worth of inspection sheets from the beginning of the month went missing by the operator, mid-October the operator traveled to Anchorage over a few days to present the compost toilet project in Yup'ik at a Tribal Environmental Conference (during this time, store staff took over O&M), and during the last part of the month the new operator was being trained and forms were either not filled out or went missing. The toilet was also emptied for the first time in early October and was closed off for use for at least 24-48 hours before it was emptied, as instructed, to allow enough time for recent liquid entering the system to evaporate and/or drain (as suggested by the manufacturer, if possible), and at which time, no sheets would've been filled out.

A blank inspection form can be viewed in Appendix F, examples of filled out inspection forms can be viewed in Appendix J, and a summary of the results from all the forms filled out can be viewed in Appendix K. What follows on the next few pages are the results of each question asked on the daily inspection sheets. Note that for the first month of the project, the operator also filled out weekly inspection sheets. The purpose of these weekly sheets however was to remind the operator to carry out weekly tasks such as replacing the odor and number of use tracking sheets, and faxing the filled out daily inspection sheets, so since they served as more of a checklist for the operator, no data were collected or recorded from these weekly sheets.

## Results from the daily inspection sheets, listed by question

### Q. How many times was the toilet used today?

For this question on the inspection sheet, the operator noted the number of checkmarks on the toilet use tracking sheets for the day and/or checked the data from the pulse input sensor. This number was used to determine the amount of peat moss/cocoa shells to add to the toilet at the end of the day. The number of uses was also used to signal when the toilet reached daily capacity. The suggested maximum daily use of the Envirolet MS10 models is 18-22 uses so the operator was instructed to close off the toilet for the remainder of the day once it was used 18 times, and to put a honeybucket in place until the next morning. As noted on the inspection forms, the toilet reached 18 uses and was closed off by the operator on 8/10/06 and 8/22/06 and a honeybucket was put in place for the rest of the day. Note that inspection forms were filled out most days but not every day, and the toilet use sensor data show that the toilet reached maximum daily capacity a total of seven times during the whole project period, so it was likely that the store staff or the operator closed off the toilet and put in a honeybucket on these other days (the store staff were trained to do this), but there is no written record that they did. It was important to keep track of the number of daily uses to eliminate overuse being an issue especially in the early stage of testing, to make troubleshooting easier for things like odor, moisture, or other potential problems. Further information about the number of uses is described in the toilet use tracking sheet section (located towards the end of this section) and in the remote sensing section (located at the beginning of this section).

**Q. How much peat moss and cocoa shell was added today?**

The operator noted the amount of peat moss and cocoa shell added each day the inspection sheet was filled out, and the total amount of additive was determined by the number of daily uses. See Appendix F for the operators guideline for the ratio of additive to number of uses (as suggested by the manufacturer). As noted earlier, the average number of daily uses marked on the checklist sheets was similar to the average number of uses indicated by the remote sensing data so it can be assumed that the operator was adding the correct amount of additive based on the manufacturer's guidelines. Since the operator generally worked on weekdays only, store staff were shown how much peat moss and cocoa shells to add on Saturday's and Sunday's and days that the operator was off sick or on travel. Although no inspection forms were filled out on the days the operator was off and no written record exists of the amount of peat moss added on those days, the operator kept in close contact with the store staff before and after day's off to ensure that peat moss was being added.

There were a few days early on in the project where inspection sheets were filled out but the amount of additive added to the toilet wasn't noted by the operator. When asked, the operator said that he did add the peat moss and cocoa shells on most of those days, but was getting used to the forms and forgot to write them down. Starting 11/13/06, the new (second) operator was filling out the inspection sheets and he was told to simply add 1.5 cups of peat moss and 1 cup of cocoa shells to the toilet everyday, regardless of the number of uses. The reason for this was because the new operator was still working out his weekly schedule and the number of days worked per week so if days were missed, slightly over-adding peat moss would make up for those days and would be better for toilet operations than under-adding. Also, the toilet was often operated on Fans Only mode so additional peat moss would help absorb any excess liquid that wasn't being evaporated from the system with the heaters on less. On days that the second operator was not working or out on travel, the store staff were also told to add the 1.5 cups of peat moss and 1 cup of cocoa shells each day. After initial experimentation with the store toilet, the store staff were then instructed to individually add their own peat moss after every use of the toilet – they were told to add a small Styrofoam cupful (approximately 1/8-1/4 sized cups provided for them in the peat moss bucket) into the toilet after each use (note that this amount and technique was also recommended by the toilet manufacturer).

**Q. Is there any odor in the bathroom?**

This question was asked as backup to the self-reporting odor sheets posted to the wall of the bathroom, and also so there would be a consistent daily record of odor levels reported by the same person. The operator reported if there was "a lot," "a little," or "none" to the question "Is there any odor in the bathroom." Of the 102 reported answers for this question on the inspection sheets filled out between 6/26/06 to 2/5/07, 75% were "none," 23% were "a little," and 2% were "a little to none." There was never "a lot" of odor ever reported. Most of the "a little" answers were reported in the last half of November, around the time the second operator took over the position and started filling out the inspection forms. During this time, the toilet was reported as being fairly full and needing emptying. The toilet was emptied on 11/29/06 by the operator, and the next day (11/30/06), the odor report was "none," so the odor was likely from the toilet being full. Note that during that time there were no reports of leaks and the wind turbine was operating correctly so the toilet being full was likely the cause of the smell. The other dates that the operator reported "a little" odor were between 12/27/06 - 12/31/06. On 12/27, 12/28, and 12/31 the wind turbine at the top of the vent pipe outside was reported by the operator as being blocked and not moving. Since the wind turbine helps draw air (and odors) out of the toilet when it is rotating, the odors reported by the operator during that time could have been from the wind turbine not working. The results of the self reporting odor tracking sheets are discussed further in this section but note that there was no reporting of "bad odor" from those tracking sheets on any of the days that the operator reported odor.

**Q. Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position)**

The reason this question was asked was to make sure that users were closing the toilet bowl after use so that odors would be reduced, air flow in the toilet would be directed up the vent pipe, and warmth from the heaters and/or composting process would be kept in the toilet. If the toilet bowl was often left open, the operator could educate users on closing it after use. The question was also used as a check that the toilet was being used correctly for obtaining accurate "number of use" counts from the pulse input adapter. Of the 104 reported answers for this question on the inspection sheets between 6/26/06 to 2/5/07, 96% were "yes" (the toilet bowl was closed), and 4% "no" the toilet bowl wasn't closed. This would indicate that the educational signs about using the toilet (i.e. opening and closing the bowl before and after use) were effective for the store installation and could be used for the household installations, and that the education given by the operator was also effective. Note that on the days that the operator noted that the bowl wasn't closed, there were no odor reports either from the self report tracking sheets or the operator inspection sheets. It is not known how long the toilet bowl was open on those days before the operator noted it, but based on the data, it's likely that odor is not so much of an issue if the bowl is left open (however it is still important for toilet operations for the bowl to be closed after use).

**Q. Do you see anything in the toilet besides human waste and peat moss? (such as garbage, toys, etc.)**

This question was asked as a check to make sure people weren't dumping things into the toilet that weren't supposed to be there. It was a concern that people might treat the compost toilets like honeybuckets (since this has happened with flush-haul toilets in some villages (Sarcone 2006)) into which some people throw anything in them including cigarettes, trash, graywater, tobacco/chew, toilet paper, women's sanitary products, etc. It was desired to not put anything in the toilet except human waste and peat moss/cocoa shells so that nothing else would interfere with the composting process and so that the toilet would be operated under ideal conditions, especially during the first experimental phase of the project (to assist potential troubleshooting). Trash and foreign objects can impede the composting process and make pulling the aerator and rake bars difficult, cigarettes can be dangerous if they are thrown in because of the electrical components in the system (could start a fire), and dumping large amounts of liquids (graywater or honeybuckets) can throw off the moisture balance of the system and turn the composting process anaerobic. Although it is acceptable to throw single ply toilet paper into the Envirolet there wasn't money in the project budget to purchase single ply paper for all the toilets for the whole project. And it wasn't known what the consequences would be of adding regular (double ply) paper to the systems (the manufacture doesn't recommend it). Toilet paper added to compost systems, in general, acts as another carbon source for the compost process and can help absorb excess liquid. But double ply paper takes longer to breakdown and could get caught up in the aerator bar blades or end up uncomposted in the bottom tray of the toilet. Adding toilet paper would also fill the toilet up at a faster rate and reduce the overall capacity of the system. So again, because it was desired to initially operate the toilet under ideal conditions (for potential troubleshooting of other issues), users were educated to throw used toilet paper into a designated bin in the bathroom. It is not unusual to see separate bins for toilet paper in bathrooms of honeybucket villages in Alaska – often honeybucket users keep toilet paper separate so their buckets don't fill up as fast and have to be emptied as often. The Raven environmental staff were asked, at the beginning of the project, if it would be a problem for people to put toilet paper in a separate bin (they thought it wouldn't be) and the question was also asked in the interviews with the households and store staff (described in section 3.9).

On the inspection sheets, the operator answered "yes" or "no" to seeing anything in the toilet besides human waste and peat moss/cocoa shells for this question, and if answered "yes," what was seen. Of the 104 reported answers for this question, 87% were "no" and 13% were "yes," and of the 13% "yes," toilet paper was what was seen in the toilet. Toilet paper was observed a few times during the second week of the project, so the operator further educated the store staff and reminded them to put the toilet paper in the labeled bin. Toilet paper was then observed just once in September, once in November, and then a couple times around New Year's when the store brought in extra staff and worked long hours on their annual inventory. As noted earlier in this section, the store toilet was overloaded during the period around New Year's and it's likely that new users used the toilet at the time and didn't know about putting toilet paper in the bin. Toilet paper was never observed by the operator in the end product when the store toilet was cleaned, so it seems as though the small amount added did indeed breakdown.

**Q. Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right?**

This question was asked so the operator would carry out and record a daily visible check of the moisture level in the toilet. This would help determine if the correct amount of peat moss was being added to the toilet. The operator was asked to answer "wet," "dry," or "good," on the inspection form and out of the 104 reported answers for this question, 99% were "good", 1% was "dry," and 0% was "wet." What was considered wet, dry, and good, was discussed during the first in-person training with the operator. Visible pools of liquid would be a sign for the waste mass being too wet, and no moisture visible would be too dry. The moisture of the premix starter that came with the Envirolet was shown as a guide for what was considered good, if not a little dry. A general rule for determining ideal compost moisture was also given to the operator which was: "the material is too wet if water can be squeezed out of a handful and too dry if the handful does not feel moist to the touch" (Pace 1995). When the second operator started the job, the first operator trained him on what was considered wet, dry, and good. The only time "dry" was reported on the inspection forms was on 12/6/2006. The store toilet was emptied out on 11/29/06 and the operator was told to add some extra peat moss to the toilet after emptying to help provide a startup base for resuming use of the toilet. Toilet use for a few days after the toilet was emptied was low (see Appendix H for tallied daily counts), so there was very little waste going into the toilet at that time. Moisture sensor readings on 12/6/06 and the few days prior were also indeed dry (0% readings). Compost processes slow down when the waste pile is too dry so the operator sprinkled a cup and a half of warm water in the toilet and also in the area at the front (inside) of the toilet where the exit points are for the aerator bar, so they would remain easy to glide and not dry up. Use of the toilet picked up more after 12/10/06 or so and moisture levels from sensor readings also started to increase.

Based on the moisture sensor readings, there were other times in the project when the waste pile in the toilet was very dry or totally saturated and these are discussed in the "measuring waste moisture" section prior. The operator only reported answers to this question on the inspection forms seven times during this period and "wet" was never reported, so there could have been days that the waste pile looked wet but wasn't recorded. Or the waste pile could have been wet underneath (where the moisture sensor was located) but was dry-looking on top because of the frequently added peat moss. In general, a visual inspection of the waste pile likely works best for measuring moisture in terms of adding more or less peat moss, but another indicator could also be any excess liquid leaking from the toilet (a sign to add more peat moss to the system).

**Q. Is there any liquid leaking from the toilet?**

It wasn't expected that there would be any leakage issues from the store toilet since the excess liquid line fit securely onto the outlet pipe on the side of the toilet, but if any leakage did occur, it would be important that it be fixed right away or there could be odor issues, so the operator checked around the toilet daily for any sign of leakage. Of the 104 reported answers for this question on the inspection sheets between 6/26/06 to 2/5/07, 100% were "no" (no leaks from the toilet).

**Q. Is the wind turbine on the roof moving or is it blocked?**

The wind turbine at the top of the ventpipe above the roofline helps draw air out of the toilet and vents outside. Ensuring that the wind turbine is moving and not blocked helps prevent odors, so this question was included on the inspection forms for troubleshooting odor issues. This question was particularly important for the winter months when ice and snow can build up on the roof near the turbine. The operator answered the question by circling one of the following: "It is moving," "It is not moving because there is no wind," "It is not moving because it is blocked or something else is wrong." Of the 104 reported answers, 97% were "It is moving" and 3% were "It is not moving because it is blocked or something else is wrong." It is often windy in Raven year round so it wasn't surprising that the operator never reported "It is not moving because there is no wind." The store is also one of the taller buildings in the community and there is nothing obstructing it so the operator verbally reported that the wind turbine was "always spinning fast." The three days that the wind turbine was reported "blocked" were 12/27 and 12/28, and 12/31/06 and on all three days the operator reported that the turbine stopped spinning due to ice and snow buildup. The operator went on the roof all three days to scrape off the snow and ice so it would turn again. The operator noted that the weather was particularly bad (wind and snow) in late December and early January so it can be assumed that the turbines were blocked because of the extreme conditions since they were never reported as blocked before or after that period. As noted previously for the odor question on the form, there was some odor reported by the operator on the same days as the wind turbine was blocked and not moving, so it seems as though a properly working wind turbine is effective at reducing odors in the bathroom.

**Q. Are there any flies in the toilet?**

The operators never reported seeing any flies in or around the compost toilet for the duration of the project. "None" was answered 100% of the time on the inspection forms. The question was asked on the inspection form because some compost toilet systems have problems with flies/insects, and some households in Raven complain about flies in and around their honeybuckets.

**Q. If the urine container has liquid in it, note how much and empty if it is full.**

The operator was asked to monitor the excess liquid container located off the side of the toilet and report if there was liquid in it and how much. The container was connected to the toilet by a flexible pvc pipe (further described in section 2.61) at the outlet on the side of the toilet at the bottom. Large amounts of liquid from the toilet would indicate that the toilet was being overused, that there wasn't enough peat moss being added, or that there may be something wrong with the heater/fans in the toilet (not evaporating enough liquid). If there was liquid in the container, the operator was asked to circle the approximate amount: "¼", "½", "¾", "full." The only time that the operator reported seeing liquid in the container was after New Year's which was when the toilet was overloaded by extra staff using it during the multi day inventory (reported as ¼ full on the inspection sheet). Toilet use was unusually high during that period (44 times on New Year's Day) so it is not surprising that liquid built up in the container. The operator waited for a week or so after that period and emptied the container at the honeybucket lagoon.

**<u>Q. If there were any problems with the toilet today, note them here</u>**

Space was given at the bottom of the inspection forms for the operator to report any other issues or problems with the toilet for that day, outside of the previous questions asked. The problems were worked out with the operator as they were reported, and a list of the problems and action taken are shown in Table 3.131:

**Table 3.3 Other problems reported and action taken for the store toilet**

| Date | Problem written by operator | Action taken |
|---|---|---|
| 7/28/06 | "Someone forgot to close the toilet bowl -- it's usually closed" | No action taken since this is the first time this happened. |
| 8/10/06 | "1st time to 18 [uses] and no use overnight" | The operator closed off the toilet for the remainder of the day and put a honeybucket in place. |
| 8/16/06 | "Someone forgot to close the bowl" | Store staff were re-educated on the importance of opening and closing the bowl, before and after use. |
| 8/22/06 | "Hit 18 uses so shut toilet down for the remainder of the day and put in a honeybucket" | The operator closed off the toilet for the remainder of the day and put a honeybucket in place. |
| 11/15/06 | "May need to empty it, is what the store said" | The toilet was emptied in late November. |
| 12/6/06 | "Kind of dry on the toilet. I will fix it" | The toilet was dry for a few days after being emptied (there was less use than normal) so the operator sprinkled a cup and a half of warm water in the toilet to raise the moisture. |
| 12/27/06 | "The wind turbine wasn't moving because there was ice, but it is cleared now" | The operator went on top of the roof and cleared the ice and snow out of the turbine. |
| 12/28/06 | "The turbine is now moving - I had to go up and clean it" | The operator had to clear the turbine again due to excess snow from a storm. |
| 12/31/06 | "At first it wasn't moving but I fixed it" | This is referring to the turbine again – the operator had to go up once more and clean it out. |

## <u>Results from the odor tracking sheets (user-based reporting)</u>

The odor tracking sheets were posted on the wall in the store bathroom for users to mark either "smells okay" or "smells bad" on the day and time the toilet was used. The sheets provided an odor check throughout the whole day, so if an odor issue came up, the operator would know what time and could potentially troubleshoot the problem. The operator replaced sheets weekly between 6/26/06-8/29/06 and the results are shown in Appendix L as the number of times each day that “smells okay” or “smells bad” were checked. “Smells okay” was checked an average of 3 times each day, and “smells bad” was never checked on any of the tracking sheets. The operator reported odor on six days during the period the odor tracking sheets were used, but the amount of odor was “a little” or “a little to none” so it was likely never enough for users to notice.

## Results from the toilet use tracking sheets (user-based reporting)

The toilet use tracking sheets were used to both track the number of daily uses of the toilets and ensure the toilets weren’t overused when the toilets were first put into operation. The tracking sheets were posted on the front of the bathroom door with a pen attached and instructions were included at the top of the page asking users to check a box before the toilet is used and if all 18 boxes were checked, the toilet shouldn’t be used for the rest of the day, and a honeybucket should be brought in for the remainder of the day. This was also explained to the store staff. Tracking sheets were collected between 6/26/06 and 1/7/07. Daily sheets were used and replaced by the operator until 7/31/07 and then weekly sheets were used from August onward to reduce time (see Appendix F for a blank tracking sheet, and Appendix J for an example of a filled out tracking sheet). Results from the tracking sheets can be viewed in Appendix K and the average daily use was found to be 5.29 which was similar to the average daily use found from the toilet use sensor data (6.09 uses per day or 5.95 if New Year’s Day isn’t included). The similarity of the averages of the tracking sheet and sensor data indicates that between five and six uses is accurate for a daily average for the store toilet. The similarity of the numbers also indicates that the self reporting toilet use tracking sheets can be an accurate method to collect data on daily use. The daily use data were used by the operator to determine the amount of peat moss/cocoa shells to add to the toilet each day, and signaled when the toilet reached daily capacity. See the prior “measuring daily toilet use” section and the section that discusses the first inspection sheet question for further information and results of the toilet use data.

## Calendar forms

As noted in section 2.35, monthly calendar reporting sheets were designed for the operator to note when maintenance activities were carried out on a daily and weekly basis. The maintenance activities were letter coded for ease of use (P= Peat moss/cocoa shells added, A=Aerator bar moved back and forth, M=Microbe accelerator added, W=Warm water added around the edges of the waste pile, E=Emptied compost from bottom of the toilet). The monthly layout made it easier to check if maintenance was being carried out when it should. Full calendar reporting sheets were only filled out by the operator for the store toilet for the months of July and August 2006, because it was determined that maintenance activities were regularly being preformed. The calendar format was particularly helpful for reporting when the microbe accelerator was added since it was a bi-monthly activity. See Appendix J for the calendar reporting sheets filled out for July and August 2006.

## *3.2 Lesson's Learned from the Store Toilet for Household Implementation*

The first household toilet was installed a month after the store toilet, and the second and third households were installed two to four months after the store toilet, so data were collected from the store toilet and monitored for 1-4 months before the household installs. All of the households had a chance to check out and try out the store toilet before deciding to have a toilet installed in their house. Probably one of the biggest benefits of testing the toilet at the store first, was for the operator to gain experience with maintaining and monitoring the toilet before installing at the households. The operator was able to see how effective the education and instruction guides were for users. The operator was also able to test filling out the inspection sheets and forms so adjustments could be made on the forms for the households.

The self reporting toilet use tracking sheets were able to be tested on the store toilet before the household installations. The average number of daily uses recorded on the tracking sheets were compared with the average daily uses recorded from the sensor in the toilet and the similarity of the numbers indicated that the toilet use tracking sheets can be an accurate method to collect data on daily use (see prior section on daily toilet use for further details). Odor was able to be tracked at the store toilet for a period of time before the household toilets were installed to see if there were any issues that needed troubleshooting before the household installations. Since there weren't any odor issues with the store toilet, it was assumed that general operation didn't need to be changed for the household installations.

The operator educated the store staff on do's and don't of using the toilet and explained the instructions on the wall and how to fill out the "toilet use tracking sheet" on the bathroom door and self-report odor forms. The level of education the operator provided to store staff seemed to be adequate because there were few, if any, reports of misuse or problems with the toilets in the experimental phase before the household toilets were installed. One point that did need attention was people throwing toilet paper into the toilet instead of the designated receptacle. This was noticed a few times early in the project so the operator needed to further educate the store staff about throwing toilet paper into the designated receptacle and not the toilet. The operator also made a point to mention this with more emphasis to the household installations.

Another important aspect of testing the toilet in the store before the household toilets were installed was to estimate the power/electricity usage of the toilet, and experiment with bringing down the usage if necessary by running the heater less often. After testing the store toilet for one month, the usage/cost for electricity was found to be fairly high (approximately $50-$70/month) so further experimentation was performed on the heater operation to bring the costs down. Operating the toilet on "Fans Only" mode (without the heater) was a successful experiment and brought the electricity costs down to a more reasonable $15 or so per month. Based on the results, it was decided to operate the household toilets on "Fans Only" mode as well. Results of the electricity usage, the experimentation, and how costs were determined, are presented in detail in the Electricity Usage Section 3.6.

The operator was also able to gauge a balanced moisture level based on operations of the store toilet. The amount of peat moss added to the store toilet was based on the number of uses, but the operator was also able to visually estimate if more or less peat moss was needed from time to time, or if water needed to be added to the toilet to increase the moisture level. This experience was carried over to the household installations. The operator also learned a lot about installing the Envirolet toilets through the store toilet installation. The best tools to use were figured out and were used on the household installations and the best way to attach the insulated vent pipe and wind turbine above the roof line was also determined and used for the household installations. The household installations took less time than the store toilet installation partly because the operator already had the experience with the store toilet.

## *3.3 System Performance - Household Toilets*

This section presents results of the inspection sheets and operator reported issues for the household toilets, in order of installation.

### 3.3.1 Results of the Inspection Sheets and Operator Reported Issues

The household toilets were installed at different times – the Snow's was installed first, then the Tundra's, and then the Moss's. Also, the number of inspection sheets filled out and the way maintenance duties were transferred to the household members varied slightly for each household, so the results are presented in this section for each of the individual households. In general, the operator made daily visits to each of the households after the toilets were installed to perform the daily/weekly maintenance duties to ensure the toilets were operated correctly from the start. During this time, the operator was able to look out for any problems with the toilets and correct them right away and further educate the household members if needed. The operator also kept a close eye on the number of times the toilet was being used and reminded the household to put a honeybucket in place for the rest of the day/night if the toilet reached maximum capacity (based on toilet use tracking sheets). After several weeks of operation, the households took over basic maintenance duties of the toilets. Household members were shown how much peat moss to add after every use of the toilet and in some cases, a designated person was given responsibility to move the aerator bar and add the microbe accelerator at the required intervals. In all of the installations, the operator continued to visit the households to fill out inspection forms, ensure that the maintenance duties were being carried out, and perform any troubleshooting if needed. The operator also emptied out the toilets when needed for the households. Inspections were carried out on a daily basis by the operator for the households for the first few weeks after installation, and then dropped to three times per week (Monday, Wednesday, and Friday), or sometimes less. Household members weren't asked to fill out either the inspection sheets or emptying forms –- both were filled out by the operator only. Note that the total number of inspection forms filled out for the household toilets was significantly less than for the store toilet (one-quarter to one-third of the amount filled out for the store toilet), and information about the operation of the household toilets was augmented by operator reports over the phone, email, and from on-site visits. Results of the inspection forms, self-reported toilet use and odor sheets, and other operator reports are given and discussed for each household installation over the next several pages.

## Snow's Installation

The Snow's toilet was installed on 7/30/06. Inspection sheets were filled out by the operator between 8/6/06 and 2/5/06, toilet use tracking sheets were filled out by household members between 7/30/06 and 11/25/06, and self-reported odor sheets were filled out by household members between 7/31/06 and 11/19/06. The operator carried out daily maintenance on the toilet for the first few weeks after installation and noted the daily number of uses. The household then took over adding their own peat moss once the average daily number of uses was known. The operator continued to visit the household to move the aerator bar, add the microbe accelerator, collect any tracking and odor sheets, and fill out inspection forms. (Note that although the inspection forms that were filled out in the month of September went missing in Raven, the calendar form for September was sent, which noted information about peat moss, the aerator bar and the microbe accelerator). The first operator trained the second operator in October on how to regularly check the household toilet and the second operator started filling out the inspection sheets in November. In Spring 2007, when the operator was frequently out of town for subsistence hunting, a designated household member took over the tasks of pulling the aerator bar and adding the microbe accelerator. A summary of the results from the forms filled out for the Snow's toilet can be viewed in Appendix M. What follows on the next few pages are the results of the questions asked on the daily inspection sheets, tracking sheets, and information from other operator reports.

### Q. How many times was the toilet used today?

When the Snow's household was selected for toilet installation, it was understood to be a "medium-sized" household (approximately five people), however, due to a miscommunication or misunderstanding, the household size turned out to between five and seven plus frequent guests on the weekends, which wasn't discovered until after installation. According to the operator, the household was diligent about filing out the toilet use tracking sheets on a daily basis for the first two weeks of the project, but then household members tapered off using it. The average daily use during the first two weeks was 16 times a day and the toilet reached maximum capacity (18 uses) four times during the first two weeks (a honeybucket was brought in for use for the remainder of the day on those particular days). As further described in the next section, the average time between toilet cleanings for the Snow's household was approximately every 1.6 months which is less than the manufacturer's suggestion of time for allowing adequate composting to take place (see section 3.6 for further information). Based on these numbers, one toilet wasn't enough to provide capacity for this household size.

A second toilet was recommended to be installed in the Snow's bathroom to increase the overall capacity, and was made available to the household. Although the bathroom was large enough to fit two toilets, the remnants of the flush-haul system would need to first be removed to fit the second toilet in. The flush-haul system was installed in their house several years back and didn't work well for them and was partially removed, but the platform in the bathroom still exists as well as the tank below the house. The operator was waiting for permission to remove the platform from the household owner but by the time he received it, snow began to fall and pile up around the house making it difficult to remove the platform and tank underneath. Unfortunately a second toilet was never able to be added to the Snow's bathroom during the project period; however, the extra toilet remained available to be installed in the household. To deal with the issue of overuse/overcapacity with the one toilet, the household needed to operate the toilet on "Heater and Fans" mode at all times, shut the toilet down for a longer period of time before emptying to allow excess liquid to evaporate, and put a honeybucket in place during the time that the toilet was shut down before emptying.

**Q. How much peat moss and cocoa shell was added today?**

Based on the toilet use data from the first few weeks after installation, the operator was able to gauge the amount of peat moss/cocoa shell to add to the toilet, and did so accordingly. In general, two cups of additive were needed daily (2 cups of peat moss, or 1 cup of peat moss plus 1 cup of cocoa shell). Since the toilet was frequently being used to its maximum capacity, a more regular addition of peat moss (versus once at the end of the day) would be beneficial to the operation of the toilet, since the peat moss helps to instantly absorb any excess liquid. Household members were instructed to add their own peat moss after every use of the toilet using small Styrofoam cups (approximately 1/8-1/4 cup size) provided to them in the peat moss bucket in the bathroom. To make it easier, household members were told to just add peat moss, and not cocoa shells, and they were also told that the size of the small Styrofoam cup was equivalent to a “handful” of peat moss (in case the small cups broke or disappeared in the future). The operator continued to monitor the household to check that people were adding the peat moss, and re-educated if needed. This question on the inspection form was also changed to “Do you think the household has been adding a handful of peat moss after each use?”, as a reminder to the operator to check with the household members. The bucket of peat moss at the household was regularly replenished by the operator which meant that the peat moss was indeed being used. Also, as described further in section 3.9, two household members were interviewed in January 2007 and asked if they thought that people in the household was adding peat moss to the toilet after each use, and they answered that they were indeed adding a ¼ cup after every use.

**Q. Is there any odor in the bathroom?**

“No” odors were reported by the operator on over 50% of the inspection sheets. “A lot” of odor was noted by the operator on the inspection form on 8/9/06. A leak was reported that day and the operator thought the odor was from the leak. The leak was coming from the front of the toilet at the bottom panel, but was fixed when the operator reattached the panel ensuring the seal was securely tightened. The toilet also had 18 uses the day before and the operator noted that the waste in the toilet looked wet, so the odor also could have been from overuse. However the day after the leak was fixed, there was no odor reported, so it was likely due to the leak. “A little” odor was also noted by the operator on 10/27 which was the same day that the toilet was emptied –- the operator didn’t note whether the odor was from the emptying process or from the toilet before emptying. The toilet bowl was also reported as being open that day which could have let odors escape. "A little" odor was also noted on 11/8, 11/16, 11/22, and 11/27, but nothing else unusual was reported except that the toilet may have been a little dry. And finally, "a little" odor was also reported on 11/29 but the operator noted that the toilet was getting full, which could have been the cause of some odor.

The only time the household checked "smells bad" on the self-reported odor tracking sheets was from 11/14/06-11/16/06. In fact, it was the only time "smells bad" was ever reported on the tracking sheets from any installation. An inspection sheet was filled out on 11/16 which also noted "a little" odor, however nothing else unusual was noted – the wind turbine was moving, the waste mass in the toilet was reported as looking "good," the bowl was closed, and there was no leakage. So the cause of the odor on those days is unknown. Note that "Smell's ok" was also checked an equal number of times on 11/15 and 11/16, so the odor was likely not that bad. Note that "Smells ok" was checked on all the other days of the project that the odor tracking sheet was filled out by the household. See Appendix L for the results of the odor tracking sheets. Note that some odor was reported by household members *outside* of the house (from the top of the vent pipe when walking by the house) and is further described and discussed in the user-reported issues section 3.9.

**Q. Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position)**

Of the 22 times that the operator reported on the bowl being closed or open, the bowl was left open three times which were all in November/late October. Most of the odor reports were also in November, so leaving the bowl open could have been part of the odor issues. The household had been good about closing the bowl after use up until November, and when the household was given an interim feedback form (further described in section 3.9) which asked if the toilet bowl was being closed after use by household members, they answered yes. The operator thought it may have been a new guest that needed to be educated on how to use the toilet, so the operator reminded the household about closing the bowl after use to reduce odors and to remind guests to read the instructions on the wall before using the toilet.

**Q. Do you see anything in the toilet besides human waste and peat moss? (such as garbage, toys, etc.)**

Nothing was ever reported as being seen in the toilet besides human waste and peat moss by the operator and by the household in the interim feedback forms.

**Q. Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right?**

The only time the toilet was reported as looking "wet" was the day after the toilet had been used 18 times. The toilet was reported as looking dry five times in November and twice in late October.

**Q. Is there any liquid leaking from the toilet?**

As mentioned previously, leaking was reported on 8/9/06. The leak was coming from the front bottom panel of the toilet so the operator took off the bottom panel and reattached it to make sure it was put back on correctly and securely sealed. This stopped the leak and any future leaks (the panel was likely just not reattached properly from the "emptying demonstration" given to the household at the beginning of the project).

**Q. Is the wind turbine on the roof moving or is it blocked?**

There were never any reported issues with the wind turbine at the Snow's. It was always noted as moving.

**Q. Are there any flies in the toilet?**

As with all the other toilet installations, there were never any flies reported in or around the toilet at the Snows.

**Q. If there were any problems with the toilet today, note them here**

Space was given at the bottom of the inspection forms for the operator to report any other issues or problems with the toilet for that day, outside of the previous questions asked. The problems were worked out with the operator as they were reported, and a list of the problems and action taken are shown in Table 3.311:

**Table 3.4 Other problems reported and action taken for the Snow's toilet**

| Date | If there were any problems with the toilet today, note them here: | Action taken |
|---|---|---|
| 8/8/2006 | "Sat for 1 night" | The toilet was used 18 times on 8/8/08, so the operator closed it off and put in a honeybucket for the rest of the day/night. |

| | | |
|---|---|---|
| 8/9/2006 | "The toilet was leaking in the evening. I told Anna to stop using the toilet and it's been sitting with no use all night. On 8/10/06 I went to go take a picture of the toilet and it seemed that it wasn't leaking. So we are going to wait and see what happens. Then use it later on during the day. There was some odor from the leakage." | See action taken on 8/11. |
| 8/10/2006 | "No use overnight" | The toilet reached 18 uses later in the day, so the operator closed it off and put in a honeybucket for the rest of the day/night. |
| 8/11/2006 | "Leakage needs to be secured and taken care of." | After talking to the operator on the phone about this, the leak was coming from the front bottom panel of the toilet. The operator took off and reattached the bottom panel and made sure it was securely sealed. This stopped the leak and any future leaks. |
| 8/21/2006 | "You can see some dates missing. So far the toilet is doing good. I checked it." | The operator noted over the phone that inspection sheets hadn't been filled out for a few days, but that the toilet was working fine. |
| 10/2/2006 | "Some part of the mass was hard" | The toilet was emptied on 9/30. The operator reported that the toilet looked "dry" today. A similar report on the store toilet occurred after it was cleaned, so it's likely that the waste mass hadn't built up yet after emptying. After talking to the operator on the phone, the mass being hard is referring to when the toilet was emptied on 9/30 (when the waste was being emptied, some was hard and dry). |
| 10/27/2006 | "Some part of the mass was hard" | The toilet was emptied again on this day (10/27) and the operator reported again that some of the waste was hard and dry when emptied out. |
| 11/29/2006 | "Needs to be cleaned" | The toilet was getting full again and the operator thought it should be emptied soon. |

## Tundra's Installation

The Tundra's toilet was installed on 9/11/06 and inspection and tracking use sheets were filled out from 9/11/06-1/31/07. The Tundra's household had two household members plus regular guests. The toilet was operated on "Fans Only" mode from the start since the store toilet was tested on "Fans Only" mode without problems and since the Tundras' are a smaller household and there was less concern of the toilet being overused. As described further in section 3.6, power usage was monitored on the Tundra's toilet during the first month of operation. The operator carried out the maintenance of the toilet, often alongside the head of the household, for the first two weeks after installation. After this time, household members were instructed to add their own peat moss, but the operator still came by on a regular basis to fill out inspection forms and to pull the aerator bar and add the microbe accelerator when needed. The first operator trained the second operator in October on how to regularly check the household toilet and the second operator started filling out the inspection sheets in November. Unlike any of the other toilet installations, the Tundra's household eventually took over all maintenance tasks from the operator, including emptying the toilet, and was fully self-sufficient by the end of the project. A summary of the results from the forms filled out for the Tundra's toilet can be viewed in Appendix M. What follows on the next few pages are the results of the questions asked on the daily inspection sheets, tracking sheets, and information from other operator reports.

**Q. How many times was the toilet used today?**

Inspection and tracking use sheets were filled out from 9/11/06--1/31/07. The average daily use of the toilet, according to these sheets was 3 times a day. When the head of the household was asked by the operator in November 2006 if he thought the tracking sheets were being checked off each time the toilet was used, he answered "yes, all the time" (see section 3.9 for feedback form results). It is unknown if he was the only one to use the tracking sheets or if the other person in the household did as well and it is also unknown whether or not guests used the tracking sheets. An average use of three times a day is on the low side for toilet use, but not unreasonable since the head of the household was often out on subsistence in the fall, and the other person in the household was at school during the day.

**Q. How much peat moss and cocoa shell was added today?**

The operator carried out the maintenance of the toilet, often alongside the head of the household, for the first two weeks after installation. After this time, small Styrofoam cups (approximately 1/8 cup size) were put in the peat moss and cocoa shell buckets and household members were instructed to add a cupful of each to the toilet everytime the toilet was used. Like the other households, the operator still came by on a regular basis to fill out inspection forms and ensure that the household members were adding the peat moss regularly and also pulled the aerator bar and added the microbe accelerator when needed. The toilet had been operating on Fans Only mode from the beginning and starting on 10/30, liquid was noticed in the excess liquid container.

It was decided to have the household add a bit more peat moss to absorb the liquid more. The household members were then told to add a full ¼ cup of peat moss after each use and to no longer add the cocoa shells (since the peat moss was a more absorbent additive). The operator verbally reported that the toilet didn't look as wet after the household started adding more peat moss and there was less liquid collecting in the container as well, so the ¼ cup per use seemed to be the right amount for the toilet. When this question on the inspection form was changed to "Do you think the household has been adding a handful of peat moss after each use?", the operator regularly reported yes on the forms. The bucket of peat moss at the household was also regularly replenished by the operator (so the peat moss was indeed being used).

**Q. Is there any odor in the bathroom?**

On the days that the inspection sheets were filled out, "a little" odor was reported on 11/16 and 11/21--25. On the feedback form given to the head of the household, it was also reported that there was "a little" odor in the first week of November. A leak from the excess liquid pipe was also reported in the first week of November and also on 11/13 and 11/16 so the odor from the first part of November could have been due to the leak, since other households that had leaks also reported odor during that time. However, when "a little" odor was reported between 11/21-25, the toilet wasn't leaking, but the operator did note on 11/25 that the toilet would soon need to be cleaned (and was cleaned (emptied) on 12/4), so odor towards the end of November could have been caused by the toilet being full. Note that the self report odor tracking sheets were only filled out by the household during the first week after installation and from November 8-11 but "smells ok" was filled out by household members on all of those forms (see Appendix L for results).

**Q. Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position)**

On the inspection sheets filled out, the toilet bowl was always reported as being closed, and the head of household reported the same on the interim feedback forms.

**Q. Do you see anything in the toilet besides human waste and peat moss? (such as garbage, toys, etc.)**

Nothing was ever reported as being seen in the toilet on the inspection forms by the operator or by the household in the interim feedback forms. However, see Table 3.313 further in this section for information about wash water added to the toilet in the third quarter. Also, during an interview with the head of the household in May 2007, it was noted that a guest using the toilet once threw a tampon into the toilet, but the head of the household took it out when he noticed it because he knew it shouldn't be there.

**Q. Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right?**

The only time the toilet was reported as looking "a little wet" was on 11/16. There was also a leak reported on this day and also there was liquid noted in the excess liquid container. As previously mentioned, the toilet had been operating on Fans Only mode from the start and since there was excess liquid noticed in the container from 10/30 onwards, it was decided to have the household add a bit more peat moss to absorb the liquid more. The household members were told to add a full ¼ cup of peat moss after each use and to no longer add the cocoa shells. The operator verbally reported that the toilet didn't look as wet after the household started adding more peat moss and there was less liquid collecting in the container as well. Note that the operator also reported that it was "partially wet on the tray" on the day of installation as well, but this was just from the water added to the toilet with the premix starter.

**Q. Is there any liquid leaking from the toilet?**

As mentioned previously, leaking was reported on 11/13 and 11/16 and in the first week of November. The leak was coming from the excess liquid pipe. The modified excess liquid pipes were fitted to the dimensions of the outlet pipe on the original store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred on the Tundra's toilet (as well as the Moss's) because they weren't fitted properly. Adjustments were made by the operator to the pipe to fix the leaking.

**Q. Is the wind turbine on the roof moving or is it blocked?**

On the inspection sheets filled out, the operator always noted that the wind turbine on top of the vent pipe was moving. However in early January, when there was a big storm in Raven, the operator verbally reported the incidences listed in Table 3.312 regarding the wind turbine, and the action taken:

**Table 3.5 Wind turbine issues at the Tundra's and action taken**

| Date | Event | Action taken |
|---|---|---|
| 1/2/07 | The wind turbine blew off vent pipe at the Tundra's due to the high winds in Raven. | The turbine was found on the ground undamaged and the operator put it back on the vent pipe the next day. |
| 1/8/07 | The wind turbine on the vent pipe of the Tundra's toilet stopped spinning due to ice and snow buildup. | The operator went on the roof of the Tundra's to scrape off the snow and ice so it would turn again. |
| 1/11/07 | The wind turbine on the vent pipe of the Tundra's toilet blew off for a second time due to high winds. | The operator fastened it back on using screws to secure it better. |

The operator was able to take action right away with the wind turbine issues so there wouldn't be associated odor issues or problems with snow/water coming into the exposed vent pipe. Note that after the operator secured the wind turbine to the vent pipe with screws, there wasn't another incident of the wind turbine coming off for the duration of the project. None of the other toilet installations had an issue with the wind turbine coming off so it is likely that the problem at the Tundra's was due to the relatively low height of the house and the location of the house in the community in terms of wind flow.

**Q. Are there any flies in the toilet?**

As with all the other toilet installations, there were never any flies reported in or around the toilet at the Tundras.

**Q. If the urine container has liquid in it, note how much and empty if it is full**

The toilet had been operating on "Fans Only" mode from the beginning and starting on 10/30, liquid was noticed in the excess liquid container (50% full). It was decided to have the household add a bit more peat moss to the toilet to absorb the liquid more. The household members were then told to add a full ¼ cup of peat moss after each use and to no longer add the cocoa shells. The operator verbally reported that the toilet didn't look as wet after the household started adding more peat moss and as of 11/20, there was less liquid reported as collecting in the container (25% full). The container continued to hold the same amount of liquid (25% full) for the time that the inspection reports were filled out because the operator (or household members) didn't empty the container.

**Q. If there were any problems with the toilet today, note them here**

There were no problems reported on the inspection sheets for the Tundra household, however there were two other incidences with the toilet that were reported verbally by the operator, shown in Table 3.313.

**Table 3.6 Other problems reported and action taken for the Tundra's toilet**

| Date | Event | Action taken |
|---|---|---|
| 2/5/07 | Operator reported some water leaking in where the vent pipe meets the ceiling on the Tundra's toilets, due to heavy rains. | The operator put more silicone sealant at the vent pipe outlet to stop the leaking. |
| Late March | Operator reported that a bowl-full of hair washing water was dumped into the toilet at the Tundra's by the son of the household owner. | The operator re-educated the household members about not dumping anything in the toilet and put the Tundra's toilet on Fans and Heater mode for a few days to evaporate the extra liquid. |

Note that leakage at the ceiling also occurred at the Moss's toilet around the same time, so the operator also checked the Snow's toilet to make sure the sealant was adequate there as well. The wash water incident at the Tundra's was the first reported incident of a household putting something in the toilet that wasn't supposed to go in. The incident was concerning because in honeybucket villages in Alaska, it has been noticed that over time, users will often treat alternative systems (such as the flush-haul system) as they do honeybuckets, if continued re-education doesn't occur (Sarcone 2006). Users tend to fall back into old patterns of dumping anything into the alternative systems (e.g. graywater, cigarettes, trash, etc.) as they had been doing for years with honeybuckets, and forget that the alternative systems can't handle the additions (Sarcone 2006). So after the wash water incident at the Tundra's, a precaution was taken with all the toilet installations to re-educate users on what shouldn't be dumped into the toilet. The only other incident of something being added to the toilet, was when the head of the household reported that a guest had thrown a tampon in the toilet (at the Tundra's) and it was taken out by the household owner when noticed (reported during the site visit to Raven in May 2007).

**<u>Moss's Installation</u>**

The Moss's household was the largest of all the installations (seven+ people) and it was desired to operate the toilets on the Fans Only mode all the time to reduce power usage (and hence electricity costs). So two toilets were installed at the household to increase the overall capacity and lessen the load on each toilet since the toilets wouldn't have the external heat source for increasing the composting rate or evaporating liquid as fast. The Moss's toilets were installed and started operating during the time that the operator position was in transition. The first toilet (referred to as Toilet B) was installed on 9/29/06 and the second toilet (referred to as Toilet A) was installed several weeks later on 10/26/06 because of weather delays, and operator turnover. The first inspection sheet for the Moss's toilets was filled out by the second operator, for monitoring activities on 11/12/06. The Moss's had the least number of inspection sheets filled out by the operator of any of the installations -- there may have been more inspection sheets filled out but they were either never sent in, or were lost by the operator. Problems with the toilets and monitoring updates were given more by verbal or other means from the operator or through interviews with household members.

The Environmental Technician (that worked in the Raven Environmental Department) lived at the Moss's household and was very familiar with the project and how the toilets worked, so the operator worked with her to instruct the family on how to operate and maintain the toilets. Household members were instructed to add their own peat moss to the toilets soon after the toilets were installed (using small Styrofoam cups provided in the peat moss bucket). The operator continued to visit the household to fill out inspection forms, to pull the aerator bar and add the microbe accelerator when needed, and also to empty out both toilets when full. In Spring 2007, when the operator was frequently out of town on subsistence leave, a designated household member took over the tasks of pulling the aerator bar and adding the microbe accelerator.

During toilet installation, the operator and the Environmental Technician divided up the household and assigned people to each toilet – four people (mixed men and women) were assigned to Toilet A, and three people (mixed men and women) to Toilet B. (Note that for the first few weeks, everyone was using Toilet B while Toilet A was still being installed). The people that stayed at home the most were divided between the two toilets, as were the people that stayed at home the least. The individual household members were told to use their assigned toilet only and were explained the reason for doing so –- to share the overall use between the two toilets so they wouldn't fill up so fast, would have time for adequate composting to take place, and wouldn't reach daily maximum capacity. A summary of the results of the forms that were filled out for the Moss's toilet can be viewed in Appendix M. What follows on the next few pages are the results of the questions asked on the daily inspection sheets (the few that were filled in), information from other operator and Environmental Technician reports, and a discussion of any issues.

**Q. How many times was the toilet used today?**

Although weekly toilet use tracking sheets were placed on the bathroom door of the Moss's, they were either rarely filled out or rarely collected by the operator. The majority of the sheets that were filled out unfortunately had formatting issues when printed and are difficult to read and understand because of the layout, have difficult to read dates, or the sheets aren't labeled for the toilet they represent (toilet A or B). Of all the households, this household was the least cooperative for whatever reason for regularly filling out the tracking sheets, so it is difficult to know what the daily toilet use was for the Moss's household. However, of all the installations, it was less important to know the daily use of the Moss's toilets, since there were two toilets in their bathroom and overuse was less of a concern. It still would've been useful however to have accurate toilet use data for a large sized household, and to ensure that toilet use was indeed divided between the two toilets.

**Q. How much peat moss and cocoa shell was added today?**

Household members were instructed to add their own peat moss to the toilets soon after the toilets were installed (using small 1/4-1/8 cup sized Styrofoam cups provided in the peat moss bucket). The operator and the Environmental Technician tried to regularly remind household members to add peat moss if they thought people weren't doing it, or if the toilets looked "too wet" they added more peat moss to the systems from time to time. On the inspection forms that were filled out, the operator always answered "Yes" to the question "Do you think the household has been adding a handful of peat moss after each use?" In interviews carried out with the Environmental Technician, it was reported in February 2007 that the woman of household had been regularly adding peat moss to the toilets, but that the head of the household (a male) wasn't good about doing it. In May 2007, it was again reported that the women were adding the peat moss, but two men in the household often didn't and had to be reminded. The Environmental Technician was instructed to add an extra ½ cup or so of peat moss a day if it looked like the men of the household weren't adding their own peat moss, and it was explained that it is better to over-add peat moss than to under-add, since the toilets were operated on Fans Only mode and the peat moss helps to absorb any excess liquid in the toilets. This was particularly emphasized because there were reports by the operator of excess liquid in the containers to the side of the toilets (around ¼ full on average), so ensuring enough peat moss was being added to the toilets was important.

**Q. Is there any odor in the bathroom?**

On the days that the inspection sheets were filled out, "a little" odor was reported on 11/12 and 11/20. The operator reported a leakage on the side of one of the toilets due to the excess liquid line not fitting properly on 11/7 and that it took a few tries to fix the leakage, so it's likely that any odor in early-mid November was due to the leakage. "A lot" of odor was reported by a household member on 11/9 on an interim feedback form specifically from a leaking toilet, which further confirms the odor issue. The operator reported that the other toilet leaked at the same place at the end of January, but there weren't any inspection sheets filled out during that time, so there likely could have been odor at that time as well. Toilet B was emptied in early December but was noted on the inspection forms that it was getting full towards the end of November which could be the source of the odor around the 20$^{th}$ since there were reports of odor at some of the other installations when the toilets were full. In interviews carried out with household members in the third and fourth quarter of the project (see section 3.9 for further details), the main issues with odor seemed to be from the leaking excess liquid pipes and also surprisingly from the used toilet paper bin. Household members said that the toilets themselves didn't really have odor because the fans do a good job of sucking the air and odor out, and once the leaks were fixed, the smell was fine again, but that the smell from the used toilet paper was the worst. To address this issue, the operator started making more frequent visits to the household to empty out the used toilet paper bin and the household said that helped reduce the odor. Toilet paper can be added to the Envirolet toilets but it should be single ply so it breaks down faster. The choice to not throw toilet paper into the any of the toilets was made early on, because toilet paper would lower the overall capacity of the toilets and cause them to fill up faster, particularly for households with one toilet. But since the Moss's household had an issue with the toilet paper, single ply toilet paper was purchased for them to experiment with. The household started throwing the single ply toilet paper into the toilet and they reported that the smell was much better once they started doing that. Note that there is no data from the self-report odor tracking sheets for the Moss's household. Odor tracking sheets were initially posted in the bathroom, but like the toilet use tracking sheets, they were either rarely filled out by the household or rarely collected by the operator. Note also that some odor was reported by household members *outside* of the house (from the top of the vent pipe when walking by the house) and is further described and discussed in the user-reported issues section 3.9.

**Q. Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position)**

On the inspection sheets filled out, the toilet bowl was always reported as being closed, and the household reported the same on the interim feedback forms.

**Q. Do you see anything in the toilet besides human waste and peat moss? (such as garbage, toys, etc.)**

Nothing was ever reported as being seen in the toilet on the inspection forms by the operator or by the household in the interim feedback forms.

**Q. Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right?**

In the inspection forms that were filled out, the operator mostly reported that the toilet looked "good." He did not note however which toilet he was referring to but when asked, he said it was the report for both toilets. On 11/16, it was reported that Toilet B looked "a little wet" so the operator added some extra peat moss on that day. The operator reported that one of the toilets looked "kind of dry" on 11/22 but it is unknown which toilet he was referring to. There was liquid gathering in the excess liquid containers (first reported in mid-November) which could indicate that the toilets were operating too wet, however, the amount of liquid in the containers decreased over time so it was likely that it just took some time to figure out the correct amount of peat moss to add to balance the system.

**Q. Is there any liquid leaking from the toilet?**

As mentioned previously, leaking from the excess liquid pipe at the side of the toilet was reported by the operator in early November, and late January. The modified excess liquid pipes were fitted to the dimensions of the outlet pipe on the original store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred on the Moss's toilets (as well as the Tundra's) because they weren't fitted properly. Adjustments were made to the pipe by the operator to fix the leaking. There was another leakage issue of a different kind with one of the Moss's toilets – the leakage of water due to heavy rains where the vent pipe meets the ceiling of the bathroom. This occurred at the Tundra's installation at around the same time, and the operator added extra sealant around the area to stop the leaking. Table 3.314 presents a list of leakage problems verbally reported by the operator for the Moss's toilets and the action taken.

**Table 3.7 Leakage issues at the Moss' and action taken**

| Date | Problem and action taken |
|---|---|
| 11/7/06 | Operator reported some leaking on the side of the toilets at the Moss's due to the excess liquid line not fitting properly. The operator was able to tighten up the lines/outlets to stop the leaking. |
| 1/31/07 | Operator reported that Moss's toilet A was leaking again on the side where the excess liquid line is. More sealant was added to stop the leakage. |
| 2/5/07 | Operator reported some water leaking in where the vent pipe meets the ceiling on one of the Moss's toilets, due to heavy rains. The operator put more silicone sealant at the vent pipe outlet to stop the leaking. |

**Q. Is the wind turbine on the roof moving or is it blocked?**

On the inspection sheets filled out, the operator always noted that the wind turbines on top of the vent pipes of both toilets were moving.

**Q. Are there any flies in the toilet?**

As with all the other toilet installations, there were never any flies reported in or around the toilet at the Moss's.

**Q. If the urine container has liquid in it, note how much and empty if it is full**

Both toilets were operating on "Fans Only" mode from the beginning and from 11/12 to 11/20, liquid was reported in the excess liquid containers of both toilets (25% full). After this time, the operator reported a container being half-full and then back to one-quarter full, but didn't note which container or if it was both of them. Liquid in the containers could indicate that the toilets were operating too wet: however, since the amount of liquid in the containers decreased over time, it was likely that it just took some time to figure out the correct amount of peat moss to add to balance the system. Some liquid would be expected in the containers regardless since the toilets were operated on "Fans Only" mode from the start and had less heat evaporating any excess liquid.

**Q. If there were any problems with the toilet today, note them here**

Other problems/issues that came up with the Moss's toilets were reported verbally by the operator or household members as stated in this section, and were not reported on the inspection sheets that were filled out. Note again that the Moss's had the least number of inspection sheets filled out compared to any of the other installations.

## *3.4 Emptying the Toilets and End Product Use*

Emptying/cleaning out the toilets when full was carried out by the operator for all the installations. As described in section 2.42, a form was developed for the operator to follow and fill out when each of the toilets were emptied for tracking purposes, but unfortunately the forms were only filled out less than half the time. This may have been due to confusion or a miscommunication on what the operator was supposed to do, or the forms were forgotten during the emptying process, or misplaced. A blank form can be viewed in Appendix F. Verbal records were also kept when talking to the operator on the phone after a toilet was emptied. Although all the dates when the toilets were emptied are known (exact or approximate), for some of the cleanings there are no descriptive records from the operator (verbal or written). A summary record which contains information given by the operator on the forms that were filled out, as well as information over the phone, for each of the cleanings can be viewed in Appendix N. Photos were also requested to be taken by the operator after each of the cleanings, but this rarely happened. Although photos were taken during 2-3 of the cleanings, photos were only received for the first cleaning of the store toilet because the operator and Raven Environmental Staff had difficulties with their digital camera part way through the project and then the camera went missing shortly after. Photos from the first cleaning of the store toilet are shown below.

Figure 97: Photo of the bottom panel removed and the tray used for emptying. Photo source: http://www.Envirolet.com/

Figure 98: Bottom of the store toilet while emptying (panel and tray removed, and looking in).

Figure 99: Full tray removed from the store toilet during emptying.

Figure 100: Tray after being emptied, before being put back

Before each of the toilets were emptied, the operator was told to close off a toilet for at least 1-3 days, to put a honeybucket in place for those days, and to put the toilet on “Heater and Fans” mode during that time to help dry out any excess liquid. The exact number of days that each of the toilets sat unused before being emptied however is unknown, but varied from a few days to a week or more. As noted in section 2.42, the emptying instructions/forms asked the operator to compare the material emptied from the toilet to the color and composition of the premix starter (the bag of material that comes with the toilet for startup) for a relative comparison. The form also asked about liquid in the tray, odor levels, and if any foreign objects were found in the material. A summary of the toilet cleanings for each of the installations, for which there are records, are presented on the next few pages. A summary of the number of times each of the toilets were emptied throughout the project and the average time (in months) in between emptying, is shown in Table 3.41.

**Table 3.8 Toilet emptying frequency for the store and household toilets**

| Toilet | Number of times emptied during the project period | Average time between emptying (in months) |
|---|---|---|
| Store 3 | | 2.5 |
| Snow's 6 | | 1.6 |
| Tundra's 3 | | 2.7 |
| Moss's A | 3 | 2.5 |
| Moss's B | 4 | 2.3 |

### 3.4.1 Record of Emptying Individual Toilets

A summary of the toilet cleanings (emptyings) for each of the installations, for which there are records, are presented in this section. See Appendix N for a full record of the cleanings.

**Store Toilet**

The store toilet was emptied by the operators three times (before the toilet was taken out) on Oct 6, Nov 29, and Feb 13 and the average time between emptying was 2.5 months. Each of the cleanings is discussed below by date (note that a summary of the operators comments from verbal and written reports are shown in bulleted italics).

Oct 6, 2006 (3 months since installed)

- *The odor when emptying the toilet wasn't bad,*
- *The material was more dry than wet and was similar to the premix starter.*

Since the odors weren't bad during the cleaning and the material was relatively dry, the toilet seems to be operating as it should and with the correct capacity, and the waste in the toilet seems to be breaking down as it should.

Nov 29, 2006 (2 months since last emptied)

- *There was next to no odor when emptying the toilet (verbal report)*

- *The odor was “not too bad” (written report)*
- *The rake bar was fairly difficult to pull (it was slightly stuck)*
- *The compost was dryer and darker than the premix starter.*
- *There was no liquid in the tray or on the bottom of the toilet.*
- *Nothing unusual was seen in the material*

With this cleaning, the toilet was left to compost one month less than the previous cleaning, but there was next to no odor, no liquid, nothing unusual seen in the toilet, and the waste was reported to be dryer than the premix starter, so the toilet still seems to be operating correctly at this point and given enough time for the wastes to breakdown. The operator’s note about the rake bar being difficult to pull is not unusual for the Envirolet brand. When researching other Envirolet installations around the country, users noted that the rake bar was difficult to pull when cleaning. Drying around the rake bar area (which is at the inside the toilet towards the front) could be from excess heating or evaporation, from salts in urine drying and hardening, from glomulin naturally produced by bacteria which acts as a glue to hold together particles (Del Porto and Steinfeld 1998), or simply because not much liquid reaches this part of the toilet (urine gets directed towards the center of the toilet). The Envirolet company suggests putting a product like petroleum jelly on the rake bars themselves, and/or to sprinkle water occasionally around the rake bar where it enters/exits the toilet to keep the area from drying up and caking. The operator was told to sprinkle some of the microbe accelerator (which gets mixed with warm water) around the rake bar entry/exit areas when it’s added to the toilet every other week to help keep the rake bar area from caking/hardening up overtime.

<u>Feb 13, 2007 (2.5 months since last emptied)</u>

- *Emptying the toilet was fast and easy and it didn’t smell bad.*

Again since the odors weren’t bad and the material was relatively dry, the toilet seems to be operating as it should at this point and with the correct capacity, and the waste in the toilet seems to be breaking down as it’s supposed to.

## Snows Toilet

The Snows toilet was emptied by the operators six times during the project period on Sept 30, Oct 27, Middle of Dec, Jan 11, Mar 1, and May 11 and the average time between emptying was 1.6 months. Each of the cleanings is discussed below (note that a summary of the operators comments from verbal and written reports are shown in bulleted italics) and note that there was no verbal or written record for the cleaning in March.

Sept 30, 2006 (2 months since installed)

- *The amount of compost emptied from the toilet filled a five-gallon bucket half-way.*
- *The compost was wetter and lighter (in color) than the premix starter.*
- *There was "a lot" of liquid in the tray and on the bottom of the toilet.*
- *The odor was "extremely strong"*
- *There was nothing unusual in toilet*

Unfortunately it is not known, how long the toilet sat unused before it was emptied out. The toilet was operated on fans and heater mode during the full two months before it was emptied out. The second time the store toilet was emptied, it had been in use the same amount of time (2 months) but it is known that the Snow's toilet was being used more frequently than the store toilet on a daily basis (and also used in the evenings) so the Snow's toilet wasn't getting the chance to "catch-up" on the composting process at night or any other time like the store toilet was. As mentioned in section 3.31, the number of household members was larger than expected for this household, so the one toilet wasn't meeting capacity (the operator's comments on this cleaning further emphasize that). Since the toilet was overused, it isn't surprising that the operator reported bad odor, liquid in the tray and bottom of the toilet, and wet waste.

Oct 27, 2006 (1 month since last emptied)

- *The compost was dryer and darker than the premix starter.*
- *There was no liquid in the tray or on the bottom of the toilet.*
- *The odor was in between "extremely strong" and "not too bad".*
- *There was nothing unusual in toilet*

One month is a very short period of time for the toilet to fill up again and for the waste to have a chance breakdown in the system. Again the number of days that the toilet was left unused before emptying is not known, but since the period of time between emptying was less than last time, yet the odor was a bit better, there was no liquid in the tray or toilet, and the waste mass was dry, it is assumed that the toilet sat unused for a least a few days so the system had a chance to "catch up" and evaporate out the extra liquid and dry out the waste mass. Comparing this cleaning to the prior one, it is likely that for the prior cleaning, the toilet wasn't shut down for long enough before cleaning took place.

<u>Middle of Dec (1.5 months since last emptied)</u>

- *The household wanted to wait for warmer weather to clean the toilet so the windows could be opened to air out the smell.*
- *While the toilet was waiting to be cleaned, there was no smell from the toilet, unless you opened the lid and then there was a slight smell of the peat moss and cocoa shells.*

According to verbal reports from the operator, the toilet filled up again in about a month's time. Since the odor levels when cleaning out the toilet the two times before were quite high, it helps to open windows near the bathroom to help vent the smell, but it's difficult to vent in the winter, particularly during major cold snaps. So the toilet was left unused for a longer period of time until the weather warmed slightly which allowed time for the excess liquid to evaporate which also reduced the odor when cleaning.

<u>Jan 11, 2007 (1 month since last emptied)</u>

- *When the toilet was emptied the odor wasn't bad*
- *There was no liquid in the tray or on the bottom of the toilet.*
- *The rake bar was fairly easy to move.*
- *The odor was better than the last time it was emptied.*
- *The Anaq's (feces) were hard and the tray was very dry.*

Again, one month is a very short period of time for the toilet to fill up again and for the waste to have a chance breakdown in the system, but the toilet must have been left unused for a longer period than the second time it was cleaned since the operator reported lower odors, no liquid, and dry waste. The operator started sprinkling some of the microbe accelerator/water mixture near the area where the rake bar meets the inside of the toilet to reduce caking/hardening of the rake bar when cleaning (after the rake bar was hard to pull on one of the store toilet cleanings) which seemed to work.

Mar 1, 2007 (2 months since last emptied)

Unfortunately there were no verbal or written records from the operator for this cleaning.

May 11, 2007 (2 months since last emptied)

- *The cleaning wasn't bad.*
- *The mass was pretty dry*

The toilet took a bit more time to fill up this time and the time before which could be because of less use due to household members being out of the area for subsistence. Also since the odors were less again, the toilet was likely not used for a longer period of time before emptying.

The overall average time between toilet cleanings was the lowest for the Snow's than any other household which again was due to the toilet not meeting capacity for the size of the household. Two toilets are needed to meet capacity for the number of people that use the toilet (household members and weekend guests).

## Tundra's Toilet

The Tundra's toilet was emptied three times during the project period on Dec 4, Feb 20, and Apr. 30th and the average time between emptying was 2.7 months. Each of the cleanings are discussed below (note that a summary of the operators comments from verbal and written reports are shown in bulleted italics).

Dec 4, 2006 (3 months since installed)

- *The toilet was a bit stinky when cleaned, but aired the place out and it was ok.*
- *The rake bar wasn't hard to pull.*

The Tundra's toilet had been operating on "Fans Only" mode from the start. The operator was told to put the toilet on "Heater and Fans" mode while the toilet was unused a few days before cleaning but again it is not known how many days the toilet was unused before cleaning (and may not have been long enough if there were odor issues while cleaning). The operator had been sprinkling some of the microbe accelerator/water mixture near the area where the rake bar meets the inside of the toilet to reduce caking/hardening of the rake bar when cleaning (after the rake bar was hard to pull on one of the store toilet cleanings) which seemed to work.

Feb 20, 2007 (2.5 months since last emptied)

- *The toilet cleaning went pretty well and the mass was quite dry.*

The toilet may have been shut down for a longer period of time before cleaning compared to the prior cleaning since the waste mass was described as dry which means the heater may have helped evaporate some of the excess liquid.

Apr 30, 2007 (2.5 months since last emptied)

- *The cleaning wasn't too bad (household owner)*
- *The odor was "not too bad" (household owner)*
- *Nothing unusual was seen in the toilet (household owner)*
- *It wouldn't be a problem to clean the toilet again on my own (household owner)*
- *The owner had gloves to use but no mask so he used an old tee-shirt over his mouth to lessen the odor.*

The toilet was cleaned by the household owner with some oversight from the operator. All the comments above are from the household owner. This was the first time this household owner emptied his own toilet and the first of any household member to empty a toilet and he didn't think it would be a problem to continue emptying the toilet (vs. the operator) or for other household members to empty their own toilets. The household owner was shown by the operator to shut down the toilet for a few days before emptying and to switch it to "Heater and Fans" mode during those days to help evaporate any excess liquid.

## Moss's Toilet B

The Moss's Toilet B was installed and started operating approximately 3 weeks before Toilet A, was emptied by the operator's once on it's own in early December and then three more times during the project period (at the same time Toilet A was emptied) on Jan 4, late March, and Jun 12. The average time between emptying was 2.3 months, although this number would have been higher if the toilet wasn't emptied until it was full (instead of being emptied early to be on the same schedule with Toilet A). Unfortunately a record only exists for one of the emptyings and it is discussed below along with a summary of the operators comments from verbal and written reports (shown in bulleted italics).

<u>Early Dec (2.5 months since installed)</u>

Unfortunately there were no verbal or written records from the operator for this cleaning.

<u>Jan 4, 2007 (1 month since last emptied)</u>

- *Both A and B toilets were cleaned at the same time.*
- *The odor from both toilets wasn't bad, there was no lingering odor in the house, and the cleaning went quite well.*
- *Relatively, Toilet B had less odor and was dryer because not much time had passed since it was last emptied.*
- *Even though Toilet B wasn't full at the time of cleaning, both toilets were emptied at the same time so operations started again at the same level.*
- *The compost was wetter and darker than the premix starter.*
- *The compost was wetter, darker, and less composted compared to the compost from the Store toilet (when emptied on Nov 29, 2006), and the odor was about the same (i.e. "not too bad").*
- *There was no liquid in the tray but "a little bit" on the bottom of the toilet.*
- *Nothing unusual found in the toilet*

The operator reported that the toilet wasn't full but since Toilet A (which was installed 3-4 weeks after Toilet B) was needing to be emptied, a decision was made to empty both toilets at the same time so they could be used at equal capacity amongst household members, since the purpose of having two toilets in the bathroom was to increase the overall capacity for larger households. Once again it is not known how long the toilet was shut down before emptying, but the operator reported that the odor was less for Toilet B than Toilet A when emptying which could be because there was less waste in it, but there may have been more peat moss added to that toilet, or aeration was better since there was less waste. The quality of the compost however was noted to be wetter and darker than the pre-mix starter, whereas Toilet A was noted to be lighter and dryer than the premix starter which is a little surprising on one hand because odor issues seem to be present with material that is more wet than dry, but on the other hand, Toilet B had less time to naturally breakdown and dry out.

Late March (3 months since last emptied)

Unfortunately there were no verbal or written records from the operator for this cleaning.

Jun 12, 2007 (2.5 months since last emptied)

Unfortunately there were no verbal or written records from the operator for this cleaning.

## **Moss's Toilet A**

The Moss's Toilet A was emptied by the operators three times during the project period at the same time that Toilet B was emptied on Jan 4, late March, Jun 12 and the average time between emptying was 2.5 months. Unfortunately a record only exists for one of the emptyings and it is discussed below along with a summary of the operator's comments from verbal and written reports (shown in bulleted italics).

Jan 4, 2007 (2 months since installed)

- *The compost was dryer and lighter than the premix starter.*
- *The compost was dryer, lighter, and more composted compared to the compost from the Corp toilet (when emptied on Nov 29, 2006), and the odor was better and barely noticeable.*
- *There was no liquid in the tray but "a little bit" on the bottom of the toilet.*
- *Nothing unusual found in the toilet*
- *The cleaning was better than the Tundra's*

Toilet A was reported as full a little over two months after installing which is the shortest period of time that it took either toilet at the Moss's to fill up during the project period. Both toilets were operated on "Fans Only" mode from the start, and the toilet performance seemed to be adequate since the operator reported that the material was dryer and lighter than the premix starter and the odor was barely noticeable, given that there were only two months for the waste to breakdown.

Late March (3 months since last emptied)

Unfortunately there were no verbal or written records from the operator for this cleaning.

Jun 12, 2007 (2.5 months since last emptied)

Unfortunately there were no verbal or written records from the operator for this cleaning.

### 3.4.2 Overall Emptying Frequency and Use of End Product

Envirolet suggests that the frequency of emptying will depend on usage, but for continued residential use, the frequency is once every 3-6 months. The overall average emptying frequency for all of the toilets during the project period was every 2-3 months, which is on the low end based on the manufacturers' suggestions. The overall time period for calculating the average frequency was relatively short however since the Moss's toilets were monitored for only 8-9 months, the Tundra's 10 months, the store toilet was only in operation for 10 months, and the Snow's household needed a second toilet to meet proper capacity. Monitoring the emptying frequency over a full 1-2 year period, so that seasonal fluctuations are captured, (such as reduction in household numbers during spring and summer subsistence leave) would be helpful for getting a more accurate overall average frequency rate.

A general rule for assessing if the end-product from compost toilets has been adequately processed (composted), is that it shouldn't look or smell like the original waste going into the toilet, no feces should be identifiable, and ideally the texture will be dry and will look and smell like "very rich garden soil or leaf humus from a garden composter or the forest floor". (Del Porto and Steinfeld 1998) The operator reported odors during several of the toilet cleanings which indicates that much of the time, the end-product from the toilets wasn't completely composted. This could be due to an insufficient amount of heat, air, or moisture, but is likely due to removing the product too early based on the overall emptying frequency of the toilets, or overloading the toilet in the case of the Snow's household.

It was desired to use the end product from the compost toilets as cover material for garbage at the Raven dumpsite, since cover material (dirt, gravel etc.) is not found in large quantities in the community; however: pathogen levels of the end product were unknown. It was beyond the scope and budget of this project to carry out testing on the end product from the compost toilets.

No further processing of the end product took place during the project, so the material emptied from the toilets during the project period was transported to the Raven honeybucket lagoon by the operator in 5 gallon buckets and dumped in one area. Although the exact amount of compost produced over the project is not known, based on operator reports, it is estimated that approximately 50 gallons total was generated from all the toilets combined for the project period. With future funding or other demonstration projects, it is recommended to include funding to test the end product for fecal coliform levels to estimate the performance of the toilet for waste decomposition and the quality of the compost for use. Note that EPA's 40 CFR Part 503 Biosolids Rule sets a limit of the acceptable coliform count at 1000 MPN per gram of total solids (dry weight basis), for compost that is to be spread in gardens and farming applications as fertilizer (USEPA 2007).

The end product from compost toilets is considered domestic septage by the State of Alaska and to use the product for dumpsite cover under State regulations, further processing is required, as set forth in EPA's 40 CFR Part 503 Biosolids Rule. Lime would need to be purchased and the minimum pathogen and vector attraction reduction requirements for domestic septage would need to be followed:

> The minimum pH of the end product would need to be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes (USEPA 2007) (Emswiler 2007) (Heatherington 2007).

As a best management practice, and to be extra cautious with the end product, it is further suggested to add sufficient lime to raise the pH to 12 after two hours of contact (Emswiler 2007) (USEPA 2007). As an extra precaution, it is also suggested to store the end product at the dumpsite/landfill in an area that is restricted to public access for one year before using as dumpsite/landfill cover (Emswiler 2007) (USEPA 2007). Interviews were carried out in 2007 with representatives from both the State of Alaska and USEPA R10, to determine the regulations for using the end product from compost toilets as dumpsite/landfill cover in Alaska, and the process for determining the regulations (through 40 CFR Part 503) is detailed in Appendix O for reference.

There are a few lessons learned from this project regarding emptying the toilets that could be applied to any future projects that test compost toilets, and are listed below:

- Work with the operator more in-person on the “emptying form” to ensure they understand the forms, and/or make the form easier for them to fill out.
- Make sure the amount of time the toilet is unused before emptying is noted every time (and if the toilet is on “Fans Only” or “Heaters and Fans” mode) to see how this length of time affects such aspects as the emptying process, the end product, and odor.
- Interview household members that were around during each emptying for their opinion on relative odor levels from prior cleanings and how the emptying went in general.
- Have the operator note the volume of end product removed from the toilet for each emptying.
- Have the operator note if they can see any identifiable feces in the end product (to help gauge the processing level).
- Try to have photos taken of each emptying (closeup of the end product, photos of any problems that occurred, etc.).
- If possible, test the end product (compost) from the toilets for fecal coliform levels.
- Experiment with using the end product as dumpsite cover, following the State regulations as outlined in this section and Appendix O.
- Have the operator note exactly what was done with the end product for each emptying (e.g. the location of where it was dumped, any further processing or treatment carried out etc.).

## *3.5 Operator Position*

The local operator position was a key aspect of the project. Part-time funding for one-year was provided for the position and more hours were worked by the operator in the beginning of the project (around 30 hrs per week for the first few months) and then tapered off (to around 10-15 hrs per week) as users at each of the installations started taking on more of the maintenance duties and needed less assistance/monitoring. The operator was hired through the Raven Environmental Department in June 2006 and was a local resident with prior sanitation work experience. The operator was trained in-person on a trip to Raven in late 2006 (see section 2.5

for further information about training the operator) and was involved with installing all of the toilets (with some assistance) and carried out the following duties on the toilets on a regular basis:

- Added peat moss and cocoa shells to the toilets (until users took over these duties)
- Pulled the aerator bar and added microbe accelerator
- Filled out all inspection sheets
- Cleaned the toilets
- Addressed any problems that come up
- Filled up household and store supplies of peat moss and cocoa shells
- Replenished educational materials on display when needed
- Replenished “Number of Uses” and “Odor” tracking sheets on the doors of the store and household bathrooms
- Ordered more peat moss when necessary
- Cleaned the bathrooms, emptied cans of used toilet paper, emptied excess liquid containers when necessary
- Checked odor levels in the bathroom
- Reported any problems with the toilets
- Carried out operational “tests” with the toilets
- Answered questions from the community about the project and the toilets
- Made announcements on the community-wide CB system about the project and the toilet installations

The operator also worked with the store staff and household members one-on-one to teach them about how the toilets worked and how to operate and maintain them, gave community presentations about the toilets and project, distributed the four page community education flyer, and gave talks at the Raven school about compost toilets, the project, honeybuckets, and the composting process in general.  Regular contact was kept with the operator by phone and email, and filled-out forms/inspection sheets were sent by fax on a daily/weekly basis.

In mid-October 2006, the operator was unable to continue working, for personal reasons, and gave his resignation to the Raven Environmental Department. Another operator, a Raven resident who also had prior sanitation experience, was hired by the Environmental Department and was trained by the first operator during the last two weeks in October. At the time the second operator was hired, the first operator was installing the toilets at the Moss's household, so the second operator was able to complete the installation with the first operator, and was trained on how to install the toilets. The first operator also trained the second operator on how to fill out the inspection sheets and forms, carry out the daily/weekly maintenance on the toilets, and was shown how to empty the toilets. Additional training was given to the second operator over the phone and by email, but in-person training was not able to be carried out since the second operator was unavailable due to illness during the next scheduled trip to Raven (in January 2007). Contact was kept with the second operator by phone and email, but not as regularly as with the first operator as it was more difficult to track down and get in touch with the second operator (he didn't have a phone at his house and didn't check in with the Environmental Department as regularly). There were some complaints reported about the second operator in the Spring of 2007 by some of the households and the store because he wasn't coming around to carry out some of the maintenance on the toilets and he wasn't available to empty out the toilets when needed. The operator was off-work for awhile during this time due to illness and was also out on subsistence leave. Inspection reports were not filled out during this time. In early May 2007, the operator had to give his resignation because he needed to be out on subsistence leave more often and wasn't going to be available to carry out the job duties. The Raven Environmental Department then talked to the City Department (who staffs honeybucket and flush-haul operators) and requested that a temporary operator be hired with the remaining project funds. A third operator was then hired and worked for the remaining few weeks of the project period. The third operator was given training over the phone and by email, and was briefly trained in-person by the second operator and the Raven Environmental Department.

A staff turnover rate for the operator position of three times in a one-year period is high, but not necessarily unusual for Raven or other rural Alaska Villages. The City of Raven faces a similar problem trying to retain trained staff for their honeybucket and flush-haul service, particularly during the Spring subsistence season –- operators and backup operators are often away from the Village for days at a time during this time of year. Subsistence is the top priority for Alaska Native Villages. According to the Alaska Department of Fish and Game, rural Alaska residents depend on subsistence foods for 35% of their calories and 100% of their protein (ADF&G 1998). But subsistence is a priority for more than just nutritional needs. The Alaska Commission on Rural Governance and Empowerment writes about subsistence:

> "Protecting subsistence is the top priority of rural Alaskans. Harvesting and consuming fish, game and other natural foods and resources for subsistence is the cornerstone of life in rural Alaska. These resources have great nutritional, economic, cultural and spiritual importance" (ACRG 1999, p.12).

Often subsistence has to take priority over other schedules including paid jobs. In the 2003 report *Sustainable Utilities in Rural Alaska*, the authors succinctly summarize the issue:

> "Rural Alaskans often face difficult trade-offs between the need for cash income and the need to participate in subsistence. This trade-off makes it harder for small rural utilities to keep trained operators on the job during all of the times when they are needed. It also means that rural villages may not wish to generate as much *cash* income as they could, because their scarce time is better spent on subsistence" (Colt 2003, p.13).

These authors report also note that in addition to the priority for subsistence, other reasons that utilities may find it difficult to keep operators on staff are "low wages, poor benefits, competition from other local employers (such as the school), and competition from larger utilities in larger communities" (Colt 2003, p.13). It is unknown if any of these reasons were why the first operator on the project gave his resignation (the Raven Environmental Department was told it was for personal reasons), but they could be applicable to the situation the City faces with the high job turnover rate for the sanitation staff.

The times when the operators were unavailable or out of town, or when the position was unfilled between hiring's, emphasized that the position was necessary for the continued operation and maintenance of the toilets. All of the installations except for the Tundra's needed/wanted the assistance of the operator for at least the emptying of the toilets. The Raven Environmental Department was asked their opinion at the end of the project about suggestions/lessons learned for an operator position in the future in a group discussion setting (see Appendix P for the group discussion notes). They thought that the first operator did a much better job than the second operator and that next time they would try to hire someone more like the first operator (they said the second operator was less reliable, and didn't do as good of a job with the toilet maintenance or educating household members). They wanted an operator who would reliably be available on-call for the households in case there was a problem, and wanted someone that could do more frequent (but brief) check-ups on each of the toilets to ensure they were operating well. They thought it would be helpful to hire one main operator who would take full responsibility for the job, but also to train two or three backup operators at the same time the main operator is being trained, to work as temporary employees if the main operator wasn't available for any reason. If the main operator left the position for any reason, there would then be a few trained people available in the community that could apply for the main position which would help reduce the time that the position was unfilled and allow for a better transition between employees.

For this project, the operators were hired by, and reported to, the Raven Environmental Department but the operators for the honeybucket and flush-haul service are managed by the City. The Environmental Department staff thought that it would be better for the City to manage all future compost toilet operators since they have a more extensive hiring process in place and carry out background checks as a matter of practice on potential employees. They also have a better monitoring process with their employees and require the use of a time card system. Note that the operators themselves were interviewed to find out their own suggestions/lessons learned and feedback/perspectives about the position and project and a summary can be viewed in section 3.9. Interview notes can be viewed in Appendix P.

## *3.6 Electricity Usage*

The Envirolet MS-10 toilets used for this project require electricity to operate properly. The toilets have one 500W heater in the back electrical panel which is thermostatically controlled by two thermostats and is supposed to stay on approximately 25% of the time (according to the manufacturer). The heater is used to help evaporate liquid from the toilet. The toilets also have two 20W fans in the back electrical panel which operate all the time and are also used to help evaporate liquid from the toilet and circulate air and odors out through the vent pipe. The other piece of equipment that uses electricity is the turbo fan which was installed in the vent pipes of all the toilets which helps to draw air up and out of the toilet, increasing evaporation of liquid from the system and decreasing odors in the bathroom. The turbo fan uses a 20W motor and is plugged in separately from the main electrical cord of the toilet. A switch on the back of the toilet gives the option of operating the toilet on “Fans and Heater” mode or “Fans Only” mode.

The store toilet was operated on “Fans and Heater” mode for the first month and a half of operation in order to test the toilet under ideal conditions. Due to the high cost of electricity in Raven (as well as in other Villages state-wide), it was important to estimate the amount of electricity used by the Envirolet toilets and experiment with bringing down the usage if necessary. As mentioned in the Materials and Methods chapter (section 2.61), a Watt’s Up? power meter device was purchased to record wattage of the store toilet at regular intervals. The power meter used on the store toilet was set to log at 10 minute intervals which meant that every 10 minutes, the meter recorded the wattage used by the toilet at that moment, and stored the amount. The meter was started on July 1st after the store toilet was installed and was stopped on July 31st during the second toilet installation trip to Raven. The data were downloaded using the software provided by Watt’s Up? and the average wattage during the 30 day period was found to be 353.6 W. Note that this wattage was for the electricity used by the internal components of the toilet and didn’t include the 20W “external” turbo fan. The total wattage including the turbo fan is 373.6 W. For a one month period (30 days), the estimated kWh usage of the toilet is 269 kWh/month.

## Raven electricity prices

The average cost of electricity in Raven from June 2006 to June 2007 was $0.49/kWh (Alaska Energy Authority 2007). Raven (like many rural Alaska Villages) receives economic assistance through the State of Alaska’s Energy Authority Power Cost Equalization program (PCE) and the PCE rate for Raven in 2006 was $0.2347/kWh, making the effective electricity rate $0.2553/kWh (Alaska Energy Authority 2007). For residences, the PCE rate is only applied to the first 500kWh used each month, and for usage over 500 kWh the original rate of $0.49/kWh is applied. The average monthly electricity usage per household in Raven is 304 kWh (Alaska Energy Authority 2007), which is under the 500 kWh PCE maximum, so an electricity rate of $0.2553/kWh will be used for calculations. Note that in June 2007, the average rate for electricity in Raven rose to $0.55/ kWh, but the PCE was also increased at the same time to $0.376/kWh, which decreased the overall effective electricity rate to $0.174/kWh (Regulatory Commission of AK 2007). Even though the current 2007 rate is $0.0813 less than the 2006 rate, the 2006 rate will still be used because it was the actual rate during the project period.

## Electricity cost calculations for the store toilet

Using a rate of $0.2553/kWh, it is estimated that electricity costs for operation of the store toilet (including the electricity usage from the external turbo fan in the vent pipe) from July 1st to July 31st were $68.67. Calculations were determined using a wattage of 373.6 for 24 hours a day, for 30 days, and converting to kW. The estimate would likely be a typical monthly electricity cost for the toilet, operating on Fans and Heater mode, if not a little underestimated. The main parameter that would increase electricity usage would be the temperature in the toilet – if the temperature is lower, the heater would run more often, using more electricity. Using data from the temperature sensor in the toilet, the average temperature in the toilet in July was 84.41 degrees F compared to the overall average monthly toilet temperature of 77.02 degrees F. So it is possible that the average monthly electricity costs of operating the toilet on fans and heater mode could be a bit more than $68.67, if the heater in the toilet is on for a longer period of time due to the decreased average temperature. Regardless, $68.67/month is a relatively high cost for households to pay each month for use of the toilet, so experimentation was necessary to see if the toilet could be operated using less electricity. Note that using the current 2007 electricity and PCE rates, would yield a cost of $46.80 (approximately $22 less) for the same 30 day period.

## Electricity usage experimentation (“switch test”)

After the store toilet had been operating for six weeks or so without problems, experimentation occurred with using the heaters less often. The first test was to operate the toilet on the Heaters and Fans mode throughout the night and then switch it back and forth between the Heaters and Fan and Fans Only mode every few hours throughout the day, for a two and a half week period starting August 14, 2006. It was estimated that this schedule would reduce the heater usage by one-third. The operator was specifically instructed to do the following to the store toilet over the test period:

> "At night make sure the switch is on 'I Heaters and Fans'.
> At 9:00am (when the store opens), move the switch to 'II Fans Only'
> At 1:00pm, move the switch to 'I Heaters and Fans'.
> At 5:00pm, move the switch to 'II Fans Only'.
> At 9:00pm, move the switch to 'I Heaters and Fans'."

The operator was told to perform this test every day that the store is open during the test period and that if there was a day that he couldn't do it, to ask someone that works at the store to move the switch throughout the day and keep it on Heaters and Fans at night.

The operator was also asked to add the following two questions to the bottom of the daily inspection and maintenance sheets and answer them, yes or no.

> "Was the switch moved between 'I Heaters and Fans' and 'II Fans Only' today?
> Was the switch on 'I Heaters and Fans' last night? "

"Yes" was answered for both questions on all of the inspection sheets filled out by the operator during that period. Note that inspection sheets weren't received for every day during the test period.

Toilet operations were monitored during the test period to see if the overall system performance changed with the heater running less often. Moisture readings from the moisture sensor were high (i.e., saturated or close to saturation) during this period, but the readings were high since late July (prior to the switch test starting). Note also that the month of August had a higher than average daily toilet usage. But regardless of moisture readings, no odors were reported on the odor self report forms during this period of the switch test, and in fact, "smells ok" was marked 28 times during the test period. The operator reported "no odor" on all the inspection sheets filled out during the test period, and the waste in the toilet was reported as looking normal and not too wet or too dry. There was also no reporting of leaking or liquid in the excess liquid tube off the side of the toilet.

Since the toilet seemed to operate without any problems during this test period of using the heater less often, it was decided to test the store toilet on "Fans Only" mode (i.e., no heater) for the last three weeks in September. The biggest concerns of not running the heater were that there wouldn't be enough liquid evaporated from the toilet and that the waste mass would be too wet for composting to occur, and that there would be odors from the toilet. However, the operator reported “no odor” on all the inspection sheets filled out during this next test period, and the waste in the toilet was reported as looking normal and not too wet or too dry. There was also no reporting of leaking or liquid in the excess liquid tube off the side of the toilet. The average temperature in the store toilet for the month of September (from the sensor data) was 74.42 degrees F and the average ambient temperature in the store bathroom for the month of September was 70.31 degrees F. This approximate 4 degree difference is half as much as the difference between the temperature in the toilet and the ambient room temperature for the month of July, when the toilet was operating on the “Heater and Fans” mode. It was expected that the average temperature in the toilet would still be higher than the ambient room temperature for the month of September, because the toilet was operated on the “Heater and Fans” mode during the first week, and also the process of composting generates a certain amount of heat.

## Household toilet operation

Since the store toilet operated without problems on the “Fans Only” mode, it was decided to operate the Tundra’s toilet on “Fans Only” mode from the start since they were a smaller household (2-3 people) and there was less concern of the toilet being overused. The Moss’s household was larger (7 people) and it was desired to operate the household toilets on the “Fans Only” mode all the time, so two toilets were installed at the Moss’s to increase the overall capacity and lessen the load on each toilet since the toilets wouldn’t have the external heat source for increasing the composting rate or evaporating liquid. The Snow’s toilet was the first household toilet installed, and since they were a larger household as well (5-7 people), it was desired to add a second toilet in their bathroom, given the results of the heater/fan tests on the store toilet, and so they would have a greater capacity. However, there wasn’t enough room in the Snow’s bathroom to add a second toilet until the flush haul platform, located in one corner, was removed. The operator was waiting for permission from the household owner to remove the platform but by the time he received it, snow began to fall and pile up around the house making it difficult to remove the platform and tank underneath. Unfortunately a second toilet was never able to be added to the Snow's bathroom, so their toilet was operated on "Heater and Fans" mode for the duration of the project since their daily toilet usage was high.

A Watt's Up power meter was plugged into the Tundra's toilet to get an estimation of the electricity used by a household toilet operated on "Fans Only" mode. The power meter was started on September 11, 2006 (after the toilet was installed), and stopped on October 8th with a logging rate of every five minutes. The data were downloaded and the average wattage during the 28 day period was found to be 39.75W, which is the approximate wattage of the two 20W fans that run all the time. In addition to the electricity used by the internal components of the toilet, the external 20W turbo fan in the vent pipe runs on a continuous basis to help evaporate liquid and draw air and odors out of the toilet, so the total estimated wattage of the toilet operated on "Fans Only" mode is 60W. Note that during the test period, the operator reported "no odor" on all the inspection sheets filled out, and the waste in the toilet was reported as looking normal and not too wet or too dry. There was also no reporting of leaking or liquid in the excess liquid tube off the side of the toilet.

The Tundra's toilet did not need to be emptied out during the power meter test period, but it was advised throughout the project for the toilets to be switched to "Fans and Heater" mode for 3-4 days before the toilet would be emptied (and longer if the waste mass looked fairly wet), to allow for extra drying and evaporation. The toilets were emptied out every 2-3 months on average, so being conservative, three days of operating the toilet on "Heater and Fans" mode should be added to the monthly electricity usage of the toilet. Using the average wattage of the store toilet operating on "Fans and Heater" mode (374 W) for three days in a month, and the wattage of the toilet operating on "Fans Only" mode (60 W) for 27 days in a month, the total estimated kWh used by the toilet for a one month period (30 days) is 66 kWh/month.

## *3.7 Costs*

Startup and annual cost estimates for the Envirolet MS-10 compost toilets tested in this project are presented in this section.

### 3.7.1 Capital Costs

Total capital costs per toilet for an Envirolet MS-10 model (based on 2006 prices) were $2,049**.** A summary of the capital costs per toilet and installation (purchased in Spring 2006) are listed in Table 3.711. Purchasing several toilets in bulk, could lower the cost per toilet, but the amount would be determined by Envirolet at the time of order. The other items purchased from project funds for the installation/startup of the toilets that aren't included in Table 3.711 were; bags of peat moss and cocoa shells (which are considered an annual cost and are described in the next section), plastic bins for throwing used toilet paper into, plastic shelving to store and organize toilet supplies, hand sanitizer, and cups/teaspoons for the peat moss and microbe accelerator.

**Table 3.8 Capital costs for an Envirolet MS-10 (2006)**

| Capital Costs | $ |
|---|---|
| Toilet (One Envirolet MS-10 model) | $1,650 |
| Wind turbine | $50 |
| Excess liquid drain kit (internal) | $37 |
| Vent pipe (included with purchase of toilet) | $0 |
| 16 oz jar of microbe accelerator (included with purchase of toilet) | $0 |
| Bag of pre-mix starter (included with purchase of toilet) | $0 |
| Turbo fan | $79 |
| Shipping | $195 |
| Excess liquid drain pipe and container (external) | $13 |
| Power strip | $15 |
| Buckets for peat moss | $10 |
| **TOTAL** | **$2,049** |

The various sensors and equipment/supplies used for the remote sensing part of the project are described in section 2.61. Table 3.712 lists each item purchased, the part number, the 2006 cost, and where they were purchased from.

**Table 3.9 Capital costs for the remote sensing equipment and installation**

| ITEM | Part Number | $ | Where purchased |
|---|---|---|---|
| Microstation Logger | H21-002 | $199 | http://www.onsetcomp.com/ |
| Hoboware software | BHW-PC | $95 | http://www.onsetcomp.com/ |
| Serial Interface Cable | CABLE-PC-3.5 | $9 | http://www.onsetcomp.com/ |
| Pulse Input Adapter Contact Closure Version | S-UCB-M006 $69 | | http://www.onsetcomp.com/ |
| Temperature sensor 12-bit with 6m cable (for inside toilet) | S-TMB-MOXX $90 | | http://www.onsetcomp.com/ |
| Temperature sensor 12-bit with 6m cable (for | S-TMB-MOXX $90 | | http://www.onsetcomp.com/ |

| | | | |
|---|---|---|---|
| bathroom) | | | |
| Soil Moisture sensor with 3m cable | S-SMA-M003 $150 | | http://www.onsetcomp.com/ |
| Stowaway tidbit temperature logger | TBI32-05 $119 | | UC Davis / http://www.onsetcomp.com/ |
| Microstation adapter cable | HWS-F | $45 | http://www.onsetcomp.com/ |
| Spring tip limit switch | | $60 | McMaster Carr |
| Solar Stream Satellite Transceiver and antenna | $839 | | http://upwardinnovations.com/upward/products.html |
| On-line monthly service for Satellite system ($20/mo for 10 months) | $200 | | http://upwardinnovations.com/upward/products.html |
| Miscellaneous parts for fitting the sensors to the toilet | $300 | | UC Davis |
| Watt's Up power meter | PRO ES | $195 | https://www.wattsupmeters.com/secure.html |
| **Total** | | **$2,460** | |

### 3.7.2 Annual O&M Costs

The direct costs associated with the on-going operation of the Envirolet compost toilets tested in Raven include the peat moss, microbe accelerator, and electricity, and are further described in the next few pages.

**Peat moss**

The bags of peat moss used throughout the project were Black Gold brand 2.2 cubic feet (~263 cups) and cost $25/bag including shipping to Raven. Assuming 1.5-2 cups of peat moss per day are added per toilet for a small to medium sized household, 2.8 bags are needed per year. Rounded to three bags per year, the annual cost of peat moss for a small to medium household is $75/year. For a large household with 2 toilets, assuming 1.5 cups of peat moss are added each day to each toilet, approximately 4 bags of peat moss are needed per year, which totals to $100/yr. Cocoa shells were also added to the store toilet and some of the household toilets initially, however, the cost of a bag of cocoa shells was the same as a bag of peat moss and when used, the cocoa shells were added in a 50/50 ratio with the peat moss, so there were no extra costs for the cocoa shells. Note that by the end of the project, only peat moss was being added to all the toilets to reduce time and burden to the store staff and household members.

## Microbe accelerator

The cost of a 16 ounce jar of Envirolet microbe accelerator was $18 in 2006, including shipping, and can be purchased from Envirolet. One tablespoon of the accelerator is added per toilet every other week, so one 16 ounce jar lasts approximately one year. For households with two toilets, one 16 ounce jar is needed for each toilet per year.

## Electricity

Electricity usage was detailed in section 3.6. Electricity costs will depend on the current price per kWh and the PCE rate offered by the state. As noted earlier, electricity usage per toilet operating on “Fans Only” mode for the majority of the time, with a few days of operation on “Heaters and Fans” mode before the toilet is cleaned, is estimated to be 66 kWh/month. Note that this includes the use of a turbo fan (located in the vent pipe) operating all the time. Also noted earlier, the price of electricity in Raven during the project period, including the PCE rate was $0.2553/kWh (see section 3.6 for details) (Alaska Energy Authority 2007). Based on this rate, the annual cost of electricity per toilet is $202. Note that the overall electricity rate went down for the 2007/2008 year, and has gone down each year for the past three years. Tables 3.713 and 3.714 summarize the annual and equivalent monthly costs for a one toilet and two toilet scenario using both the 2006/2007 and the 2007/2008 electricity rates.

**Table 3.10 Annual costs for a one toilet scenario**

| Annual costs for one toilet* | Using the 2006/07 electricity rate of $0.2553/kWh | Using the 2007/08 electricity rate of $0.1740/kWh |
|---|---|---|
| Peat moss (3 bags per year for a large household, $25/bag including shipping) | $75 | $75 |
| Microbe accelerator (one 16 oz jar per year @ $18/jar including shipping) | $18 | $18 |
| Electricity costs (operating on Fans Only mode for the majority of the time, with a few days of operation on Heater and Fans mode before the toilet is cleaned, based on 66 kWh/month) | $202 | $138 |
| **TOTAL ($/yr)** | **$295** | **$231** |
| **Monthly equivalent ($/month)** | **$25** | **$19** |

**Table 3.11 Annual costs for a two toilet scenario**

| **Annual costs for two toilets*** | **Using the 2006/07 electricity rate of $0.2553/kWh** | **Using the 2007/08 electricity rate of $0.1740/kWh** |
|---|---|---|
| Peat moss (4 bags per year for a large household, $25/bag including shipping) | $100 | $100 |
| Microbe accelerator (one 16 oz jar per year per toilet @ $18/jar including shipping) | $36 | $36 |
| Total electricity costs for two toilets (both operating on Fans Only mode for the majority of the time, with a few days of operation on Heater and Fans mode before the toilet is cleaned, based on 66 kWh/month) | $404 | $276 |
| **TOTAL ($/yr)** | **$540** | **$412** |
| **Monthly equivalent ($/month)** | **$45** | **$34** |

* Both tables assume that all maintenance on the toilets (including emptying/cleaning) is carried out by the households, without an operator.

## Other potential annual costs

### Replacement parts

Replacement parts for the toilet, such as fans, electrical system, etc. weren't considered in the annual costs because a free warranty is provided by Envirolet that includes lifetime coverage on the system body and a five year coverage on the internal components. The components of the system that are most vulnerable to failure (and likely the most expensive to fix) are the electrical parts which all fit in the "works in the drawer" box at the back of the toilet. The cost to replace the "works in a drawer" box is $225, so if it was desired to factor in replacement costs after the five year warranty expires, an additional $33.75 could be added to the annual costs assuming the electrical box may need to be replaced every five years for a 20 year period.

### Local operator

As described further in section 3.5, having a local operator to help maintain the toilets and at the very least, empty the toilets when needed, was desired by two of the three households and the store staff. This is another potential on-going expense for successful operation of the compost toilets. Currently the City of Raven Water and Sewer Utility (City) provides operators to service households with flush-haul systems and honeybuckets, for a fee to the households. The rates the City charges for the collection service are given here. Funding for the operators is provided partially (about half) from Bingo funds and partially from the household fees collected.

***Flush-haul Service***

Twelve households and two businesses have flush-haul in the community. Costs are $10 to have the 100 gallon water tank in the home filled and $30 to have the outdoor wastewater tank pumped, and households pay per fill/collection (i.e. there isn't a set monthly fee). The service frequency varies by household –- some are serviced 1-4 times/month, and others every 1-2 months. The number of households that request service each month is around 4-5. (Note that these are costs for operator service only and don't include other costs that the household pays for the system such as electricity, parts replacement, etc.)

***Honeybucket Collection***

The cost for an operator to pickup honeybuckets is $35/month. The $35 fee is paid on a month-to-month basis, and for the month that it is paid, honeybuckets are picked up a few times a week during that month. The number of households that sign up each month varies but averages around 11-15).

For the compost toilet project, the operator was paid from grant funds and the position finished when the grant was over. The Raven Environmental staff discussed the possibility of the compost toilet operator continuing under the City's program (Bingo funds). Since one to two of the households that have compost toilets installed used to pay for honeybucket collection, they may also be willing to pay an operator a fee to empty their compost toilet on an as needed basis. In addition, perhaps the City would be able to supplement the fee as they do with honeybucket and flush-haul service.

Based on interviews with the first and second operators for the project, the time required to empty the toilets is 1-2 hours and both operators thought a wage of $16/hr (including fringe) was reasonable for the job. If households were to pay an operator on an as-needed basis to just empty the toilets, the costs would be as follows (note that the costs listed do not include any supplement from City Bingo funds):

- For a single household to pay to have their toilet emptied on an as-needed basis would cost $20 for one toilet, or $40 for two toilets (note that these are per event costs, not monthly costs)
- Based on the average emptying frequency of every 2.5 months, the equivalent annual cost would be $96/yr for one toilet and $192/yr for two toilets, and converted to monthly basis would be $8/mo for one toilet and $16/mo for two toilets.
- A ssumptions
  - The average number of times the toilets needed to be emptied throughout the project was every 2.5 months, or 4.8 times per year.
  - The estimated amount of time an operator would need to empty out one toilet is 1.25 hours (or 2.5 hours for households with two toilets).
  - The hourly wage for the operator is $16/hour including fringe.

If an operator was servicing multiple households with compost toilets installed (emptying the toilets only), based on the same assumptions, the annual operator costs required for servicing households for three scenarios (all households, one-third of households, and two-thirds of households) would be as follows in Table 3.715  (costs listed do not include any supplement from City Bingo funds):

**Table 3.12  Estimated annual operator costs**

| Number of households serviced by operator* (emptying toilets only) | Estimated operator costs $/yr |
|---|---|
| Operator servicing one-third of households in Raven | $4,760 |
| Operator servicing two-thirds of households in Raven | $9,520 |
| Operator servicing all households in Raven | $14,280 |

* Assuming that 75% of households serviced would have two toilets, and 25% would have one toilet

Since the City of Raven supplements the collection service for honeybuckets and flush-haul with Bingo funds, the City may also be able to supplement an operator to service compost toilets. Households would still need to pay a fee if this was the case, but it would be lower.

Based on interviews with household members and store staff (see Appendix P for interview summaries), a few people wanted to have an operator available to carry out basic maintenance on the toilets, as well as to empty them. Assuming the household members would be responsible for adding their own peat moss after every use of the toilet, the operator would likely need to spend 1-2 hours per week per household for carrying out basic maintenance such as:

- Going around the households (each one every other day) and checking the following:
  - →Making sure people are adding peat moss (the right amount and frequency)
  - →Making sure the waste pile looks "normal" (i.e. not too wet or too dry)
  - →Making sure the microbe accelerator is being added every other week
  - →Making sure the aerator bar is being pulled three times per week
- Troubleshooting any problems with the toilet
- Ordering parts if needed
- Empting any excess liquid in the side drain container
- Ordering peat moss and distributing when needed
- Maintaining a log of duties performed for each household
- Emptying the toilets when needed.

The total hours required for the operator to carry out the basic maintenance and emptying the toilets for the households would again depend on the total number of households with compost toilets, but would likely be a full time position (40 hours/wk) for 20-40 households, and a second position would certainly be required to service over 40 households.

## *3.8 Comparisons Between Flush-haul, Piped Utilities, Compost Toilets, and Honeybuckets*

In 2000, CE2 Engineers produced a report for Raven which comprehensively compared a piped water/sewer system to a flush-haul system (including technical and financial feasibility specifically for Raven) based on the results of operating 14 flush-haul units in Raven for one year. The report produced is the "Sanitation Facilities Preliminary Engineering Study, Raven, Alaska, 2000." Two tables were produced in the report which compared the level of protection to health and customer convenience, as well as other considerations, between the flush-haul (closed tank and haul system) and piped utilities. The tables were duplicated from the report and comparative information for compost toilets and honeybuckets were added as two separate columns, based on the results of this project, so the four current/potential sanitation systems for Raven could be viewed side by side. Criteria such as maintenance skill requirements, homeowner involvement, costs, waste handling, etc. are included in the tables. Note that some criteria can't be compared between the four options such as quality/quantity of water provided, bathing and laundry abilities since compost toilets and honeybuckets do not provide water to the home. Since the two tables span several pages, they are presented in Appendix Q to save space.

## *3.9 Socio-Cultural Assessment*

The methods used to carry out the socio-cultural assessment and gather information on user perspectives and opinions about the compost toilets were based in part on Participatory Rural Appraisal (PRA) and Rapid Rural Assessment (RRA) (also referred to as Rapid Rural Appraisal), which are both proven methods for collecting and evaluating qualitative information on rural projects, and in particular, for assessing sanitation planning and operation in Alaska Native Villages. Lessons learned from prior participatory based Alaska sanitation projects were also taken into consideration. An overview of PRA and RRA concepts and methodology is described in section 1.4 and the application of PRA and RRA to the project, and the results, are given in this section. An overview of the particular methods used is presented first, and a summary of the results follows.

### 3.9.1 Overview of Methods

**Feedback forms**

Feedback forms were given to household users to find out what they liked and didn't like about the compost toilets and to see which system (honeybucket, flush haul, and compost toilet) was preferred. The forms were filled out in the third and fourth quarter of the project during visits to Raven and a total of 10 forms were filled out. A blank feedback form can be found in Appendix F and the full results of the forms can be found (by household) in Appendix R. A summary of the results of the forms are given in Table 3.9222.

Separate feedback forms were given by the operator to households in the second quarter of the project to gauge user perspectives and to find out what maintenance tasks were being carried out by the households at that point. Results of those forms can be viewed in Appendix R. Another general feedback form was also made available to store users from the start of the project (blank forms were posted on the wall), for people to give opinion on the toilets directly after use, however, only a few people (4 total) filled these out. Results from these forms can be viewed in Table 3.9222 as well.

**Semi-structured interviews**

Semi-structured interviews were given to store and household users, as well as the local operators, to augment information given in feedback forms. The store and household interviews were carried out in-person during the third and fourth quarters of the project. The interviews with the operators were mostly carried out over the phone. The store and household interviews were informal and were mostly carried out in people's homes or wherever they were located in town at the time. The role as the interviewer was more as a listener. People were encouraged to talk in general about what they thought of the toilets with questions interjected. Many of the interviews were short because people had busy schedules. The interviews were also used as a way to get general opinion of the current sanitation situation in Raven and the direction residents would like to see it go. Much was learned from the first round of interviews and adjustments were made for the final round of interviews, such as the time of day to carry out interviews, location, and questions to ask. It was better to catch people where they were and interview them on the spot, rather than setting up scheduled interviews. Interviews carried out can be viewed in Appendix P and summary results of the interviews are given in the next section 3.92.

Interviews were also carried out with the first and second operators and were invaluable as they were able to provide information about the operator's experience with the toilets installed, maintenance, and suggestions for improving the toilets and project overall. A brief phone interview was carried out with the first operator before he moved on from his position. Phone interviews were also given to the second operator in the third and fourth quarters of the project. See Appendix P for the interviews with the operators and section 3.92 for a summary of the interviews and lessons learned from the operators.

## Group interviews/discussion

Group interviews were given in the third and fourth quarters of the project. Attendees varied for each interview, but generally included Raven environmental staff and residents. The group interviews were helpful for generating discussion about Raven's sanitation situation in general, for reflecting on the compost toilet project, for making suggestions for improvement, and for discussing overall results. The group interviews/discussion carried out can be viewed in Appendix P and summary results of are given in the next section 3.922.

## Triangulation of information

As mentioned in section 1.4, triangulation is "gathering information about a particular topic from a variety of different sources, using a variety of data-gathering methods" (Crawford 1997) Triangulation was used for the socio-cultural assessment part of this project to cross-check information, to gain perspectives from a variety of angles, and to ensure greater accuracy of community opinion about the toilets. Information from semi-structured interviews came from multiple sources including household and store users, the local operator(s), and Raven environmental staff. Multiple methods were also used to gather user perspectives such as feedback forms, individual interviews, and group interviews. Triangulation was also used in other ways throughout the project. For example, multiple methods of information distribution were used to educate the community about the compost toilets including written flyers, radio (VHF) announcements, and Council meetings.

## Use of indigenous knowledge and systems perspective

The Raven environmental staff and the community store owner were seeking alternatives to honeybuckets and specifically wanted to test compost toilets in their community. The environmental staff, store owner, and local operator(s) were key to ensuring that the project was carried out in a way that was appropriate and best for Raven. The environmental staff, store owner, and some TC members helped select the type of compost toilet that would work best for Raven's situation. The environmental staff and operator translated toilet instructions and other educational materials about the project into Yup'ik, made announcements about the project over the radio system in Yup'ik, and also gave community presentations about how the toilets work in

Yup'ik. The environmental staff and operator(s) also advised on the best ways to educate the community about the toilets, and after experimenting with toilet use and operation over time, the operators were deferred to as the experts for optimal toilet operation for Raven's environment.

**Direct observations from frequent village visits**

Having worked with Raven for several years before the project started, and having visited on several occasions, helped to build relationships with the environmental staff and community and helped to get a better and more comprehensive understanding of their sanitation situation. On-site visits, prior to the project starting, allowed for direct observation of the household structures and common bathroom layout which enabled informed decision-making about the type and size of compost toilets that would be suitable for the community. Visits also allowed for conversation with sanitation operators which helped for designing the operator position for the project. Once the project started, frequent visits to Raven throughout the project period allowed for direct observation of the toilet's performance and direct conversation with users, both of which were key to monitoring the toilets and augmenting the information relayed from the local operator.

### 3.9.2 Summary Results Overview

The following is a summary of the findings from the individual interviews, group discussions, feedback forms, and operator interviews. Information is broken out into three sections –- current sanitation situation, compost toilet technology, and lessons learned from the operator position.

#### 3.9.2.1 Current Sanitation Situation in Raven: Summary of Results from User Feedback

At the beginning of the group interviews/discussions, people were asked about the current sanitation situation in Raven and the overall response from attendees was quite uniform. People were asked what they thought of the flush-haul systems and honeybuckets, which systems were preferred, and generally discussed the state of sanitation in Raven. The problems and issues people that had with current sanitation options in Raven are as follows:

Flush haul

- Has limited use
- When the tanks fill up, the system can't be used until it's emptied

- The water tanks must be filled or the system can't be used
- There are many problems with the flush haul system
- When full, the flush haul tanks overflow raw sewage onto the ground and residents really don't like that
- The flush haul system is loud and takes up a lot of room
- The flush haul system is expensive
- It can take a long time for an operator to come and empty the flush haul tanks, so they often sit full for a long time
- There are often complaints from the households in the winter when the operator doesn't come to empty out the tanks for a long time because of bad weather, access to the house, laziness, or being out of town
- The flush haul systems often sit full and households have to use a honeybucket until the operators come around to empty them.
- Some households can't even get flush haul if they wanted to, because access is a problem

<u>Honeybuckets</u>

- Honeybuckets are unhealthy, they have germs and bacteria and they smell horrible
- Some people still dump them in the river instead of the lagoon
- The honeybucket wastes sit in tied plastic bags at the lagoon and they don't breakdown
- People dump chemicals like Lysol into their honeybuckets which gets into the environment
- Honeybuckets spill and are heavy to haul
- Most households need to have them dumped every one to two days
- People don't like having to haul honeybuckets, especially in the winter

<u>General</u>

- The lagoon is overflowing with human wastes and is also full of plastics (bags)
- The watering points in town are ok but running water in the homes would be better
- The community would like a piped water and sewer system but they don't know if it will ever happen

- The costs for a piped system that CE2 calculated would be too expensive for people to pay - less than 10% of people would be able to pay it

### 3.9.2.2 Compost Toilet Technology - Summary of Results from User Feedback and Operator Records/Reports

From the feedback forms given in January 2007, all but one of the toilet installations preferred compost toilets to honeybuckets (see Table 3.9222 for a summary of results). The main reasons given for preferring compost toilets to honeybuckets were reduced odors from the compost toilets, and the compost toilets didn't need to be emptied all the time like honeybuckets.

The one installation that thought compost toilets were the same or worse than honeybuckets in the January 2007 feedback forms was the Moss's and according to interviews carried out with members of the Moss's household, the biggest problems they had with the toilets were the odor from the used toilet paper bin, leaking from the faulty excess liquid line, water leaking from the ceiling during heavy rains, and noise from the fans. The toilet paper smell and leak issues were

**Table 3.13 Summary results of feedback forms for all installations**

| Question asked | Snow's (Jan, 2007) | Tundra's (Jan, 2007) | Moss's (Jan, 2007) | Store (Jul, 2006) |
|---|---|---|---|---|
| What do you think of the compost toilet? "I like it," "I don't like it", "I don't know" | 67% "I like it"<br>33% "I don't know" | 100% "I like it" | 60% "I don't like it"<br>20% "I like it"<br>20% "I don't know" | 75% "I don't know"<br>25% "I like it" |
| Is there something you don't like about this toilet? What? | • Toilet fills up too fast. During the winter season it is hard to dump the inside since there is no vent and the smell is too strong when they empty it.<br>• Needs another toilet, like it needs more capacity<br>• Has to be emptied often. Sometimes little bit of odor outside when you walk by. | • When it leaked on the side and when it's really windy there's a bit of noise from the pipe shaking.<br>• Jus t sometimes when it leaks on the side. | • It's stinky sometimes and don't know<br>• When it stinks and the fan and noisy<br>• The smell (at times) and that we need to put tissue in a different container.<br>• It's noisy, takes a lot of space, uses a lot of electricity.<br>• I don't like the smell, not having to put the tissue in it, and the fan. The fan gets the butt dry and keeping track of how many times we pee in it and they're noisy. | • It doesn't flush<br>• Smell and once it's up to capacity, you have to wait, even on emergency<br>• When peat moss is not put on, you can see the poop |
| If there are things you like about this toilet, what are they? | • It runs okay but Question 2 (above) is just my concern. Since it fills up to fast.<br>• They don't smell like honeybuckets<br>• No odor (except when you empty it) | • Never have to dump the honeybucket.<br>• No odor like honeybuckets | • We don't have to fill and empty a honeybucket every 1.5 days. And that the soil or end product is usable for soil enhancers and can be sold.<br>• No thing<br>• Don't have to take out the honeybuckets a lot. I just don't like it.<br>• You can't drop your used toilet tissue in it, you have to take it out, and drop it somewhere else. (stinks up the place)<br>• Not having to dump honeybuckets and the anaq dissolving. | (Different form – this question wasn't asked). |
| How does use of this compost toilet compare to using a honeybucket? | 100% "Better" | 100% "Better" | 40% "Worse"<br>60% "Same" | 100% "Better" |
| How does use of this compost toilet compare to a flush-haul toilet? "Same", "Better", "Worse", "Don't know" | 100% "Better" | 100% "Better" | 100% "Don't know" | 100% "Don't know" |
| Which do you like best? "Honeybucket." "Flush-haul," "Compost Toilet" | 100% "Compost Toilet" | 100% "Compost Toilet" | 40% "Honeybucket"<br>60% "Flush haul" | (Different form – this question wasn't asked) |
| Do you think that compost toilets should be installed in other honeybucket households in Raven? "Yes", "No", "I don't know" | 67% "Yes<br>33% "I don't know"<br>• It depends on the people .I can't boss them around)<br>• Bigger houses like us need 2 toilets. | 100% "Yes"<br>• Many people have come over to try to compost toilet and they want one. | 20% "Yes"<br>20% "I don't know"<br>60% "No" | (Different form – this question wasn't asked) |

remedied, and the noise from the fans was reported as less of an issue by the end of the project because household members said they got used to the “hum” sound. There was still some concern that leaking would occur again however. From interviews carried out in May 2007 all the toilet installations still preferred compost toilets to honeybuckets, but the Moss’s household was mixed—some members preferred compost toilets to honeybuckets and some still thought they were the same or worse than honeybuckets. All the installations except for the Tundra’s wanted the operator to at least carry out the task of emptying the toilet(s), and the lack of operator availability (due to subsistence season and staff turnover) towards the end of the project was frustrating to people, particularly the Moss’ household.

A group interview/discussion was carried out toward the end of the project and included Raven environmental staff and a resident of Raven (all of which had used the compost toilets and were very familiar with all the installations and the project in general), and they were asked to list the pros and cons of honeybuckets and compost toilets. Results are shown in Table 3.9221.

**Table 3.14 Pros and cons of honeybuckets and compost toilets listed in Raven group interview/discussion (2007)**

| | Pros | Cons |
|---|---|---|
| **Honeybuckets** | • Everyone knows how to use them<br>• People can dump them themselves at any time and they know where the lagoon is | • They are unhealthy<br>• They have germs and bacteria and they smell horrible<br>• Some people still dump them in the river instead of the lagoon<br>• The honeybucket wastes sit in tied plastic bags at the lagoon and they don’t breakdown<br>• People dump chemicals like Lysol into their honeybuckets and that gets into our environment |
| **Compost Toilets** | • There are less germs and bacteria from them<br>• You don’t have to empty them as often as honeybuckets<br>• The end result is like mud<br>• The mud can be used for something and it doesn’t mess up our environment like honeybuckets do<br>• The compost toilets have no flies, and no smell<br>• They don’t spill like honeybuckets<br>• They’re not heavy to take out like honeybuckets<br>• You don’t have to dump them for 2-3 months, where honeybuckets have to be dumped every two days or so | • Maintaining the toilets –- it takes work to maintain them unlike honeybuckets<br>• Sometimes there are odors if they leak or when you clean them out<br>• They are harder to dump than honeybuckets, and an operator is needed |

<u>Likes and benefits</u>

In feedback forms and interviews with household users and store staff, people were asked what they liked about the compost toilets and what they disliked or had issues with. Things that people liked about the toilets included:

- Bathroom odor reduction
- Useful end product that doesn't hurt the environment
- Less maintenance in terms of frequency of emptying (compost toilets don't have to be emptied as often as honeybuckets)
- Less mess than honeybuckets

Some specific comments about what users liked about the toilets are listed below:

> "There's never any odor except when it gets cleaned. I'm so happy that I don't have to haul honeybuckets anymore. I never have to smell *anaqs* (feces) anymore."
>
> "Odors from the compost toilets aren't an issue except when there is a leak, or they are being emptied."
>
> "The compost toilets are better than honeybuckets because they don't have to be dumped out and emptied all the time."
>
> "Compost toilets work as an alternative to honeybuckets because the cost is cheap and the toilets work well when there's a good operator."
>
> "The good part is that the compost toilet reduces the dumping of honeybucket wastes."
>
> "Compost toilets smell much better than honeybuckets and they make less of a mess"
>
> "Between compost toilets and honeybuckets, I prefer compost toilets. But I would like to have an operator to clean it out when it needed it. I think the operator position is really key for having the compost toilets."

<u>Dislikes and issues</u>

The issues or dislikes that people had with the toilets varied for each installation, but there were a few common issues shared by two or more installations which were:

- Odor when the toilet is being emptied or is full
- Toilet leaks (from faulty liquid line)
- Noise from the vent pipe shaking when it's windy
- Water leaks (from rain) where the vent pipe meets the ceiling
- Odor outside from the vent pipe exit

Comments about issues or what users disliked about the toilets included:

> "Sometimes there is some noise from the toilets – it's like a hum like a refrigerator. When the door is closed, the noise is ok, but otherwise it's a little loud."
>
> "When the toilet is full, sometimes there is odor, even when the lid is closed, but it's not as bad as a honeybucket."
>
> "As far as other odors, it smells ok inside but outside of the house in the summer it sometimes smells from the vent pipe."
>
> "Odor was also sometimes a problem when it was really windy."
>
> "Sometimes it's noisy (the fans) and when it's windy, the pipe shakes and is noisy."
>
> "We need to get the second toilet installed so the one doesn't fill up so fast. We need two toilets for our household size."
>
> "The worse odor is from the toilet paper in the can. The toilets themselves are ok because I think the fan sucks out the smell."

On the following pages, a summary of the issues that were reported by users for each of the individual installations is presented, along with information on how the issue was addressed, or could be addressed. Also presented is a summary of the technical issues that arose throughout the project period that were reported/recorded by the operator for each individual installation.

**Table 3.15 Store toilet - technical issues that occurred during the project period**

| Issue | How issue was addressed, or could be addressed |
|---|---|
| The wind turbine on the store toilet stopped spinning due to ice and snow buildup during a winter storm on 3 separate days | The operator went on top of the roof of the store and cleared the ice and snow out of the turbine on each occasion. The wind turbine did not ice up again for the remainder of the project after this storm. |
| Towards the end of the project, more people than just the store staff were regularly using the toilet (particularly during events held in near-by buildings such as Bingo). A second toilet may be needed in the store to meet the new capacity. | Although one toilet was suitable for the capacity needs of the store for over half of the project period, a second toilet is recommended to meet the increased use of the toilet seen towards the end of the project. The toilet was taken out a month or so before the project ended but since the store was remodeling a new bathroom, it was recommended to the store owner to set aside space for two toilets in the new remodeled bathroom. The store owner also suggested that a couple compost toilets be installed at the Bingo hall for people to use. |
| There were odor reports on a couple days when the wind turbine was blocked, once or twice when the toilet was full, and on a couple of particularly windy days. | The operator said that the odor went away after the wind turbine was fixed and started spinning again. Odors were also reported gone after the toilet was emptied. Odor reports on windy days were rare but it is assumed that odor resulted from reverse air flow from strong wind (i.e. air moving down through the vent pipe into the toilet/bathroom). |
| An overuse capacity issue occurred over New Year’s when the store was carrying out their annual inventory and had all their employees, plus additional temporary staff, working long hours over a short period of time and everyone was using the store toilet. The toilet was overused during this time and had to be shut down for a couple days to allow the toilet to “catch up” (i.e. allow excess liquid to evaporate so adequate composting could take place). | According to store staff, this kind of inventory happens just once a year, so the overuse experienced over New Year’s was not expected to be an on-going occurrence. If a second toilet was installed at the store, this type of occasional overuse would be less of a problem. Regardless, the store staff were told that the next time a major over-use of the toilet was expected, the easiest thing to do would be to shut down the toilet and put a honeybucket in place for that period. |

**Table 3.16 Store toilet - user reported issues throughout project**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| When the toilet is full and the operator isn't available right away to come empty it | This was more of an issue towards the end of the project because the 2nd operator was out a lot in the spring on sick leave and/or for subsistence. The store wanted the operator to carry out the maintenance duties of the toilet throughout the project (aside from adding peat moss and pulling the aerator bar), particularly the task of emptying the toilet, as opposed to doing it themselves. There were some odor issues when the toilet was full and needed to be emptied and it frustrated the store staff when the operator wasn't available to work on the toilet. Flush-haul households face similar operator issues in Raven. When the flush-haul tank outside the home is full and needs to be emptied out with the vacuum pump, an operator is not always available to come and do it, particularly during the spring subsistence time and during the winter when there are access issues due to snow buildup. When that occurs in flush-haul households, honeybuckets are put into place until their system can be used again. Odor can also be an issue when the flush-haul tanks are full.<br>Emptying an Envirolet compost toilet doesn't require specific equipment or skills, but the store staff and owner wanted it to be carried out by the operator, so as people do for the flush-haul system, the store needs to put a honeybucket in place when the compost toilet is full until an operator is able to empty it. |
| Occasional odor when it was windy | This was mentioned in the prior technical issues section. The store was the only installation that mentioned odor issues on windy days. The store also had the longest vent pipe extension of all the installations (twice the length than the household installations). So this issue could be due to the specific location of the store building in the community for wind flow, or that a longer vent pipe allows for more backdraft. It is unknown if the wind turbine at the top of the vent pipe helps reduce backdraft or increases it on windy days. An alternative option to the wind turbine is a "Special "V" rain cap that is placed on top of the vent pipe which doesn't spin but has a V shaped top that prevents rain from going into the pipe. This alternative cap could be tested to see if it helps the backdraft issue on windy days, however the spinning action of the wind turbine help draw out odors from the toilet on a regular basis so it is likely that the turbine is still the best option on top of the vent pipe. The backdraft odor issue was reported as only happening occasionally and was not a daily or even monthly reported issue. |
| Seeing feces in the toilet | This was a concern stated early on in the project on a feedback form from a store user. Since toilet paper wasn't thrown into the toilet after use, this is an understandable concern that some people may have. Early in the project, peat moss/cocoa shell was only being added one time a day by the operator. Part-way through the project however, the store staff were shown to add a handful of peat moss into the toilet after every use. Being able to cover feces with the peat moss may alleviate this concern for some people. |

| | |
|---|---|
| You can't "flush" the toilet | This was also a concern stated early on in the project on a feedback form from a store user. This issue may be similar to the one prior. Some people like to have all waste flushed away and "gone" and not be able to see it. As mentioned with the prior issue, store staff were shown to add a handful of peat moss into the toilet after every use. This in combination with turning the handle to open and close the toilet bowl before and after use, may offer a substitute for "flushing" for some people. |
| Sometimes the bathroom is odorous when the toilet is being cleaned | This was a common response from several of the toilet installations. The process of emptying the toilet will likely always produce some level of odor and the strength of the odor will depend on how dry or wet the end product is and how composted it is. Ventilation during and after cleaning (in the bathroom and/or the house) is necessary although it becomes more difficult in the winter time when it's really cold outside (it can be too cold outside to do any ventilation). In the winter, it may be necessary to put a honeybucket in place and wait until a storm passes or the weather warms enough to ventilate adequately. |
| The toilet fills up fast when a lot of people are using it | This was seen after the New Year's over-usage mentioned in the prior technical issues section. And also mentioned previously there were more people using the toilet towards the end of the project (especially during weekly events such as Bingo). Adding a second toilet to the store bathroom was recommended to the store owner if the increased use of the toilet during events continued. A second toilet would give more capacity and increase the time that the toilets would fill up and need to be emptied. |

**Table 3.17 Snow's toilet - technical issues that occurred during the project period**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| One toilet didn't offer the capacity needed for the household size. The toilet filled up too fast and needed to be emptied too frequently. | Due to a miscommunication or misunderstanding, there were more people living in the household than originally thought when the household was selected to test the toilet. Five people were thought to have lived in the household, but it turned out to be more like 5-7 or more plus frequent guests on the weekends. Based on tracking sheets and operator reports, the toilet was frequently used at maximum capacity. The average time between toilet cleanings was also the lowest for the Snow's than any other household (approximately every 1.6 months) and the toilet often filled up too fast due to the overuse. A second toilet was recommended to be installed in their bathroom to increase the overall capacity, and was made available to the household. Although their bathroom was large enough to fit two toilets, the remnants of the flush-haul system would need to be removed first to fit the second toilet in. The flush-haul system was installed in their house several years back but it didn't work well for them so they partially removed it, but the platform in the bathroom still exists as well as the tank below the house. The operator was waiting for |
| | permission to remove the platform from the household owner but by the time he received it, snow began to fall and pile up around the house making it difficult to remove the platform and tank underneath. Unfortunately a second toilet was never able to be added to the Snow's bathroom during the project period: however, the extra toilet remained available to the household.<br>To deal with the issue of overuse with the one toilet, the household needed to operate the toilet on Heater and Fans mode at all times, shut the toilet down for a longer period of time before emptying to allow excess liquid to evaporate, and put a honeybucket in place during the time that the toilet was shut down before emptying. |
| Leakage from the front of the toilet early on in the project | This was the only time (of any of the installations) when there was leakage reported from the front of the toilet. According to conversations with the operator and operator records, the leakage occurred because the front panel wasn't securely put back on after the operator had taken it off to demonstrate to the household how the toilet is cleaned out. The front panel on the bottom of the toilet fits back on the toilet with 4 knob/screws and needs to be fully tightened so the gasket/metal backplate are firmly attached and sealed. The operator removed the front panel and put it back on securely and there were no further issues with leakage for the rest of the project. |
| Odor issues when the toilet leaked and sometimes when the toilet was full. | Odor issues inside the bathroom were rarely reported at the Snow's but there were odor issues when the leak out of the front panel occurred. The odor issues went away however when the leak was cleaned up and the front panel was securely reattached. There were also a few odor issues reported when the toilet was full and also when the toilet was being emptied, but the odor went away after the toilet was emptied out. |

**Table 3.18 Snow's toilet - user reported issues throughout project**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| The toilet fills up too fast | The average time between toilet cleanings was the lowest for the Snow's than any other household (approximately every 1.6 months) and the toilet often filled up too fast due to overuse. See the first technical issue "One toilet didn't offer the capacity…" in Table 3.9225 for more information about this issue. A second toilet was recommended to be installed in their bathroom to increase the overall capacity and increase the time between cleanings, and was made available to the household. |
| Odor issues when emptying the toilet in the wintertime | The process of emptying the Envirolet toilets will likely always produce some level of odor and the strength of the odor will depend on how dry or wet the end product is and how composted it is. Ventilation during and after cleaning (in the bathroom and/or the house) helps dissipate any odors but it does become more difficult in the winter time when it's really cold outside (it can get too cold outside to do any ventilation). The Snow's bathroom unfortunately didn't have any windows so ventilation needed to take place through the windows in the other rooms in the back of the house. In the winter, if there was a cold snap when the toilet needed to be cleaned, it was necessary to put a honeybucket in place and wait until the weather warmed a bit so the area could be ventilated. The longer the toilet can sit unused on Heater and Fans mode, the more the material will dry out and the less the odors will be when emptying. If the Snow's had two toilets in operation, when one toilet needed to be cleaned, it could be shut down for 1-2 weeks in the winter if needed, while the other toilet is being used, which would significantly lower odors during cleaning. Two toilets would also increase the overall capacity and allow more time for the waste to breakdown before they had to be emptied. |
| Sometimes people can smell a little odor outside when walking by the house from the top of the vent pipe | There were few indoor odor complaints from this household – odor issues inside were mostly from when the toilet was emptied out. But a couple members of the household complained about odor issues from the vent pipe outside the house when walking by the house. Odors outside from the vent pipe meant that the wind turbine and turbo fan were doing their job of pushing/drawing air out of the toilet/bathroom and to the outside. The bathroom in the Snow's household is located towards the back of the house in an area that has a lower ceiling height than the other parts of the house (the back part of the house has a lower flat roof, where the front of the house has a higher peaked roof). A standard 2' long section of insulated ventpipe (that came with the toilet) was installed above the roofline with the wind turbine attached at the top. Adding an additional section or two of insulated ventpipe above the roofline shouldn't affect toilet operations and it would hopefully reduce any smell drifting from the top of the vent pipe because it would be higher up and possibly carried away from natural wind flow. This wasn't able to be tested during the project period, but would be good to do for any future toilet installations. Another option that could be tested with future (or current) installations is a filter that scrub odors out of the exhaust (such as activated carbon or Zeolite, or |

| | |
|---|---|
| | those that Orenco® or Sun-Mar sell). Such a filter could be placed at the end of the vent pipe, but would need to be fitted so the wind turbine is still able to be used.<br>There were never any reported odor issues from people walking by the back of the store where the store toilet was installed, but the store roofline is much higher than the Snows. Presumably raising the vent pipe higher at the Snows should reduce or eliminate the outdoor odor issues. Certainly it is preferable for any odor from the toilets to be drawn outside rather than having any inside, which is what the Envirolet toilet was designed to do, and this issue does at least show that the wind turbine and vent pipe are effective at drawing any odors out. |

**Table 3.19 Tundra's toilet - technical issues that occurred during the project period**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| The toilet leaked on the side a couple times where the excess liquid line is | Leakage off the side of the toilet was unfortunately a problem with some of the toilets, including the Tundra's. The modified excess liquid pipes were originally fitted to the dimensions of the outlet pipe on the store toilet: however, all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred because they weren't fitted properly. New parts for the liquid line fitting were sent to the operator after the leakage occurred and adjustments were made by the operator to fix the leaking. (Note that the store toilet did not experience issues with leaking throughout the project). (Also note that the reason the excess liquid lines needed to be modified in the first place is that the area underneath a typical house in Raven is an open and un-insulated space, so a gravity drainline underneath the bathroom (as recommended by the manufacturer) wouldn't work –- it would freeze. See section 2.61 for more information about the modifications made). |
| Occasional odor reported when the toilet leaked on the side or when the toilet was really full. | As mentioned above, leakage off the side of the toilet occurred because the modified excess liquid pipes were originally fitted to the dimensions of the outlet pipe on the store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. Odor issues occurred because some liquid waste leaked onto the floor of the bathroom, but the odor was reported to have disappeared once the waste was cleaned up and the leakage was stopped. There were also a few odor issues reported when the toilet was full, which was also reported at some of the other installations, but the odor was reported to have gone away after the toilet was emptied out. |
| The wind turbine blew (and fell) off the vent pipe two times and was blocked and stopped spinning once | The wind turbine blew off the vent pipe on two separate occasions (in early and mid January) due to the high winds in Raven. The first time it happened, the turbine was found on the ground undamaged and the operator put it back on the vent pipe the next day. The second time it happened, the operator fastened it back on using screws to secure it better. After that, there wasn't another incident of the wind turbine coming off for the duration of the project. None of the other toilet installations had an issue with the wind turbine coming off so it is likely that the problem at the Tundra's was due to the relatively low height of the house and the location of the house in the community in terms of wind flow. When the wind turbine stopped spinning once (in early Jan) it was due to snow and ice buildup, so the operator went on the roof to scrape off the snow and ice so it would turn again. |
| Water leakage at the ceiling | The operator reported some water leaking in where the vent pipe meets the ceiling in early February due to heavy rains. Similar leakage at the ceiling also occurred in the Moss's bathroom around the same time. The operator put more silicone sealant around the vent pipe outlet to stop the leaking. |
| Water dumped into toilet | The operator reported that a bowl-full of hair washing water was dumped into the toilet by the son of the household owner in late March. The operator re-educated the household members about not dumping anything in the toilet and put the Tundra's toilet on "Heater and Fans" mode for a few days to evaporate the extra liquid. This incident prompted a re-education of users at all the toilet installations about what shouldn't be dumped into the toilet. |

**Table 3.20 Tundra's toilet - user reported issues throughout project**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| Toilet leakage on the side a couple times where the excess liquid line is | This was discussed in the technical issues Table 3.9227 prior. The modified excess liquid pipes were originally fitted to the dimensions of the outlet pipe on the store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred because they weren't fitted properly. New parts for the liquid line fitting were sent to the operator after the leakage occurred and adjustments were made by the operator to fix the leaking. |
| Sometimes the toilet is a little noisy at night when it's really windy and the pipe shakes | The Tundra's was the only household that had the wind turbine fall off the vent pipe. This could mean that the location of the house is in a particularly windy area of the community. Extra windy days would cause the wind turbine to spin even faster than normal which could cause the vent pipe to shake. The operator added even more silicone sealant around the vent pipe hole in the ceiling to try to secure the pipe further to lessen the shaking, and hence the noise. Note that the Tundra's house was the most susceptible to noise issues because their bathroom didn't have a door on it - a curtain hung from a rod which separated it from the rest of the house. |
| Ceiling leakage around the vent pipe during heavy rains | This was discussed in the technical issues Table 3.9227 prior. The operator put more silicone sealant around the vent pipe outlet to stop the leaking. |
| Guests sometimes forget to add peat moss | The Tundra's frequently had guests over that used the toilet. Even though there were clear instructions on the wall of the bathroom about how to use the toilet (including adding a handful of peat moss after every use of the toilet), the guests didn't always add the peat moss, according to the head of the household. The head of the household was told to keep reminding the guests of how to properly use the toilet and if they still forgot, to add some extra peat moss to the toilet afterwards. |

**Table 3.21 Moss' toilets - technical issues that occurred during the project period**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| The toilets leaked on the side a couple times where the excess liquid line is | Similar to the Tundra's toilet, leakage occurred on the Moss's toilets because the modified excess liquid pipes were originally fitted to the dimensions of the outlet pipe on the store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred because they weren't fitted properly. New parts for the liquid line fitting were sent to the operator after the leakage occurred and adjustments were made by the operator to fix the leaking. (Note that the store toilet did not experience issues with leaking throughout the project). |
| Odor reported when the toilet leaked | Odor issues occurred because some liquid waste leaked onto the floor of the bathroom from the excess liquid line, but the odor was reported to have gone away once the waste was cleaned up and the leakage was stopped. |
| Water leakage at the ceiling | The operator reported some water leaking in where the vent pipe meets the ceiling on one of the Moss's toilets in early February due to heavy rains. Similar leakage at the ceiling also occurred in the Tundra's bathroom around the same time. The operator put more silicone sealant around the vent pipe outlet to stop the leaking. |

**Table 3.22 Moss' toilets - user reported issues throughout project**

| Issue | How the issue was addressed, or could be addressed |
|---|---|
| Odor from the used toilet paper in the bin | The Moss's household was the only toilet installation that didn't like having to throw used toilet paper into a separate bin instead of the toilet. Several household members complained of the odor from the used toilet paper sitting in the bin. The operator started making more frequent visits to the household to empty out the used toilet paper bin and the household said that helped reduce the odor. Toilet paper can be added to the Envirolet toilets but it should be single ply so it breaks down faster. The choice to not throw toilet paper into the any of the toilets was made early on, because toilet paper would lower the overall capacity of the toilets and cause them to fill up faster, particularly for households with one toilet. But since the Moss's household had an issue with the toilet paper, single ply toilet paper was purchased for them to experiment with. The household started throwing the single ply toilet paper into the toilet and they reported that the smell was much better.<br>The main odor issues the household had with the toilet were from the used toilet paper and when the toilet leaked. The head of the household thought the fan system in the toilet did a good job of keeping any odors from the toilet out of the bathroom. He said that if they had to go back to throwing toilet paper into a separate bin, it would be great if you could put a similar "suction fan" system in the bin to draw out any odors. |

| | |
|---|---|
| | Note: One other thing that could be tried regarding the used toilet paper smell, is to use a bin that seals better. Note: One question that wasn't asked, but would be good to know, is if the smell from the used toilet paper can was better or worse than the smell from having a honeybucket in the bathroom. |
| Leaking on the side where the excess liquid pipe is | This issue was mentioned in the prior technical issues Table 3.9229. Leakage occurred on the Moss's toilets because the modified excess liquid pipes were originally fitted to the dimensions of the outlet pipe on the store toilet, however all the toilets that arrived after the store toilet, had different sized outlet pipes. So leaking occurred because they weren't fitted properly. New parts for the liquid line fitting were sent to the operator after the leakage occurred and adjustments were made by the operator to fix the leaking. |
| Feeling of "draftiness" when the toilet is being used | At least one female member of the Moss's household was bothered by the feeling of "draftiness" when the toilet was being used. The household member said that it felt "dry from the air" when the toilet is used and she worried about getting contaminated from the air. None of the users from the other toilet installations voiced this issue; however, a similar issue came up in a compost toilet project carried out in Canada (different types of compost toilets were tested with this project, but some users found the toilet to be uncomfortable because it was "too drafty") (CIER 2001). So this is not necessarily an uncommon feeling for people to have. The operator explained to the household member(s) that they wouldn't get "contaminated" and that the air wouldn't hurt them. He mentioned that it wasn't necessary to do this for a health or any other reason, but it if would make them feel more comfortable, they could temporarily unplug the toilet during use if desired and then plug it back in afterwards (the only way to turn off the fans in the toilet is to unplug the system). |
| Noise from the fans in the toilets | The Moss's household is the only household that had an issue with noise from the fans in the toilet, but they were also the only household with two toilets, so the noise level could have been amplified with the two toilets. The location of the bathroom relative to the other rooms in the house, or the way sounds carried in the house could also have been different compared to the other households. The Moss's described the noise as a hum "like a refrigerator," but was quieter when the bathroom door was closed. The household had an issue with the noise early on in the project and when asked about the noise again towards the end of the project, they said it wasn't really an issue any more because they got used to the hum. |
| Noise when it's windy and the vent pipe shakes | The other issue with noise at the Moss's installation was when it was windy and the vent pipe would shake. Extra windy days would cause the wind turbine to spin even faster than normal which could cause the vent pipe to shake. This was also an issue at the Tundra's household. To address this, the operator added even more silicone sealant around the vent pipe hole in the ceiling to try to secure the pipe further to lessen the shaking, and hence the noise. |

| | |
|---|---|
| Sometimes people can smell a little odor outside when walking by the house from the top of vent pipe | This was also a reported issue at the Snow's house. Odors outside from the vent pipe meant that the wind turbine and turbo fan were doing their job of pushing/drawing air out of the toilet/bathroom and to the outside. Two toilets however could likely produce a reasonable amount of odor outside. The odor issues outside from the vent pipe were noticed more in the warmer months than in the winter months –- people are of course outdoors more often in the summer, but there could also be a difference in the wind direction at different times of the year.<br>A standard 2' long section of insulated ventpipe (that came with the toilets) was installed above the roofline with the wind turbine attached at the top for each toilet. Adding an additional section or two of insulated ventpipe above the roofline shouldn't affect toilet operations and it would hopefully reduce any smell drifting from the top of the vent pipe because it would be higher up and possibly carried away from natural wind flow. This wasn't able to be tested during the project period, but would be good to do for any future toilet installations. Another option that could be tested with future (or current) installations is a filter that scrub odors out of the exhaust (such as activated carbon or Zeolite, or those that Orenco® or Sun-Mar sell). Such a filter could be placed at the end of the vent pipe, but would need to be fitted so the wind turbine is still able to be used.<br>There were never any reported odor issues from people walking by the back of the store where the store toilet was installed, but the store roofline is much higher than the Moss's. Presumably raising the vent pipe higher should reduce or eliminate the outdoor odor issues. Certainly it is preferable for any odor from the toilets to be drawn outside rather than having any inside, which is what the Envirolet toilet was designed to do, and this issue does at least show that the wind turbine and vent pipe are effective at drawing any odors out. |
| Rain leaking from the ceiling where the vent pipe is | This issue was also mentioned in the prior technical issues Table 3.9229. Water leakage was reported where the vent pipe meets the ceiling on one of the Moss's toilets in early February due to heavy rains. Similar leakage at the ceiling also occurred in the Tundra's bathroom around the same time. The operator put more silicone sealant around the vent pipe outlet to stop the leaking. |

### 3.9.2.3 Lessons Learned from the Operator Position

The first operator was briefly interviewed before he left his position and the second operator was interviewed more comprehensively in the last quarter of the project. Notes from the interviews can be viewed in Appendix P, and a summary of the information learned from the operators is given here. Both operator's preferred compost toilets to honeybuckets and flush-haul. Both also wanted a compost toilet in their home, but the first operator thought it would be helpful if the emptying process could be improved upon. When asked about what they liked and disliked about the compost toilets, the first operator liked that compost toilets reduce the frequency of dumping wastes (compared to honeybuckets), but disliked the emptying process itself. The second operator liked that the odor was much better with compost toilets than honeybuckets, that the toilets made less of a mess than honeybuckets, and that the toilets were easier to dump and dumped less frequently than honeybuckets, but disliked the emptying process when the waste was really wet (because the odor was strong).

Emptying the toilets was one of the biggest maintenance issues for the operators. The operator's noted that the hardest thing to train the households to do, regarding maintenance, was emptying out the toilets and that most of the installations wanted the operators to do it. Some of the comments the operators made during the interviews about emptying the toilets included:

> "The household sometimes complains about the odor when it's cleaned."
> "There needs to be improvements for cleaning it."
> "There isn't enough room to empty the tray and the contents."
> "It's hard to get your arm in to empty it out."
> "It's also difficult to empty when there's liquid."
> "The households can clean the toilets themselves but I'm not sure they will."
> "Joe Tundra cleaned his by himself and it went really well."
> "We should give out more rubber gloves and masks to all the households (for emptying/cleaning the toilets)."
> "A tip for cleaning the toilets is to have the toilet as dry as possible – add peat moss and turn on the heater for as long as possible before the toilets are cleaned."

The operators noted that it would take from 15 minutes to two hours to empty/clean the toilets and that the amount of time would depend if the mass was more wet or dry (it was faster and easier the dryer the mass was). They noted that if an operator was working on a temporary, on-call basis, around 1-2 hours to clean the toilet should be allocated at a wage of $10-15/hr.

When asked about ways to improve the toilets or ideas for what else to try in the future, the operators thought that a toilet that might be easier to empty should be tested, such as “remote unit” Envirolet in houses that have the space underneath, or possibly another brand of compost toilet. They also suggested that more of the same type of Envirolets sould be tested in more households. The remote toilet was suggested because the portion of the toilet that holds the waste is located outside of the home (underneath the house) so any odor during cleaning would be less of an issue. The remote toilets also have a greater capacity so they don’t need to be emptied out as often. The problems however with the remote toilets are that since they sit outside underneath the house, an insulated box must be built around them so they stay warm, and many of the houses in Raven don’t have a big enough space underneath the house to install them. According to the second operator, a main concern the households had with the toilets was when they needed to be emptied, particularly during the winter. The issue with emptying the toilets in the winter was that it was harder to vent out the house when it was cold outside -- emptying the toilets out in non-winter months was easier because all the windows could be opened for ventilation. For this issue, the remote toilet might work better because emptying/cleaning would occur outside.

Prior to this project, the operators hired had no experience with operating and maintaining compost toilets – all training was received on the job. All three operators hired however had prior sanitation experience (honeybucket or flush-haul haulers), which they thought was helpful since they were use to handling and working with wastes. The operators noted that training, and in particular on-site or hands-on training, was important for learning about how to properly take care of the toilets, and that all future operators should have adequate training.

The second operator noted that people from the community that tried the compost toilets thought the odors were much reduced from honeybuckets and that several people asked the operators how they could sign up to get a compost toilet for their home because they were tired of using honeybuckets. A list was started by both operators for households interested in getting a compost toilet installed if further funding was available. Both operators felt that the operator position was quite important for the project and for any future compost toilet projects, so that someone was available to at least empty out the toilets when needed and help the households with installation and any potential troubleshooting.

# 4.0 CONCLUSIONS AND RECOMMENDATIONS

## *4.1 Overall Conclusions*

Envirolet MS10 self-contained compost toilets were tested as an alternative to honeybuckets in a rural Alaska Native Village that predominantly uses honeybuckets for human waste disposal. The toilets were installed in three households and the community store and were monitored for a 10 month period. The toilets were evaluated on system performance, user perspectives and opinions, and capital and annual costs. Conclusions for the project are as follows:

Envirolet MS10 compost toilets are capable of providing economical management of human waste as an alternative to honeybuckets and can be successful with the following considerations:

- A local operator position is needed to assist the households with at least the emptying of the toilets, and possibly other maintenance required for the successful operation of the toilets
- Education is necessary for users to understand the limitations of the toilets and how to operate them, and should be carried out when a toilet is first installed and on a semi-regular basis after installation to ensure that the toilets continue to be used properly
- For larger households (four or more people), two toilets are needed to meet capacity
- An initial training component for the operator is needed so there is an understanding of how the toilets work, how they need to be maintained and operated, and how to troubleshoot any problems that arise.

During the 10 month test period that the toilets were monitored, the toilet installed in the 2-3 person household performed the best in terms of user satisfaction, frequency of emptying, and transfer of maintenance tasks (the household successfully took over all maintenance tasks including emptying the toilet). Compost toilets were preferred to honeybuckets by the majority of users for the reasons that compost toilets have fewer odors than honeybuckets and don’t have to be emptied as often as honeybuckets.

**Further conclusions/findings from the project are presented by topic as follows:**

***Operator Position***

- All toilet installations except for one, required the use of an operator throughout the project for at least the task of emptying out the toilets.
- Training 2-3 “alternate” operators in addition to one designated lead operator, so back-up is available if the lead operator is away or leaves the job, may help address the staff turnover issue that persists.
- Emptying the toilet was the most difficult maintenance task reported by the operators.
- The inspection sheets were a useful tool for the operators to log maintenance, and track and troubleshoot any problems with the toilets.
- The operator’s hired for this project preferred compost toilets to honeybuckets and flush-haul and both wanted a compost toilet installed in their home.
- The operators noted that training, and in particular on-site or hands-on training, was important for learning about how to properly take care of the toilets, and that all future operators should have adequate training before the job starts.

***Costs and electricity usage***

- Capital costs for an Envirolet MS10 toilet, including shipping and installation supplies, are approximately $2000.
- Estimated monthly operating costs for one Envirolet toilet are $19-$25/month and for two toilets are $34-$45/month (not including costs for an operator).
- The Envirolet toilets can be operated on “Fans Only” mode (i.e. without heaters) to lower electricity costs.
- Electricity usage for each Envirolet toilet operating on “Fans Only” mode for the majority of the time (with a few days of operation on Heaters and Fans mode before the toilet is cleaned), is estimated to be 66 kWh/month.

***Remote sensing and real time data collection***

- Remote sensing devices can be a useful tool for troubleshooting problems, tracking operations, and logging data to assist with maintenance and monitoring real time use of compost toilets.
- Based on the performance from this project, the most useful sensors were the temperature (for monitoring both the inside the toilet and the ambient room temperature), and the pulse input/switch (for logging the number of daily uses).
- Of all the sensors used, the moisture sensor was the least used and least helpful of all installed.
- Having access to the data in real-time and being able to view the data remotely was helpful for indicating possible problems with the toilets and helping to troubleshoot problems as they came up.
- If it can be afforded, it is recommended that the temperature and pulse input/switch sensors be used on any compost toilet installed, along with the real-time satellite data logging system.
- The power meter was a useful device for estimating electricity usage (and hence electricity costs) of the compost toilets and is also recommended to be used with any other types/brands of compost toilets tested to compare electricity usage/costs.

***Odor***

- Indoor odor issues with the toilets were mostly from leakage (from faulty liquid line fittings), when the toilets were full and needed to be emptied, and during the process of emptying.
- Adequate ventilation in the bathroom and/or house was needed when the toilets were being emptied.
- Outdoor odor issues were occasionally reported from the vent pipes for some of the installations.

- The wind turbine and turbo fan were effective at drawing odors out of the household and should be used on further installations.

***Miscellaneous***

- No flies were reported in any of the toilets throughout the project period.
- There were very few incidences of users adding things into the toilet that weren't supposed to go in (e.g. trash, graywater, cigarette butts), but re-education should take place every few months as a reminder.
- Extra sealant around the vent pipe (where it meets the ceiling) is important for preventing any water leakage from heavy rains and for securing the vent pipe from shaking (and creating noise) when the wind turbine is spinning fast.
- Temporary use of honeybuckets during the project was necessary on the following occasions: when a toilet was shut down for a few days before being emptied (so any excess liquid was evaporated and odors were further reduced), when a toilet reached maximum daily capacity and was shut down for the remainder of the day (to avoid overuse during monitoring), and when a toilet was full and waiting to be emptied by the operator when the operator was out on subsistence or unavailable.
- Ensuring that the bottom panel of the toilet and the excess liquid line are always properly secured is important to avoid any leaks (and consequent odors) from the front or side of the toilet.

## *4.2 Future Research/Next Phase*

Next phase testing and recommendations for future compost toilet research are given here:

- Test more Envriolet MS-10 toilets (especially the two toilet scenario for larger families) for a longer period of time (at least 1.5-2 years) and in more homes to gather more data, and get a more accurate record of the frequency rate of emptying the toilets (Note that several households in Raven requested to have a compost toilet installed if more funding is available (the Raven Environmental Department keeps a list of households interested))

- Test an Envriolet remote/centralized toilet, which offers a greater overall capacity, at a home(s) that has adequate space underneath the house for a specially built insulated box around the main waste chamber, and compare it's performance and operating costs to the Envirolet MS10 self-contained model
- Test other brands of compost toilets in the community to compare their performance and operating costs to the Envirolet
- Test urine diverting toilets (which separate urine before it mixes with feces) and compare the results to honeybuckets and the Envirolet compost toilets
- Carry out another compost toilet project, building on the findings from this project, in another honeybucket Village that has an interest in the technology and compare the results.

## *4.3 Suggestions for Future Compost Toilet Demonstrations*

The following is a list of suggestions based on lessons learned from the Raven demonstration project and was developed by looking at 1) things that were carried out for the project and were successful, 2) lessons learned from things that were carried out and weren't successful, and 3) things that weren't carried out but would have been helpful. These suggestions could be used for a continued or new compost toilet project in Raven or for a compost toilet project performed in another Alaska Native Village.

- Carry the project out in a community that has an interest in compost toilets, and a willingness to test them. With this project, Raven wanted to test the toilets and sought the assistance to do so. The following statement made by a rural development specialist emphasizes the importance of starting sanitation projects from a village identified point and the approach to best assist Alaska Villages in meeting their sanitation needs: "All villages in Alaska fall along a continuum of capability to manage, operate and maintain services and infrastructure. Capability can be built starting at any point on the continuum. The best place to start is at a point the village identifies. A village identified starting point is more likely to lead to a sustainable outcome" (Sarcone 2002, p.10).

- Present the community with the various options of compost toilets and the pros and cons to each, and let the community decide which to try based on their knowledge of what will work or not work in their environment.
- Before the type of compost toilets are selected, hold a community meeting prior to the project starting, to hear any concerns or issues people may have with the technology and discuss ways they could be remedied and answer any questions that people have.
- Suggest that people check out other compost toilets installed in Alaska for them to get a first hand perspective (note that there aren't many compost toilets installed in Alaska Native Villages, but Raven's could be observed as well as the few mentioned in the first Chapter).
- Educate the community through:
  - Community presentations lead by an operator/local technician, carried out in the local language, and if possible including an actual toilet (unused) as a model for people to check out first hand. Videos from the manufacturer could also be used at presentations to show how the toilets work and other users who have them.
  - Educational materials in both English and the local language
  - Easy-to-read instructions for operating the toilets
  - A locally made video of how the toilets work, that lists all the pros and cons to using them, which can be shown to the community through the local TV channel, at meetings, school presentations, etc.
- Allocate a project test period of at least 1.5 years.
- Fund a local operator position for the full project period.
- Talk to and work with the local utilities that provide sanitation operators (for flush-haul, honeybucket service etc.) to work out a plan for an operator(s) to continue service to the households with compost toilets after the project period ends.
- In addition to the main operator, train 2-3 alternate operators as backup.

- Provide technical assistance and training throughout the project to the operator and household members with toilets, both on-site and by phone/email.
- Carry out meetings with community members throughout the project to share information get feedback and address any issues.
- Seek the advice of the operators that worked on the Raven project for installation, operation and maintenance, and other lessons learned.
- Use similar tracking and inspection sheets developed for this project to help keep track of maintenance, record events, and troubleshoot problems.
- Include funding for remote sensing equipment for all the installations to assist with troubleshooting and maintenance.
- Include funding for a power meter to measure electricity usage and costs of the toilets tested.
- Ensure that all members of the households are trained on how the toilets work and how to maintain them.
- Supply the households with informational material about the toilets and how to maintain them for easy reference.
- Sample end-product compost for fecal coliform levels.
- Keep detailed records of when the toilets were emptied and how long they sat unused before emptying. Also, take photos of the end-product from each emptying for comparative purposes.
- Experiment with using the end product as dumpsite covers, following State regulations (see Appendix O for regulations and process to follow).
- Keep a detailed chronological report of events, issues, comments etc. that are shared by the operator, installation household members, or community members over the phone, by email, or in-person to augment other reports developed by the operator or household members. This information can be referenced to help troubleshooting or to date check any problems that arise.

- Add additional insulated vent piping above the roof line (minimum of four feet) for lower level houses for reduction of occasional outside odors from wind draft.
- Work with the community to develop feedback forms for user opinions of the toilets, and have users fill out the forms at different stages of the project.
- Use participatory methods to carry out the project.
- Carry out semi-structured interviews with users and operators at different stages of the project and document the interviews.
- Carry out group discussions with users, operators, and community members at different stages of the project to get opinions and perspectives of the toilet technology and project. Document the discussions.
- Use triangulation for information gathering.

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# Appendix A

## Recommendations from rural Alaska sanitation reports regarding alternative sanitation technologies

## Recommendations from Rural Alaska Sanitation Reports Regarding Alternative Sanitation Technologies

| **Report title/agency/ organization/year** | **Statements from the report regarding alternative sanitation technologies** |
|---|---|
| Recommendations of the Alaska Sanitation Task Force, A Commitment to Alaskans, Executive Summary, 1992 | "Recommendation: Secure funding to continue research and field testing of alternative sanitation technologies to determine their feasibility/ effectiveness in rural Alaska."<br><br>"Action Needed: Recommend appropriate technologies to meet resident's needs based on financial, technical, and management capabilities of the community." |
| Federal Field Workgroup Report to Congress on Alaska Rural Sanitation, U.S. Environmental Protection Agency, Water Division,1995. | "Recommended Next Steps (#11): Develop a better understanding of the potential for alternative type systems to address needs in smaller villages."<br><br>"Other identified needs (for improving sanitation services) include improving the availability and acceptance of alternative technologies…."<br><br>"A number of technologies exist which could significantly improve the sanitation conditions in rural Alaska communities. The Federal Field Workgroup recognizes that some technologies that are identified in the Office of Technology Assessment report such as composting and incinerating toilets, may be demonstrated to be feasible in rural Alaska communities in the future. However, these types of facilities have not yet proven to be a solution to human waste disposal in rural Alaska villages and communities. Future changes in available products, operational requirements, or economies of operation may result in changing acceptance. At this time, piped water and sewer systems and flush haul systems are the only technologies which have been demonstrated to be applicable to the Alaskan Villages in the YK Delta, the Bering Strait/Western Coastal Region, and the Interior." |
| Alaska Governor's Council on Rural Sanitation, Rural Sanitation 2005 Action Plan, 1998 | "Action Plan Recommendation: Promote the research, development, implementation and testing of appropriate new/alternative technologies." |
| Institute of Social and Economic Research: Financing Water and Sewer Operations and Maintenance in Rural Alaska, 2000 | *"Develop lower-cost systems through planning and designing.* Possible means include developing alternative technologies with lower O&M costs; presenting the community with good information on the costs of various systems; promoting strong community involvement in system planning, to insure that agencies understand local concerns and that local residents understand the financial obligations they are undertaking." |

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| An Alaska Challenge: Native Village Sanitation, U.S. Congress, Office of Technology Assessment, 1994 | "Many conditions in Alaska's Native villages (i.e., inadequate water supply, poor soil drainage, permafrost, unacceptable topography, high seasonal flooding potential, and weak local economies) appear to favor the application of less costly and complex approaches than piped sanitation systems. However, to date, few alternative methods have benefited from field demonstration tests to determine their actual performance in cold climate regions." |
| An Alaska Challenge: Native Village Sanitation, U.S. Congress, Office of Technology Assessment, 1994, continued | "Areas in which the (Alaska sanitation) work group's participation would be highly beneficial to the delivery of long term Federal sanitation assistance include the following:<br>• working with State and Federal agencies to promote demonstration pilot projects,<br>• identifying within a reasonable time the criteria needed for selecting, installing, and operating the next level of waste sanitation service in those communities now operating honey bucket systems."<br><br>"OTA has presented the following actions that Congress and the Administration could take (#4 listed below):<br>• Establish a comprehensive Federal research, development, and testing program for innovative sanitation technologies"<br><br>"Federal and State agencies have not formally supported the development of alternative sanitation technologies that may be more affordable than conventional piped systems. Only minimal attempts have been made to formally incorporate existing alternative sanitation systems into the technology selection process currently in place."<br><br>"Development of a more comprehensive technology evaluation and selection approach capable of supporting demonstration, applied research, and application of innovative technologies is still needed. Congress could facilitate the research, development, and demonstration of innovative sanitation technologies by taking the following steps (one is listed below):<br>Directing the Environmental Protection Agency, Indian Health Service, or another appropriate Federal agency to:<br>• establish a program for research, development, and demonstration (RD&D) of innovative sanitation technologies considered potentially appropriate for application in Arctic regions, such as rural Alaska;<br>• advocate the application of those innovative technologies successfully demonstrated under the RD&D program."<br><br>"To address the waste sanitation problem in Alaska's Native communities, Congress could establish programs to:<br>• provide safe and healthy alternatives to honey buckets,<br>• identify and test more cost-effective alternatives to piped systems,<br>• provide adequate support for O&M-including technical, administrative, operational, and personal hygiene training—to offset the operational costs of sanitation systems."<br><br>"Very few alternative sanitation methods have benefited from field demonstration tests in rural Alaskan communities |

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| An Alaska Challenge: Native Village Sanitation, U.S. Congress, Office of Technology Assessment, 1994,continued | in the past. Most of the attempted evaluations failed. The failures were largely the result of limited or inadequate guidance provided to Natives by technology developers."<br><br>"Unfortunately, programs to fund field demonstrations of alternative technologies, to coordinate Federal and State technology programs and policies, and to establish a forum for the advancement of innovative sanitation systems do not exist. Alternative sanitation technologies must be evaluated prior to their actual use among Native communities and must be designed to accommodate the unique Alaskan environment, including factors such as (two are listed below):<br><br>Technical training—Training Natives in how to operate sanitation technologies has not always been successful. The reasons for such failure have been primarily the use of inappropriate off-the-shelf packaged training programs and the increasing shortage of technical assistance from Federal and State agencies. To avoid these failures, there is a need to develop programs that are culturally sensitive and practical, and that focus on the realities of the particular village in which the technology will be applied.<br><br>Native community involvement—Although the intrusion of Western culture has sometimes been met with resentment, many Natives continue to believe that the main source of resentment has emerged primarily from being told by outsiders what to do and how to do it, and rarely being included in the development of solutions to local sanitation problems. Encouraging and supporting continued village participation in the selection and implementation process are extremely important for ensuring a strong perception of community ownership over the project—an element crucial to the successful application of any technology."<br><br>"Consequently, addressing the waste sanitation problem in Alaska's Native communities requires steps that focus on identifying, demonstrating, and adopting more cost-effective alternatives to honey buckets. Selecting technologies that deliver sanitation with little additional adverse impact on the limited or declining local economies is needed. Alternative sanitation technologies, such as composting, electric, and propane toilets, appear to be an improvement over honey buckets because they reduce the possibility of users coming in contact with human waste and they may reduce overall, long-term costs. Not only do these technologies eliminate the need for a sewage lagoon to hold the wastewater for treatment, as in a conventional piped or haul system, they may also yield a byproduct that is generally more environmentally safe or easier to handle." |

# Appendix B

## Capacity and electricity use comparisons between the Envirolet, Biolet, and Sun-Mar compost toilets

## Capacity and Electricity Comparisons Between the Various Models of Envirolet, Biolet, and Sun-Mar Compost Toilets

| Toilet | Capacity | Electricity Usage |
|---|---|---|
| **SUN MAR Excel**  | 3 adults or families of 5 | 260 W heater<br>35 W fan<br>Average Power Use in Watts (Heater on 1/2 time) 150 watts |
| **SUN MAR Compact**  | 1 person | 200 W heater<br>35 W fan |
| **SUN MAR Excel-Non-Electric**  | 2-3 people | No heater or fan |
| **SUN MAR Excel AC/DC**  | Capacity:<br>As Excel with AC Power (3/5 people)<br>As Excel-NE with no power<br>or 12 volt only. (2/3 people) | 260 W heater<br>1.4 W fan<br>Use with electricity, without electricity, or just with DC power. |
| **Envirolet MS10 Composting Toilet**  | 6 people full-time (~18 uses/day) | Uses a maximum of 540W. 2 x 20W Fans and 1 x 500W Heater.<br>The Heater is thermostatically controlled and only operates approximately 25-30% of the time. Therefore, an Envirolet® 120VAC model will operate at a maximum of 540W about 6 hours a day. |
| **Envirolet DC12 Composting Toilet (12VDC Battery)** | 4 people full-time (~12 uses/day | 2 20w fans |

| Toilet | Capacity | Electricity Usage |
|---|---|---|
| **Envirolet Basic Plus Composting Toilet (Non-Electric)** | 2 people | Non-Electric |
| **BioLet XL**<br> | 4 People<br>Occasional Overload*:<br>12 People<br>*Maximum 1 day | Total - 370 Watts<br>Average continuous consumption over 24 hr period - 65 Watts<br>Heaters (thermostatically controlled) - 305 Watts<br>Fan motor - 25 Watts<br>Mixer Motor - 40 Watts |
| **BioLet Deluxe** | 3 People<br>Occasional Overload*:<br>8 People<br>*Maximum 1 day | Total - 290 Watts<br>Average continuous consumption over 24 hr period - 55 Watts<br>Heater - 225 Watt<br>Fan motor - 25 Watts<br>Mixer motor - 40 Watts |
| **BioLet Standard** | 3 People<br>Occasional Overload*:<br>8 People<br>*Maximum 1 day | Total - 250 Watts<br>Average continuous consumption over 24 hr period - 55 Watts<br>Heater - 225 Watt<br>Fan motor - 25 Watts |
| **BioLet NE** | 4 - 6 People<br>Occasional Overload*:<br>12 People<br>*Maximum 1 day | Non-Electric |

# Appendix C

# Overall comparison of Envirolet, Biolet, and Sun-Mar compost toilets

## Comparison of Envirolet, Biolet, and Sun-Mar Compost Toilets

| Item | Envirolet MS10 | Biolet XL | Sun- Mar Excel |
|---|---|---|---|
| **Peat type** | Any kind of peat, also sawdust OK, plain air popped popcorn, dry coffee grounds. | Only biolet approved peat | Sun-Mar Compost Sure (or 50/50 mixture of peat moss and non-cedar wood shavings) |
| **Peat use** | ¼ cup per person per day. Can be done after each use or all at once at night. | Ideally ½ c after each fecal use. Could also add 1 quart/person once a week. | 1 c per person per day |
| **Other operation** | 3 times a week, pull aeration bar. Every 2 weeks, add microbe accelerator | Built in mixing system so no stirring required. Mixing system is triggered when seat is lifted and then closed. | Rotate the drum 4-6 complete revolutions, three times a week |
| **Use** | Manual. Lift toilet seat, move handle. | Automatic. For women, lift seat and sit down (sitting opens the toilet). For male urination, the gentlemen may either sit or stand close enough to the toilet so their knee applies a little pressure to the toilet seat and opens the compost cover. | Lift lid and use. |
| **Toilet paper** | 1 ply white tp only | Any kind is fine but 1 ply would be ideal. | Any kind is fine but 1 ply would be ideal. |
| **Electricity use of largest capacity units (wording taken directly from websites)** | Uses a maximum of 540W. 2 x 20W Fans and 1 x 500W Heater.<br>The Heater is thermostatically controlled and only operates approximately 25-30% of the time. Therefore, an Envirolet® 120VAC model will operate at a maximum of 540W about 6 hours a day. | Total - 370 Watts<br>Average continuous consumption over 24 hr period - 65 Watts<br>Heaters (thermostatically controlled) - 305 Watts<br>Fan motor - 25 Watts<br>Mixer Motor - 40 Watts | One 260 W heater<br>One 35 W fan<br>Average Power Use in Watts (Heater on 1/2 time): 150 watts<br><br>The electric units require elec to power a fan (30 Watts continuous) and a heating element that is thermostatically controlled. |
| **Thermostat and fans** | Has a switch for Fans and Heater and Fans. | Has a thermostat which can be easily adjusted. | Switch for fan speed??? |
| **Room temp** | Heater kicks in when needed. Ideally room should not be cold | During periods while the unit is in use, the ambient room temperature needs to be maintained above 64F. Whenever the unit is not going to be used for more than 2 days the temperature can drop below 64F | Room should be a minimum of 55 degrees Fahrenheit |
| **Capacity of largest model** | 6 people full-time (~18 uses/day) | 4 people full time (~12 uses/day) (thermostat can be turned up higher to accommodate 5-6 people FT) | 5 people full-time (~15 uses/day) |
| **Durability** | Toughest plastic | Slightly less tough than envirolet (made of fiberglass) but probably still fine | Slightly less tough than envirolet (made of fiberglass) but probably still fine |

| **Item** | **Envirolet MS10** | **Biolet XL** | **Sun- Mar Excel** |
|---|---|---|---|
| **Emptying** | At max use empty every 3- 6 months | Under normal operating conditions, it will require emptying only once every 2 - 12 months, depending on usage. | Every few months. Depends on use. |
| **Sensor possibilities** | Number of uses – sensor attached to the handle<br>Temp<br>Soil moisture | May be more difficult to hook up "number of uses" sensor and other sensors bec. of auto mixer in toilet. | May be more difficult to hook up "number of uses" sensor and other sensors bec. of drum design. |
| **Height from ground to seat** | 19.75" | 19.5" | 29.5" from ground to seat<br>19.5" from step to seat |
| **Warranty** | 5 yr | 3yr | 3 yr |
| **Certifications** | Envirolet® is CSA® International certified to meet ANSI/NSF® Standard 41-1998. Envirolet® is also CSA International certified to meet NSF® Standard 41. All Envirolet® Systems meet these standards. http://www.envirolet.com/doesenhavnsf.html | NSF *International* (NSF) has determined, by performance evaluation under the provisions of NSF Standard 41: Wastewater Recycle/Reuse and Water Conservation Devices, that the BioLet biological toilet manufactured by Vakuumplast AB, Industrigigatan 4, S 33021 LE, SWEDEN, has fulfilled the requirements of Standard 41. This BioLet model has therefore been authorized to bear the NSF Mark so long as it continues to meet the requirements of Standard 41.All tests of the BioLet biological toilet were completed on a system installed at NSF in Ann Arbor, Michigan. Waste loading for the test was provided by NSF staff. A description of respective waste loading characteristics is included in this report http://www.biolet.com/nsf.htm#certification | Residential and Cottage use composting toilet systems certified and listed under NSF Standard 41 http://www.nsf.org/Certified/Wastewater/Listings.asp?TradeName=&Standard=041 |

# Appendix D

## Installation and operation instructions for the Envirolet self-contained system

# Envirolet™ Waterless Self-Contained System

# INSTALLATION INSTRUCTIONS

Envirolet Composting Toilet Systems

**MULTI SYSTEM 10/3**

For customer service please contact us:

**USA 1-800-387-5126**
**CDA 1-800-387-5245**

**info@envirolet.com**

You can also find us online at:

**www.Envirolet.com**

For your convenience, parts and accessories can be purchased online 24 hours a day!

SANCOR™

SANCOR 140-30 Milner Ave. Toronto, Ontario, Canada M1S 3R3

# Envirolet™

## WATERLESS AND LOW WATER TOILET SYSTEMS

## INSTALLATION AND OPERATION INSTRUCTIONS

Envirolet™ is a biological or composting toilet system that evaporates water and breaks down waste by natural bacterial action. This patented toilet system accelerates the decomposition process and converts waste material into natural soil residue. Envirolet™ is easy to install. The many features offered with Envirolet™ make the toilet system easy to operate. Read the following INSTALLATION AND OPERATION INSTRUCTIONS carefully to ensure that your Envirolet™ toilet system will function properly.

## INSTALLATION OF YOUR ENVIROLET™ TOILET SYSTEM

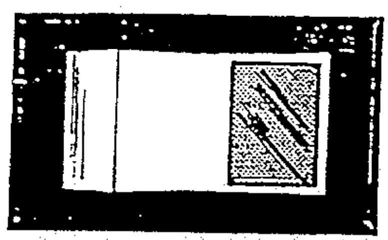
**NOTE:**
Do not remove Paper Mat in toilet system.

1. Position Envirolet™ in bathroom.
2. Install Vent Kit - installation instructions are located in Vent Kit.
3. Add Premix Starter - special soil mixture (1) bag supplied with toilet system. Remove Toilet Bowl and open Bowl Trap cover and spread contents of soil bag evenly across Paper Mat. Sprinkle gently one (1) pint of water evenly over Premix Starter in toilet system. Replace Toilet Bowl and close Bowl Trap.
4. Switch the 2-Position Neon Switch to Position 1-Fans and Heater.
5. Plug in Power-Plug to 3 prong plug outlet (receptacle should be connected to 120V. 60Hz 15 amp fuse service in electrical box). UNPLUG toilet when leaving system more than 2 weeks or when servicing.

YOUR ENVIROLET™ IS INSTALLED AND READY FOR USE.

## SPECIAL FEATURES MAKE OPERATION EASY!

2-POSITION NEON SWITCH



Position II - Fans Only

Position 1 - Fans & Heater

Use position 1 - NORMAL USE

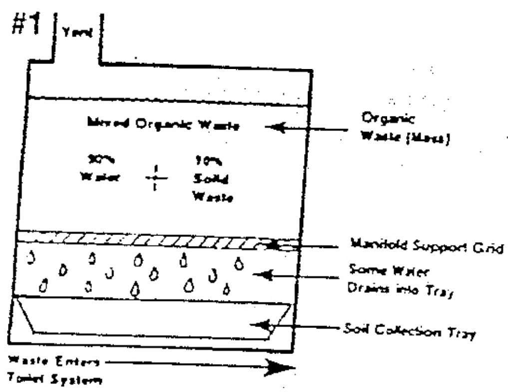
**Position 1 - Fans & Heater**
When toilet is in daily use. On & off red neon indicates Heater on & off

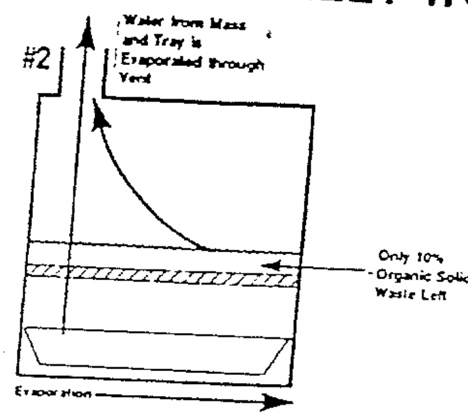
**Position II - Fans Only**
When leaving toilet for short periods of non-use (2 days or more - 2 weeks or less).

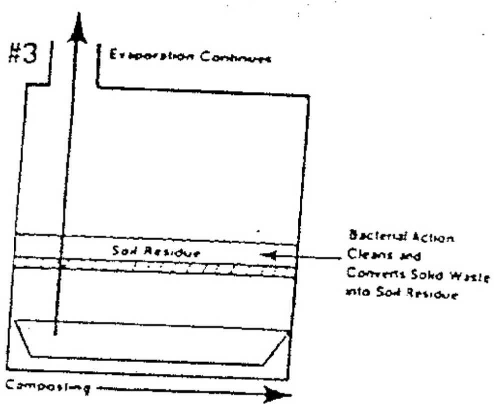
# ENVIROLET™ DAY TO DAY OPERATION MADE EASY!

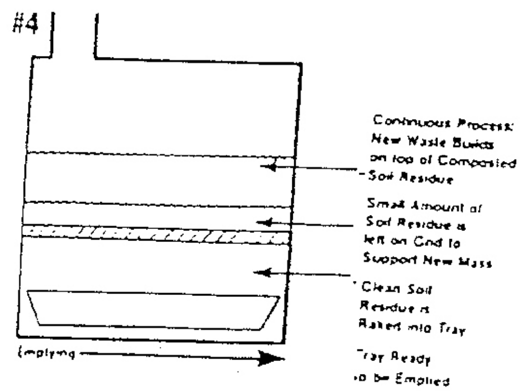
1. Switch the 2-position Neon Switch to Position 1 Fans & Heater for normal use of your Envirolet™ toilet system.
2. Add 1/4 of a cup of peat moss per person per day. The peat moss will help cover the mass below the Bowl Trap; keep the mass from becoming too hard, dry or compacted; and help feed the natural bacterial action continuing in the toilet system. Use regular fine peat moss or ask your dealer for **Envirolet™ Premix Starter.**
3. Try and keep the mass in the toilet system moist-not dry or soaked for proper composting to take place. If the mass becomes too dry add a small amount of water and peat moss or **Envirolet™**
4. Use biodegradable or single-ply toilet paper in Envirolet™
5. The Bowl below the toilet seat is a sanitary enclosure for the toilet system. The Bowl is easily removed for reg sanitary cleaning with soap and water. The Bowl Trap covers the bottom of the Bowl and acts as a sanitary cover above the mass. The Bowl Trap ca be opened and closed using the Leveller Bar Handle on top of the toilet system.
6. Use the Airator Handle often to move the Airator in the toilet system. The airator is a series of blade-like cutters that will help break up the mass, distribute waste across the system, and help airate the composting process.
7. The Envirolet™ is ideal for winter usage. Ensure bathroom is warm. Check that outside Roof Ventillator is clear. Operate Envirolet™ as you would normally. Add 1 TBSP of Sancor* Fast Acting Enzyme Accelerator once every two weeks with 1 pint of water. Unplug Envirolet™ if leaving system in cold or freezing temperatures.

# HOW DOES YOUR ENVIROLET™ COMPOSTING TOILET WORK




Envirolet™ is unique aerobic and evaporation toilet system. Envirolet™ also incorporates a natural organic break-down process (composting). Envirolet™ requires no water (no water connection), no chemicals, and no septic tank. Envirolet™ is not an incinerating toilet. Human waste, toilet paper, organic material and urine are transformed by Envirolet™ into water vapour and environmentally-clean soil. Approximately 90% of mass or liquid entering the toilet is comprised of water. Envirolet™ evaporates water out of the toilet by means of an engineered aeration system. An attached Air Vent carries the water vapour to the outside. Any remaining waste material (dramatically reduced in volume and weight by the removal of water) is transformed into clean, dry soil. The process is accomplished by the continuous action of the forced warm air (aerobic) and natural organic break-down process (composting). The Envirolet™ Premix Starter is sufficient to start up the toilet system. From time to time small amounts of organic material (peat moss, etc) should be added to the toilet system to assist the breakdown process. The self-contained system operates continuously and only a small amount of soil residue must be removed from Envirolet™

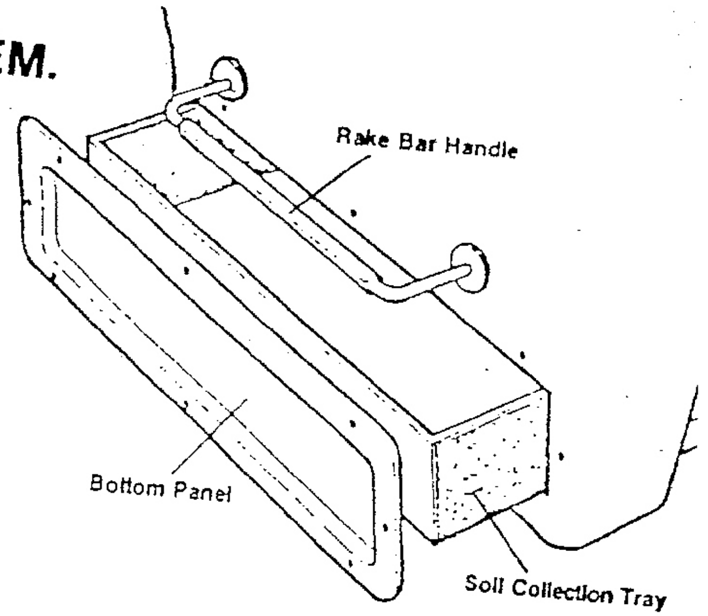
# HOW TO EMPTY YOUR ENVIROLET™ TOILET SYSTEM.

The Rake Bar is a series of blade-like cutters with tiny rakes attached. The Rake Bar is used to rake composted material into the Soil Collecting Tray. **Use The Rake Bar Handle only when emptying the Soil Collecting Tray.**

Note: The Airator and Rake Bar Handles only pull in and out a couple of inches.

Emptying of your Envirolet™ can be as little as once a year. Heavier usage will require emptying more often. A vacation home will normally only have to be emptied once per year. Home users (all year round) will have to empty the system between 3-6 months. The need to empty the system will of course be in direct relation to the frequency of toilet use. When the mass in the toilet system no longer reduces in height from the removal of water by evaporation and by bacterial action (mass reaches height of Airator Bar in system), rake down the mass into the Soil Collecting Tray using the Rake Bar Handle. Place newspaper on the floor in front of Envirolet™. Remove the Bottom Tray Panel carefully- **run system without use for at least 24 hours to ensure all water in Soil Collecting Tray area is evaporated.** Remove the Soil Collecting Tray. Dispose of contents in proper disposal site. Replace the Soil Collecting Tray back in toilet system. Check gasket seal around Bottom Panel. Replace the Bottom Panel. Because every toilet system is used differently, you will learn through experience the ideal time to empty your Envirolet™.

**Note:** Do not rake all the soil residue into Soil Collecting Tray. Leave a small amount of soil residue on upper support grid to help support additional mass being accumulated.

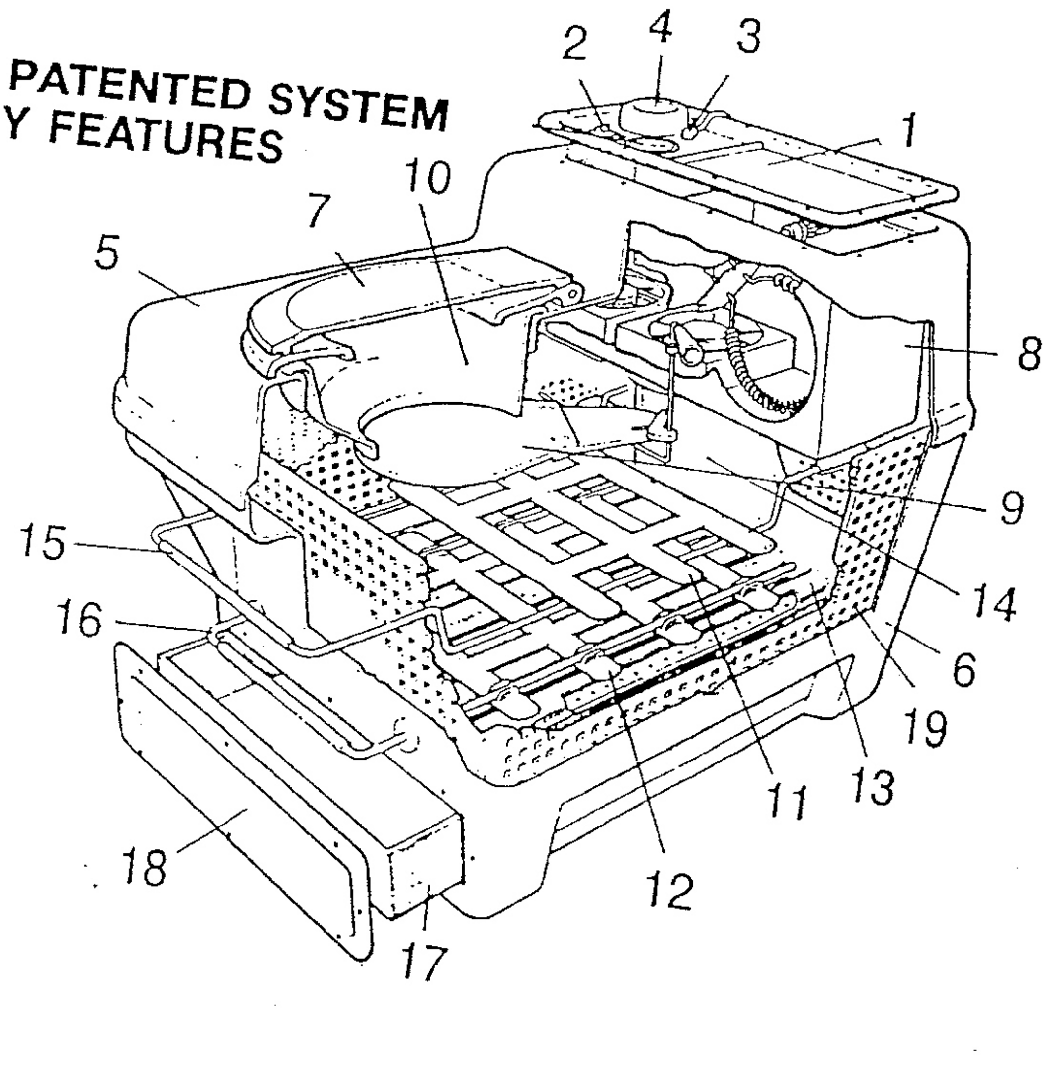



# CLEANING - BE KIND TO YOUR ENVIROLET™

Use only mild soap or detergents to clean your Envirolet™ toilet system. **Do not use any harsh chemicals.** Remove the toilet bowl for sanitary cleaning, if necessary wipe the bowl trap clean to sanitize. **Do not spill any chemicals into the toilet system.**

# ENVIROLET™ PATENTED SYSTEM OFFERS MANY FEATURES

1. Top Panel
2. 2-Position Neon Switch
3. Plug Connection
4. Vent Connection
5. Envirolet Top
6. Envirolet Bottom
7. Toilet Seat
8. "Works-In-A-Drawer" Service Compartment
9. Bowl Trap
10. Bowl
11. Airator Bar
12. Rake Bar
13. Manifold Grid
14. Blower
15. Airator Bar Handle
16. Rake Bar Handle
17. Soil Collecting Tray
18. Bottom Panel
19. Airation Basket



# SOLVING ANY PROBLEMS WITH YOUR ENVIROLET™

Your Envirolet™ toilet system should provide you with carefree operation. However, should any problems develop review the following problem situations and carry out the suggested remedies. In most cases these remedies should solve your Envirolet™ problem. If any problem continues, contact your dealer or factory service representative to assist you.

**Problem: "Outside Odour"**
**Remedies:**
- Add peat moss or Envirolet™ Premix Starter.
- Add baking soda over mass.
- Remove vent obstructions.
- Check to see if mass is dry - add water.
- Use Airator to break-up mass.
- Add cup of white vinegar to Soil Collecting Tray.

**Problem: "Inside Odour"**
**Remedies:**
- Check that there are no angles or obstructions interfering with vent system.
- Check for leaks around switch, plug connection, gaskets, top panel, bottom panel, vent connections, between top and bottom connection of unit.
- Check to see if bathroom fan is operating - do not use.
- Check if nearby fireplace drawing air out of toilet system - shut door to bathroom.
- Check any open window in bathroom creating air draw.
- Check fans (2) are working properly.

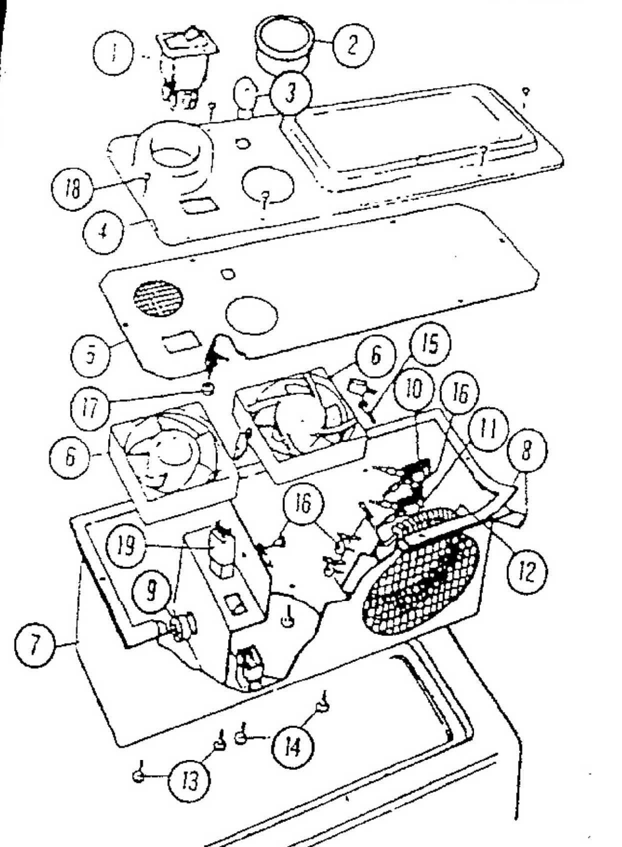
**Problem: "Mass dry and compacted"**
**Remedies:**
- Add water and peat moss or Envirolet™ Premix Starter more often to toilet system.
- Use Airator more often to break-up mass.

**Problem: "Mass too wet"**
**Remedies:**
- Add peat moss or Envirolet™ Premix Starter to toilet system more often.
- Place vaseline on rods at bushings entering toilet system (lubrication).

**Problem: "Electrical component failure"**
**Remedies:**
- Contact dealer or factory service representative to repair or replace defective component(s).
- See Envirolet™ "Works-In-A-Drawer" Service Compartment

**Make sure toilet system is unplugged anytime Envirolet™ is being serviced - for your safety.**

## SERVICE COMPARTMENT PARTS




1. 2-Position Neon Switch
2. Hygrometer Gauge *DISCONTINUED
3. Plug Cord - Strain Relief
4. Top Panel
5. Metal Lid
6. Exhaust Fan (left) and Intake Fan (right)
7. "Works-In-A-Drawer" Service Compartment
8. Gasket Seal (on top of box lip and below)
9. Bushing
10. Top Thermostat (regular)
11. Bottom Thermostat (Hi-temperature safety)
12. Heater
13. Exhaust Fan Mounting Screws (4)
14. Intake Fan Mounting Screws
15. Thermostat Mounting Screws
16. Thermostat Mounting Nuts
17. Ground Nut
18. Top Panel Screws
19. Electrical Connectors

To remove "Works-In-A-Drawer" Service Compartment **-first unplug toilet system.** Remove Top Panel Screws (18). Lift Top Panel breaking peelable seal and disconnect wiring harness (not shown) from Electrical Connector (19). Lift out "Works-In-A-Drawer" Service Compartment (7). Repair or replace defective components. Replace Gasket Seals (8). Replace Service Compartment (7). Replace Top Panel Screws (18). Make sure good seal is obtained.

## SPECIFICATIONS OF YOUR ENVIROLET™

| | |
|---|---|
| **Specifications:** | Envirolet™ Multi System 10 |
| **Dimensions:** | 25 inches - W x 33 inches - L x 25 inches - H |
| **Weight:** | Approx. 70 lbs |
| **Material:** | High impact HDPE plastic with UV protection |
| **Colour:** | White |
| **Electrical:** | 120 Volts, 60 Cycles, 540 Watts max<br>Thermostatically-controlled Heater<br>40 Watts Fans Only |
| **Regulations:** | C S A Approved |

Complies with Government Regulations

Patented Canada & U.S.A.
U.S. Pat. No. 4 156,477

SANCOR


Sancor Industries Ltd.
140-30 Milner Ave.
Scarborough, Ontario
Canada M1S 3R3
(416) 299-4818

## INSTALLATION INSTRUCTIONS

Please follow the Installation Instructions carefully. Do not hesitate to call Sancor™ if you have any Installation questions. **Proper installation is essential to the performance of your Envirolet™Composting Toilet System.**

1. Position Envirolet™ Waterless Self-Contained System in the bathroom. Please remember that the Vent Opening is on the left hand side in 12v and 110v models and in the center in Non-Electric models.

**IMPORTANT NOTE:** It is recommended that your Envirolet™ 3" Vent System be installed vertically (i.e., straight-up with no bends) for best efficiency. However, if an angle is required, use only 2 45° elbows. An angled vent installation **should not be used** with a Non-Electric model and is **not recommended** with a 12v Battery model. **Do not use any 90° angles** in your vent installation. An optional 12v or 110v Turbo Fan is available from Sancor™ for extended, angled or difficult vent installations.

2. Cut or drill a 3" diameter hole through your roof and/or ceiling. Ensure that the center of the vent connection on your Envirolet™ is aligned with the center of any holes through roof and/or ceiling. Use a plumb line to center, if necessary.

3. Install Insulated Roof Stack:

A) Seal with Silicone Sealant around edge of hole in roof and/or ceiling to prevent any leakage.
B) Slide Rubber Roof Flashing over 4" Insulated Roof Stack.
C) Slide protruding 3" Vent Pipe through 3" hole in roof and/or ceiling. Ensure that the Rubber Roof Flashing is well sealed with Silicone Sealant (over bottom and around edges). Also seal around the opening in Rubber Roof Flashing where the Vent Pipe and Insulated Roof Stack slide through.

4. Securely connect remaining 3" Vent Pipe, using the 3" Couplings provided, to the Vent Opening on your Envirolet™ System. (Do not use any other type of coupling or connection.) It may be necessary to cut the 3" Vent Pipe supplied to fit your particular installation height. **Seal securely with Silicone Sealant around all vent/coupling connections to prevent any air leakage.**

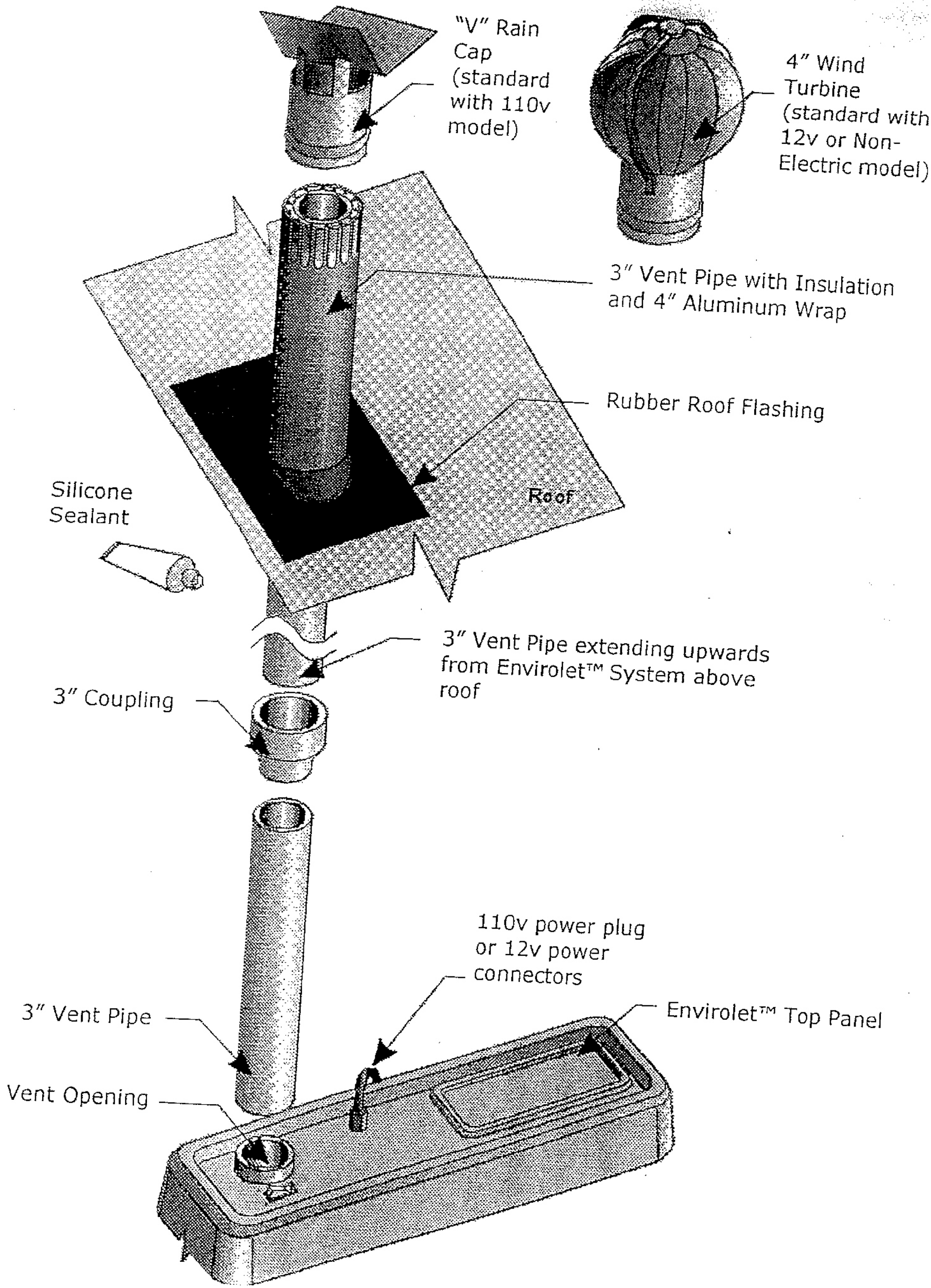
**IMPORTANT:** Insulate around any exposed 3" Vent Pipe or Couplings located outside, in attic spaces, between walls, on outside walls, above roof, in unheated bathrooms, in cold basements, in cold air spaces, etc. to prevent condensation and liquid build-up in your Envirolet™ System. **TIP:** It is always better to "over-insulate" than not to insulate enough.

5. As provided with your Envirolet™ System, install either the "V" Rain Cap (included with 110v models) or 4" Wind Turbine (included with all other models) to the top of the Aluminum Pipe Wrap. Use screws to secure.

**If you require any assistance, please do not hesitate to contact Sancor™ Technical Support (9am - 4pm EST, Monday - Friday) at:**

**USA 1-800-387-5126** **CDA 1-800-387-5245** Direct 416-299-4818

# ... Kit Installation



# Emptying The Compost

Emptying the compost from your system is easy. Depending on your application and amount of usage, you empty the compost as little as once per year. The compost should be emptied when the waste in the System reaches above the Aerator Bar and no longer reduces in height through evaporation, leveling and recycling.

| System Application | Approximate Compost Emptying Period |
|---|---|
| Cottage & Cabin Use | Once per year, at start of following season only |
| Light Commercial Use | Once per year |
| Continual Residential Use | Once every 3-6 months |
| Heavy Commercial Use | Once every 3-6 months |

**Use Rake Bar Only When Emptying Compost**
The Rake Bar is a series of blade-like cutters with tiny rakes attached.
The Rake Bar is used to rake compost material down into the Collecting Tray.

## Emptying Instructions

1. Undue Bottom Panel and attached Back Plate by first unfastening the two outside Fastener Knobs and then loosen only the two inside Fastener Knobs and remove together the Bottom Panel and attached Back Plate.
2. Pull the Rake Bar in and out of the System to rake down compost into Collecting Tray.
3. Remove Collecting Tray and empty compost in garden or proper disposal site.
4. Re-install Collecting Tray in System.
5. Re-install Bottom Panel and attached Back Plate by inserting attached Back Plate through opening and first "hand-tighten only" the two outside Fastener Knobs to fasten and secure the Bottom Panel to System. Then "hand-tighten only" the two inside Fastener Knobs to fully secure Bottom Panel and attached Back Plate to System.

## Installation & Maintenance of 2-Stage Pre-Sediment Filter

All Waterless Non-Electric, Waterless 12v Battery and all Low Water Toilet Systems come with a standard Filter Drain (optional on Waterless 110v Electric Systems). This Filter Drain must be "gravity" connected to either a small plastic container (Waterless Systems only), approved leaching pit or other acceptable drain site. This Filter Drain allows for any excess liquid, not evaporated, to drain from System. Connect securely the provided brass "T" fitting (in "up" position) and the 5' or more 3/8" nylon drain to the 3/8" nylon drain line protruding from bottom side of System and gravity connect to proper site.

Clean or replace Filters(2 ) in System once per year, if required.
Remove Collecting Tray and clean or replace Filter (round shaped) in tray with soap and water. Next, disconnect Nylon Drain at brass fitting, then loosen liquid tight bushing on outside of System and remove Filter Drain (tube shaped) from System. Clean or replace Filter Drain with soap and water. Reinstall Filter Drain in System.
Contact Sancor™ to order parts, if replacement is required.

# 3″ Vent Kit Installation Instructions

Please read these instructions carefully. A correctly installed Vent, along with proper System operation and maintenance, are essential to the performance of your Envirolet™ Composting Toilet System.

The 3″ Vent Kit is used with the following Envirolet™ Systems:

**Envirolet™ Basic Plus (Non-Electric)**
**Envirolet™ MS 10 (110v Electric)**
**Envirolet™ DC 12 (12v Battery)**
**Envirolet™ SC Hybrid (12v/110v)**

## IMPORTANT

**1. Ensure that all Vent connections are sealed with silicone sealant.**

**2. Install Vent Kit straight-up for maximum efficiency and performance.**

**3. Insulate all Vent Pipe and Couplings located outside or in cold air spaces.**

**If you require any assistance with the Installation or Operation of your Envirolet™ System, please do not hesitate to contact Sancor™ Technical Support toll-free at:**

**USA 1-800-387-5126**
**CDA 1-800-387-5245**
Direct 416-299-4818

(Technical Support: 9am - 4pm EST, Monday - Friday)

### INCLUDED WITH 3″ VENT KIT

| Part | Qty | Notes |
|---|---|---|
| 3″ Vent Pipe (white) | 10′ | 3 x 40″ sections for 10′ total (1 section is pre-inserted into Insulated Roof Stack) * Please note that Sancor™ Vent Pipe is special white designer pipe and is a non-standard size |
| 3″ Couplings | 2 | Connects 3″ Vent Pipe |
| Insulated Roof Stack | 1 | 4″ x 24″ Aluminum wrap with Styrofoam insulation |
| "V" Rain Cap | 1 | Standard with Envirolet™ MS 10 |
| 4″ Wind Turbine | 1 | Standard with Envirolet™ BP, Envirolet™ DC 12 and Envirolet™ SC Hybrid |
| Roof Flashing | 1 | Rubber Roof Flashing with 4″ diameter hole |
| Silicone Sealant | 1 | Small clear tube |

# ENVIROLET™

## OPERATION MADE EASY

### DAY-TO-DAY

Add a quarter of a cup of Peat Moss per person per day through the bowl or through the Servic[e] Panel on Remote Systems.

### WEEK-TO-WEEK

1. Agitate the mass by pulling the Aerator/Mulchator Bar (top bar) back and forth.
2. Add **Sancor™ Microbe Accelerator** evenly over mass once every two weeks according to package instructions.

**ONLY USE THE RAKE BAR (BOTTOM BAR) WHEN EMPTYING YOUR SYSTEM.**

### CLEANING

1. Spray inside bowl with an enzyme cleaner or mild soap and a small amount of water. Call and order **Sancor™ Enzyme Cleaner.**
2. Clean the bowl as you would a ceramic toilet. The bowl removes for easy cleaning on all self contained models.

**<u>DO NOT</u> USE ANY HARSH CHEMICALS TO CLEAN YOUR ENVIROLET™ TOILET SYSTEM.**

Sancor™ Industries Ltd. 140-30 Milner Ave. Scarborough, ON CANADA M1S 3R3

☎ 416-299-4818 ☎ USA 1-800-387-5126 ☎ CDA 1-800-387-5245

# Appendix E
# Results of the interview for hiring the first operator

**Questions and Answers from the Compost Toilet Operator Interview Carried out in June 2006 by the Raven Environmental Department and Compost Project Technical Assistance Provider**

| **Question** | **Interviewee 1** | **Interviewee 2** |
|---|---|---|
| **Why do you want this job?** | Noone had applied and wanted to find out about it. Wanted to try out the toilets and see how they work. | It'd be a good idea to put the envirolet to use. The water/sewer has problems and this could help. |
| **Why do you think you would do a good job as the technician?** | I have done work on the flush haul systems and provided honeybucket services. | Experience with igap and env situation here. I'm interested in the toilet and I'd do a good job checking out the toilet. |
| **If you currently have a job, what is your job schedule? What days and what hours do you work each week?** | I am unemployed at this time. Not working at water and sewer. And that's why I applied | Right now working 5 days/week on the boardwalk project. In the next 2 weeks, it will drop to 3-4 days work. If hired I could make it work. I have a flexible schedule. |
| **If you were hired for this position, would your hours at your current job stay the same?** | I don't have a job so I can do the hrs | See above. |
| **Is your job schedule flexible?** | See above. | Yes |
| **Do you have any other commitments during specific hours or days?** | I got a call from water resources bia training. They asked if I was still interested. Someone else from Raven might go. | No |
| **Would you be able to work the hours required for this job?** | Yes | Yes |
| **Do you plan to be in Raven for the next year?** | Yes | Yes |
| **Do you go out of town (to Bethel, Anchorage, etc) on a regular basis for work or other reasons? If so, about how often do you think you will need to go out of town in the next year and for how long?** | Don't plan to go out for more than a day or two. | No plans to be out of Raven |
| **What is your current toilet situation? Does your household have flushhaul?** | Have a flush haul system. | Honeybucket now. Honeybucket at new house. |
| **Would you want to have one of the toilets installed in your house in about two months time?** Do you think people who live or come to the house would use it? | I would want to check out the store first and then decide. | Yes. Would be willing to have it in. 5 people in household. |
| **Comments** | Suggested putting another toilet at the "complex" (the complex is the community gathering place where we did the Eskimo dancing (which is where the meetings were held). This could be another good place for people to try it out, but it might get overused unless it could be regulated. | |

# Appendix F
# Inspection/reporting forms and instruction guides

**Daily Inspection and Maintenance Sheet** **Date_____________ Time:_______**

| Question | Answer (write in, or circle answer) | Comments |
|---|---|---|
| How many times was the toilet used today? | | |
| How much peatmoss and cocoa shell was added today? | Peatmoss _______cup<br><br>Cocoa shell_______cup | |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Was the "number of uses" sheet taken down today and replaced with a blank one? | Yes No | |
| Record "watts", "kilowatt-hours", and "hours" readings from power meter (to do this, press the "mode" button on the *Watt's Up* power meter. | ________________Watts<br>________________Kilowatt-hours<br>________________Days/Hours | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Wet Dry Good | |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>It is not moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| Are there any flies in the toilet? | A lot Some None | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Pickup any feedback forms and fax to Simone. | How many forms did you find? | |
| Empty can of used toilet paper if full. | | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge. | | |
| If there were any problems with the toilet today, note them here: | | |

**FAX TO SIMONE AT: 1 (619) 489 0429**

**Household (Circle One): Snow's Moss's Tundra's**

**Fill out this Inspection and Maintenance Sheet Every Monday, Wednesday, and Friday and then fax it to Simone at 1 (619) 489 0429**

**Date____________ Time:_______**

| Question | Answer (write in, or circle answer) | Comments (Did something happen? |
|---|---|---|
| Do you think the household has been adding a handful of peatmoss after each use? | Yes No I am not sure | |
| Pull the aerator bar in and out a few times (the aerator bar is the top bar on the front of the toilet) | | |
| **Every other Wednesday**, add the microbe accelerator (powder in the white jar) (Add 1 Tablespoon of the microbe powder into a coffee mug size cup and fill it up with slightly warm water. Pour this mixture over the whole waste pile that is in the toilet. | | |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as toilet paper, garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Too Wet Too Dry Good | |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>It is not moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Empty the trash can of used toilet paper if it is full. | | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge (do NOT use any chemicals or soap on or in the toilet or it break - by harming the natural composting process) | | |
| If there were any problems with the toilet today, note them here: | | |

# Corporation Store Toilet

**Date_____________ Time:_______**

| Question | Answer (write in, or circle answer) | Comments (Did something happen? |
|---|---|---|
| How many times was the toilet used today? (look on the checkmark sheet) | | |
| Add **1.5** MEASURING cups full of peatmoss to the toilet. Also add **1** MEASURING cup full of cocoa shells to the toilet. IMPORTANT NOTE: If there was a day when peatmoss and cocoa shells weren't added for any reason, add an additional 1.5 cups of peatmoss, and 1 cup of cocoa shells for each day missed. | | |
| **Every Monday, Wednesday, and Friday** pull the aerator bar in and out a few times (the aerator bar is the top bar on the front of the toilet) | | |
| **Every Monday**, remove the "number uses checkmark sheet" on the door of the bathroom and **fax** it to Simone. Put up a new sheet on the door. | | |
| **Every other Wednesday**, add the microbe accelerator (add 1 Tablespoon of the microbe accelerator into 8 ounces (1 cup) of slightly warm water and sprinkle it into the toilet) | | |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as toilet paper, garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Too Wet Too Dry Good | |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>It is not moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Empty the trash can of used toilet paper if it is full. | | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge (do NOT use any chemicals on or in the toilet or it break - by harming the natural composting process) | | |
| If there were any problems with the toilet today, note them here: | | |

**FAX TO SIMONE AT: 1 (619) 489 0429**

## Try out the new toilet!

See the store staff for the key.
Before you use the toilet, please **place an "X" in one of the empty checkboxes** below before you use the toilet. This is very important. We need to make sure that the toilet keeps working. We need to know when it needs to be checked.

**If there are no empty checkboxes below, DO NOT USE THE TOILET. See store staff**

Please respect our community. These toilets may help us get rid of our honeybuckets.

| | |
|---|---|
| **1** | |
| **2** | |
| **3** | |
| **4** | |
| **5** | |
| **6** | |
| **7** | |
| **8** | |
| **9** | |
| **10** | |
| **11** | |
| **12** | |
| **13** | |
| **14** | |
| **15** | |
| **16** | |
| **17** | |
| **18** | |

**Household (Circle One):** **Snow's** **Moss's** **Tundra's**

**For the week of:**_______________

Before you use the toilet, please **place an "X" in one of the empty checkboxes** below before you use the toilet. This is very important. We need to make sure that the toilet keeps working. We need to know when it needs to be checked.

**If there are no empty checkboxes below, use the honeybucket for the rest of the day.**

Please respect our house. These toilets may help us get rid of our honeybuckets.

| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| 18 | 18 | 18 | 18 | 18 | 18 | 18 |

**Does the toilet and room smell okay? Or is there a bad smell from the toilet? Please use a check mark ✓ to let us know what you smell. Thank you!**

DATE:________________________

| Time | Monday | | Tuesday | | Wednesday | | Thursday | | Friday | | Saturday | | Sunday | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** | **Smells okay** | **Smells bad** |
| 8:00-9:00 am | | | | | | | | | | | | | | |
| 9:00-10:00 am | | | | | | | | | | | | | | |
| 10:00-11:00 am | | | | | | | | | | | | | | |
| 11:00-12:00 pm | | | | | | | | | | | | | | |
| 12:00-1:00 pm | | | | | | | | | | | | | | |
| 1:00-2:00pm | | | | | | | | | | | | | | |
| 2:00-3:00 pm | | | | | | | | | | | | | | |
| 3:00-4:00 pm | | | | | | | | | | | | | | |
| 4:00-5:00 pm | | | | | | | | | | | | | | |
| 5:00-6:00 pm | | | | | | | | | | | | | | |
| 6:00-7:00 pm | | | | | | | | | | | | | | |
| 7:00-8:00pm | | | | | | | | | | | | | | |
| 8:00-9:00pm | | | | | | | | | | | | | | |
| 9:00-10:00pm | | | | | | | | | | | | | | |

**Weekly Inspection and Maintenance Sheet Date_____________________**
**(This should be filled out every Wednesday)**

| Question | Check if completed ☒ | Comments |
|---|---|---|
| Replace weekly "odor sheets" with blank ones in the bathroom. Fax to Simone each week. | ☐ | |
| Fax daily inspection and maintenance sheets from last week to Simone. | ☐ | |
| Fax "number of uses" sheets from the last week to Simone. | ☐ | |
| Fill the 'Warm Water Cup" we provided to the 500 ml line with warm (but not hot) water. Sprinkle the warm water around the edges of the waste pile (but not in the middle of the toilet). Note that it was done on the calendar form. | ☐ | |

**FAX TO SIMONE AT: 1 (619) 489 0429**

# Compost Toilet Maintenance Schedule

**Every day**
- Add Peatmoss and cocoa shells (see directions for amount to add) and note that it was done on Calendar form
- Fill out Daily Inspection and Maintenance Sheet (orange sheet)

**Every Monday, Wednesday, Friday**
- Pull the aerator bar in and out a few times and note on Calendar form
- Take the used toilet paper to the burnbox (when the bucket is full)

**Every Wednesday**
- Fill out Weekly Inspection and Maintenance Sheet (green sheet)

**Every other Wednesday (i.e. every two weeks)**
- Add the microbe accelerator (see directions for amount to add) and note on Calendar form

**The first Wednesday of every month**
- Fax previous month’s calendar sheet to Simone

**Every 3 months or when the waste in the toilet reaches the aerator bar (top bar)**
- Empty the compost from the bottom tray (follow instructions for emptying compost)

## Emptying the compost material from the bottom of the toilet

When the waste in the toilet reaches the aerator bar (top bar), it is time to empty the compost out from the bottom of the toilet. **The toilet should not be used for at least 24 hours before emptying, and preferably not for 1-3 days. It's best to move the switch at the back of the toilet to the "Fans and Heater" mode during these 1-3 days (it will help the toilet dry out more).** Follow these steps when emptying the toilet.

**STEP 1** Put on Gloves and place cardboard in front of the toilet.

**STEP 2** Carefully remove the panel at the bottom of the toilet by following the instructions on the attached pages.

**STEP 3** Pull the tray out of the toilet

**STEP 4** Dump the material in tray into a bucket or bag or anything convenient and then put the tray back into the toilet.

**STEP 5** Pull the Rake Bar (Bottom Bar) in and out several times until the waste drops down into the Tray. Note: do not rake all of the waste down into the tray. Leave a base of waste (2-3 inches high) in the upper chamber because this will help continue the composting process in the toilet.

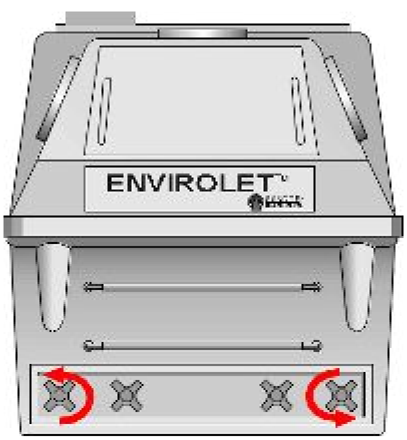
**STEP 6** Empty the material in the tray into a bag or bucket.

**STEP 7** Sprinkle some peat moss (about ¼-½ inch high) in the bottom of the tray before putting the tray back into the toilet (this is to absorb any new liquid that enters the tray once the toilet is in use again).

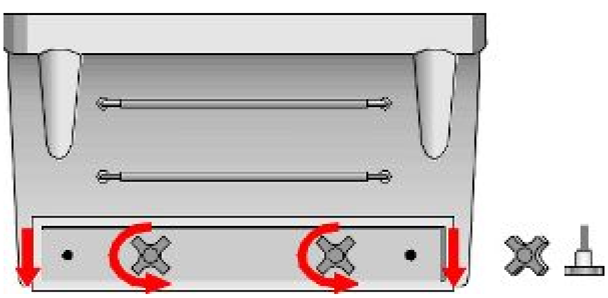
**STEP 8** Put the panel securely back on the toilet following the instructions on the attached pages.

## Instructions for removing the Bottom Panel for access to the soil collecting Tray. (from Envirolet http://www.envirolet.com/ )

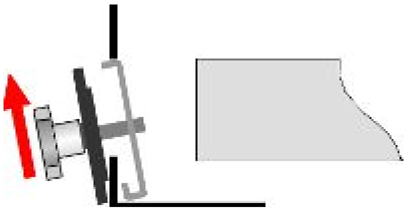
**1.** Turn the 2 outer Grey Knobs on the Bottom Panel counter-clockwise until they are completely removed.




**2.** Loosen the 2 inner Grey Knobs on the Bottom Panel counter-clockwise. Do not remove completely.



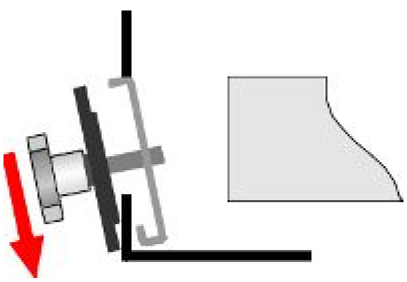
**3.** With the 2 inner Grey Knobs still attached, but loose, push with your thumbs on the Grey Knobs to bring the plastic Bottom Panel towards yourself until it rests flush with the Grey Knobs. Lower the panel downward slightly to bring the metal Backplate through the opening in the System. Your Bottom Panel should now be removed.



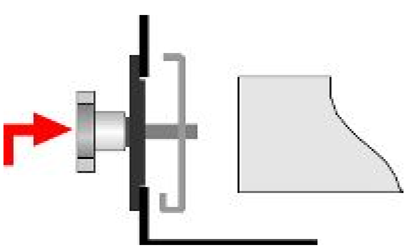
**RE-ATTACHING THE BOTTOM PANEL**

**4.** Before re-attaching the Bottom Panel, please make sure that your Bottom Panel Gasket does not have any rips or tears that could cause a leak from your System.

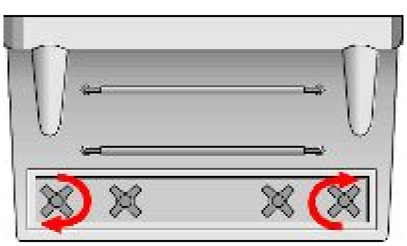
With the 2 inner Grey Knobs still attached, but loose, push with your thumbs on the Grey Knobs to bring the the plastic Bottom Panel until it comes flush with the Knobs. Place the metal Backplate downward through the opening in the System. **Be sure that the "L" edge of the metal Backplate is on the top and the "C" edge is on the bottom.**



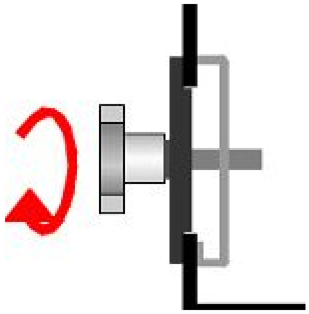
**5.** Line up the panel evenly and turn the 2 inner Grey Knobs clockwise to tighten. Before completely tightening the inner Grey Knobs, insert the 2 outer Grey Knobs and turn clockwise to tighten.



**6.** Tighten all 4 Grey Knobs. Make sure they are firmly attached but do not over tighten.



**7.** Check to make sure Bottom Panel is completely attached and that there are no air or liquid gaps.



# Compost Toilet Maintenance Schedule

**There is not much you need to do to maintain the compost toilet, however you must do the things listed below or the toilet won't work.**

**Every day**

- Add a handful of peatmoss into the toilet everytime it is used. It's better to add too much peatmoss, than not enough. If household members aren't adding their own peatmoss, one designated person should add 1 to 1.5 cups of peatmoss to the toilet at the end of every day.
  **Why do it?** Peatmoss helps to soak up liquid like a sponge and it is necessary for the compost process to happen.

**Every Monday, Wednesday, Friday**

- Pull the aerator bar (the top bar on the front of the toilet) in and out a few times.
  **Why do it?** Doing this adds air into the system which helps the composting process.

**Every other Wednesday (i.e. every two weeks)**

- Add the microbe powder to the toilet. To do this, add 1 Tablespoon of the microbe powder into a coffee mug size cup and fill it up with slightly warm water. Pour this mixture over the whole waste pile that is in the toilet.
  **Why do it?** Adding the powder helps speed up the composting process.

**Every 3 months or when the waste in the toilet reaches the aerator bar (top bar)**

- Empty the compost from the bottom tray (follow instructions for emptying compost)

If you run out of peatmoss, bring your plastic box over to the environmental department and you can get it re-filled with peatmoss. You can also call the environmental department at xxx xxxx.

If you run out of microbe powder, you can also call the environmental department or you can call Envirolet (the company that makes the toilets) to order some more. Envirolet's number is: 1-800-387-5126

**If you ever have a problem with the compost toilet, call the environmental department at xxx xxxx. You can also always call Simone Sebalo at 1 866 325 0069 if you have a problem or any questions.**

**Things to remember:**

Only pull the bottom rake bar when it's time to empty the compost from the bottom of the toilet.

NEVER use any chemicals to clean the toilet – that means no bleach, no Lysol or any other type of cleaners. The only thing that should be used to clean is water and possibly mild soap (like Dove or Ivory) if needed. The compost toilet is a natural system and chemicals will break it.

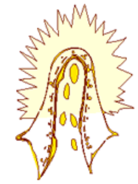
**This sheet is for a member of the household to fill out twice a month.**
**Quyana for your time for filling this out.**

Name of person filling out this form:_______________________

Household (Circle One): Snow Moss Tundra

**Date:_______________ Time:________**

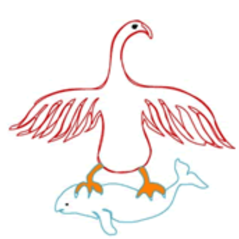
| **Question** | **Answer (write in, or circle answer)** | **Comments** |
|---|---|---|
| Has there been any odor in the bathroom in the last 2 weeks? | A lot a little none | |
| If there was odor, which day(s) did you notice it? | | |
| **If there was odor**, is it worse or better than a honeybucket? | Worse than honeybucket<br>Better than honeybucket<br><br>If you know the smell of flush-haul system, is it better or worse?<br>Better Worse Same | |
| Has there been any liquid leaking from the toilet in the last two weeks? | Yes No<br>If yes, where is the leak? | |
| Do you think your sheet on the bathroom door is being checked off each time before people use the toilet?, (One "use" means **urine or anaq's**) | Yes, every time<br>No, not all the time<br>Not sure | |
| Is the small cupful of peatmoss and cocoa shells added everytime the toilet is used? | Yes, every time<br>No, not all the time<br>Not sure | |



Questions Continued…

| Question | Answer (write in, or circle answer) | Comments |
|---|---|---|
| Do you think the toilet bowl is being closed after using the toilet each time? (moving the handle back to the "down" position) | Yes No Not sure | |
| Do you think someone in your household put anything in the toilet besides human waste, peatmoss, and cocoa shells? | Yes No<br><br>If yes, what did they put in? | |
| Do you have any comments about the toilet you would like to share? For example, how does your household like the toilet now? Or what did you not like or like about the toilet in the past week or two? What would make having the toilet better? | | |
| Do you have any questions about the toilet or filling out the forms? Write them here. | | |
| If there were any problems with the toilet in the last two weeks, note them here: | | |

**AFTER FILLING OUT, GIVE THIS SHEET BACK TO xx. Quyana.**



**July, 2006** **Write what day each operation task was carried out this month. Use the Letter code (P, A, M, W, E). If you did the task different, or noticed something different, write it down in the box.**

P= Peat moss/cocoa shells added A=Aerator bar moved back and forth M=Microbe accelerator added
W=Warm Water added around the edges of the waste pile E=Emptied compost from bottom of the toilet

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | | | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

**Feedback form. If you have the time, please write additional comments. Quyana.**

**What do you think of this toilet? (Circle one)**

I like it | I don't like it | I don't know

**Is there something you don't like about this toilet? What?**

**How does use of this toilet compare to using a honeybucket? (Circle one)**

Same | Better | Worse | Don't know

**How does use of this toilet compare to a flush-haul toilet? (Circle one)**

Same | Better | Worse | Don't know

**Would you like to have this kind of toilet in your home? (Circle one)**

Yes | No | Maybe | Don't know

**What would make the toilet better? What would you like to see if it was in your home?**

**We want to be sure that everyone in the community has a chance to try this toilet. It will help us if you answer the next two questions about yourself.**

**Circle one:** Man/boy | Woman/girl

**What age are you? (Circle one)**

under 13 | 13-24 | 25-40 | 41 to 65 | Over 65

## Information About The Compost Toilet Project

### What is a Compost Toilet?

Photo of the compost toilet

Compost toilets look just like regular toilets. They are different because there is no water tank. The waste mixes with plant moss, instead of water. There is no liquid. Soil is made in the toilet from the moss and waste mixture. This soil is called "compost". The compost has no germs, and can grow plants. It is like regular dirt. It is emptied from a tray. Composting is a natural process and no chemicals are used.

### What is the plan?

The first compost toilet is in the store bathroom. The store volunteered so the people from Raven can go see it, and try it out. The project funds an operator to inspect and maintain the toilet for a full year. xx was selected for the operator position. In the fall, 3 to 4 volunteer households will be given the toilets to use. When the household toilets are installed, the operator can answer any questions and assist with maintenance.

### Are there different types of compost toilets?

Yes. The type of compost toilet in the Raven store is called an ***Envirolet***. This is the type of toilet requested by Raven. Experts consider the Envirolet to be a very good design, and it is different from older compost toilets. If you would like to read more about the Envirolet toilet, you or your children can go to their computer website at www.envirolet.com. You can also request printouts from the Environmental Department or the new Operator.

There are several other different types and styles of compost toilets. Some people have even designed and built their own. If you would like to learn about different types of compost toilets, hear how they work, and see photos of them, contact xx in the Raven Environmental Department or Simone Sebalo at 1 866 325 0069.

### Is the Envirolet different than an Incinolet?

They are very different. The "Incinolet" has been used in Teacher's housing here. It is **not** a compost toilet. It uses electricity to burn the waste with fire. Compost toilets do not use fire and they do not burn the wastes. There is no risk that a fire will start in the toilet. These are two different companies and two different kinds of toilets.

### What is Composting?

Composting is a natural process. During composting, micro-organisms eat the waste and break it down into its simplest parts. To break it down, they also need air and water. The operator adds some other natural products once each week to break down the wastes more quickly.

Micro-organisms are so small they cannot be seen. But the compost micro-organisms have always been in the tundra and water. These micro-organisms help the tundra and water stay healthy. The end product of the composting process has a lot of fiber. It looks like dirt. It is called compost. It contains a lot of nutrients that are good for plants to grow. It takes about 60 to 120 days for the wastes in the toilet to become compost.

### What can be done with the Compost after it is ready?

Compost can be used like dirt. As mentioned above, compost contains a lot of nutrients that help plants grow. Most often, people use compost for gardening projects- to grow flowers, shrubs, etc.

If enough households start using compost toilets, the compost might be able to be used to cover the garbage at the dump. Spreading soil over garbage reduces odor, prevents the garbage from flying around, and reduces the attraction of wildlife and flies. At first, there would not be much compost produced from just four or five toilets. After some time, the amount of dirt produced could be very helpful in controlling the dump, or filling holes.

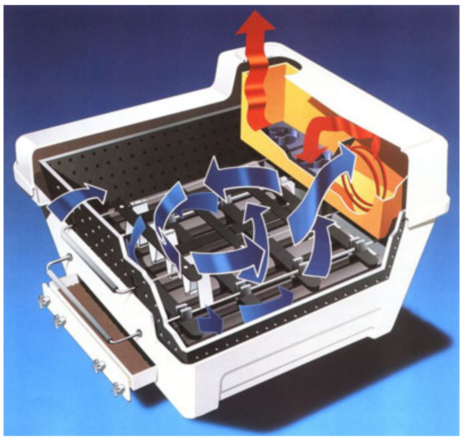
### How do you operate and maintain the toilet?

To use the toilet, you need to lift the toilet seat lid and then turn the handle to open the bowl. When you're finished, turn the handle back to close the bowl and put the toilet seat lid back down. Here's what the ongoing maintenance is:

- Add a small amount of peatmoss (dirt-like substance) every day that the toilet is used
- Move the aerator bar at the front of the toilet in and out a few times each week
- Every two weeks, add a compost accelerator (non-chemical)
- Every few months, empty the finished compost out from the tray at the bottom of the toilet

### How does the toilet work?

Almost 90% of all toilet waste is water. The rest is called "organic material". Fans and a small heater built into the toilet evaporate much of the water portion of waste through the vent pipe to the outside. The rest of the waste degrades into compost with the help of the added peatmoss and microbe accelerator. Every so often, air is added by pulling the **aerator bar** on the outside of the toilet. This helps to speed up the composting. Every couple of months, you pull the **rake bar** on the outside of the toilet in and out several times so it makes the compost fall into a tray in the bottom of the toilet. Then you open the tray door, pull the tray out, and empty out the compost.



Airflow in the toilet - the fans and heater push the air out through the vent pipe


Photo of Envirolet Toilet

### What are the costs?

A toilet similar to the one installed at the store costs about $2000 including shipping and supplies needed for installation (like the vent pipe). As far as the monthly or yearly costs, we don't know yet. We are hoping to get good cost numbers from testing the toilets with this project. Below are the costs we *have estimated*.

Peatmoss: $100-$150/year

Compost accelerator: $20/year

Electricity: $10-$50/month

But remember we won't know what the real costs are until the toilets are tested. To find out what the actual electricity costs are for this project, we have a power meter which will record the energy use. We can use the energy use to find the electricity costs.

### How do you install a toilet?

When you order an Envirolet toilet, it arrives pre-assembled and ready to use. A vent pipe however MUST be installed that connects to the toilet and goes out through the roof. The vent pipe can be ordered from the Envirolet company. It is included in the $2000 price for the toilet. When the vent pipe is installed, it must be vertical, or as close to vertical as possible. The toilets won't work as well if there are big bends and angles in the vent pipe. Also, this type of compost toilet uses electricity for a heater that evaporates the liquids, so the toilet will need to be plugged into the wall wherever it is installed.

**Environmental and health benefits of Compost Toilets vs. Honeybuckets**
A benefit of using compost toilets instead of honeybuckets is that the honeybucket lagoon will not be used as much. In the future, if everyone decided to use a compost toilet, there would be no need for the honeybucket lagoon. If we stop using honeybuckets, the wastes and their germs and chemicals will not go into the creek and River. Compost is like dirt and can be used for gardening projects or as a cover material for the dumpsite. There are no liquids to handle. It is much cleaner and safer and easier to empty out compost than a honeybucket. And compost only needs to be emptied one time in two months. Honeybuckets and flush haul must be emptied out much more often. Another benefit of compost toilets is that contact with human wastes is stopped, both inside and outside the home. This greatly reduces the contact with germs that can spread illnesses in the community

**Who can I talk to if I have questions about compost toilets or this project?**
xx was the operator hired for this project in Raven. He is very knowledgeable about how the toilets work and can answer questions. He can be reached at: xx. You can also contact Simone Sebalo at 1 866 325 0069 or by email at ssebalo@zender-engr.net and also xx of xx.

# Directions for Adding Peatmoss, Cocoa Shell, and Microbe Powder

**Directions for Peatmoss and Cocoa Shell Addition**
Peatmoss and cocoa shells need to be added to the toilet every day. The only day it is not added is on the day before emptying the compost. On that day the bathroom is closed so that no one is using the toilet.

The amount of peat moss and cocoa shells depends on the number of times the toilet is used. Use the table below to find the amount that is needed. Count the number of times the toilet was used by **starting from the last time** peat moss and shells were added.

| Number of times the toilet was used | Amount of peat moss to add | Amount of cocoa shells to add |
|---|---|---|
| 16-20 | 1 cup | 1 cup |
| 11-15 | ¾ cup | ¾ cup |
| 6-10 | ½ cup | ½ cup |
| 1-5 | ¼ cup | ¼ cup |

How to add the peat moss and cocoa shells to the toilet:

1) Mix the peat moss and cocoa shells together in a container
2) Sprinkle the mixture into the toilet fairly evenly over the waste pile.

**Directions for "Microbe Accelerator"**

This power should be mixed and added **every other Wednesday (that is, every two weeks).**

1) Put 1 Tablespoon of the microbe powder into the measuring cup we gave you with 8 ounces (oz.) of slightly warm water (more hot than a room temperature, but not "hot").
2) Stir the water and powder quickly for a very short time.
3) Pour the mixture over the whole waste pile that is in the toilet (try to pour it around the edges of the waste pile as well as in the middle).

# STOP

## PLEASE READ BEFORE USING THE TOILET OR IT WILL BREAK

## To use this toilet….

1) Lift the lid
2) Turn the handle to open the bowl
3) Throw toilet paper in the can in the bathroom, (don't put the toilet paper in the toilet)

## When finished….

1) Turn the handle to close the bowl.
2) Put down the lid.

Do not put **ANYTHING** in the toilet besides human waste.

- No toilet paper
- No cigarettes
- No paper towels
- No "women's products"
- No garbage of any kind
- No hand washing water
- No tobacco/chew
- No sodas
- No hand-washing water
- No food scraps
- No dog waste
- No honeybucket dumping

# UTAQAQAA

## NAAQLLUKU UNA ATURPAILEGG'PEGU QERRUN NAVEGYUARTUQ

**Atuqataaquvgu una qerrun…**

1) Patua mayurrluku
2) Ikirrluku qerrutervigkan nugtarrluku teguusuun maagun
3) Uq'rutallren eksaquunaku qerrutmun, taugaam trashcan-amun (ekeksaunaku uqrutallren qerrutmun)

**Taqkuvet….**

4) Teguusuun uitallratun nugtarrluku
5) Patunqiggluku.

**KIINGAN QERRULLREN/ANALLREN EKCIQUQ. Piciatun ekiyaaqunak.**

- Eksaquunaki uqrutallten
- Eksaquunaki kuingillten
- Eksaquunaki paper towel-aat
- Eksaquunaki 'arnat atullrit'
- Ekiyaaqunak caarllugnek
- Mermek ekiyaaqunak
- Ekiyaaqunak iqmigmek
- Qeciryaqunak iluanun
- Ciqiiciyaqunak carririsuutnek iluanun
- Neqallret eksaquunaki
- Qimugtet anait eksuitut
- Qerrutet ciqiicaqunaki

**Please respect our community.** We do not want to lose this opportunity to get rid of our honeybuckets and **protect our subsistence waters.** If anything besides human waste goes into the toilet, the toilet will not work properly.

Again, please **do not** dump honeybucket wastes into the toilet. If people use this toilet for dumping honeybuckets, there will be too much. The toilet will break.

**Takaqlluku nunaput.** Tamaryuumiitaput una cikiutaq qerruteput cimirkait, mermun pingailameng ima-i. Piciatun ekvik'uni una qerrun, calingaituq.

Ciqiiciyaqunaci qerrutnek uum iluanun. Ciqicivitun piureskan, calisciigaciquq muirpallaami.

# Appendix G
## Timeline of project events

## Timeline of Events for Compost Toilet Project

| Date | Event |
|---|---|
| Fall 2005-Spring 2006 | Communication with Raven about the project, compost toilet technology, and selection of toilet |
| March-April 2006 | First toilet and remote sensing equipment ordered |
| May-June 2006 | Installation of remote sensing equipment in toilet at UC Davis |
| May 2006 | Interviews carried out for the local operator position |
| June 2006 | Hiring of [redacted] as the operator |
| 6/23/06-7/1/06 | Trip to Raven (operator training, first toilet install) |
| 6/23/06-6/24/06 | Store toilet installed |
| 6/23/06-7/1/06 | Operator trained in-person |
| 6/23/06 | Started data collection on sensors in store toilet (temperature, moisture, and number of uses) |
| 6/30/06 | Community education meeting/presentation |
| 7/1/06 | Started Watt's Up power recording meter on the store toilet |
| 7/28/06-8/1/06 | Trip to Raven (second toilet install, further operator training, household training, store toilet check) |
| 7/30/06 | First household toilet installed (Snow's household) |
| 7/31/06 | Second community education meeting/presentation |
| Mid-late August | Electricity reduction tests (experimenting with the heaters and fans) on the store toilet |
| 9/9/06-9/12/06 | Trip to Raven (third toilet install, further operator training, household training, first and second toilet check) |
| 9/11/06 | Second household toilet installed (Tundra's household) |
| 9/11/06 | Started Watt's Up power recording meter on Tundra's toilet |
| 9/29/06 | Third household toilet installed (Moss's Toilet B) |
| 9/30/06 | Snow's toilet emptied for the first time |
| 10/6/06 | Store toilet emptied for the first time |
| 10/16/06 | xx, the local operator, gave his resignation. xx worked for two more weeks and trained the replacement operator, xx |
| 10/19/06 | Changed data logger (remotely) from 20 minute intervals to 30 minute intervals at 6pm CA time to reduce satellite data transmission costs |
| 10/24/06 | xx was hired as the new operator |
| 10/26/06 | Moss's Toilet A installed |
| 10/27/06 | Snow's toilet emptied for the second time |
| 11/7/06 | Operator reported some leaking on the side of the toilets at the Moss's and Tundra's due to the excess liquid line not fitting properly. The operator was able to tighten up the lines/outlets to stop the leaking. |
| 11/27/06 | The wind turbine on the vent pipe of the store toilet stopped spinning due to ice and snow buildup. The operator went on the roof to scrape off the snow and ice so it would turn again. |

| | |
|---|---|
| 11/29/06 | Store toilet emptied for the second time. |
| Early Dec | Moss's toilet "B" emptied for the first time |
| 12/4/06 | Tundra's toilet emptied for the first time. |
| 12/15/06 | Snow's toilet emptied for the third time |
| 1/1/07 | All store staff members (plus temporaries) were working at the store for several days in a row, 12 hours a day, for the store's end of the year inventory. The toilet was overused during this period and filled up. |
| 1/2/07 | The wind turbine blew off vent pipe at the Tundra's due to the high winds in Raven. The turbine was found and undamaged and the operator put it back on the next day. |
| 1/4/07 | Moss's toilet "B" emptied for the second time<br>Moss's toilet "A" emptied for the first time |
| 1/8/07 | The wind turbine on the vent pipe of the Tundra's toilet stopped spinning due to ice and snow buildup. The operator went on the roof of the Tundra's to scrape off the snow and ice so it would turn again. |
| 1/11/07 | Snow's toilet emptied for the fourth time |
| 1/11/07 | The wind turbine on the vent pipe of the Tundra's toilet blew off for a second time due to high winds. The operator fastened it back on using screws. |
| 1/14/07-1/17/07 | Trip to Raven (check on toilets, carry out interviews with users etc.) |
| 1/31/07 | Operator reported that Moss's toilet A was leaking again on the side where the excess liquid line is. More sealant was added to stop the leakage. |
| 2/5/07 | Operator reported some water leaking in where the vent pipe meets the ceiling on one of the Moss's toilets, due to heavy rains. The operator put more silicone sealant at the vent pipe outlet to stop the leaking. Water leaks were also reported at the Tundra's household during this time, so the vent pipe outlet was given extra sealant at the Tundra's as well. |
| 2/13/03 | Store toilet emptied for the third time. |
| 3/1/07 | Snow's toilet emptied for the fifth time |
| Mid March | Operator was off work for at least one week on personal/sick leave |
| Late March | Operator reports that a bowl-full of hair washing water was dumped into the toilet at the Tundra's by the son of the household owner. The operator re-educated the household members about not dumping anything in the toilet and put the Tundra's toilet on Fans and Heater mode for a few days to evaporate the extra liquid. |
| Mid-late March | Moss's toilet B emptied for the third time<br>Moss's toilet A emptied for the second time |
| Early-mid April | Operator was off work for 1.5-2 weeks due to illness |
| 4/30/07 | Tundra's toilet was emptied for the second time (by the household owner with supervision by the Operator) |
| 5/1/07 | xx., the local operator, gave his resignation because he needed to carry out subsistence. |
| 5/2/07 | Store toilet was removed (bathroom was being moved to a different part of the store) |

| | |
|---|---|
| 5/2/07 | Data collection from sensors in store toilet is stopped |
| 5/6/07-5/10/07 | Trip to Raven (check on toilets, carry out interviews with users, operator etc.) |
| 5/8/07 | xx is hired by the Raven Tribal Council as the new operator |
| 5/8/07-5/11/07 | xx is trained over the phone, and in person by xx and the Raven Environmental Department |
| 5/11/07 | Snow's toilet emptied a sixth time |
| 6/12/07 | Moss's toilet A emptied for the third time and toilet B emptied for the fourth time |
| 6/29/07 | Project period comes to a close. Toilets continue to be used by households, but data collection stops and operator is no longer funded by the grant. |

# Appendix H

## Results from the sensor installed in the store toilet (tallied "counts" for daily toilet use)

## Sensor results from the store toilet - tallied "counts" for each day

| Date | Number of times store toilet was used each day (i.e. number of times the handle was moved, less one time for daily O&M) |
|---|---|
| 6/26/2006 0:18 | 11 |
| 6/27/2006 0:18 | 16 |
| 6/28/2006 0:18 | 7 |
| 6/29/2006 0:18 | 11 |
| 6/30/2006 0:18 | 16 |
| 7/1/2006 0:18 | 7 |
| 7/2/2006 0:18 | 1 |
| 7/3/2006 0:18 | 10 |
| 7/4/2006 0:18 | 4 |
| 7/5/2006 0:18 | 8 |
| 7/6/2006 0:18 | 5 |
| 7/7/2006 0:18 | 3 |
| 7/8/2006 0:18 | 3 |
| 7/9/2006 0:18 | 5 |
| 7/10/2006 0:18 | 4 |
| 7/11/2006 0:18 | 9 |
| 7/12/2006 0:18 | 11 |
| 7/13/2006 0:18 | 14 |
| 7/14/2006 0:18 | 14 |
| 7/15/2006 0:18 | 12 |
| 7/16/2006 0:18 | 5 |
| 7/17/2006 0:18 | 10 |
| 7/18/2006 0:18 | 14 |
| 7/19/2006 0:18 | 10 |
| 7/20/2006 0:18 | 7 |
| 7/21/2006 0:18 | 12 |
| 7/22/2006 0:18 | 4 |
| 7/23/2006 0:18 | 7 |
| 7/24/2006 0:18 | 11 |
| 7/25/2006 0:18 | 13 |
| 7/26/2006 0:18 | 12 |
| 7/27/2006 0:18 | 17 |
| 7/28/2006 0:18 | 12 |
| 7/29/2006 0:18 | 7 |
| 7/30/2006 0:18 | 2 |
| 7/31/2006 0:18 | 11 |
| 8/1/2006 0:18 | 14 |
| 8/2/2006 0:18 | 10 |
| 8/3/2006 0:18 | 15 |
| 8/4/2006 0:18 | 20 |
| 8/5/2006 0:18 | 4 |
| 8/6/2006 0:18 | 2 |
| 8/7/2006 0:18 | 15 |
| 8/8/2006 0:18 | 14 |
| 8/9/2006 0:18 | 19 |
| 8/10/2006 0:18 | 25 |
| 8/11/2006 0:18 | 17 |
| 8/12/2006 0:18 | 9 |
| 8/13/2006 0:18 | 6 |
| 8/14/2006 0:18 | 14 |
| 8/15/2006 0:18 | 9 |
| 8/16/2006 0:18 | 7 |
| 8/17/2006 0:18 | 23 |
| 8/18/2006 0:18 | 12 |
| 8/19/2006 0:18 | 2 |
| 8/20/2006 0:18 | 13 |
| 8/21/2006 0:18 | 15 |
| 8/22/2006 0:18 | 18 |
| 8/23/2006 0:18 | 11 |
| 8/24/2006 0:18 | 16 |
| 8/25/2006 0:18 | 14 |
| 8/26/2006 0:18 | 15 |
| 8/27/2006 0:18 | 8 |
| 8/28/2006 0:18 | 9 |
| 8/29/2006 0:18 | 17 |
| 8/30/2006 0:18 | 9 |
| 8/31/2006 0:18 | 13 |
| 9/1/2006 0:18 | 12 |
| 9/2/2006 0:18 | 1 |
| 9/3/2006 0:18 | 3 |
| 9/4/2006 0:18 | 7 |
| 9/5/2006 0:18 | 7 |
| 9/6/2006 0:18 | 14 |
| 9/7/2006 0:18 | 16 |
| 9/8/2006 0:18 | 11 |
| 9/9/2006 0:18 | 2 |
| 9/10/2006 0:18 | 6 |
| 9/11/2006 0:18 | 11 |
| 9/12/2006 0:18 | 6 |
| 9/13/2006 0:18 | 10 |
| 9/14/2006 0:18 | 14 |

| Date | Number of times store toilet was used each day (i.e. number of times the handle was moved, less one time for daily O&M) |
|---|---|
| 9/15/2006 0:18 | 7 |
| 9/16/2006 0:18 | 10 |
| 9/17/2006 0:18 | 8 |
| 9/18/2006 0:18 | 15 |
| 9/19/2006 0:18 | 13 |
| 9/20/2006 0:18 | 22 |
| 9/21/2006 0:18 | 13 |
| 9/22/2006 0:18 | 21 |
| 9/23/2006 0:18 | 4 |
| 9/24/2006 0:18 | 4 |
| 9/25/2006 0:18 | 10 |
| 9/26/2006 0:18 | 10 |
| 9/27/2006 0:18 | 15 |
| 9/28/2006 0:18 | 11 |
| 9/29/2006 0:18 | 0 |
| 9/30/2006 0:18 | 0 |
| 10/1/2006 0:18 | 0 |
| 10/2/2006 0:18 | 0 |
| 10/3/2006 0:18 | 0 |
| 10/4/2006 0:18 | 0 |
| 10/5/2006 0:18 | 0 |
| 10/6/2006 0:18 | 4 |
| 10/7/2006 0:18 | 3 |
| 10/8/2006 0:18 | 4 |
| 10/9/2006 0:18 | 5 |
| 10/10/2006 0:18 | 8 |
| 10/11/2006 0:18 | 10 |
| 10/12/2006 0:18 | 12 |
| 10/13/2006 0:18 | 4 |
| 10/14/2006 0:18 | 1 |
| 10/15/2006 0:18 | 2 |
| 10/16/2006 0:18 | 6 |
| 10/17/2006 0:18 | 6 |
| 10/18/2006 0:18 | 9 |
| 10/19/2006 0:18 | 11 |
| 10/20/2006 0:18 | 8 |
| 10/21/2006 0:18 | 5 |
| 10/22/2006 0:18 | 1 |
| 10/23/2006 0:18 | 4 |
| 10/24/2006 0:18 | 7 |
| 10/25/2006 0:18 | 12 |
| 10/26/2006 0:18 | 11 |
| 10/27/2006 0:18 | 11 |
| 10/28/2006 0:18 | 3 |
| 10/29/2006 0:18 | 1 |
| 10/30/2006 0:18 | 10 |
| 10/31/2006 0:18 | 8 |
| 11/1/2006 0:18 | 8 |
| 11/2/2006 0:18 | 12 |
| 11/3/2006 0:18 | 8 |
| 11/4/2006 0:18 | 1 |
| 11/5/2006 0:18 | 1 |
| 11/6/2006 0:18 | 8 |
| 11/7/2006 0:18 | 5 |
| 11/8/2006 0:18 | 4 |
| 11/9/2006 0:18 | 4 |
| 11/10/2006 0:18 | 4 |
| 11/11/2006 0:18 | 2 |
| 11/12/2006 0:18 | 2 |
| 11/13/2006 0:18 | 8 |
| 11/14/2006 0:18 | 11 |
| 11/15/2006 0:18 | 9 |
| 11/16/2006 0:18 | 3 |
| 11/17/2006 0:18 | 5 |
| 11/18/2006 0:18 | 5 |
| 11/19/2006 0:18 | 0 |
| 11/20/2006 0:18 | 6 |
| 11/21/2006 0:18 | 6 |
| 11/22/2006 0:18 | 1 |
| 11/23/2006 0:18 | 0 |
| 11/24/2006 0:18 | 0 |
| 11/25/2006 0:18 | 1 |
| 11/26/2006 0:18 | 0 |
| 11/27/2006 0:18 | 0 |
| 11/28/2006 0:18 | 0 |
| 11/29/2006 0:18 | 3 |
| 11/30/2006 0:18 | 1 |
| 12/1/2006 0:18 | 0 |
| 12/2/2006 0:18 | 0 |
| 12/3/2006 0:18 | 0 |
| 12/4/2006 0:18 | 4 |
| 12/5/2006 0:18 | 5 |

| Date | Number of times store toilet was used each day (i.e. number of times the handle was moved, less one time for daily O&M) |
|---|---|
| 12/6/2006 0:18 | 1 |
| 12/7/2006 0:18 | 3 |
| 12/8/2006 0:18 | 3 |
| 12/9/2006 0:18 | 0 |
| 12/10/2006 0:18 | 1 |
| 12/11/2006 0:18 | 16 |
| 12/12/2006 0:18 | 8 |
| 12/13/2006 0:18 | 12 |
| 12/14/2006 0:18 | 8 |
| 12/15/2006 0:18 | 15 |
| 12/16/2006 0:18 | 4 |
| 12/17/2006 0:18 | 1 |
| 12/18/2006 0:18 | 1 |
| 12/19/2006 0:18 | 1 |
| 12/20/2006 0:18 | 4 |
| 12/21/2006 0:18 | 6 |
| 12/22/2006 0:18 | 9 |
| 12/23/2006 0:18 | 1 |
| 12/24/2006 0:18 | 3 |
| 12/25/2006 0:18 | 2 |
| 12/26/2006 0:18 | 10 |
| 12/27/2006 0:18 | 15 |
| 12/28/2006 0:18 | 11 |
| 12/29/2006 0:18 | 12 |
| 12/30/2006 0:18 | 4 |
| 12/31/2006 0:18 | 8 |
| 1/1/2007 0:18 | 44 |
| 1/2/2007 0:18 | 0 |
| 1/3/2007 0:18 | 4 |
| 1/4/2007 0:18 | 3 |
| 1/5/2007 0:18 | 5 |
| 1/6/2007 0:18 | 3 |
| 1/7/2007 0:18 | 3 |
| 1/8/2007 0:18 | 3 |
| 1/9/2007 0:18 | 3 |
| 1/10/2007 0:18 | 0 |
| 1/11/2007 0:18 | 2 |
| 1/12/2007 0:18 | 0 |
| 1/13/2007 0:18 | 0 |
| 1/14/2007 0:18 | 0 |
| 1/15/2007 0:18 | 0 |
| 1/16/2007 0:07 | 0 |
| 1/16/2007 2:47 | 0 |
| 1/17/2007 0:07 | 7 |
| 1/18/2007 0:07 | 1 |
| 1/19/2007 0:07 | 1 |
| 1/20/2007 0:07 | 1 |
| 1/21/2007 0:07 | 0 |
| 1/22/2007 0:07 | 1 |
| 1/23/2007 0:07 | 4 |
| 1/24/2007 0:07 | 1 |
| 1/25/2007 0:07 | 1 |
| 1/26/2007 0:07 | 3 |
| 1/27/2007 0:07 | 1 |
| 1/28/2007 0:07 | 0 |
| 1/29/2007 0:07 | 1 |
| 1/30/2007 0:07 | 0 |
| 1/31/2007 0:07 | 0 |
| 2/1/2007 0:07 | 0 |
| 2/2/2007 0:07 | 2 |
| 2/3/2007 0:07 | 0 |
| 2/4/2007 0:07 | 0 |
| 2/5/2007 0:07 | 0 |
| 2/6/2007 0:07 | 0 |
| 2/7/2007 0:07 | 0 |
| 2/8/2007 0:07 | 0 |
| 2/9/2007 0:07 | 0 |
| 2/10/2007 0:07 | 0 |
| 2/11/2007 0:07 | 0 |
| 2/12/2007 0:07 | 0 |
| 2/13/2007 0:07 | 9 |
| 2/14/2007 0:07 | 4 |
| 2/15/2007 0:07 | 9 |
| 2/16/2007 0:07 | 2 |
| 2/17/2007 0:07 | 0 |
| 2/18/2007 0:07 | 4 |
| 2/19/2007 0:07 | 1 |
| 2/20/2007 0:07 | 1 |
| 2/21/2007 0:07 | 9 |
| 2/22/2007 0:07 | 7 |
| 2/23/2007 0:07 | 4 |
| 2/24/2007 0:07 | 1 |

| Date | Number of times store toilet was used each day (i.e. number of times the handle was moved, less one time for daily O&M) |
|---|---|
| 2/25/2007 0:07 | 0 |
| 2/26/2007 0:07 | 7 |
| 2/27/2007 0:07 | 10 |
| 2/28/2007 0:07 | 10 |
| 3/1/2007 0:07 | 12 |
| 3/2/2007 0:07 | 8 |
| 3/3/2007 0:07 | 1 |
| 3/4/2007 0:07 | 1 |
| 3/5/2007 0:07 | 6 |
| 3/6/2007 0:07 | 5 |
| 3/7/2007 0:07 | 11 |
| 3/8/2007 0:07 | 9 |
| 3/9/2007 0:07 | 7 |
| 3/10/2007 0:07 | 1 |
| 3/11/2007 0:07 | 4 |
| 3/12/2007 0:07 | 6 |
| 3/13/2007 0:07 | 10 |
| 3/14/2007 0:07 | 14 |
| 3/15/2007 0:07 | 10 |
| 3/16/2007 0:07 | 11 |
| 3/17/2007 0:07 | 2 |
| 3/18/2007 0:07 | 7 |
| 3/19/2007 0:07 | 7 |
| 3/20/2007 0:07 | 8 |
| 3/21/2007 0:07 | 13 |
| 3/22/2007 0:07 | 9 |
| 3/23/2007 0:07 | 11 |
| 3/24/2007 0:07 | 1 |
| 3/25/2007 0:07 | 4 |
| 3/26/2007 0:07 | 5 |
| 3/27/2007 0:07 | 5 |
| 3/28/2007 0:07 | 3 |
| 3/29/2007 0:07 | 9 |
| 3/30/2007 0:07 | 17 |
| 3/31/2007 0:07 | 4 |
| 4/1/2007 0:07 | 1 |
| 4/2/2007 0:07 | 5 |
| 4/3/2007 0:07 | 5 |
| 4/4/2007 0:07 | 9 |
| 4/5/2007 0:07 | 4 |
| 4/6/2007 0:07 | 7 |
| 4/7/2007 0:07 | 4 |
| 4/8/2007 0:07 | 3 |
| 4/9/2007 0:07 | 6 |
| 4/10/2007 0:07 | 0 |
| 4/11/2007 0:07 | 0 |
| 4/12/2007 0:07 | 0 |
| 4/13/2007 0:07 | 0 |
| 4/14/2007 0:07 | 0 |
| 4/15/2007 0:07 | 0 |
| 4/16/2007 0:07 | 0 |
| 4/17/2007 0:07 | 0 |
| 4/18/2007 0:07 | 0 |
| 4/19/2007 0:07 | 0 |
| 4/20/2007 0:07 | 0 |
| 4/21/2007 0:07 | 0 |
| 4/22/2007 0:07 | 0 |
| 4/23/2007 0:07 | 0 |
| 4/24/2007 0:07 | 0 |
| 4/25/2007 0:07 | 0 |
| 4/26/2007 0:07 | 0 |
| 4/27/2007 0:07 | 0 |
| 4/28/2007 0:07 | 0 |
| 4/29/2007 0:07 | 0 |
| 4/30/2007 0:07 | 0 |
| 5/1/2007 0:07 | 2 |
| | |
| **Sum** | **1894.00** |
| **Average counts per day** | **6.09** |
| **Average with New Year's Day not included** | **5.95** |
| **Maximum** | **44** |
| **Maximum with New Year's Day not included** | **25** |
| **Minimum** | **0** |

# Appendix I

## Results from the user-reported toilet use tracking sheets for the store toilet

| Results from the store toilet self-report toilet use tracking sheets | |
|---|---|
| Date | Number of checkmarks on the tracking sheet (i.e. number of times people self reported using the toilet) |
| 6/26/06 | 7 |
| 6/27/06 | 11 |
| 6/28/06 | 7 |
| 6/29/06 | 7 |
| 7/3/06 | 4 |
| 7/4/06 | 3 |
| 7/5/06 | 6 |
| 7/6/06 | 3 |
| 7/7/06 | 6 |
| 7/10/06 | 4 |
| 7/11/06 | 6 |
| 7/12/06 | 6 |
| 7/13/06 | 9 |
| 7/14/06 | 10 |
| 7/15/06 | 8 |
| 7/16/06 | 6 |
| 7/17/06 | 5 |
| 7/18/06 | 9 |
| 7/19/06 | 11 |
| 7/20/06 | 5 |
| 7/21/06 | 10 |
| 7/22/06 | 2 |
| 7/23/06 | 4 |
| 7/24/06 | 8 |
| 7/25/06 | 10 |
| 7/26/06 | 9 |
| 7/27/06 | 11 |
| 7/28/06 | 9 |
| 7/31/06 | 8 |
| 8/1/06 | 3 |
| 8/2/06 | 6 |
| 8/3/06 | 3 |
| 8/4/06 | 7 |
| 8/5/06 | 5 |
| 8/6/06 | 3 |
| 8/7/06 | 8 |
| 8/8/06 | 8 |
| 8/9/06 | 7 |
| 8/10/06 | 18 |
| 8/11/06 | 9 |
| 8/14/06 | 12 |
| 8/15/06 | 7 |
| 8/16/06 | 4 |
| 8/17/06 | 10 |
| 8/18/06 | 6 |
| 8/21/06 | 12 |

| Date | Number of checkmarks on the tracking sheet (i.e. number of times people self reported using the toilet) |
|---|---|
| 8/22/06 | 18 |
| 8/23/06 | 4 |
| 8/24/06 | 13 |
| 8/25/06 | 9 |
| 8/26/06 | 10 |
| 8/27/06 | 5 |
| 8/28/06 | 5 |
| 8/29/06 | 8 |
| 9/4/06 | 1 |
| 9/5/06 | 7 |
| 9/6/06 | 10 |
| 9/7/06 | 10 |
| 9/8/06 | 7 |
| 9/11/06 | 8 |
| 9/13/06 | 8 |
| 9/14/06 | 6 |
| 9/15/06 | 5 |
| 9/18/06 | 13 |
| 9/19/06 | 8 |
| 9/20/06 | 5 |
| 9/21/06 | 10 |
| 9/22/06 | 22 |
| 9/23/06 | 5 |
| 9/24/06 | 3 |
| 9/25/06 | 5 |
| 9/26/06 | 8 |
| 9/27/06 | 1 |
| 9/29/06 | 5 |
| 9/30/06 | 9 |
| 10/6/06 | 6 |
| 10/7/06 | 4 |
| 10/8/06 | 3 |
| 10/9/06 | 4 |
| 10/10/06 | 9 |
| 10/11/06 | 7 |
| 11/13/06 | 2 |
| 11/14/06 | 4 |
| 11/15/06 | 1 |
| 11/16/06 | 0 |
| 11/17/06 | 0 |
| 11/18/06 | 3 |
| 11/19/06 | 0 |
| 11/20/06 | 0 |
| 11/23/06 | 0 |
| 11/24/06 | 0 |
| 11/26/06 | 0 |
| 11/27/06 | 0 |

| Date | Number of checkmarks on the tracking sheet (i.e. number of times people self reported using the toilet) |
|---|---|
| 11/29/06 | 0 |
| 11/30/06 | 0 |
| 12/1/06 | 1 |
| 12/2/06 | 1 |
| 12/3/06 | 0 |
| 12/4/06 | 2 |
| 12/5/06 | 3 |
| 12/6/06 | 0 |
| 12/7/06 | 1 |
| 12/8/06 | 2 |
| 12/9/06 | 1 |
| 12/10/06 | 2 |
| 12/11/06 | 4 |
| 12/12/06 | 6 |
| 12/13/06 | 8 |
| 12/14/06 | 4 |
| 12/15/06 | 3 |
| 12/16/06 | 3 |
| 12/17/06 | 2 |
| 12/18/06 | 4 |
| 12/19/06 | 3 |
| 12/20/06 | 5 |
| 12/21/06 | 1 |
| 12/22/06 | 2 |
| 12/23/06 | 2 |
| 12/24/06 | 3 |
| 12/25/06 | 2 |
| 12/26/06 | 1 |
| 12/27/06 | 7 |
| 12/28/06 | 3 |
| 12/29/06 | 5 |
| 12/30/06 | 1 |
| 12/31/06 | 3 |
| 1/1/07 | 9 |
| 1/2/07 | 1 |
| 1/3/07 | 0 |
| 1/4/07 | 1 |
| 1/5/07 | 1 |
| 1/6/07 | 3 |
| 1/7/07 | 1 |
| (The tracking sheets were no longer used past 1/7/07) | |
| **Total** | **704** |
| **Average** | **5.29** |
| **Minimum** | **0** |
| **Maximum** | **22** |

# Appendix J
## Sample inspection/reporting forms filled out for the project

## Daily Inspection and Maintenance Sheet

Date June 28 Time: 10:48 AM

| Question | Answer (write in, or circle answer) | Comments |
|---|---|---|
| How many times do you think the toilet was actually used today? | 7 | |
| How much peatmoss and cocoa shell was added today? | Peatmoss 1/4 cup<br>Cocoa shell 1/4 cup | |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "up" position) | Yes No | |
| Was the "number of uses" sheet taken down today and replaced with a blank one? | Yes No | |
| Record "watts", "watt-hours", and "hours" readings from power meter (to do this, press the "mode" button on the *Watt's Up* power meter. | 4.63 Watts<br>24.9 Watt-hours<br>2:09 Hours | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Wet Dry Good | |
| Is there any liquid leaking from the toilet? If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>It is not moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| Are there any flies in the toilet? | A lot Some None | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Pickup any feedback forms and fax to Simone. | How many forms did you find?<br>None | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge. | O-kay | |
| Make sure the switch on the top of the toilet is on number I (fans and heater). | switch O-kay | |

If there were any problems with the toilet today, note them here:

Today is: 6/27/06

# Try out the new toilet!

**See the store staff for the key.**

Before you use the toilet, please **place an "X" in one of the empty checkboxes** below before you use the toilet. This is very important. We need to make sure that the toilet keeps working. We need to know when it needs to be checked.

**If there are no empty checkboxes below, DO NOT USE THE TOILET. See store staff**

Please respect our community. These toilets may help us get rid of our honeybuckets.

| | |
|---|---|
| 1 | ✓ |
| 2 | ✓ |
| 3 | ✓ |
| 4 | ✓ |
| 5 | ✓ |
| 6 | ✓ |
| 7 | ✓ |
| 8 | ✓ |
| 9 | ✓ |
| 10 | ✓ |
| 11 | ✓ |
| 12 | |
| 13 | |
| 14 | |
| 15 | |
| 16 | |
| 17 | |
| 18 | |

**Household (Circle One):** [redacted]'s [redacted]'s [redacted]'s

**Michael, Fill out this Inspection and Maintenance Sheet Every Monday, Wednesday, and Friday**

**Date** Feb 1 **Time:**______

| Question | Answer (write in, or circle answer) | Comments (Did something happen? |
|---|---|---|
| How many times was the toilet used today? (look on the checkmark sheet) | None | |
| Do you think the household has been adding a small cupful of peatmoss and coco shells after each use? | Yes No I am not sure | |
| Pull the aerator bar in and out a few times (the aerator bar is the top bar on the front of the toilet) | | D |
| **Every Monday**, remove the "number uses checkmark sheet" on the door of the bathroom and fax it to Simone. Put up a new sheet on the door for the household to fill out. | | O |
| **Every other Wednesday**, add the microbe accelerator (if you need directions for how to do this, contact Simone) | | W |
| **Every other Wednesday**, give Jessica Lewis, Jobe Abraham, and Joe Mukluk the "household self report sheet" for them to fill out. Once they've filled it out, fax it to Simone | | E |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as toilet paper, garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Too Wet Too Dry Good | |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>~~It is not moving~~ because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Empty the trash can of used toilet paper if it is full. Cleared | | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge (do NOT use any chemicals on or in the toilet or it break - by harming the natural composting process) Cleared | | |
| If there were any problems with the toilet today, note them here: NO | | |

**FAX TO SIMONE AT: 1 (619) 489 0429**

**Household (Circle One):** [redacted]'s [redacted]'s [redacted]'s

**Daily Inspection and Maintenance Sheet** **Date** Sept 14 **Time:** ______

| Question | Answer (write in, or circle answer) | Comments |
|---|---|---|
| How many times was the toilet used today? | 4 | |
| Do you think the household has been adding a small cupful of peatmoss after each use? Yes No<br><br>At the end of the day, how much peatmoss and cocoa shells were added? | Peatmoss 1/4 cup<br>Cocoa shell 1/4 cup | |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Wet Dry Good | |
| Is there any liquid leaking from the toilet? If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>~~It is not~~ moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| Are there any flies in the toilet? | A lot Some None | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Empty can of used toilet paper if full. | | Good |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge. | | Good |

If there were any problems with the toilet today, note them here:

**FAX TO SIMONE AT: 1 (619) 489 0429**

**Household (Circle One):** [redacted]'s [redacted]'s [redacted]'s

**Michael, Fill out this Inspection and Maintenance Sheet Every Monday, Wednesday, and Friday**

**Date** Jan 8 **Time:**________

| Question | Answer (write in, or circle answer) | Comments (Did something happen? |
|---|---|---|
| How many times was the toilet used today? (look on the checkmark sheet) | 2 | |
| Do you think the household has been adding a small cupful of peatmoss and coco shells after each use? | Yes No I am not sure | |
| Pull the aerator bar in and out a few times (the aerator bar is the top bar on the front of the toilet) | | D |
| **Every Monday**, remove the "number uses checkmark sheet" on the door of the bathroom and **fax** it to Simone. Put up a new sheet on the door for the household to fill out. | | O |
| **Every other Wednesday**, add the microbe accelerator (if you need directions for how to do this, contact Simone) | | N |
| **Every other Wednesday**, give Jessica Lewis, Jobe Abraham, and Joe Mukluk the "household self report sheet" for them to fill out. Once they've filled it out, fax it to Simone | | E |
| Is there any odor in the bathroom? | a lot a little none | |
| Was the toilet bowl closed when you first saw the toilet today? (that is, was handle in the "down" position) | Yes No | |
| Do you see anything in the toilet besides human waste and peatmoss? (such as toilet paper, garbage, toys, etc.) | Yes No<br>If yes, what do you see? | |
| Does waste in toilet look too wet, too dry, or does the amount of "wet" look about right? | Too Wet Too Dry Good | |
| Is there any liquid leaking from the toilet?<br>If yes, take a photo of the leak. | Yes No<br>If yes, where is the leak? | |
| Is the wind turbine on the roof moving or is it blocked? | It is moving<br>~~It is not~~ moving because there is no wind<br>It is not moving because it is blocked or something else is wrong. | |
| If the urine container has liquid in it, note how much and empty if it is full. | Level of Urine:<br>None ¼ ½ ¾ Full | |
| Empty the trash can of used toilet paper if it is full. Cleaned | | |
| If the toilet needs to be cleaned on the outside, wipe it down with water and a sponge (do NOT use any chemicals on or in the toilet or it break - by harming the natural composting process) Cleaned | | |
| If there were any problems with the toilet today, note them here: NO | | |

**FAX TO SIMONE AT: 1 (619) 489 0429**

**For the week of:** Sept 11 - 17 [redacted]

Before you use the toilet, please place an "X" in one of the empty checkboxes below before you use the toilet. This is very important. We need ~~to~~ make sure that the toilet keeps working. We need to know when it needs to be checked.

**If there are no empty checkboxes below, use the honeybucket for the rest of the day.**

Please respect our house. These toilets may help us get rid of our honeybuckets.

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
|---|---|---|---|---|---|---|---|
| 1 | X | | X | X | X | X | X |
| 2 | X | | X | X | X | X | X |
| 3 | X | | X | X | X | | |
| 4 | X | | | X | X | | |
| 5 | | | | | X | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |

**Does the toilet and room smell okay? Or is there a bad smell from the toilet? Please use a check mark ✓ to let us know what you smell. Thank you!**

DATE: August 14-20, 2006

| Time | Aug 14 Monday | | 15 Tuesday | | 16 Wednesday | | 17 Thursday | | 18 Friday | | 19 Saturday | | 20 Sunday | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Smells okay | Smells bad | Smells okay | Smells bad | Smells okay | Smells bad | Smells okay | Smells bad | Smells okay | Smells bad | Smells okay | Smells bad | Smells okay | Smells bad |
| 8:00-9:00 am | | | | | | | | | | | | | | |
| 9:00-10:00 am | ✓ | | | | ✓ | | ✓ | | ✓ | | | | ✓ | |
| 10:00-11:00 am | | | ✓ | | | | | | | | | | | |
| 11:00-12:00 pm | ✓ | | | | | | | | ✓ | | ✓ | | | |
| 12:00-1:00 pm | | | | | ✓ | | ✓ | | | | | | ✓ | |
| 1:00-2:00pm | ✓ | | ✓ | | | | | | | | | | | |
| 2:00-3:00 pm | | | | | | | | | ✓ | | | | | |
| 3:00-4:00 pm | | | | | ✓ | | | | | | | | | |
| 4:00-5:00 pm | ✓ | | ✓ | | | | ✓ | | | | ✓ | | | |
| 5:00-6:00 pm | | | | | | | | | ✓ | | | | | |
| 6:00-7:00 pm | | | | | | | | | | | | | ✓ | |
| 7:00-8:00pm | | | | | | | | | | | | | | |
| 8:00-9:00pm | | | | | | | | | | | | | | |
| 9:00-10:00pm | | | | | | | | | | | | | | |

**July, 2006** **Write what day each operation task was carried out this month. Use the Letter code (P, A, M, W, E). If you did the task different, or noticed something different, write it down in the box.**

**P**= Peat moss/cocoa shells added **A**=Aerator bar moved back and forth **M**=Microbe accelerator added
**W**=Warm Water added around the edges of the waste pile **E**=Emptied compost from bottom of the toilet

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | | | 1 |
| 2 | A 3 | 4 | A 5 | P 6 | A P 7 | 8 |
| 9 | A P 10 | P 11 | A W M P 12 | P 13 | A P 14 | 15 |
| P 16 | A P 17 | P 18 | A P 19 | P 20 | A P 21 | P 22 |
| P 23 | A P 24 | P 25 | A P M 26 | P 27 | A P 28 | P 29 |
| P 30 | A 31 | | | | | |

**August, 2006 Write what day each operation task was carried out this month. Use the Letter code (P, A, M, W, E).**
**If you did the task different, or noticed something different, write it down in the box.**

**P**= Peat moss/cocoa shells added **A**=Aerator bar moved back and forth **M**=Microbe accelerator added
**W**=Warm Water added around the edges of the waste pile **E**=Emptied compost from bottom of the toilet

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | P A | 1 P | 2 A P | 3 P | 4 AP | 5 P |
| 6 P | 7 A P | 8 P | 9 P A M | 10 P | 11 P A | 12 P |
| 13 P | 14 A P | 15 P | 16 P A | 17 P | 18 P A | 19 P |
| 20 PA | 21 A P | 22 P | 23 P A M | 24 P | 25 A P | 26 P |
| 27 P | 28 A P | 29 P | 30 P A M | 31 P | | |

# Appendix K
# Results of inspection sheets filled out for the store toilet

| Results of store toilet inspection sheets | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Notes | Date | How many times was the toilet used today? | How much peatmoss was added today? (in cups) | How much cocoa shell was added today? (in cups) | Is there any odor in the bathroom? (a lot, a little, or none) | Was the toilet bowl closed when you first saw the toilet today? (y=yes, n=no) | Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) (y=yes, n=no) | Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? (wet, dry, good) |
| | 6/26/06 | 7 | 0.25 | 0.25 | none | y | n | good |
| | 6/27/06 | 11 | 0.75 | 0.75 | none | y | n | good |
| | 6/28/06 | 7 | 0.25 | 0.25 | none | y | n | good |
| | 6/29/06 | 7 | 0.25 | 0.25 | none | y | n | good |
| | 6/30/06 | | | | a little | y | n | good |
| | 7/3/06 | 4 | | | none | y | y (tissue) | good |
| | 7/4/06 | 3 | | | none | n | n | good |
| | 7/5/06 | 6 | 0.25 | 0.25 | a little | y | y (tissue) | good |
| | 7/6/06 | 3 | 0.25 | 0.25 | none | y | y (tissue) | good |
| | 7/7/06 | 6 | 0.25 | 0.25 | none | y | n | good |
| | 7/10/06 | 4 | 0.25 | 0.25 | none | y | y (tissue from last time) | good |
| | 7/11/06 | 6 | 0.25 | 0.25 | a little to none | y | n | good |
| | 7/12/06 | 6 | 0.5 | 0.5 | none | y | n | good |
| | 7/13/06 | 9 | 0.5 | 0.5 | none | y | n | good |
| | 7/14/06 | | | | none | y | n | good |
| | 7/17/06 | 5 | 0.25 | 0.25 | none | y | n | good |
| | 7/18/06 | 9 | 0.5 | 0.5 | a little | y | n | good |
| | 7/19/06 | 11 | 0.5 | 0.5 | a little to none | y | n | good |
| | 7/24/06 | 8 | 0.5 | 0.5 | none | y | n | good |
| | 7/25/06 | 10 | 0.5 | 0.5 | none | y | n | good |
| | 7/26/06 | 9 | 0.5 | 0.5 | none | y | n | good |
| | 7/27/06 | 11 | 0.5 | 0.5 | none | y | n | good |
| | 7/28/06 | 9 | 0.5 | 0.5 | | n | n | good |
| | 7/31/06 | 8 | 0.5 | 0.5 | a little | y | n | good |
| | 8/1/06 | 3 | 0.25 | 0.25 | a little | y | n | good |
| | 8/2/06 | 6 | 0.25 | 0.25 | none | y | n | good |
| | 8/3/06 | 3 | 0.25 | 0.25 | none | y | n | good |
| | 8/4/06 | 7 | 0.5 | 0.5 | none | y | n | good |
| | 8/7/06 | 8 | 0.5 | 0.5 | none | y | n | good |
| | 8/8/06 | 8 | 0.5 | 0.5 | none | y | n | good |
| | 8/9/06 | 7 | 0.5 | 0.5 | none | y | n | good |
| | 8/10/06 | 18 | 1 | 1 | none | y | n | good |
| | 8/11/06 | 9 | 0.5 | 0.5 | none | y | n | good |
| | 8/14/06 | 12 | 0.75 | 0.75 | none | y | n | good |
| | 8/15/06 | 7 | 0.5 | 0.5 | | | | |
| | 8/16/06 | 4 | 0.25 | 0.25 | none | n | n | good |
| | 8/17/06 | 10 | 0.5 | 0.5 | none | n | n | good |
| | 8/18/06 | 6 | 0.5 | 0.5 | none | y | n | good |
| Only sent "use" and cups added data | 8/21/06 | 12 | 0.75 | 0.75 | | | | |
| Only sent "use" and cups added data | 8/22/06 | 18 | 1 | 1 | | | | |
| Only sent "use" and cups added data | 8/24/06 | 13 | 0.75 | 0.75 | | | | |
| | 8/25/06 | 9 | 0.5 | 0.5 | none | y | n | good |
| Only sent "use" and cups added data | 8/26/06 | 10 | 0.5 | 0.5 | | | | |
| Only sent "use" and cups added data | 8/27/06 | 5 | 0.25 | 0.25 | | | | |
| | 8/28/06 | 5 | 0.25 | 0.25 | none | y | n | good |
| | 8/29/06 | 8 | 0.5 | 0.5 | none | n | n | good |
| | 9/8/06 | 7 | 0.25 | 0.25 | none | y | y (tissue) | good |
| | 9/14/06 | 6 | 0.5 | 0.5 | none | y | n | good |
| | 9/18/06 | 13 | 0.75 | 0.75 | none | y | n | good |
| | 9/19/06 | 8 | 0.5 | 0.5 | none | y | n | good |
| | 9/20/06 | 5 | 0.25 | 0.25 | | | | |
| | 9/21/06 | 10 | 0.5 | 0.5 | | | | |
| | 9/22/06 | 13 | 0.5 | 0.5 | none | y | n | good |
| | 9/25/06 | 5 | 0.25 | 0.25 | none | y | n | good |
| | 9/26/06 | 8 | 0.5 | 0.5 | | y | n | good |
| New (2nd) operator filling out the forms | 11/13/06 | 2 | 1.5 | 1 | a little | y | n | good |

| Date | Is there any liquid leaking from the toilet? (y=yes, n=no) | Is the wind turbine on the roof moving or is it blocked? | Are there any flies in the toilet? (a lot, some, none) | If the urine container has liquid in it, note how much and empty if it is full. (none, 0.25, 0.5, 0.75, full) | If there were any problems with the toilet today, note them here: | | |
|---|---|---|---|---|---|---|---|
| 6/26/06 | n | it is moving | none | none | | | |
| 6/27/06 | n | it is moving | none | none | | | |
| 6/28/06 | n | it is moving | none | none | | | |
| 6/29/06 | n | it is moving | none | none | little odor smelled | | |
| 6/30/06 | n | it is moving | none | none | | | |
| 7/3/06 | n | it is moving | none | none | | | |
| 7/4/06 | n | it is moving | none | none | | | |
| 7/5/06 | n | it is moving | none | none | | | |
| 7/6/06 | n | it is moving | none | none | | | |
| 7/7/06 | n | it is moving | none | none | | | |
| 7/10/06 | n | it is moving | none | none | | | |
| 7/11/06 | n | it is moving | none | none | | | |
| 7/12/06 | n | it is moving | none | none | | | |
| 7/13/06 | n | it is moving | none | none | | | |
| 7/14/06 | n | it is moving | none | none | | | |
| 7/17/06 | n | it is moving | none | none | | | |
| 7/18/06 | n | it is moving | none | none | | | |
| 7/19/06 | n | it is moving | none | none | you can almost smell the difference, but okay. | | |
| 7/24/06 | n | it is moving | none | none | | | |
| 7/25/06 | n | it is moving | none | none | | | |
| 7/26/06 | n | it is moving | none | none | | | |
| 7/27/06 | n | it is moving | none | none | | | |
| 7/28/06 | n | it is moving | none | none | someone forgot to close the toilet bowl - it's usually closed | | |
| 7/31/06 | n | it is moving | none | none | using the weekly checklist now (for number of uses - instead of the daily checklist) | | |
| 8/1/06 | n | it is moving | none | none | | | |
| 8/2/06 | n | it is moving | none | none | | | |
| 8/3/06 | n | it is moving | none | none | | | |
| 8/4/06 | n | it is moving | none | none | | | |
| 8/7/06 | n | it is moving | none | none | | | |
| 8/8/06 | n | it is moving | none | none | | | |
| 8/9/06 | n | it is moving | none | none | | Switch test questions added from 8/1-8/29 | |
| 8/10/06 | n | it is moving | none | none | 1st time to 18 (uses) and no use overnight | Was the switch moved between "heaters and fans" and "fans only" today | Was the switch on "heaters and fans" last night |
| 8/11/06 | n | it is moving | none | none | | | |
| 8/14/06 | n | it is moving | none | none | | y | y |
| 8/15/06 | | it is moving | | | | | |
| 8/16/06 | n | it is moving | none | none | somone forgot to close the bowl | y | y |
| 8/17/06 | n | it is moving | none | none | | y | y |
| 8/18/06 | n | it is moving | none | none | | y | y |
| 8/21/06 | | | | | | | |
| 8/22/06 | | | | | Hit 18 uses so shut toilet down for the remainder of the day and put in a honeybucket | | |
| 8/24/06 | | | | | | | |
| 8/25/06 | n | it is moving | none | none | | y | y |
| 8/26/06 | | | | | | | |
| 8/27/06 | | | | | | | |
| 8/28/06 | n | it is moving | none | none | | y | y |
| 8/29/06 | n | it is moving | none | none | | y | y |
| 9/8/06 | n | it is moving | none | none | | | |
| 9/14/06 | n | it is moving | none | none | | | |
| 9/18/06 | n | it is moving | none | none | | | |
| 9/19/06 | n | it is moving | none | none | | | |
| 9/20/06 | | | | | | | |
| 9/21/06 | | | | | | | |
| 9/22/06 | n | it is moving | none | none | | | |
| 9/25/06 | n | it is moving | none | none | | | |
| 9/26/06 | n | it is moving | none | none | | | |
| 11/13/06 | n | it is moving | none | none | No problems | | |

| Results of store toilet inspection sheets | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Notes** | **Date** | **How many times was the toilet used today?** | **How much peatmoss was added today? (in cups)** | **How much cocoa shell was added today? (in cups)** | **Is there any odor in the bathroom? (a lot, a little, or none)** | **Was the toilet bowl closed when you first saw the toilet today? (y=yes, n=no)** | **Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) (y=yes, n=no)** | **Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? (wet, dry, good)** |
| | 11/14/06 | 4 | 1.5 | 1 | a little | y | n | good |
| | 11/15/06 | 1 | 1.5 | 1 | a little | y | n | good |
| | 11/16/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/17/06 | 0 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 11/18/06 | 3 | 1.5 | 1 | a little | y | n | good |
| | 11/19/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/20/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/23/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/24/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/26/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/27/06 | 0 | 1.5 | 1 | none | y | n | good |
| | 11/29/06 | 0 | 1.5 | 1 | a little | y | n | good |
| | 11/30/06 | 0 | 1.5 | 1 | none | y | n | good |
| | 12/1/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/2/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/3/06 | 0 | 1.5 | 1 | none | y | n | good |
| | 12/4/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/5/06 | 3 | 1.5 | 1 | none | y | n | good |
| | 12/6/06 | 0 | 1.5 | 1 | none | y | n | too dry |
| | 12/7/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/8/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/9/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/10/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/11/06 | 4 | 1.5 | 1 | none | y | n | good |
| | 12/12/06 | 6 | 1.5 | 1 | none | y | n | good |
| | 12/13/06 | 8 | 1.5 | 1 | none | y | n | good |
| | 12/14/06 | 4 | 1.5 | 1 | none | y | n | good |
| | 12/15/06 | 3 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/16/06 | 3 | 1.5 | 1 | none | y | n | good |
| | 12/17/06 | 2 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/18/06 | 4 | 1.5 | 1 | none | y | n | good |
| | 12/19/06 | 3 | 1.5 | 1 | none | y | n | good |
| | 12/20/06 | 5 | 1.5 | 1 | none | y | n | good |
| | 12/21/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/22/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/23/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/24/06 | 3 | 1.5 | 1 | none | y | n | good |
| | 12/25/06 | 2 | 1.5 | 1 | none | y | n | good |
| | 12/26/06 | 1 | 1.5 | 1 | none | y | n | good |
| | 12/27/06 | 7 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/28/06 | 3 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/29/06 | 5 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/30/06 | 1 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 12/31/06 | 3 | 1.5 | 1 | a little | y | y (toilet paper) | good |
| | 1/1/07 | 9 | 1.5 | 1 | none | y | y (toilet paper) | good |
| | 1/2/07 | 1 | 1.5 | 1 | none | y | n | good |
| | 1/3/07 | 0 | 1.5 | 1 | none | y | n | good |
| | 1/4/07 | 1 | 1.5 | 1 | none | y | n | good |
| | 1/5/07 | 1 | 1.5 | 1 | none | y | n | good |
| | 1/6/07 | 3 | 1.5 | 1 | none | y | n | good |
| | 1/7/07 | 1 | 1.5 | 1 | none | y | n | good |
| | 2/1/07 | | 1.5 | 1 | none | y | n | good |
| | 2/2/07 | | 1.5 | 1 | none | y | n | good |
| | 2/3/07 | | 1.5 | 1 | none | y | n | good |
| | 2/4/07 | | 1.5 | 1 | none | y | n | good |
| | 2/5/07 | | 1.5 | 1 | none | y | n | good |

| Date | Is there any liquid leaking from the toilet? (y=yes, n=no) | Is the wind turbine on the roof moving or is it blocked? | Are there any flies in the toilet? (a lot, some, none) | If the urine container has liquid in it, note how much and empty if it is full. (none, 0.25, 0.5, 0.75, full) | If there were any problems with the toilet today, note them here: | | |
|---|---|---|---|---|---|---|---|
| 11/14/06 | n | it is moving | none | none | May need to empty it, is what the store said | | |
| 11/15/06 | n | it is moving | none | none | May need to empty it, is what the store said | | |
| 11/16/06 | n | it is moving | none | none | May need to empty it | | |
| 11/17/06 | n | it is moving | none | none | | | |
| 11/18/06 | n | it is moving | none | none | | | |
| 11/19/06 | n | it is moving | none | none | | | |
| 11/20/06 | n | it is moving | none | none | | | |
| 11/23/06 | n | it is moving | none | none | | | |
| 11/24/06 | n | it is moving | none | none | | | |
| 11/26/06 | n | it is moving | none | none | | | |
| 11/27/06 | n | it is moving | none | none | | | |
| 11/29/06 | n | it is moving | none | none | Cleaned it out today They are happy today because it is cleaned. | | |
| 11/30/06 | n | it is moving | none | none | | | |
| 12/1/06 | n | it is moving | none | none | | | |
| 12/2/06 | n | it is moving | none | none | | | |
| 12/3/06 | n | it is moving | none | none | | | |
| 12/4/06 | n | it is moving | none | none | | | |
| 12/5/06 | n | it is moving | none | none | | | |
| 12/6/06 | n | it is moving | none | none | Kind of dry on the toilet. I will fix it | | |
| 12/7/06 | n | it is moving | none | none | | | |
| 12/8/06 | n | it is moving | none | none | | | |
| 12/9/06 | n | it is moving | none | none | | | |
| 12/10/06 | n | it is moving | none | none | | | |
| 12/11/06 | n | it is moving | none | none | | | |
| 12/12/06 | n | it is moving | none | none | | | |
| 12/13/06 | n | it is moving | none | none | | | |
| 12/14/06 | n | it is moving | none | none | | | |
| 12/15/06 | n | it is moving | none | none | | | |
| 12/16/06 | n | it is moving | none | none | | | |
| 12/17/06 | n | it is moving | none | none | | | |
| 12/18/06 | n | it is moving | none | none | | | |
| 12/19/06 | n | it is moving | none | none | | | |
| 12/20/06 | n | it is moving | none | none | | | |
| 12/21/06 | n | it is moving | none | none | | | |
| 12/22/06 | n | it is moving | none | none | | | |
| 12/23/06 | n | it is moving | none | none | | | |
| 12/24/06 | n | it is moving | none | none | | | |
| 12/25/06 | n | it is moving | none | none | | | |
| 12/26/06 | n | it is moving | none | none | | | |
| 12/27/06 | n | It is not moving because it is blocked or something else is wrong | none | none | The wind turbine wasn't moving because there was ice, but it is cleared now | | |
| 12/28/06 | n | It is not moving because it is blocked or something else is wrong | none | none | The turbine is now moving - I had to go up and clean it | | |
| 12/29/06 | n | it is moving | none | none | | | |
| 12/30/06 | n | it is moving | none | none | | | |
| 12/31/06 | n | It is not moving because it is blocked or something else is wrong | none | none | At first it wasn't moving but I fixed it | | |
| 1/1/07 | n | it is moving | none | none | | | |
| 1/2/07 | n | it is moving | none | none | | | |
| 1/3/07 | n | it is moving | none | 0.25 | | | |
| 1/4/07 | n | it is moving | none | 0.25 | | | |
| 1/5/07 | n | it is moving | none | 0.25 | | | |
| 1/6/07 | n | it is moving | none | 0.25 | | | |
| 1/7/07 | n | it is moving | none | 0.25 | | | |
| 2/1/07 | n | it is moving | none | none | | | |
| 2/2/07 | n | it is moving | none | none | | | |
| 2/3/07 | n | it is moving | none | none | | | |
| 2/4/07 | n | it is moving | none | none | | | |
| 2/5/07 | n | it is moving | none | none | | | |

# Appendix L
## Results of user-reported odor sheets

**Results of self-reporting odor sheets posted in the bathrooms (the numbers represent the number of times "Smells ok" or "Smells bad" was checked throughout the day)**

| Store Toilet | | |
|---|---|---|
| Date | Smells ok | Smells bad |
| 26-Jun | 3 | |
| 27-Jun | 6 | |
| 28-Jun | 3 | |
| 29-Jun | 4 | |
| 30-Jun | 3 | |
| Jun-31 | 2 | |
| 3-Jul | 3 | |
| 4-Jul | 3 | |
| 5-Jul | 4 | |
| 6-Jul | 3 | |
| 7-Jul | 4 | |
| 10-Jul | 3 | |
| 11-Jul | 2 | |
| 17-Jul | 3 | |
| 18-Jul | 4 | |
| 19-Jul | 3 | |
| 24-Jul | 4 | |
| 25-Jul | 3 | |
| 26-Jul | 3 | |
| 27-Jul | 4 | |
| 28-Jul | 3 | |
| 14-Aug | 4 | |
| 15-Aug | 3 | |
| 16-Aug | 3 | |
| 17-Aug | 3 | |
| 18-Aug | 4 | |
| 19-Aug | 2 | |
| 20-Aug | 3 | |
| 28-Aug | 3 | |
| 29-Aug | 3 | |

| Snow's | | |
|---|---|---|
| Date | Smells ok | Smells bad |
| 31-Jul | 4 | |
| 1-Aug | 3 | |
| 2-Aug | 4 | |
| 3-Aug | 3 | |
| 4-Aug | 4 | |
| 5-Aug | 3 | |
| 6-Aug | 2 | |
| 21-Aug | 14 | |
| 22-Aug | 14 | |
| 23-Aug | 14 | |
| 24-Aug | 14 | |
| 25-Aug | 14 | |
| 26-Aug | 14 | |
| 27-Aug | 14 | |
| Oct 2-8 | "no complaints about odor" | |
| 14-Nov | | 1 |
| 15-Nov | 1 | 1 |
| 16-Nov | 1 | 1 |
| 17-Nov | 1 | |
| 19-Nov | 1 | |

| Tundra's | | |
|---|---|---|
| Date | Smells ok | Smells bad |
| 11-Sep | 4 | |
| 13-Sep | 3 | |
| 14-Sep | 4 | |
| 15-Sep | 5 | |
| 16-Sep | 2 | |
| 17-Sep | 2 | |
| 8-Nov | 1 | |
| 9-Nov | 1 | |
| 11-Nov | 1 | |

# Appendix M
# Results of inspection sheets filled out for the household toilets

| Results of Snow's toilet inspection sheets | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Date** | **How many times do you think the toilet was actually used today?** | **How much peatmoss was added today? (in cups)** | **How much cocoa shell was added today? (in cups)** | **Is there any odor in the bathroom? (a lot, a little, or none)** | **Was the toilet bowl closed when you first saw the toilet today? (y=yes, n=no)** | **Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) (y=yes, n=no)** | **Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? (wet, dry, good)** | **Is there any liquid leaking from the toilet? (y=yes, n=no)** | **Is the wind turbine on the roof moving or is it blocked?** | **Are there any flies in the toilet? (a lot, some, none)** | **If the urine container has liquid in it, note how much and empty if it is full. (none, 0.25, 0.5, 0.75, full)** | **If there were any problems with the toilet today, note them here:** |
| | 8/6/2006 | 12 | 0.75 | 0.75 | none | y | n | good | n | it is moving | none | none | |
| | 8/7/2006 | 17 | 1 | 1 | none | y | n | good | n | it is moving | none | none | |
| | 8/8/2006 | 18 | 1 | 1 | none | y | n | good | n | it is moving | none | none | Sat for 1 night |
| | 8/9/2006 | 13 | 0.75 | 0.75 | a lot | y | n | wet | y | it is moving | none | | The toielt was leaking in the evening. I told Anna to stop using the toilet and it's been sitting with no use all night. On 8/10/06 I went to go take a picture of the toilet and it seemed that it wasn't leaking. So we are going to wait and see what happens. Then use it later on during the day. There was some odor from the leakage. |
| | 8/10/2006 | 18 | 1 | 1 | a little (from leakage) | y | n | good | y (front right corner) | it is moving | none | | No use overnight |
| | 8/11/2006 | 11 | 0.5 | 0.5 | a little (from leakage) | y | n | good | y (from the front left side) | it is moving | none | | Leakage needs to be secured and taken care of. |
| | 8/21/2006 | 12 | 0.5 | 0.5 | none | y | n | good | n | it is moving | none | | You can see some dates missing. So far the toilet is doing good. I checked it |
| | 10/2/2006 | 5 | 0.25 | 0.25 | none | y | n | dry | n | it is moving | none | | Some part of the mass was hard |
| | 10/23/2006 | 9 | 0.5 | 0.5 | | | | good | | | | | |
| | 10/27/2006 | 1 | | | a little | n | n | dry | n | it is moving | none | | Some part of the mass was hard |
| household form changed | 11/8/2006 | 2 | | | a little | y | n | good | n | it is moving | none | | |
| | 11/13/2006 | | | | | n | n | too dry | | | | | |
| | 11/16/2006 | | | | a little | y | n | good | n | it is moving | none | | |
| | 11/19/2006 | 6 | not sure | | none | n | n | good | n | it is moving | none | | |
| | 11/22/2006 | 5 | not sure | | a little | y | n | too dry | n | it is moving | none | | |
| | 11/24/2006 | 7 | a little | | none | y | n | little dry | n | it is moving | none | | |
| | 11/27/2006 | | not sure | | a little | y | n | kind of dry | n | it is moving | none | | |
| | 11/29/2006 | | not sure | | a little | y | n | too dry | n | it is moving | none | | Needs to be cleaned |
| changed | 2/1/2007 | | yes | | none | y | n | good | n | it is moving | none | | |
| | 2/2/2007 | | yes | | none | y | n | good | n | it is moving | none | | |
| | 2/3/2007 | | yes | | none | y | n | good | n | it is moving | none | | |
| | 2/4/2007 | | yes | | none | y | n | good | n | it is moving | none | | |
| | 2/5/2007 | | yes | | none | y | n | good | n | it is moving | none | | |

**Results of Tundra's toilet inspection sheets**

| | Date | How many times do you think the toilet was actually used today? | How much peatmoss was added today? (in cups) | How much cocoa shell was added today? (in cups) | Is there any odor in the bathroom? (a lot, a little, or none) | Was the toilet bowl closed when you first saw the toilet today? (y=yes, n=no) | Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) (y=yes, n=no) | Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? (wet, dry, good) | Is there any liquid leaking from the toilet? (y=yes, n=no) | Is the wind turbine on the roof moving or is it blocked? | Are there any flies in the toilet? (a lot, some, none) | If the urine container has liquid in it, note how much and empty if it is full. (none, 0.25, 0.5, 0.75, full) | If there were any problems with the toilet today, note them here: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | 9/11/2006 | 4 | 0.25 | 0.25 | none | y | n | partially wet on tray | n | it is moving | none | none | |
| | 9/14/2006 | 4 | 0.25 | 0.25 | none | y | n | good | n | it is moving | none | none | |
| | 10/14/2006 | 4 | 0.25 | 0.25 | none | y | n | good | n | it is moving | none | none | |
| Peatmoss question changed to "did the household add peatmoss today" | 10/30/2006 | | | | none | y | n | good | n | it is moving | none | 0.50 | |
| | 11/13/2006 | 2 | not sure | | none | y | n | | y (drain) | it is moving | none | 0.50 | |
| | 11/16/2006 | | Yes | | a little | y | n | little wet | y (pee pipe) | it is moving | none | 0.50 | |
| | 11/20/2006 | 2 | Yes | | none | y | n | | n | it is moving | none | 0.25 | |
| | 11/21/2006 | 4 | Yes | | a little | y | n | good | n | it is moving | none | 0.25 | |
| | 11/22/2006 | 3 | Yes | | a little | y | n | good | n | it is moving | none | 0.25 | |
| | 11/24/2006 | 7 | Yes | | a little | y | n | good | n | it is moving | none | 0.25 | |
| | 11/25/2006 | 3 | Yes | | a little | y | n | good | n | it is moving | none | 0.25 | May need to be cleaned soon. |
| | 12/7/2006 | 4 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/8/2006 | 5 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/9/2006 | 4 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/10/2006 | 7 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/11/2006 | 5 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/12/2006 | 3 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/13/2006 | 6 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/26/2006 | 2 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/27/2006 | 3 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/30/2006 | 1 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 12/31/2006 | 1 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/1/2006 | 3 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/2/2006 | 2 | | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/3/2006 | 2 | Yes | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/4/2006 | 2 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/5/2006 | 2 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/6/2006 | 2 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/7/2006 | 2 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/8/2006 | 2 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/29/2006 | 3 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/30/2006 | 4 | y | | none | y | n | good | n | it is moving | none | 0.25 | |
| | 1/31/2006 | 1 | y | | none | y | n | good | n | it is moving | none | 0.25 | |

**Results of Moss's toilet inspection sheets**

| | Date | How many times do you think the toilet was actually used today? | Do you think the household has been adding a handful of peatmoss after each use? | How much cocoa shell was added today? (in cups) | Is there any odor in the bathroom? (a lot, a little, or none) | Was the toilet bowl closed when you first saw the toilet today? (y=yes, n=no) | Do you see anything in the toilet besides human waste and peatmoss? (such as garbage, toys, etc.) (y=yes, n=no) | Does waste in the toilet look too wet, too dry, or does the amount of "wet" look about right? (wet, dry, good) | Is there any liquid leaking from the toilet? (y=yes, n=no) | Is the wind turbine on the roof moving or is it blocked? | Are there any flies in the toilet? (a lot, some, none) | If the urine container has liquid in it, note how much and empty if it is full. (none, 0.25, 0.5, 0.75, full) | If there were any problems with the toilet today, note them here: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| | 11/12/2006 | 3 | Yes | | a little | y | n | good | n | it is moving | | A 1/4 B 1/4 | |
| | 11/13/2006 | | Yes | | none | y | n | good | n | it is moving | | A 1/4 B 1/4 | |
| | 11/16/2006 | A 7 B 2 | Yes | | none | y | n | A g B little wet | n | it is moving | | A 1/4 B 1/4 | I added some peatmoss on the B side |
| | 11/20/2006 | | Yes | | a little | y | n | good | n | it is moving | | A 1/4 B 1/2 | |
| | 11/22/2006 | 4 | Yes | | none | y | n | kind of dry | n | it is moving | | 1/2 | |
| | 11/24/2006 | 3 | Yes | | none | y | n | good | n | it is moving | | 1/2 | |
| | 11/27/2006 | 2 | Yes | | | y | n | good | n | it is moving | | 1/2 | may need to clean the B side soon |
| | 11/29/2006 | | Yes | | | y | n | good | n | it is moving | | 1/2 | Emptied toilet paper can |
| | 1/21/2006 | | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 1/22/2006 | 7 | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 1/23/2006 | 4 | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 3/1/2006 | | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 3/2/2006 | | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 3/3/2006 | | Yes | | none | y | n | good | n | it is moving | | 1/4 | |
| | 3/4/2006 | | Yes | | none | y | n | good | n | it is moving | | 1/4 | |

# Appendix N
# Record of emptying the toilets

## Record for when the toilets were emptied by the operator

| Toilet | Dates the toilets were emptied | Approximate time since the toilet was last emptied | Who emptied the toilet? | Verbal comments over the phone | Summary of Survey (Form) Sheet |
|---|---|---|---|---|---|
| **Store** Installed on June 24th | Oct 6, 2006 | 3 months | O1 | O1 said the odor when emptying the toilet wasn't bad, and that the material was more dry than wet and was similar to the premix starter. | |
| | Nov 29, 2006 | 2 months | O2 | O2 said there was next to no odor when emptying the toilet. He also mentioned that the rake bar was fairly difficult to pull (it was slightly stuck). | The compost was dryer and darker than the premix starter. The odor was "not too bad". There was no liquid in the tray or on the bottom of the toilet. |
| | Feb 13, 2007 | 2.5 months | O2 | O2 said that emptying the toilet was fast and easy and it didn't smell bad. | |
| | May 2, 2007 | | | Store toilet was taken out | |
| **Snow's** Installed on July 30th | Sept 30, 2006 | 2 months | O1 | The amount of compost emptied from the toilet filled a 5 gallon bucket half-way. | The compost was wetter and lighter (in color) than the premix starter. There was "a lot" of liquid in the tray and on the bottom of the toilet. The odor was "extremely strong". |
| | Oct 27, 2006 | 1 month | O2 | | The compost was dryer and darker than the premix starter. There was no liquid in the tray or on the bottom of the toilet. The odor was in between "extremely strong" and "not too bad". |
| | Middle of Dec | 1.5 months | O2 | The household wanted to wait for warmer weather to clean the toilet so the windows could be opened to air out the smell. While the toilet was waiting to be cleaned, there was no smell from the toilet, unless you opened the lid and then there was a slight smell of the | |

| Toilet | Dates the toilets were emptied | Approximate time since the toilet was last emptied | Who emptied the toilet? | Verbal comments over the phone | Summary of Survey (Form) Sheet |
|---|---|---|---|---|---|
| **Snows Continued** | | | | peatmoss and cocoa shells. | |
| | Jan 11, 2007 | 1 month | O2 | O2 said that when the toilet was emptied the odor wasn't bad and there was no liquid in the tray or on the bottom of the toilet. The rake bar was fairly easy to move. The odor was better than the last time it was emptied. The Anaq's (feces) were hard and the tray was very dry. | |
| | Mar 1, 2007 | 2 months | O2 | | |
| | May 11, 2007 | 2 months | Jason | The cleaning wasn't bad. The mass was pretty dry. | |
| **Moss B** Installed Sept 29th | Early Dec | 2.5 months | O2 | | |
| | Jan 4, 2007 | 1 month | O2 | Both A and B toilets were cleaned at the same time. O2 said the odor from both toilets wasn't bad, there was no lingering odor in the house, and the cleaning went quite well. Relatively, Toilet B had less odor and was dryer because not much time had passed since it was last emptied. Even though Toilet B wasn't full at the time of cleaning, both toilets were emptied at the same time so operations started again at the same level. | The compost was wetter and darker than the premix starter.<br>The compost was wetter, darker, and less composted compared to the compost from the Store toilet (when emptied on Nov 29, 2006), and the odor was about the same (i.e. "not too bad").<br>There was no liquid in the tray but "a little bit" on the bottom of the toilet. |
| | Mid-late March | 3 months | | | |
| | Jun 12, 2007 | 2.5 months | | | |

| Toilet | Dates the toilets were emptied | Approximate time since the toilet was last emptied | Who emptied the toilet? | Verbal comments over the phone | Summary of Survey (Form) Sheet |
|---|---|---|---|---|---|
| **Moss A**<br>Installed Oct 26th | Jan 4, 2007 | 2 months | O2 | See above. | The compost was dryer and lighter than the premix starter.<br>The compost was dryer, lighter, and more composted compared to the compost from the Corp toilet (when emptied on Nov 29, 2006), and the odor was better and barely noticeable.<br>There was no liquid in the tray but “a little bit” on the bottom of the toilet. |
| | Mid-late March | 3 months | | | |
| | Jun 12, 2007 | 2.5 months | | | |
| **Tundras**<br>Installed on Sept 11th | Dec 4, 2006 | 3 months | O2 | O2 said the toilet was a bit stinky when cleaned, but aired the place out and it was ok. The rake bar wasn’t hard to pull. | |
| | Feb 20, 2007 | 2.5 months | O2 | O2 said the toilet cleaning went pretty well and the mass was quite dry. | |
| | Apr 30, 2007 | 2.5 months | Xx with some oversight from O2 | Xx said that the cleaning wasn’t too bad. He had gloves but no mask so he used an old tee-shirt over his mouth to lessen the odor. xx said it wouldn’t be a problem to clean the toilet again on his own. | |

# Appendix O

## Review of the State/federal regulations for use of the end product from compost toilets

## Review of the state/federal regulations for use of the end product from compost toilets.

Through conversations in 2007 with representatives from both the State of Alaska and USEPA R10, the following information documents the process of determining the regulations under 40 CFR 503 for using the end product from compost toilets as dumpsite/landfill cover in Alaska.

Contacts:
Ed Emswiler, Solid Waste Specialist for the Alaska State Department of Environmental Conservation
Dick Heatherington, Biosolids Coordinator for USEPA Region 10

References:
40 CFR 503:
http://yosemite.epa.gov/R10/WATER.NSF/95537302e2c56cea8825688200708c9a/e2140732f6b427f488256a860003302a?OpenDocument

A Plain English Guide to the EPA Part 503 Biosolids Rule:
http://www.epa.gov/OWM/mtb/biosolids/503pe/index.htm

**The first step was to determine if the product from compost toilets was considered by the State of Alaska to be domestic septage or sewage sludge. Based on the definitions from 503.9 (listed below), it was determined that the product would be domestic septage. (Emswiler 2007) Considering the product as domestic septage is also allowable by EPA Region 10 (Heatherington 2007).**

**503.9**
(f) **Domestic septage** is either liquid or solid material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar treatment works that receives only domestic sewage. Domestic septage does not include liquid or solid material removed from a septic tank, cesspool, or similar treatment works that receives either commercial wastewater or industrial wastewater and does not include grease removed from a grease trap at a restaurant.
(w) **Sewage sludge** is solid, semi-solid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes, but is not limited to, domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works.

**Next, the operational standards for pathogens and vector attraction reduction for domestic septage needed to be reviewed. (see bolded sections below)**

**§ 503.15 Operational standards—pathogens and vector attraction reduction.**
(a) Pathogens—sewage sludge. (1) The Class A pathogen requirements in §503.32(a) or the Class B pathogen requirements and site restrictions in §503.32(b) shall be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site.
(2) The Class A pathogen requirements in §503.32(a) shall be met when bulk sewage sludge is applied to a lawn or a home garden.

(3) The Class A pathogen requirements in §503.32(a) shall be met when sewage sludge is sold or given away in a bag or other container for application to the land.
**(b) Pathogens—domestic septage. The requirements in either §503.32 (c)(1) or (c)(2) shall be met when domestic septage is applied to agricultural land, forest, or a reclamation site.**
(c) Vector attraction reduction—sewage sludge. (1) One of the vector attraction reduction requirements in §503.33 (b)(1) through (b)(10) shall be met when bulk sewage sludge is applied to agricultural land, forest, a public contact site, or a reclamation site.
(2) One of the vector attraction reduction requirements in §503.33 (b)(1) through (b)(8) shall be met when bulk sewage sludge is applied to a lawn or a home garden.
(3) One of the vector attraction reduction requirements in §503.33 (b)(1) through (b)(8) shall be met when sewage sludge is sold or given away in a bag or other container for application to the land.
**(d) Vector attraction reduction—domestic septage. The vector attraction reduction requirements in §503.33(b)(9), (b)(10), or (b)(12) shall be met when domestic septage is applied to agricultural land, forest, or a reclamation site.**

**The pathogen requirements for domestic septage are to follow either §503.32 (c)(1) OR (c)(2) and are listed below:**

**§503.32 (c)(1) or (c)(2)**
(c) Domestic septage.
(1) The site restrictions in **§503.32(b)(5**) shall be met when domestic septage is applied to agricultural land, forest, or a reclamation site; or
(2) The pH of domestic septage applied to agricultural land, forest, or a reclamation site shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes and the site restrictions in **§503.32 (b)(5)(i) through (b)(5)(iv)** shall be met. [58 FR 9387, Feb. 19, 1993, as amended at 64 FR 42571, Aug. 4, 1999]

**For use of the end product as dumpsite/landfill cover, it was decided to follow 503.32 (c)(2), so the pH of the end product would need to be "raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes and the site restrictions in §503.32 (b)(5)(i) through (b)(5)(iv) shall be met." (Emswiler 2007) Since the end product would be used for dumpsite cover only, and not used on food crops, 503.32 (b)(5)(i) through (b)(5)(iv) do not need to be considered. (See below for details of 503.32 (b)(5))**

**§503.32(b)(5)**
(5) Site restrictions.
(i) Food crops with harvested parts that touch the sewage sludge/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of sewage sludge.
(ii) Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of sewage sludge when the sewage sludge remains on the land surface for four months or longer prior to incorporation into the soil.
(iii) Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than four months prior to incorporation into the soil.
(iv) Food crops, feed crops, and fiber crops shall not be harvested for 30 days after application of sewage sludge.
(v) Animals shall not be grazed on the land for 30 days after application of sewage sludge.
(vi) Turf grown on land where sewage sludge is applied shall not be harvested for one year after application of the sewage sludge when the harvested turf is placed on either land with a

high potential for public exposure or a lawn, unless otherwise specified by the permitting authority.
(vii) Public access to land with a high potential for public exposure shall be restricted for one year after application of sewage sludge.
(viii) Public access to land with a low potential for public exposure shall be restricted for 30 days after application of sewage sludge.

**The vector attraction reduction requirements for domestic septage are to follow 503.33(b)(9), (b)(10), or (b)(12) and are listed below:**

**§503.33(b)(9), (b)(10), or (b)(12)**
**(9)** (i) Sewage sludge shall be injected below the surface of the land.
(ii) No significant amount of the sewage sludge shall be present on the land surface within one hour after thesewage sludge is injected.
(iii) When the sewage sludge that is injected below the surface of the land is Class A with respect to pathogens, the sewage sludge shall be injected below the land surface within eight hours after being discharged from the pathogen treatment process.
**(10)** (i) Sewage sludge applied to the land surface or placed on an active sewage sludge unit shall be incorporated into the soil within six hours after application to or placement on the land, unless otherwise specified by the permitting authority.
(ii) When sewage sludge that is incorporated into the soil is Class A with respect to pathogens, the sewage sludge shall be applied to or placed on the land within eight hours after being discharged from the pathogen treatment process.
**(12)** The pH of domestic septage shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes. [58 FR 9387, Feb. 19, 1993, as amended at 64 FR 42571, Aug. 4, 1999]

**For use of the end product as dumpsite/landfill cover, it was decided to follow 503.33(b)(12), so the pH of the end product would need to be "raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for 30 minutes." (Emswiler 2007)**

**As a best management practice, and to be extra cautious with the end product, it was suggested to follow the process for lime stabilization in 503 Appendix B (5) which is: "Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 after two hours of contact."(Emswiler 2007) (See details of 503 Appendix B (5) below). Also as an extra precaution, it was suggested to store the end product at the dumpsite/landfill in an area that is restricted to public access for 1 year before using as dumpsite/landfill cover. (Emswiler 2007)**

**Appendix B to Part 503—Pathogen Treatment Processes**
A. Processes To Significantly Reduce Pathogens (PSRP)
1. Aerobic digestion—Sewage sludge is agitated with air or oxygen to maintain aerobic conditions for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and
temperature shall be between 40 days at 20 degrees Celsius and 60 days at 15 degrees Celsius.
2. Air drying—Sewage sludge is dried on sand beds or on paved or unpaved basins. The sewage sludge dries for a minimum of three months. During two of the three months, the ambient average daily temperature is above zero degrees Celsius.
3. Anaerobic digestion—Sewage sludge is treated in the absence of air for a specific mean cell residence time at a specific temperature. Values for the mean cell residence time and

temperature shall be between 15 days at 35 to 55 degrees Celsius and 60 days at 20 degrees Celsius.

4. Composting—Using either the within-vessel, static aerated pile, or windrow composting methods, the temperature of the sewage sludge is raised to 40 degrees Celsius or higher and remains at 40 degrees Celsius or higher for five days. For four hours during the five days, the temperature in the compost pile exceeds 55 degrees Celsius.

**5. Lime stabilization—Sufficient lime is added to the sewage sludge to raise the pH of the sewage sludge to 12 after two hours of contact.**

## References

Emswiler, E. (2007). Phone interview. Alaska DEC Solid Waste Specialist.

Heatherington, D. (2007). Phone interview. Biosolids Coordinator for USEPA Region 10.

# Appendix P

# Semi-structured interviews, group interviews/discussions

Semi-structured interviews with household and store users, shown in order by date. Interviews carried out by Simone Sebalo

Interview with xx Tundra on 1/16/07 at xx's house.

**Q. How do you like the compost toilet and have you had any problems with it?**
I'm really happy with it because there's no smell, except when it leaked on the side, and I don't have to haul honeybuckets. Sometimes it is a little noisy at night when the pipe shakes. That only happens when it's windy though. The wind turbine blew off when it was really windy. Sometimes when it rains, a little bit of water comes into the bathroom at the ceiling where the pipe is. There is sometimes a leak on the side when the pipe falls off.

**Q. How many people are living in your house now?**
Still myself and my son. Sometimes we have 1-3 guests stay. We have had many people come to our house to try out the toilet. All of them really like it and have been asking me where they can get one for their home.

**Q. Is everyone adding peatmoss after the toilet is used?**
My son and I add peatmoss but my guests usually don't. It would be good to replace the signs about peatmoss on my wall because some of them got damaged by some water coming in. It would also be good to replace the sign on the toilet which describes which way to turn the handle.

**Q. Has it been a problem putting the toilet paper in the separate can?**
No I don't mind. That's not a problem for us.

*(Note that after the interview, the operator sealed up the pipe at the ceiling to make it water tight, secured the side pipe tighter, and replaced all the signs. Note also that there was no odor from the toilet when I was in xx's house.)*

Interview with xx and xx Snow on 1/16/07 at the Snow's house.

**Q. How do people in your household like the toilet?**
People like the toilet. The two problems however are that it fills up too fast and airing out the house when it is cleaned in the winter is hard because it's so cold. The odor can be strong when the toilet is cleaned out. Sometimes we need to wait for warmer weather in the winter before the toilet can be cleaned out. Everyone likes the compost toilet better than the honeybucket though. We need to get the second toilet installed so the one doesn't fill up so fast. We need two toilets for our household size.

**Q. Do you think everyone is adding peatmoss after the toilet is used?**
Yes we add ¼ cup peatmoss after every use.

**Q. Are there any problems with odors with the toilets?**
The only problems with odors inside is when the toilet is cleaned out. But otherwise there aren't really any odors. Sometime when you walk by the house outside though, there is an odor from the pipe.

Interview with store owner on 1/16/07 at the Store office.

**Q. Tell me about how the toilet is going**

Many people in the community use the compost toilet, in addition to the staff. When Bingo is on, some people come over from there to use the toilet. I'd like to have the toilet be used by staff only. If it's possible, a few compost toilets should be installed over at the Bingo hall. The bathroom is generally locked but a few times kids have gone in there too.

When the toilet is full, sometimes there is odor, even when the lid is closed, but it's not as bad as a honeybucket. The toilet needs to be cleaned out a little too often for my liking. Maybe we could buy an extra grey tray, and then you could take out the full tray, set it aside to continue composting and then put the empty tray in.

The compost toilet is ok, but for my home, I would like a piped water and sewer system (full flush toilet). I like to flush it away and I would pay whatever for that.

Interview with xx Moss on 1/16/07 at the utility office.

**Q. How do you like the compost toilet and have you had any problems with it?**

I don't really like the compost toilets. Some rain leaked in from the ceiling awhile back. O2 came in to put some silicone where the pipe meets the ceiling and since that time, there hasn't been any leakage. But I worry about a hard rain. Sometimes it's noisy (the fans) and when it's windy, the pipe shakes and is noisy. There were also some leaks on the side when the tube fell off. But the leaks are ok now. Shoegoo seemed to work best to seal it. The odor is the main thing I don't like about the toilets.

**Q. When is it odorous and from what part of the toilet?**

When the tube leaked it smelled. But now that it's fixed it doesn't smell anymore. The worse odor is from the toilet paper in the can. The toilets themselves are ok because I think the fan sucks out the smell. Even when the toilets are being cleaned it's ok. The toilet paper smell is the main problem I have with the toilets. If the used toilet paper has to go into a can, maybe have a suction fan on it so it sucks out the smell.

**Q. Is there any problem with having the two toilets (as opposed to one) in your bathroom?**

No, the two toilets aren't a problem. The problem is the toilet paper smell.

**Q. Since you said you didn't like the toilets, would you like us to take them out of your house?**

No. Let's try to take care of the toilet paper problem and then see how that goes.

*(I noted that we can order single ply toilet paper and experiment with having the household throw the toilet paper into the toilets instead of in the can. And in the meantime, the operator will come over daily to empty out their toilet paper can, to remove the smell. He agreed with both of those ideas.)*

Brief interview with one of xx Moss's daughters (xx Moss's sister) at the Moss's household on 1/16/07

**Q. How do you like the compost toilets?**

I don't use them all the time because I don't like the air from them. It's sort of dry when I use it from the air and I'm worried about getting contaminated from the air.

Interview/conversation with xx Moss at the AFE Conference in Anchorage on 2/17/07

**Q. Your dad told me that the toilet paper smell is a problem with the toilets.**

The toilet paper smell is a problem for me too, so experimenting with putting toilet paper in the toilet would be good. Sometimes there is some noise from the toilets – it's like a hum like a refrigerator. When the door is closed, the noise is ok, but otherwise it's a little loud. As far as other odors, it smells ok inside but outside of the house in the summer it smells from the vent pipe. (*I asked if a higher pipe would be good, but she was worried it would tip over in the wind, and when it's windy, she was worried that the smells would blow down regardless*.) There were some leaks from the toilet, but they have been fixed now. My mom wanted to take the toilets out at one point, but I said that they should try them out because they could be a way to help to get rid of the honeybuckets, and then she said it was fine to keep the compost toilets. At least three other families in Raven really want to try out the toilets in their homes.

**Q. Is there a problem with noise from the vent pipe shaking when it's windy?**

No. Just the hum from the fans when the door is open.

**Q. Are you or other household members bothered by the air from the toilet, like your sister is?**

No, only my sister is bothered by the air.

**Q. Do you think everyone is adding peatmoss and cocoa shells after the toilet is used?**

The women of the house have been throwing peatmoss in after using but not my dad.

Interview with store manager on 5/8/07 at the Store office, regarding the store compost toilet.

**Q. Tell me how you liked the compost toilet?**

The toilet was working really well when O1 was working on it and during the first few months that O2 was working on it. In the early spring, O2 wasn't doing his job and he wasn't coming around to maintain the toilet much and didn't clean it out. We are moving our bathroom to a different place so we had to take the toilet out. Plus we thought we might as well because O2 wasn't coming around to clean it.

We had more people using the toilet than expected. More and more customers were using it and more and more people were coming over to use it during Bingo as well. That filled the toilet up faster than just the staff using it. The time when the toilet was used the most however was during New Year's when we were doing inventory. There was many

staff around during that time for several days at a time and everyone was working long hours. I think the toilet filled up pretty fast then.
The toilet was working really well up until early Spring when O2 started slacking. Particularly when O1 was working on it, it worked really well. O1 would come here everyday to monitor and maintain it and he would empty it when it needed to be.

**Q. Was odor ever an issue?**
When the toilet wasn't cleaned for awhile, sometimes there was odor. Odor was also sometimes a problem when it was really windy. Sometimes the smell would blow in down from the pipe. Sometimes there was an odor when the toilet was being cleaned as well.

**Q. Which do you prefer - flush haul, compost toilets, or honeybuckets?**
I would prefer flush toilets (not even flush haul, but flush toilets). I'd prefer whatever system that you don't have to do any work with. Between compost toilets and honeybuckets, I prefer compost toilets. But I would like to have an operator to clean it out when it needed it. I think the operator position is really key for having the compost toilets.

**Q. Is there anything that could make the compost toilets better?**
Just a better operator than O2. If O1 would have remained the operator, things would've been better. Maybe better ventilation somehow?

**Q. What did you think of the information provided in the bathroom about the toilets and how they work?**
I thought the information was good for people who can read. There wouldn't really be a need for a long document in Yup'ik because Yup'ik is spoken more than it is read. Verbal education is good.

**Q. Do you think the store staff minded adding their own peatmoss?**
People didn't mind that, but it probably would be better if the operator did it. It's better if the operator does the daily maintenance stuff.

**Q. Would you be willing to try a different type of compost toilet in the future?**
Yes we'd be willing to try it. There should definitely be an operator position with it though.

**Q. Do you think compost toilets are an alternative to honeybuckets for Raven?**
I think so because the cost is cheap and the toilets work well when there's a good operator. I'm not sure if people will do the maintenance themselves, especially cleaning the toilets. So as long as there's an operator, they are a good alternative. The problem with the toilets is when they're not emptied. The households should definitely be shown how to do all the maintenance themselves so they can do it if the operator is out though too.

Interview with xx Moss on 5/8/07 at the Environmental office regarding the two compost toilets installed at her house (the Moss's).

**Q. How are the compost toilets working in your household?**
Our toilets haven't been cleaned out by O2 since March. We're using a honeybucket right now because the toilets are full. If the toilets were emptied, we would definitely keep using them. I don't know what happened to O2.

**Q. Did you start using the single ply toilet paper and throwing it in the toilet to reduce the odors from the used toilet paper?**
We started using the single ply toilet paper in one toilet, but the other toilet was full so we were only using it for the one. We were throwing the toilet paper into that toilet and the smell was much better. There's no odor with the toilets now. O2 was really good about coming over to dump out the toilet paper regularly and that reduced the odor. The only problem I could see with odor now, is if the toilets ever leaked again. But they haven't leaked since O2 sealed the tube.

**Q. You mentioned that the noise the toilets made was a little bothersome. Is it still bothersome?**
We got used to the hum noise actually. So the noise isn't really an issue now.

**Q. How does your household like the toilets?**
My dad doesn't really like the toilets. It bothers him when O2 doesn't come around to clean the toilets. My mom didn't like the toilets so much at first, but now she said she's used to them and she wants to keep them. I don't know about all my sisters, but they seem to think the toilets are ok.

**Q. Are household members adding their own peatmoss?**
My mom and my sisters add the peatmoss but my dad and my brother don't. We keep having to remind them.

**Q. What are the worst problems with the toilets?**
Cleaning out the toilets. You have to have an operator to clean out the toilets. The operator could give households more education on how to do it but I'm not sure if they'd do it.

**Q. A estimate of the monthly costs of the compost toilets is around $20-$40/month. What do you think of those costs?**
$40/month is very reasonable. That's cheaper than our light bill, internet, and phone bills!

**Q. Which do you prefer - flush haul, compost toilets, or honeybuckets?**
Our family might prefer flush haul, but access to our house is really difficult because it's marshy so they said flush haul might not be feasible for us. The compost toilets are better than honeybuckets because they don't have to be dumped out and emptied every other day.

Interview with xx Tundra on 5/8/07 at the Tundra's house regarding the compost toilet installed at his house.

**Q. How do you like the compost toilet?**

The toilet is great. There's never any odor except when it gets cleaned. I'm so happy that I don't have to haul honeybuckets anymore. I never have to smell anaq's (feces) anymore!

**Q. Have you had any problems with the toilet?**

Only when it's really windy out, sometimes the pipe still shakes a little. O2 hasn't been doing a good job lately. He's been lazy. He should be replaced with someone better.

**Q. I understand you cleaned the toilet out last time. How did that go?**

It went well. O2 brought over the gloves and I cleaned it out while he supervised. We didn't have the mask so I used a t-shirt over my nose when I cleaned it because it was a bit smelly. The mass was pretty dry. It was fine to clean it out.

**Q. Have you and your son been adding peatmoss after the toilet is used?**

Yes we both have been adding peatmoss after we use the toilet. I still have several guests that come to use the toilet and I'm still educating them that they have to put the peatmoss in. I also remind them to put the toilet paper in the can and not the toilet. One time someone put a tampon in the toilet, but I pulled it out because I know you're not supposed to put anything in there. During Eskimo dances, people come over to use my toilet because they like it. Lots of people have been asking how they can get one in their home. They can't believe that I don't have to dump honeybuckets anymore.

**Q. Which do you prefer – compost toilets or honeybuckets?**

Compost toilets for sure! I don't have to dump honeybuckets any more.

**Q. Do you think other households should get compost toilets in Raven?**

Yes other households should get these toilets. They work good and they won't have to dump honeybuckets any more.

## Group interviews shown in order by date, facilitated by Simone Sebalo

### Group interview with x Moss (env staff), xx (env staff) and a resident of Raven on 1/17/07 at the Environmental office

Discussion of flush haul, compost toilets, and honeybuckets.
The disadvantage of flush haul is when it fills up, you can't use it. It has limited use. If the water supply goes down, you can't use it. If compost toilet were less costly, less maintenance, I'd prefer it. I've heard problems with leaks and smell of toilet paper. If the compost toilet cost $20 or $30 (even $40) per month, that would definitely be fine to pay. For someone that doesn't work, $20 is the highest they could probably go.

xx Tundra likes the compost toilet. xx Moss doesn't because of the toilet paper smell. But Walter likes not having to haul a honeybucket. People don't like seeing their waste in the compost toilet, but the honeybucket is even less appealing.
Our lagoon is such a problem. There's too much plastic in it too.

The compost toilet stinks when it is being cleaned out, maybe even worse than a honeybucket. We need to do a video to show people how to maintain the toilet, but show all the pros and cons to it. I worry that people might not do the maintenance required on the compost toilets.

I don't like that the flush haul system overflows onto the land. The compost toilet uses electricity and I worry about what the costs are. It sometimes smells when you walk by the compost toilet vent pipe at the Snows and I worry about the air quality. I also worry about dumping the compost. I don't think it's a problem though that you don't put tp in the toilet and that you put it in a separate can.

### Group interview with xx Moss (env staff), xx Snow (env staff), Jessica Moss (env staff), xx (env staff) and a resident of Raven on 5/8/07 at the Environmental office

**Q. How do you feel about the current sanitation system in Raven?**
We were really hoping to get a piped water and sewer system in Raven someday but we don't know if that's going to happen. The watering points in town are ok but running water in our homes would be better. But when CE2 told us how much it would cost households for water and sewer, a lot of people said it would be too expensive. People are ok with hauling their own water because it's cheap. But probably less than 10% of households would be able to pay the estimated $210/month for the piped water and sewer system. Employment is really low here. People have just enough to pay their food, heat, and electricity and other bills. Not too many jobs are posted around here.

**Q. What are the pros and cons to using honeybuckets and compost toilets?**
**With honeybuckets:**

**the pros are –** everyone knows how to use them, they can dump them themselves at any time and they know where the lagoon is

**the cons are –** they are unhealthy, they have germs and bacteria and they smell horrible, some people still dump them in the river instead of the lagoon, the honeybucket wastes sit in tied plastic bags at the lagoon and they don't breakdown, and people dump chemicals like Lysol into their honeybuckets and that gets into our environment.

**With compost toilets:**

**the pros are –** the end result is like mud, there are less germs and bacteria from them, the mud can be used for something and it doesn't mess up our environment like honeybuckets do, and you don't have to empty them as often as honeybuckets

**the cons are –** maintaining the toilets, it takes work to maintain them unlike honeybuckets, sometimes there are odors if they leak or when you clean them out, they are harder to dump than honeybuckets, and an operator is needed.

**Q. What would you do differently about a project like this, the next time around?**
It would probably be better if it were a longer project – like 5 years. It would be good to see how the toilets work over a longer period of time. We would try to hire a more reliable operator – someone more like O1. O2 started off ok, but then he got lazy and didn't do his job well. He also didn't do as good as a job at educating the household members.

We would have the operator monitor things again on a daily basis and be able to come right away if the households had a problem. Like have them on-call. It might be a good idea to hire more than one operator. But that could also backfire because they might shift the responsibility onto each other. There would have to be one person in charge with most of the responsibilities but then have a backup trained.

It also might be better to go through the TC to hire the operator because they hire reliable workers and have a system in place for doing background checks. They would be able to monitor the operators time more because they have a time card system.

**Q. The estimated O&M cost results of the toilets are around $20-$40/month (depending on one or two toilets). What do you think people would think of these costs?**
You might need to do a survey around the community to ask people. But TV cable is more expensive than the toilets ($50/month), so the costs seem very reasonable and people would probably be fine with that.

**Q. What do you like or dislike about the compost toilets?**
The compost toilets have no flies, no smell, they don't spill like honeybuckets, and they're not heavy to take out like honeybuckets, you don't have to dump them for 2-3 months, where honeybuckets have to be dumped every two days or so! Dislikes are that they are sometimes hard to clean out and they smell a bit when you clean them out and they smell when there are leaks.

**Q. What do you think of the flush haul system.**
My family (the Snows) didn't like the one installed at our house. It was loud and took up a lot of room and it would take ages to find an operator to come and empty it, so it would sit full for a long time. With other people that have them, there have been complaints that in the winter the operator doesn't come to flush out their tanks for a long time either, because of bad weather, access to the house, laziness, or they're out traveling a lot and aren't around to do their job. Most people that have the flush haul systems though still pay for them (to get them emptied). They just sit full and have to use a honeybucket when the operators don't come around.

**Q. Where do you see the compost toilet project going from here?**
Right now the Moss's and Snow's are temporarily using honeybuckets because O2 hasn't been around to empty out the compost toilets. But if a new operator was hired, both of those households would continue using the compost toilets. They're irritated about O2 but they don't want to get rid of the compost toilets. They need to be emptied out soon though. We will talk to the TC to get a new operator hired. xx Tundra was able to empty out his own toilet and didn't mind, so it is possible for households to do it themselves, maybe the other households just don't want to. The TC should be able to hire an operator with bingo funds to assist the households with cleaning the toilets etc.

## Interviews with operators, carried out by Simone Sebalo

### Phone interview with O1 (first operator) October 2006

**Q. Would you have a compost toilet in your home? Why or why not? What do you like or dislike about the compost toilets?**

Yes I would have a compost toilet in my home. I prefer the compost toilet to both the honeybucket and flush haul. The good part is that the compost toilet reduces the dumping of honeybucket wastes. The bad part is emptying the toilet. There isn't enough room to empty the tray and the contents. It's hard to get your arm in to empty it out. It's also difficult to empty when there's liquid. You need to have the right tools. Also, the household sometimes complains about the odor when it's cleaned.

I would have a compost toilet in my home but it would be nice to have a toilet that was easier to empty and clean. There needs to be improvements for cleaning it. Right now it takes 1-2 hours to clean. It would be nice if it was just 20-30 minutes. It might be good to test a different type of toilet that was easier to empty. Maybe a sun-mar or other brand?

### Phone interview with O2 (operator) on 4/16/07

The main downside with the compost toilets is that they fill up too fast. xx at the store thinks so too. But there is no doubt that the compost toilets smell better than honeybuckets. The two toilet scenario is good because they don't fill up as fast. The hardest thing to train the households regarding maintenance is the cleaning (emptying) of the toilets. They are adding the peat moss themselves ok. It might be good to try to build some sort of insulated box underneath the house and test the "remote chute" toilets, so they don't have to be cleaned out so often.

### Phone interview with O2 (operator) on 5/7/07

**Q. Would you have a ct in your home?**

Yes I would definitely like to get a compost toilet in my trailer. I prefer them to honeybuckets.

**Q. What do you like or dislike about the ct?**

I like the compost toilets but when the waste is really moist, the odor can be strong. When you add the peatmoss and the waste is dry, there isn't much odor.

**Q. What are the worst problems with the ct?**

Cleaning the toilets is the worst thing. Especially when the mass is wet, the odor is high.

**Q. Do you like ct, hb, or flush haul better?**

I like the compost toilets the best. There's too many problems with the flush haul system and I don't like using and dumping honeybuckets.

**Q. What would make the ct's better?**
The remote toilet with the chute under the house would be good to try. Then the cleaning would happen outside and the smell would be less of a problem. The Moss's in particular were interested in trying a remote toilet.

**Q. How long does it take to clean the toilets? If a household wanted to hire someone to clean their toilet, what would the charge need to be?**
It can take from 15 minutes to 1 hour to clean the toilets. It depends if the mass is wet or dry (it's faster and easier if it's dry). You'd probably need to charge for 1-2 hours of work at $10-15/hr.

**Q. How much do you think people would pay per month for the ct?**
It might depend on how fast the toilets fill up.

**Q. What would be the problems for the under-house system. Do you have any design ideas for the insulation?**
Some of the materials for the insulation box are available in Raven but we'd have to ship in the insulation.

**Q. How do you think the households and store like the ct's?**
Within each household, some people like them and some people don't. The people that don't like them seem to not like it when the toilets have to be cleaned.

**Q. How would you do this project differently if it were to happen again?**
Maybe try some more of these toilets and the remote type of toilet.

**Q. What was your experience with sanitation prior to this job?**
I used to be an operator for dumping honeybuckets through water and sewer.

**Q. What kind of experience would you recommend with future operators?**
Sanitation experience is definitely good because you're used to dealing with wastes. The more the operator can be trained, the better.

**Q. Would you change the way O1 trained you? Would you have liked more training?**
O1 taught me good. He showed me a lot. But he didn't tell me about the odor when you clean the toilets!

**Q. Did you have to reeducate the users much? How?**
I had to keep telling people to add their own peatmoss and that by doing that it makes it more dry which is better.

**Q. How many hours a week is necessary for the operator position?**
It will depend when the toilets need to be cleaned. Probably 10-15 hours maximum.

**Q. How important is it to have an operator?**
Yes. Having an operator is much better because some households don't like to clean out the toilet so they need help with that.

**Q. What kind of personality traits would you recommend for other operators that are hired?**
The most important thing is to train whoever is hired really well.

**Q. What concerns did people have with the toilets?**
Mostly that they fill up too fast (Snow's) and they don't like cleaning them out during the winter because it's cold outside and harder to vent out the house. Summertime is ok because you can open up all the windows. The remote toilet would be better in the winter.

**Q. Did people ask you many questions about how they worked?**
Several people from the community asked me how they can get a compost toilet for their home because they are tired of honeybuckets. They tried out the toilets and think they are less stinky than honeybuckets.

**Q. Based on your experience, do you feel that ct's can be an alternative to honeybuckets?**
Yes compost toilets are definitely better than honeybuckets. They smell so much better than honeybuckets and they make less of a mess and even though cleaning the toilets can be a pain, at least you only have to clean them every so often. With honeybuckets you have to deal with them and dump them all of the time. The compost toilets are easier and better to dump than honeybuckets. I want a compost toilet for my trailer.

**Q. Do you think households will eventually clean the toilets themselves?**
Maybe. xx Tundra cleaned his by himself and it went really well. We should give out more rubber gloves and masks to all the households. With the store toilet, more and more people were coming to use the toilet and it was filling up too fast. They need a second toilet for their new bathroom.

**Q. Do you have any tips for cleaning the toilets?**
Have the toilet as dry as possible. Add peatmoss and turn on the heater for as long as possible before the toilets are cleaned.

# Appendix Q

# Comparison table of flush-haul, piped utilities, compost toilets, and honeybuckets

## Comparison table of flush-haul, piped utilities, compost toilets, and honeybuckets

**Compost Toilet and Honeybucket information** added to a Table (“Table 2. Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Tank and Haul and Piped Utilities”) originally produced from the “Sanitation Facilities Preliminary Engineering Study, Alaska” by CE2 Engineers (2000). The first three columns of the table (“Measure of Customer Health/Convenience,” “Closed Tank and Haul,” and “Piped Utilities”) are all original content from the CE2 Study, and all the information in the last two columns (“Compost Toilets” and “Honeybuckets”) was produced for this compost toilet project.

### Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Tank and Haul, Piped Utilities, Compost Toilets, and Honeybuckets

| Measure of Customer Health/Convenience[1] | Closed Tank and Haul[1] | Piped Utilities[1] | Compost Toilets | Honeybuckets |
|---|---|---|---|---|
| Quantity of water “provided” to the home | Only a limited amount of delivered water is affordable. That amount is much less than most customers would prefer. Customers sometimes haul their own water, rather than pay for water delivery. | An ample amount of water is available at the tap. Water is much less expensive, on a cost per gallon basis, than for the closed tank and haul system. | No water provided to the home with this system. | No water provided to the home with this system. |
| Quality of water available to household members | Fair to good – the water is generally warm and possibly affected by long storage time and buildup of sediments and / or biological growth in the holding tank. Water from customers holding tanks is not routinely tested for purity. | Excellent and regularly tested. | N/A | N/A |
| Household floor space occupied by water and sewer devices | Greatest amount required. Space must be available to install the typical plumbing fixtures plus a holding tank, pressure pump, pressure tank etc. | Moderate amount of space is required to install the typical plumbing fixtures. | Small to moderate amount of space is required depending on household size (for 1-2 people, 1 toilet is required and for 3+ people, 2 toilets are required (toilets are approx 2’x3’ in size) | Small amount of space is required. Enough for a 5 gallon bucket or a bench-type set-up where the bucket is placed underneath a wooden bench (or box) with a hole cut out the size of a toilet seat. |

| **Measure of Customer Health/Convenience**[1] | **Closed Tank and Haul**[1] | **Piped Utilities**[1] | **Compost Toilets** | **Honeybuckets** |
|---|---|---|---|---|
| Mechanical complexity of water and sewer devices installed in the home | Most complex – more mechanical devices than for piped utilities. | Less complex than closed tank and haul | Less complex than closed tank and haul. | Least complex. |
| Noise in the house from the water and sewer devices | Noise is generated by the water pressure pump and when the toilet is flushed. | Noise is generated when the toilet is flushed and/or when the vacuum valve opens to empty the wastewater sump. | Fans in the toilet (which are on at all times) make a low humming noise. Sometimes during high winds, there is some noise from the vent pipe shaking due to the wind turbine spinning at high speeds. | No noise. |
| Puddle on the floor from the water holding tank "sweating" | Probable unless the water holding tank is insulated. | Not applicable. | Not applicable. | Not applicable. |
| Ease of draining/protecting the water and sewer devices if the house is left without heat | Complex – more devices have to be drained than for piped utilities. | Less complex than closed tank and haul. | No issue – the compost toilet can be unplugged if it's not being used and plugged back in when ready for use. | No issue. |
| Ability to bathe at home | If a shower is installed, even a very short shower at home is generally more expensive than showering at a washeteria. | Baths and full showers are possible at no additional charge. | Not possible - no water provided to the home with this system. | Not possible - no water provided to the home with this system. |
| Ability to do laundry at home. | Expensive due to the high cost of water delivery and wastewater pick-up. | Most families eventually buy washers and dryers and do laundry at home. | Not possible - no water provided to the home with this system. | Not possible - no water provided to the home with this system. |
| Fire protection for the home. | Essentially none. | Some. | None. | None. |
| Odors in the home from human waste | Some odor, depending on frequency of toilet flushing. | No odor. There is no incentive not to flush the toilet after each use. | Low to no odor during normal use. Reports of high odor when the toilet is being emptied out. | Highest odor likely. Especially if the honeybucket sits open without a lid. |

| **Measure of Customer Health/Convenience**[1] | **Closed Tank and Haul**[1] | **Piped Utilities**[1] | **Compost Toilets** | **Honeybuckets** |
|---|---|---|---|---|
| Requires household members to handle (and potentially spill) human waste | No | No | When toilet is emptied every few months, must handle a solid product (compost). A small closed container connected to the toilet via a drain pipe for excess liquid may need to be emptied from time to time. | Yes |
| Characterized by wastewaters other than toilet waste (often called "greywater") being dumped on the ground outside the home. | Most probable. Users may remove plumbing fixture traps and collect wastewater in a bucket for disposal on the ground (to reduce waste haul charges). Some communities have ordinances prohibiting the indiscriminate dumping of greywater. Fines can be imposed. | No, there is no incentive to dispose of greywater on the ground. | Yes. No plumbing for greywater with this system. | Yes. No plumbing for greywater with this system. |
| Odors from human waste or decomposing greywater in the yard outside the home or along public thoroughfares | Wastewater holding tanks are vented and may cause odors. Greywater may cause odors. | No odor. | Compost toilets are installed with outdoor vent pipes and wind turbines. Odors may be present outside from the vent pipes. | Honeybucket hoppers placed throughout communities may cause odors if they are left open or are cracked and leaking. Some honeybuckets indoors have a ventpipe in place with a bench-type setup, in which case, may pose odor issues outdoors. |
| Amount of contact utility workers have with human waste | Some contact | Very little contact – only when wastewater equipment repairs are necessary. | When toilet is emptied every few months, must handle a solid product (compost). A small closed container connected to the toilet via a drain pipe for | Highest contact. |

| **Measure of Customer Health/Convenience**[1] | **Closed Tank and Haul**[1] | **Piped Utilities**[1] | **Compost Toilets** | **Honeybuckets** |
|---|---|---|---|---|
| | | | excess liquid may need to be emptied from time to time. | |
| Homeowner time involved with "operating" the facilities installed in the home | Highest amount. Must monitor holding tank levels, call for water deliveries and waste pickup, and maintain more devices. | Least amount. | Moderate to high amount. Must add peatmoss daily, pull an aerator bar 3x a week and add microbe accelerator every other week. Also must empty toilet every few months or call operator to have it emptied. | No operation required aside from emptying the honeybucket when full. |
| Monetary cost to the household per gallon of water used in the home | Most expensive, at least five times more expensive per gallon than for piped utilities. * | Less expensive per gallon than closed tank and haul. | No water is provided with this system, but monthly costs are approximately $19-$25 for a household with 3 or less people, and $34-$45 for a household with over 3 people. Note that these numbers do not include costs for an operator. | No water is provided with this system, but costs are $35/month for an operator to haul full honeybuckets to the dumping area. |

[1] First three columns of the table contain information taken directly from "Table 2. Relative Comparison of the Level of Protection to Health and Customer Convenience Afforded Under Tank and Haul and Piped Utilities" in the document "Sanitation Facilities Preliminary Engineering Study, Alaska" by CE2 Engineers (2000).

*Assuming a residential piped water and sewer charge of $216 per month, 6 persons per household and an average use of 45 gallons per person per day, the cost for piped water and sewer service is 2.7 cents per gallon. This number can be compared with the cost of your closed tank and haul service, where residents pay $40 for the utility to supply up to 100 gallons of water and haul off up to 115 gallons of wastewater per month. The minimum cost per gallon is therefore 40 cents per gallon or 14.8 times as expensive as piped water. Furthermore, note that even if the household size is reduced from 6 to 2 persons per household for evaluation of the piped utilities scenario, the cost per gallon for service from the closed tank and haul system is still approximately five times greater than the per gallon cost for the typical piped system. This analysis ignores any accumulation of serves to provide for the eventual replacement of the infrastructure, which is common practice in rural Alaska

**Compost Toilet and Honeybucket information** added to a Table ("Table 3. Other Considerations in the Comparison of the Closed Tank and Haul System to Piped Utilities") originally produced from the "Sanitation Facilities Preliminary Engineering Study, [redacted], Alaska" by CE2 Engineers (2000). The first three columns of the table ("Criteria," "Closed Tank and Haul," and "Piped Utilities") are all original content from the CE2 Study, and all the information in the last two columns ("Compost Toilets" and "Honeybuckets") was produced for this compost toilet project.

**Other Considerations in the Comparison of the Closed Tank and Haul System, Piped Utilities, Compost Toilets, and Honeybuckets**

| **Criteria**[1] | **Closed Tank and Haul System**[1] | **Piped Utilities**[1] | **Compost Toilets** | **Honeybuckets** |
|---|---|---|---|---|
| Maintenance skill level required | Requires a highly skilled water treatment operator. Requires less mechanical maintenance skill than for piped utilities. | Requires a highly skilled water treatment operator. Requires excellent mechanical skills to maintain the water plant, water pressurization and circulation equipment, vacuum collection station, heat recovery equipment, sewage pumps, etc. | Low skill required. Maintenance and operation of the toilet is basic, but must be carried out on a daily/weekly basis.<br>Note there is no water provided to the home with this system. | Lowest skill required. Note there is no water provided to the home with this system. |
| Susceptibility to catastrophic failure | Components can fail (haul vehicles, individual home pressurization units, etc.) but failures usually inconvenience only a few customers. | Requires conscientious operator attention to avoid catastrophic failure, but failures are extremely rare in well designed systems which utilize modern materials. | Requires conscientious attention by household members to do regular basic maintenance or the toilets won't work properly. All electrical components are in a removable box which can be replaced with minimal effort. | There are no "parts" to fail. Buckets or hoppers could spilt, break and leak. |
| What happens if one-third of the residential customers cant' pay their water and sewer bill | Those who can't pay won't receive service. The cost of service will remain about the same for the people who can pay. Operators would work fewer hours and get paid less. Those who can't afford the service will return to the honeybucket. | Service will be shut off to those who don't pay. The annual cost to operate the system will decrease by approximately 10 percent. The monthly cost of service to both the School District and the remaining residential customers will increase by approximately 25% percent to $40,000/year for the school and $285/mo for the residential customer. As more customers | Households pay for their own peatmoss, microbe accelerator, and electricity. If households can't pay for these items, the toilet won't work properly and they would need to return to the honeybucket. An operator isn't necessary unless households wanted to pay extra for emptying their toilet. | Those who can't pay, won't receive honeybucket collection service. Operators would work fewer hours and get paid less. |

| Criteria[1] | Closed Tank and Haul System[1] | Piped Utilities[1] | Compost Toilets | Honeybuckets |
|---|---|---|---|---|
| | | subscribe to the service the monthly user bill will decrease. Those who can't afford the service will return to the honey bucket. | | |
| Does household size affect the monthly cost of service? | The cost of haul service varies with household size and water use practices within the home. The criteria used in the economic analysis that follows assumes a monthly fee of $171 per month based on an average of 6.0 persons per household, each using two gallons of water per day at home, of which two gallons per day go to the wastewater holding tank. Under these assumptions the monthly cost of service would vary with household size as follows:<br>Size of household — Estimated monthly cost of service<br>1 — $28.50<br>2 — $57.00<br>3 — $85.50<br>4 — $114.00<br>5 — $142.50<br>6 — $171.00<br>7 — $199.50<br>8 — $228.00<br>9 — $256.50<br>10 — $285.00<br>11 — $313.50<br>12 — $342.00<br>As a practical matter, small households may use more water than the assumed two gallons per person | Most small Alaskan communities charge residential customers a flat monthly fee for piped water and sewer service. That fee allows the household to use as much water as it needs for domestic purposes regardless of household size. Some communities install water meters and charge residential customers per gallon of water used. The use of water meters makes billing more complicated. (Note that the monthly fee calculated in 2000 for an average household in [illegible] was $216). | Yes. For households with over 3 people, two toilets are required to meet capacity. Monthly costs are approximately $19-$25 for a household with 3 or less people, and $34-$45 for a household with over 3 people. Note that it is difficult to compare monthly costs between the four systems listed here, because compost toilets and honeybuckets don't provide water to the home. Also, the numbers listed here for compost toilets, don't include costs for an operator. | Not really. All households have the option to pay $35/month for household collection service. If the $35 is paid for the month, honeybuckets will be collected once a week or more for that month, regardless of the number of honeybuckets generated by the household. |

| Criteria[1] | Closed Tank and Haul System[1] | Piped Utilities[1] | Compost Toilets | Honeybuckets |
|---|---|---|---|---|
| | per day and therefore may pay more on average than the estimated costs shown in the table. | | | |
| How would school district facilities be served with water and sewer? | The school will continue to obtain piped water from the circulating main which also serves the watering points. Wastewater from the school will continue to be treated at the existing school lagoon, or the existing school lagoon will be closed and the school will be required to pipe its wastewater to the new community wastewater lagoon waste of town. | The school will probably subscribe to piped water and sewer service from the Community and pay 13% of the operating cost of the new piped system. The school sewage lagoon will be abandoned. Wastewater generated at the school will be piped through community sewer lines to a new community wastewater lagoon west of town. | The school will continue to obtain piped water from the circulating main which also serves the watering points. Wastewater from the school will continue to be treated at the existing school lagoon. | No change. |

[1] First three columns of the table contain information taken directly from “Table 3. Other Considerations in the Comparison of the Closed Tank and Haul System to Piped Utilities” in the document “Sanitation Facilities Preliminary Engineering Study, , Alaska” by CE2 Engineers (2000).

# Appendix R
# Results of feedback forms

**Results of feedback forms for the [redacted] from late January 2007**

| Questions | Household member #1 | Household member #2 | Household member #3 |
|---|---|---|---|
| What do you think of the compost toilet? (Circle one)<br>I like it, I don't like it, I don't know | I like it | I don't know | I like it |
| Is there something you don't like about this toilet? What? | Toilet fills up too fast. During the winter season it is hard to dump the inside since there is no vent and the smell is too strong when they empty it. | Needs another toilet, like it needs more capacity | Has to be emptied often. Sometimes little bit of odor outside when you walk by. |
| If there are things you like about this toilet, what are they? | It runs okay but Question 2 (above) is just my concern. Since it fills up to fast. | They don't smell like honeybuckets | No odor (except when you empty it) |
| How does use of this compost toilet compare to using a honeybucket?<br>Same, Better, Worse, Don't know | Better Better | | Better |
| How does use of this compost toilet compare to a flush-haul toilet? (Circle one)<br>Same, Better, Worse, Don't know | Better Better | | Better |
| How much would you be willing to pay per month for honeybucket collection? (Circle one)<br>$0 $15 $20 $25 $30 $35 $40 $45 $50 | $0 | $15 | I don't know |
| How much would you be willing to pay per month for the flush-haul system? (Circle one)<br>$0 $15 $20 $25 $30 $35 $40 $45 $50 | $0 | $20 | I don't know |
| How much would you be willing to pay per month for the compost toilet system? (Circle one)<br>$0 $15 $20 $25 $30 $35 $40 $45 $50 | | $20 | I don't know |
| Which do you like best? (Circle one)<br>Honeybucket Flush-haul Compost Toilet | Compost toilet | Compost toilet Compos | t toilet |
| Do you think that compost toilets should be installed in other honeybucket households in [redacted]? Yes, No, I don't know | I don't know (It depends on the people . I can't boss them around) | Yes | Yes but bigger houses like us need 2 toilets. |

| Results of feedback forms for the [redacted] from late January 2007 | | | | | |
|---|---|---|---|---|---|
| **Questions** | **Household member #1** | **Household member #2** | **Household member #3** | **Household member #4** | **Household member #5** |
| What do you think of the compost toilet? (Circle one)<br>I like it, I don't like it, I don't know | I like it and I don't like it | I don't like it | I don't like it | I don't like it | I don't know |
| Is there something you don't like about this toilet? What? | The smell (at times) and that we need to put tissue in a different container. | It's stinky sometimes and don't know | When it stinks and the fan and noisy | It's noisy, takes a lot of space, uses a lot of electricity. | I don't like the smell, not having to put the tissue in it, and the fan. The fan gets the butt dry and keeping track of how many times we pee in it and they're noisy. |
| If there are things you like about this toilet, what are they? | We don't have to fill and empty a honeybucket every 1.5 days. And that the soil or end product is usable for soil enhancers and can be sold. | Nothing | Don't have to take out the honeybuckets a lot. I just don't like it. | You can't drop your used toilet tissue in it, you have to take it out, and drop it somewhere else. (stinks up the place) | Not having to dump honeybuckets and the anaq dissolving. |
| How does use of this compost toilet compare to using a honeybucket? (Circle one)<br>Same, Better, Worse, Don't know | Same Wo | rse | Same Wo | rse | Same |
| How does use of this compost toilet compare to a flush-haul toilet? (Circle one)<br>Same, Better, Worse, Don't know | Don't know | Don't know | Don't know | Don't know | Don't know |

| Results of feedback forms for the  from late January 2007, Continued | | | | | |
|---|---|---|---|---|---|
| **Questions** | **Household member #1** | **Household member #2** | **Household member #3** | **Household member #4** | **Household member #5** |
| How much would you be willing to pay per month for the flush-haul system? (Circle one)<br>$0 $15 $20<br>$25 $30 $35<br>$40 $45 $50 | $20 | $15 | $15 | $15 | $15 |
| How much would you be willing to pay per month for the compost toilet system? (Circle one)<br>$0 $15 $20<br>$25 $30 $35<br>$40 $45 $50 | $15 | $15 | $15 | $15 | $15 |
| Which do you like best? (Circle one)<br>Honeybucket<br>Flush-haul<br>Compost Toilet | Flush toilet (written in) | Flush haul | Honeybucket | Honeybucket | Flush haul |
| Do you think that compost toilets should be installed in other honeybucket households in ?<br>Yes, No, I don't know | Yes | No No | | No I | don't know |

## Results of feedback forms for the [redacted] from late January 2007

| Questions | Household member #1 | Household member #2 |
|---|---|---|
| What do you think of the compost toilet? (Circle one)<br>I like it, I don't like it, I don't know | I like it | I like it |
| Is there something you don't like about this toilet? What? | When it leaked on the side and when it's really windy there's a bit of noise from the pipe shaking. | Just sometimes when it leaks on the side. |
| If there are things you like about this toilet, what are they? | Never have to dump the honeybucket. | No odor like honeybuckets |
| How does use of this compost toilet compare to using a honeybucket? (Circle one)<br>Same, Better, Worse, Don't know | Better | Better |
| How does use of this compost toilet compare to a flush-haul toilet? (Circle one)<br>Same, Better, Worse, Don't know | Better | Better |
| How much would you be willing to pay per month for honeybucket collection? (Circle one)<br>$0 $15 $20 $25 $30 $35<br>$40 $45 $50 | | I don't know |
| How much would you be willing to pay per month for the flush-haul system? (Circle one)<br>$0 $15 $20 $25 $30 $35<br>$40 $45 $50 | | I don't know |
| How much would you be willing to pay per month for the compost toilet system? (Circle one)<br>$0 $15 $20 $25 $30 $35<br>$40 $45 $50 | $20 | I don't know |
| Which do you like best? (Circle one)<br>Honeybucket<br>Flush-haul<br>Compost Toilet | Compost toilet | Compost toilet |
| Do you think that compost toilets should be installed in other honeybucket households in [redacted]?<br>Yes, No, I don't know | Yes. Many people have come over to try to compost toilet and they want one. | Yes. |

**Results of feedback form given to one member of each household in the second quarter**

| Question | [redacted] | [redacted] | [redacted] |
|---|---|---|---|
| **Name** | [redacted] | [redacted] | [redacted] |
| **Household** | | | |
| **Date** | 11/8/06 11/6/ | 06 11/9/06 | |
| **Has there been any odor in the bathroom in the last 2 weeks? A lot a little none** | None | A little | A lot - From a leak |
| **If there was odor, which day(s) did you notice it?** | None | First week of November | The day the hose leaked. |
| **If there was odor, is it worse or better than a honeybucket?** **If you know the smell of flush-haul system, is it better or worse? Better Worse Same** | N/A | Better than honeybucket. | Worse than honeybucket. - Smelled it all through the house. Flush-haul – I don't know. |
| **Has there been any liquid leaking from the toilet in the last two weeks? Yes No If yes, where is the leak?** | No. | Yes . Filter on the side. | Yes.- Hose/screw thing. |
| **Do you think your sheet on the bathroom door is being checked off each time before people use the toilet?, (One "use" means urine or anaq's)** **Yes, every time No, not all the time Not sure** | No, not all the time | Yes, every time | Not sure |
| **Is the small cupful of peatmoss and cocoa shells added everytime the toilet is used?** **Yes, every time No, not all the time Not sure** | Not sure | Not sure | Not sure |
| **Do you think the toilet bowl is being closed after using the toilet each time? (moving the handle back to the "down" position) Yes No Not sure** | Yes | Yes | Yes |
| **Do you think someone in your household put anything in the toilet besides human waste, peatmoss, and cocoa shells? Yes No If yes, what did they put in?** | No | No | No |

**Results from Store Toilet User Feedback Forms**

| Question asked | Answers and date feedback form received | | | |
|---|---|---|---|---|
| | **July 14, 2006** | **July 14, 2006** | **August, 2006** | **August, 2006** |
| **What do you think of this toilet? (Circle one)** I like it I don't like it I don't know | I don't know | I don't know | I don't know | I like it |
| **Is there something you don't like about this toilet? What?** | It doesn't flush. | Smell and once it's up to capacity, you have to wait, even on emergency. | Well, when peat moss is not put on – you can see the poop. | No |
| **How does use of this toilet compare to using a honeybucket? (Circle one)** Same Better Worse Don't know | Better Better | | Better | Better (less smell) |
| **How does use of this toilet compare to a flush-haul toilet? (Circle one)** Same Better Worse Don't know | Don't know | Don't know | Don't know | Don't know (flush toilet is always better) |
| **Would you like to have this kind of toilet in your home? (Circle one)** Yes No Maybe Don't know | Don't know | Don't know | Maybe | Maybe |
| **What would make the toilet better? What would you like to see if it was in your home?** | Flush | Won't meet the capacity. No smell and not waiting for it when it's full. | If you can't see the poop. | Bigger capacity |
| **We want to be sure that everyone in the community has a chance to try this toilet. It will help us if you answer the next two questions about yourself. Circle one:** Man/boy Woman/girl | Girl Man | | Man | Man |
| **What age are you? (Circle one)** under 13 13-24 25-40 41 to 65 Over 65 | 13-24 | 41 to 65 | 41 to 65 | 41 to 65 |