WATER GLOBAL PRACTICE

Challenges and Opportunities for Improving Household Sanitation in the Ger Areas of Ulaanbaatar

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with William Kingdom,
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ACKNOWLEDGEMENTS

This report is a product of the Water Global Practices. It was prepared by a team led by Diego J. Rodriguez (Senior Water Resources Management Specialist, Water Latin America and Caribbean, World Bank) and by Martin P. Gambrill (Lead Water and Sanitation Specialist, Water Global Programs, World Bank), and comprising Maryanne Leblanc (Consultant), and Robert A. Reed (Consultant). This report is based on preliminary reports that were produced by G. V. Jones & Associates, Inc.; by Dr. Robert A. Reed (Consultant); and by Gilles Roger (Consultant) with the Mongolian Marketing Consulting Group (MMCG), Vismay Parikh (Consultant), and Narantsatsral Choinzon (Consultant).

The team would like to thank the following for their contributions and support: Jim Anderson (Country Manager, Mongolia, World Bank); William Kingdom (Lead Water and Sanitation Specialist, Water Global Programs, World Bank); Maria-Angelica Sotomayor Araujo (Practice Manager, Water Global Programs, World Bank); Ousmane Dione (Country Director, Vietnam, World Bank); Taehyun Lee (Senior Economist, GMF East Asia and Pacific, World Bank); Toyoko Kodama (Water and Sanitation Specialist, Water PM Strategy & Operations, World Bank); Christopher "Rey" Ancheta (Senior Sanitary Engineer, EASPS, World Bank); Jon Strand (Consultant); Matthijs Schuring (Operations Officer, Water Global Programs, World Bank); Otgonbayar Yadmaa (Program Assistant, Ulaanbaatar, World Bank); Bolormaa Gurjav (Resource Management Analyst, BPSES, World Bank); Arailym Murat (Team Assistant, EACMF, World Bank); and Elisabeth Kvarnström.

The team would also like to thank the following for their constructive feedback in peer reviewing the document: Srinivasa Rao Podipireddy (Senior Water and Sanitation Specialist, Water South Asia Region, World Bank); Jean-Martin Brault (Senior Water and Sanitation Specialist, Water, Middle East and North Africa Region, World Bank); Björn Vinnerås (Associate Professor, Swedish University of Agricultural Science); and William Kevin Tayler (Consultant). Also providing comments were Prithvi Simha and Jenna Senecal (Swedish University of Agricultural Science); and Erdene Ochir Badarch (Operations Officer, Social Development, East Asia and Pacific, World Bank).

The team also wishes to thanks the many representatives of the Governments of Mongolia and of Ulaanbaatar who contributed their time and effort as well as information, experiences, plans, and views to the report, including members of the Office of the Capital City Governor and the Office of the Mayor of the Capital City; the Implementing Agency of the Governor, Administration of Development Ger Area; the Director and many staff members of the Ulaanbaatar Water Supply and Sewerage Authority (USUG); the National Statistical Office of Mongolia; the Mongolian University of Science and Technology; the Water Service Regulatory Commission of Mongolia; the Standard Measurements Department and the Agency for Standardization and Metrology; the Ministry of Health; the Ministry of Construction and Urban Development; the Ministry of Industry and Agriculture; the Ministry of Labor; the Tuul River Basin Authority, Ministry of the Environment and Green Development; the Environmental and Green Development Agency of Capital City; and the 22nd Khoroo of Bayangol District and the 24th Khoroo of SGH District. Also in Mongolia, the team would like to thank Action Contre le Faim (ACF) and WASH Action, as well as the Mongolian Red Cross, World Vision, the Green City Association, The Asia Foundation, the United Nations Children's Fund (UNICEF), the United Nations Development Programme (UNDP), the World Health Organization (WHO), UN-Habitat, Gesellschaft für Internationale Zusammenarbeit (GIZ), and the Asian Development Bank (ADB).

This work was made possible by financial contributions from the Water Partnership Program (WPP).

CONTENTS

Abbreviations

ACF	Action Contre le Faim
ADB	Asian Development Bank
CG	Central government
EcoSan	Ecological sanitation
FSM	Fecal sludge management
GARD	Ger Area Redevelopment
GASI	General Agency for Specialized Inspection
GLAAS	Global Analysis and Assessment of Sanitation and Drinking-Water
GoM	Government of Mongolia
HDPE	High-density polyethylene
JICA	Japan International Cooperation Agency
JMP	Joint Monitoring Programme
KOICA	Korean International Cooperation Agency
LIC	Low-income country
MASM	Mongolian Agency for Standardization and Metrology
MAP-21	Mongolian Action Program for the 21st Century
MCUD	Ministry of Construction and Urban Development
MDG	Millennium Development Goal
MEGD	Ministry of Environment and Green Development
MoF	Ministry of Finance
MoH	Ministry of Health
MoL	Ministry of Labor
NGO	Nongovernmental organization
NWC	National Water Committee
O&M	Operation and maintenance
OECD	Organisation of Economic Co-operation and Development
OSNAAG	Housing and Communal Services Authority
PHI	Public Health Institute
SCR	Sustainable cost recovery

SDG	Sustainable Development Goal
SWA	Sanitation and Water for All
TRBA	Tuul River Basin Authority
UBCO	Ulaanbaatar City Office
UDDT	Urine-diverting dry toilet
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Program
USUG	Ulaanbaatar Water and Sewerage Company
VIP	Ventilated improved pit (latrine)
WASH	Water supply, sanitation, and hygiene
WRC	Water Regulatory Committee
WSRC	Water Services Regulatory Commission
WSP	Water and Sanitation Program (World Bank)
WSS	Water supply and sanitation

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Executive Summary

Objective

This report will assist decision makers and other stakeholders in Ulaanbaatar in deciding how to improve sanitation in the Ger areas, which are fast-growing, largely unplanned peri-urban settlements around the city. It is part of a larger study on improving sanitation in cold regions where sewerage may not be a practical solution. The report grew out of a pilot project meant to improve sanitation in the Ger areas by connecting households to the municipal water supply system and to a small, independent sewerage system. For a number of reasons, operating the system was very challenging. Thus, the question arose of what practicable, affordable technical options exist for improving sanitation in the Ger areas of Ulaanbaatar and other cold regions. The study is aimed at answering that question.

In this report, the term *sanitation* refers to the management of human excreta. However, the "user interface," or toilet that receives the excreta, is only the first link in the sanitation service chain. Chains vary, but commonly include the user interface, containment, emptying, collection, conveyance, treatment, and end use or disposal of excreta. Each link affects the others.

Challenges and Options in Ulaanbaatar

Improving sanitation in the peri-urban Ger areas is a significant challenge. Today over 750,000 people depend on basic pit latrines and buy water at kiosks and transport it to their homes. The pit latrines frequently consist of a few planks over a collapsing pit. These facilities are often unpleasant, unsafe, and unhygienic, frightening for children, and accessible to rats, insects, and other vermin that spread fecal matter into the environment. Government plans to move people into denser housing served by piped water supply and sewerage networks will take time and considerable resources to implement. Even if the plans are fully implemented, 400,000 people would not be connected to municipal sewer services by 2030 (NJS Consultants 2013); therefore, other options must be developed if these people are to access safe sanitation services.

Several factors in the Ger areas favor improving sanitation. Most importantly, Ger area residents want to improve their sanitation. Most households own their land, so are willing to invest in improving their residential arrangements. Plots are large, so there is space for sanitation facilities. However, people have little knowledge of how they could improve their facilities, especially given the restraints imposed by limited financial means and by climatic conditions.

Technical Options

In Ulaanbaatar, technical options for improving sanitation are limited, since many sanitation facilities and processes that work well in tropical or temperate climates would be prohibitively costly or complex to build or operate in the cold climate. For example, critical biological processes that break down excreta and other organic matter slow and stop as temperatures decrease, and liquid wastes cannot infiltrate into frozen soil, so provision must be made to contain all wastewater generated during the cold season.

Sanitation options are also affected by hydrogeological and geological factors, economic conditions, cultural preferences, population density, land tenure, housing type, construction and operations costs and requirements, and the availability of other municipal services. For example, the limited volumes of water available to most households in the Ger areas means that "wet" sanitation options, such as sewers or septic tanks, are not feasible. In addition, about 25 percent of households report that hydrogeological conditions make it difficult to dig pits on their plots. Also, in surveys conducted for this study, most households indicate that their willingness to invest in improved sanitation facilities is lower than the estimated cost of such facilities. Improving sanitation in the Ger areas is possible, but options are limited; the following are considered the most suitable:

- Upgrading and improving simple pit latrines so they provide a more pleasant user experience, while protecting human health and the environment. The pits can be closed and abandoned when full, or emptied and the contents conveyed to a treatment facility.
- Container-based sanitation, in which the feces are directly deposited into a container. When full, the container is conveyed to a facility in which the feces are treated for reuse or disposal. Urine can be allowed to soak into the ground, collected separately, or mixed with the feces.
- With families who are willing to support the expense and effort required, houses may be equipped with a water system that includes, among other fixtures, a low-flush toilet. Wastewater passes through pipes to a soak pit, in which the liquid wastes soak into the ground, and solids are collected and periodically removed for additional treatment and disposal.

As the Ger areas continue to grow, and as latrine pits fill, the need for fecal sludge management (FSM) can also be expected to grow. Fecal sludge management involves the emptying, collection, conveyance, treatment, and end use or disposal of fecal sludge from on-site sanitation facilities such as pit latrines. Current arrangements in Ulaanbaatar involve discharge of the sludge into sewer main pipelines. As the population of the Ger areas continues to grow, the quantities of sludge will also increase. The increased amounts of sludge could block sewers and interfere with the operation of the wastewater treatment plant. Therefore, an adequate system for safe management of fecal sludge is required.

Institutional, Financial, and Regulatory Arrangements

Making suitable technical options available to consumers will not lead to widespread or sustained improvements in sanitation without appropriate institutional, financial, or regulatory frameworks. In Ulaanbaatar, there are gaps and overlaps in roles and responsibilities for Ger area sanitation. Poor coordination among stakeholders and low levels of community or user participation—along with inflexible, prescriptive, aspirational regulations; a lack of skilled human resources; and low levels of investment—are all barriers to improving sanitation in the Ger areas. Moreover, current plans and policies focus mainly on sewerage. Regulations, financial arrangements, institutional support, policies, strategies, plans, and resources for other sanitation options are needed.

Recommendations

Sanitation, including on-site sanitation, should be considered as a system, not just a facility. The entire service chain needs to be considered, including management of the wastes from capture to containment to conveyance to treatment and potential reuse or final disposal. Otherwise, improper reuse or disposal of excreta poses a risk to public health and the environment.

The most cost-effective and sustainable options will generally be the least complex and costly technologies that will provide the desired level of services to consumers, while protecting human health and the environment. Costs to users and providers over the entire life of the facilities must be considered.

Immediate Steps

- An institution at the national level should be named as responsible for sanitation for all Mongolian citizens, and given the necessary powers, resources, and capacities to develop the enabling environment and to coordinate and monitor the sector. This institution, in collaboration with other actors, should continue to update and develop the institutional, financial, and regulatory arrangements for sanitation.
- A municipal agency should be designated or created in Ulaanbaatar to be responsible for sanitation for the entire city, including both sewered and non-sewered sanitation, and provided with the necessary resources and powers to improve sanitation in the non-sewered Ger areas.
- The responsible city-level entity should develop a strategy and plans for fecal sludge management (FSM) for Ulaanbaatar before demand overwhelms the current capacity.
- While creating the enabling environment, the City of Ulaanbaatar, with the districts and *khoroos*,[1] could develop, finance, and implement a program to identify and promote improvements to pit latrines along with4 beneficial hygiene behaviors. This would include informing consumers of the technical options for sanitation, and their costs, maintenance requirements, and other implications.
- The city could explore ways to institutionalize container-based sanitation, in concert with the related Asian Development Bank (ADB) project, to ensure its sustainability.

Medium-Term Steps

- As the sector evolves, continued review and updates of institutional frameworks, laws, regulations, standards, and norms, and financial arrangements related to sanitation can be led by the responsible agencies, which should be given the resources and powers needed to be effective. The agencies would also continuously coordinate and monitor the sector.
- Staffing requirements for the whole water and sanitation sector need to be reviewed, and programs and institutions for training for engineers, technicians, planners, and other staff should be developed.
- The government should support the private sector in designing and marketing locally appropriate sanitation facilities. Sharing responsibility for sanitation with the private sector would reduce the burden on government departments and promote the local economy.
- A thorough review of sector financing should be undertaken to confirm the source and adequacy of existing capital and operational spending for the city as a whole, and the Ger areas in particular. Financial planning should include district- and khoroo-level officials.
- With the world's coldest national capital, Mongolia is in a unique position to immediately develop a Center of Excellence for research into water supply and sanitation (WSS) in cold regions. The center could train engineers and technicians to ensure future staffing needs in the sector. This Center of Excellence will take time to establish, but first steps could be taken now.

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[1] Administrative subdivisions of Ulaanbaatar.

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Chapter 1 INTRODUCTION

Globally, relatively little attention has been paid to sanitation for cold regions, especially non-sewered, on-site technologies. Yet technical problems caused by very low temperatures add significantly to the cost and complexity of designing, building, operating, and maintaining sanitation infrastructure. Many simple, low-cost sanitation technologies for warm climates will not function well in cold climates, but settlements in cold regions often do not have the resources to build, operate, or maintain complex systems.

Box 1.1: What do we mean by "sanitation"?

There is no agreed definition of "sanitation". The Law of Mongolia on Sanitation (1998) defines sanitation as *"Activities to eliminate adverse natural and social factors having potential impact on the public health and to prevent the public health from diseases"* (Govt. of Mongolia, 1998).

This is too general for the purposes of this study, and therefore, for this report, the definition used for the SDG (Sustainable Development Goals) will be used:

> *"Sanitation is the provision of facilities and services for safe management and disposal of human urine and faeces.[2]"*

The JMP defines 'safely managed sanitation services' as use of an improved sanitation facility (i.e. flush or pour flush toilet to sewer system, septic tank or pit latrine, ventilated improved pit latrine, pit latrine with a slab, and composting toilet) which is not shared with other households and where excreta is safely disposed on site or treated off-site (UNICEF & WHO, 2015).

Objective and Scope

This report focuses on improving sanitation in the Ger areas of Ulaanbaatar. The Ger areas are the peri-urban, mostly unplanned settlements that have grown up around the central city. Overall, the report tries to answer the question:

> *What are the main measures that should be implemented (technically, socially, institutionally, legally, and financially) to deliver sustainable improved sanitation services to the Ger areas of Ulaanbaatar?*

Photo 1-1: Pit Latrine, Ulaanbaatar
Source: World Bank

This report is part of a larger study that aims to answer the same question for cold regions in general. It synthesizes the contents of the three specialist reports undertaken in Ulaanbaatar between April 2014 and June 2015: (i) socioeconomic survey (Roger 2015); (ii) technical options study for Ger areas of Ulaanbaatar (GV Jones & Associates 2015); (iii) review of institutional, financial, and regulatory frameworks for sanitation (Reed 2015). This report also discusses the gaps in knowledge and other factors that constrain efforts to sustainably improve sanitation in the Ger areas.

[2] UNICEF and WHO, undated. *WASH Post-2015: Proposed indicators for for drinking water, sanitation and hygiene* accessed at http://www.who.int/water_sanitation_health/monitoring/coverage/wash-post-2015-rev.pdf on October 27, 2017

This report complements the plans of the City of Ulaanbaatar to improve conditions in the Ger areas. The Ulaanbaatar City government plans to upgrade the Ger areas, replacing current housing with medium- to high-density planned settlements served by water supply and sewer networks, among other services. This is an exciting plan, but it is likely to be years or even decades before it can be fully implemented. As of 2014, there were over 750,000 Ger area residents without access to sewers. Instead, they depend on basic pit latrines, as shown in Photo 1-1, which often consist of a few planks over a collapsing pit. These facilities are frequently unpleasant, unsafe, and unhygienic, frightening for children, and accessible to rats, insects, and other vermin that spread fecal matter into the environment. Even when the Ger Area Redevelopment Plan is fully implemented, in 2030, there will still be a projected 400,000 Ger area residents without connections to municipal sewers. Sanitation improvements for Ger area residents without access to sewers are clearly needed to protect human health and the environment. Further, most Ger area residents have expressed a desire for improved sanitation facilities.

Origins of the Report

This study grew out of an unsuccessful attempt to improve sanitation in one part of the Ger areas. The difficulties led to the question of what options for improving sanitation in the Ger areas would be feasible and cost-effective. The only technologies widely used in Ulaanbaatar are (i) conventional sewers that serve the central part of the city; and (ii) simple, basic pit latrines, used almost universally in the Ger areas. However, the Ger areas are not well-suited to sewerage, and the pit latrines are generally poorly built, unpleasant, and unhygienic. Moreover, none of the other sanitation technologies introduced by projects implemented in the Ger areas have been widely replicated. The question remains: how to sustainably and affordably improve sanitation in the Ger areas**?**

Why Sanitation Is Different in Cold Regions

There is no agreed definition of the term *cold regions*. Cold regions vary in the length and severity of the cold season, and in the resulting depth of soil freezing and duration. They also vary in the amount of snowfall, soil conditions, vegetative cover, and more. The effects of soil freezing also vary. Freezing to a depth of 1 meter has significantly different consequences than soil freezing to a depth of 4 meters.

Ulaanbaatar is in the north central part of Mongolia. It is the coldest capital city in the world, with an average annual temperature of -2.4 degrees Celsius and average monthly temperatures between -25 degrees Celsius and +17 degrees Celsius.[3] According to World Bank data from 1961 to 1999, Ulaanbaatar's average monthly temperature is less than -10°C for four months of the year.[4] Although the climate may have warmed somewhat since 1999, it is still very cold.

In Ulaanbaatar, the ground freezes in winter to a depth of 2.8–4.5 meters, with an average of about 4 meters. The area has some sporadic, discontinuous permafrost. In most of the city, however, the soil freezes in the winter and thaws in the summer. The depth of soil freezing varies depending on soil type, location, and season of the year, and is likely to change as the city develops and because of climate change (Lomborinchen 1998; Tumurbaatar 1998; Wu et al. 2011).

[3] See "Ulan-Bator/Ulaanbaatar Climate & Temperature," (accessed 4 October 2017), www.ulaanbaatar.climatemps.com.

[4] Data from Climate Change Knowledge Portal: Historical Data (database), World Bank, Washington, DC (accessed 4 October 2017), http://data.worldbank.org/data-catalog/cckp_historical_data.

Cold temperatures affect the design, construction, and operation of sanitation systems, and the processes that take place within them. Some of the main effects include the following:

- The biological processes that break down excreta and other organic matter slow and stop as temperatures decrease. Many physicochemical processes are also affected by the cold.
- Frozen, saturated soil is impermeable and cannot absorb liquids, which remain in the sanitation system's fixtures, pipes, pits, tanks, vaults, or other containers.
- The contents of the pipes, pits, tanks, vaults, and other containers can freeze, blocking and potentially damaging them.
- Dumped into drainage canals, wastewater can freeze and block the canal. Wastewater dumped onto land can create an icy hazard. When it thaws, it can pollute the surrounding area.
- The expansion and shrinkage of the water and ice in the soil as it freezes and thaws can cause movements in the soil, which can damage and displace fixtures, pipes, pits, tanks, and vaults.
- Digging in frozen soil can be very difficult, and concrete that freezes while hydrating is likely to be very weak, among other construction challenges.

Consequently, designs and processes that work well in tropical or temperate climates must generally be modified to work in cold climates—if they can be made to work at all. For many options, the modifications required would be prohibitively costly or complex. For example, freezing of pipes or tanks can be prevented by "heat tapes" or cables, but the cost of electricity to operate them is usually quite high. Thus, the choice of feasible, cost-effective systems for cold regions in low-income countries (LICs) is limited.

Structure and Use of Report

The report is divided into six sections. Chapter 1, the introduction, justifies why the work was necessary, and summarizes the larger project to which this work belongs. Chapter 2 summarizes the challenges to improving sanitation globally and the difficulties posed by cold climates. Chapter 3 is an assessment of sanitation in the Ger areas of Ulaanbaatar and its context. Chapter 4 presents options for improvement. Chapter 5 presents the conclusions of the study. Chapter 6 offers recommendations for actions and approaches for improving sanitation in the Ger areas.

Readers will benefit from reading sections of the report that match their needs. For example, senior managers and politicians may be more interested in the institutional, regulatory, and financial recommendations made at the end of the report. Technical staff members are more likely to focus on the technical elements of the report, such as the recommended sanitation options and methods for improving sustainability and reducing costs. Some readers will be interested in all aspects of the report, depending on their organization's areas of interest and their individual areas of expertise.

Chapter 2 Global Sanitation Challenge and Particular Challenges in Cold Climates

Improving Sanitation—A Global Challenge

Globally, 2.4 billion people lack access to improved sanitation. Access to improved sanitation lags far behind access to improved water supplies; about 663 million people lack access to improved water supplies (UNICEF and WHO 2015). In 2016, world leaders adopted the Sustainable Development Goals (SDGs). The sixth goal is to ensure access to water and sanitation for all by 2030, and its targets include, among others: (i) universal and equitable access to safe and affordable drinking water; (ii) access to adequate and equitable sanitation and hygiene for all and an end to open defecation, paying special attention to the needs of women and girls and those in vulnerable situations; (iii) improvement of water quality by reducing pollution, in part through a substantial increase in recycling and safe reuse of waste around the world (WHO and UNICEF 2017b).

Data from the WHO/UNICEF Joint Monitoring Programme (JMP) show that access to improved sanitation in urban areas of Mongolia has remained nearly constant from 1995 to 2015. Access to improved sanitation in rural areas, however, has doubled in the same period, as shown in Table 2-1 (UNICEF and WHO 2015).

Year	Improved	Shared	Other Unimproved	Open Defecation
Urban sanitation				
1995	65	31	3	1
2015	66	32	1	1
Rural sanitation				
1995	21	15	28	36
2015	43	30	0	27
Total urban and rural sanitation				
1995	46	24	14	16
2015	60	31	0	9

Table 2-1: Estimated Access to Sanitation Facilities in Mongolia
Percent
Source: (UNICEF and WHO 2015)

However, the JMP measures the type of facility, so that any single-family latrine with a slab is considered "improved," whether it adequately isolates the excreta from human contact or not. Some of the latrines in Ulaanbaatar consist of two planks across an unlined pit. They cannot be considered hygienic or as adequate protection for human health and the environment.

Benefits of Improving Sanitation

Health is often cited as the main reason to improve sanitation. The importance of sanitation to health was clearly summarized in 2007, when readers of the *British Medical Journal* agreed that:

> ***"The introduction of clean water and sewage disposal— "the sanitary revolution"—is the single most important medical advance since 1840."*** [5]

Adequate sanitation can help prevent the spread of diarrhea, cholera, typhoid, and other excreta-related diseases. In Mongolia, UNICEF estimated in 2012 that 8 percent of the deaths of children under five were

[5] BMJ 2007; 334:111, accessed on October 31, 2017 at http://www.bmj.com/content/334/7585/111.2.

from diarrheal diseases.[6] Better sanitation, water supply, and improved hygiene practices related to water and sanitation could help reduce these numbers.

There is growing evidence that poor sanitation also contributes to malnutrition and stunting (Schmidt 2014). The World Health Organization (WHO) estimates that over 15 percent of children under the age of five in Mongolia are stunted[7]. Long-term undernutrition has a negative effect on the physical and mental development of children, makes them even more vulnerable to disease, and reduces their ability to learn and to progress in life (Carlotta et al. 2014). In the long term, this has an impact on the economic development of the whole country.

However, when communities and household members around the world are asked why they value improved sanitation, disease prevention is rarely cited. Privacy, improved dignity and status, women's security, children's safety and comfort are cited more frequently (Jenkins 1999). Improved dignity, privacy, and safety can be especially important to women.

Investment in water supply and sanitation (WSS) services provides substantial benefits for human health, the economy, and the environment. The returns from these benefits are usually greater than the cost of providing the services, which should motivate investment in the sector (OECD 2011). Inadequate water supply and sanitation in rural areas can also be an incentive for migration from rural to urban areas.

Sanitation Service Chain

The Joint Monitoring Program defines sanitation services as "the management of excreta from the facilities used by individuals, through emptying and transport of excreta for treatment and eventual discharge or reuse." (UNICEF and WHO 2017a). Sanitation service chain links correspond to the elements of the sanitation service system. The elements include some or all the following:

- **The "user interface**," sometimes called the toilet, refers to the fixture used to capture excreta and isolate it from contact with the user.
- **Containment** consists of a pit, vault, tank or other receptacle that receives and "contains" or stores the excreta after defecation.
- **Emptying or collection** is when treated or untreated excreta are removed directly from the pit, tank, vault, or container where they have been deposited after defecation, or collected, for example by sewer pipes, for conveyance.
- **Conveyance**, or transport, is the transfer of treated or untreated excreta from one place to another.
- **Treatment:** The sludge is often treated so that it poses no risk to either public health or the environment; the degree of treatment required will vary according to the intended reuse or disposal method for the sludge.
- **End Use/Disposal:** After treatment, the sludge can be safely disposed of or reused, for example as a fertilizer or soil conditioner.

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[6] Data from Mongolia: WHO Statistical Profile (database), WHO, Geneva (accessed February 21, 2017), http://www.who.int/gho/countries/mng.pdf?ua=1.

[7] Data from Mongolia: WHO Statistical Profile (database), WHO, Geneva (accessed February 21, 2017), http://www.who.int/gho/countries/mng.pdf?ua=1.

Photo 2-1: Typical Latrine Superstructure, Ecuador

Source: World Bank

Although not an element in the service chain, the superstructure, or shelter, is also important to the user experience. It houses the user interface and provides privacy and protection from the elements. Photo 2-1 shows a typical superstructure in a cold region.

Together, these elements constitute an improved sanitation system that protects and promotes human health and the environment by isolating excreta, keeping them out of the environment and away from human contact, and treating them so that they can be safely and productively reused or disposed.

More information on the sanitation service chain can be found in Appendix 5.

Types of Systems

Dry and Wet

The basic toilet choice is between a "dry" toilet, which requires no water for use, and a 'wet' water flushed toilet. In both cases, many variations are possible. Figure 2-1 summarizes the ways in which water availability can influence sanitation choices.

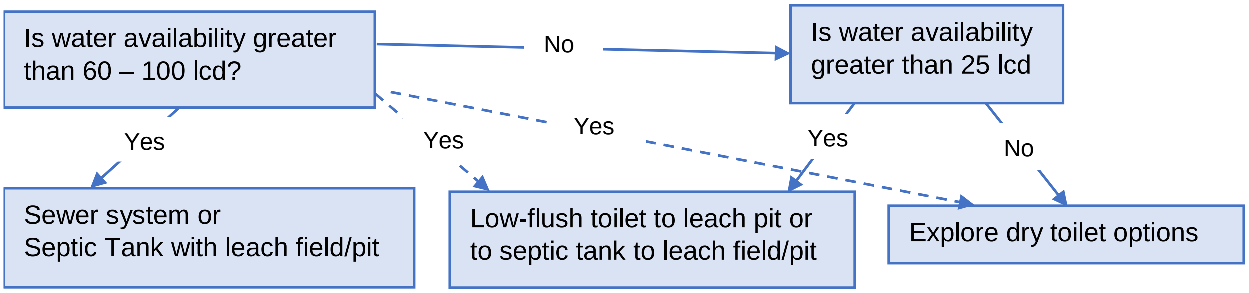

Figure 2-1: Effect of Water Availability on Sanitation Choice

Note: lcd means liters per capita per day.

Wet systems require enough water to flush excreta away from the toilet pan and carry them through sewer pipes to treatment plants, septic tanks, or holding tanks. The necessary volume of water will normally be available only if there is a water connection or a high-yielding well on or near the household plot.

Dry toilets are the only feasible option when water availability is less than about 25 liters per capita per day, although dry options can generally be used even if larger volumes of water are available. Some dry latrines can handle small amounts of "greywater," that is, wastewater from bathing, laundry, cooking, and other domestic uses that does not contain excreta. If dry toilets are used, but water consumption is high, separate provision will be needed for greywater. Many wet sanitation options can handle both greywater and blackwater.

On-Site, Off-Site, and Hybrid Options

Both wet and dry toilets can be on-site or off-site sanitation, or a combination, often called "hybrid" sanitation.

- In an on-site system, excreta are retained on-site for some time, and are partially or fully treated on-site.
- In an "off-site" system, excreta are removed soon after defecation for further treatment.
- In a hybrid system, some excreta are retained on-site, while some are conveyed off-site for treatment and disposal.

Most dry toilets, such as pit latrines, are on-site systems, although some container-based systems are off-site dry systems. Common on-site dry options include the following:

- Pit latrines, in which excreta drop into a pit below the toilet. Solids are retained and decompose in the pit while liquids infiltrate into the soil surrounding the latrine.
- Vault latrines, which hold excreta in a watertight vault for periodic emptying and collection.
- Eco-San latrines, which are intended to contain and treat excreta on-site so that it can be reused, for example, as a nutrient-rich soil additive.

An example of a dry off-site option, which is in use in some urban and peri-urban areas, follows:

- "Container-based" systems, also be called "containerized" sanitation, involve short-term retention of excreta in a container, including feces and possibly some added material such as sawdust, with or without urine. The container, or its contents, is periodically conveyed to a facility in which its contents undergo further treatment for reuse or safe disposal.

Wet sanitation can be off-site or on-site systems. Examples of wet on-site options follow:

- A low flush or pour flush toilet, connected to a leach pit that retains the solid wastes, which are periodically removed for further treatment, while liquid effluent infiltrates into the ground;
- An "aquaprivy," which consists of a watertight vault under the toilet; solids remain in the vault and are removed periodically while liquid effluent soaks into the soil in a leach pit or field.
- Flush toilets with offset septic tanks, in which solids settle out and are periodically removed for additional treatment; liquids infiltrate into the soil in a leach pit or field.

In wet "off-site" systems, excreta are removed from the toilet site for further treatment. Common options for off-site systems include the following:

- Sewerage, in which wastewater is conveyed off-site through sewer pipes for treatment or disposal.
- Flush-tank-haul systems, in which wastewater is kept on-site for a short time in a holding tank or other container. The container is emptied regularly and the contents taken for treatment.

An example of a hybrid wet system would be settled sewage. Solids settle and are retained in an interceptor tank and removed periodically for further treatment. Liquid effluent flows into a sewer system that conveys it to a facility where it is treated for reuse or safe disposal.

How Sanitation Components Affect Each Other

Since elements in a sanitation system are linked, choices and decisions relating to one element in the sanitation system will influence choices and decisions regarding other elements. For example, whether the sanitation is wet or dry influences emptying and collection, conveyance, and treatment. Sewers can be used only with wet sanitation. Sewage can be treated in wastewater treatment plants, but more concentrated sludge from a latrine or septic tank can disrupt treatment processes at the treatment plant.

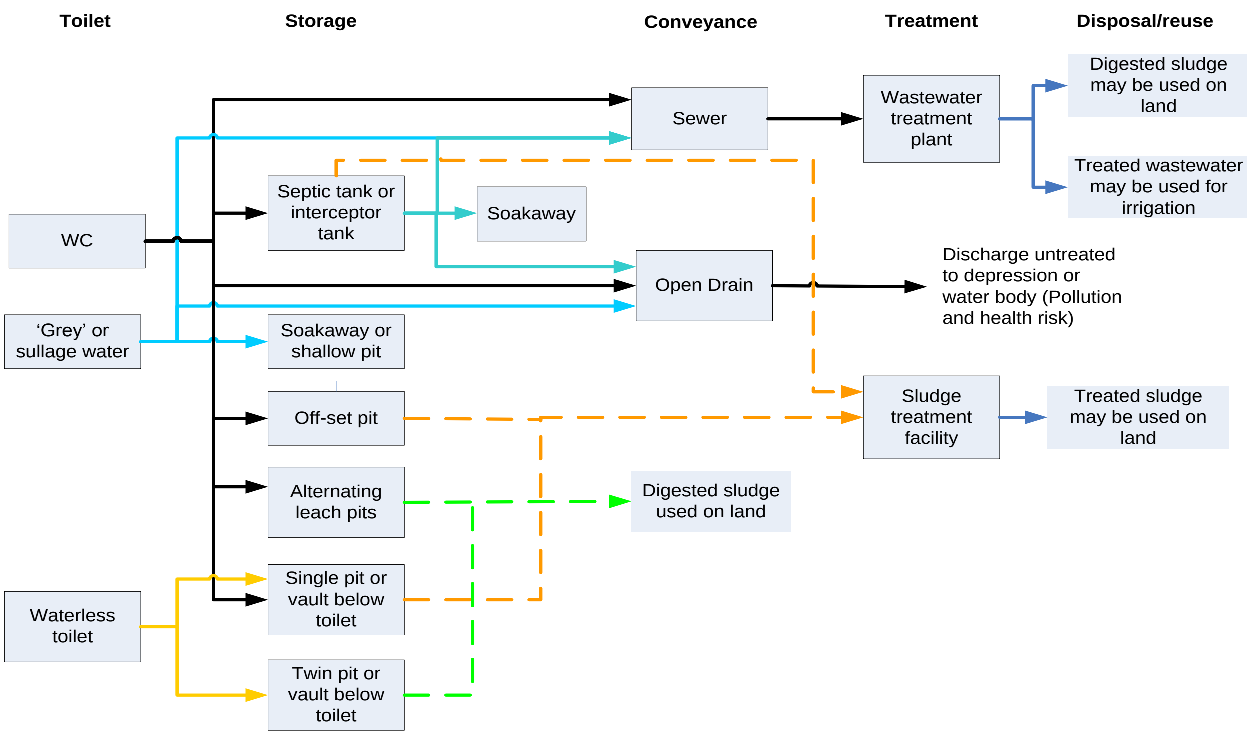

Figure 2-2: Possible Routes through the Sanitation Service Chain

Figure 2-2 illustrates some of the potential routes through the sanitation chain. Black connecting lines show blackwater or sewage; blue lines show greywater; dark blue lines show sewage sludge; yellow lines show raw excreta; brown broken lines indicate periodic sludge collection via vehicle; and green broken lines show collection of sludge, also normally in a vehicle, that has digested to a safe state on-site.

Level of Service

The level of service provided by a sanitation system depends on the type and quality of sanitation facilities, the location of the facility, and the adequacy of the management arrangements. Figure 2-3 shows the levels of service in the "sanitation ladder". Limited service consists of the use of improved but shared facilities without safe management of excreta. Basic sanitation is defined as the use of an improved sanitation facility without safe management of excreta. A safely managed sanitation service comprises the use of improved sanitation facilities when the excreta is either (i) treated and disposed on site; (ii) stored temporarily, then emptied and conveyed to treatment off-site; (iii) or transported through a sewer and treated off-site (UNICEF and WHO 2017a).

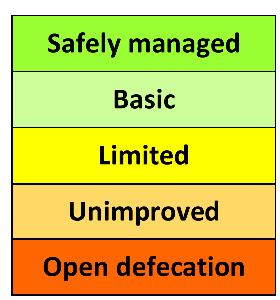

Figure 2-3: Sanitation Ladder
Source: UNICEF and WHO 2017a

The perceived level of service can be as important as the actual level of service. For example, people often assume that a flushed toilet provides a higher level of service than a dry “direct drop” latrine. Even though well-managed dry toilets may provide a high level of service with minimal smell and fly problems (while potentially conserving valuable nutrients), many users prefer a flush toilet because they view it as providing a higher level of service than any dry toilet.

Level of service is also related to the location of the toilet; common options in Ulaanbaatar are as follows:

- Communal or public toilets located away from individual plots
- Shared toilets, often located on shared household plots and accessible to several households
- Household toilets, located outdoors, normally on individual plots
- Household toilets located inside the dwelling

Overall, household toilets are likely to be perceived as offering a high level of service. Indoor toilet may be especially desirable in cold climates, since visiting an outside toilet during winter can be inconvenient and uncomfortable. However, users who associate toilets with smells, flies, and other nuisances, may not believe that indoor toilets could offer a high level of service.

Communal or public toilets are often perceived as the lowest level of service. Maintaining them, and keeping them clean, can be difficult and requires good management. Also, in low-density rural or peri-urban settings, such as Ulaanbaatar, communal toilets may be too far from most households.

As for the quality of the service, sanitation systems of any type that are not well-designed and constructed, and not well-managed or maintained, will normally offer a low level of service and will not protect human health and the environment. A simple pit latrine that is kept clean and managed well can safeguard human health and be more pleasant to use than a dirty flush toilet. A poorly maintained sewer or wastewater treatment plant can pose a risk to human health and the environment.

Challenges of Improving Sanitation in Cold Regions

Cold regions include a wide range of conditions, from polar to more moderate climates. The effects of the cold will, of course, depend on its duration and intensity. In some regions, as in Ulaanbaatar, the average temperature can remain below freezing for months at a time, while in others, the temperature may drop below freezing for a just few nights during the cold season.

Designers and builders need to understand the effects of the cold on the design, construction, and operation of water and sanitation infrastructure. In considering whether a technology can be used in a cold climate, the planner must decide whether it can be economically adapted to physically withstand the effects of the climate and still provide the desired results. For example, sanitation facilities that must be continually heated may be too complex or expensive to operate.

In cold climates, the quality of construction materials, especially of critical components such as pipes, insulation, or heating cables, must be high or the system will operate poorly. Investment in high-quality construction can save significant costs for operation and maintenance (O&M) and improve service levels. For example, modern pipe materials, such as high-density polyethylene (HDPE) and other plastics, can withstand occasional freezing several times without being damaged. When metal pipes freeze, however, they often rupture and must be replaced.

How the Cold Affects Wet and Dry Sanitation

Waste placed into a pit, tank, or vault during the cold season, whether solid or liquid, can freeze and remain in place until the soil thaws after the end of the cold season. In addition, many sanitation systems depend on soil absorption to treat the liquid portion of the waste. However, frozen saturated soils are impermeable, since soil pores are blocked with ice. Since the soil around installations such as soak pits, leach pits, and leach fields is generally saturated, it will be impermeable in the cold season. Moreover, pits and other openings in the soil can cool the soils around the pit, and cause them to freeze to a greater depth than soil further from the pit. This is an important consideration for policy makers, especially if their strategy for preventing freezing is to bury the installations below the depth of soil freezing.

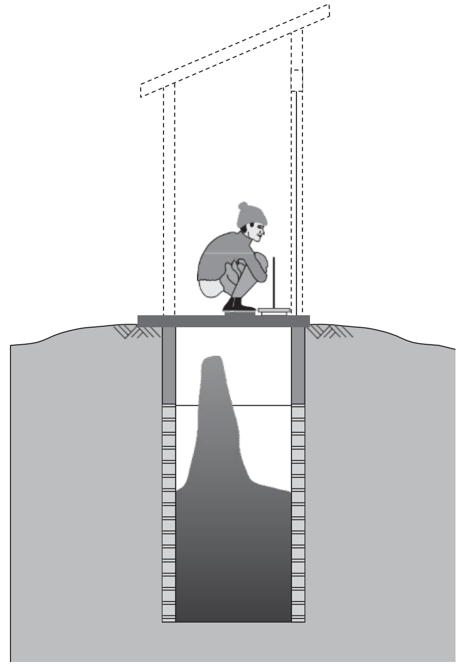

Figure 2-4: Pit Latrine with Frozen Excreta
Source: Adopted from WEDC, Loughborough University

It is difficult to empty most pits, tanks, or vaults when their contents are frozen. Therefore, at the start of the cold season, the pit, tank, or vault receiving the excreta must have enough empty space to hold all the waste put into it during the cold season. Moreover, it must be deep enough to accommodate the heap of frozen waste that can accumulate in the pit (see Figure 2-4). An exception is when the frozen waste can be broken up by workers with compression hammers and removed as solid waste. However, the frozen waste can contaminate the environment when it thaws.

Urine diverting toilets and pipes must be designed to avoid blockage by frozen urine. If urine goes into the vault, the vault must be large enough to accommodate the urine as well as feces and other wastes generated during the cold season. If the urine is diverted into a soak pit, it must be large enough to store the urine generated during the cold season, when it cannot infiltrate into the ground. If diverted urine is collected in containers, their capacity must be sufficient to store all the urine generated during the winter, since urine can be used only during the warm season when the soil is not frozen and can absorb it. The containers themselves must be resistant to freezing.

For wet sanitation options, liquid in toilet fixtures, pipes, fixtures, tanks, soak pits, and other parts of the system can freeze if exposed to frozen soil or to freezing air temperatures. The frozen waste can block the pipes, fixtures, tanks, and other components of the system. Also, the expansion of the freezing liquid can damage and destroy them. Therefore, toilet fixtures that use water must be in heated enclosures, such as a house. Pipes, fixtures, tanks, and other fittings must have a heat tape or other means to keep them from freezing and to thaw them in case of accidental freezing. Frozen waste can be quite difficult to thaw.

How the Cold Affects Treatment Processes

In the cold, the biological processes integral to treating excreta slow and stop as the waste cools and freezes. The amount of biological treatment needed to stabilize and sanitize excreta, and make it safe for reuse, depends on time and temperature. in general, sludge is sanitized more quickly at higher temperatures, but the effect of very low temperatures on decomposition and on the survival rate of pathogens in excreta is complex and not fully understood. Some experts believe that it is impossible for a household composting latrine to reach the thermophilic temperatures required to fully inactivate some pathogens, even in warmer climates.[8] Therefore, further treatment of fecal sludge will always be required; this is especially true in cold regions. Moreover, in the cold, the reduction of volume of the excreta caused by decomposition slows, so the pit, tank, vault, or container should be larger or it will fill more quickly.

Some chemical processes for sanitizing sludge are also temperature dependent. For example, during treatment of fecal sludge with urea, rates of pathogen reduction and inactivation decreased as the temperature decreased (Nordin, Ottoson, and Vinnerås 2009). In another example, neither lime nor urea will interact with frozen sludge, since they can react only with liquid water, not ice.[9]

Effects of Freezing and Thawing on Soil Movements

In cold regions, the ground freezes in winter. Frozen soil can be unstable, particularly if it is saturated with water. As the water in the soil pores freezes and thaws, it expands and contracts, which causes the soil to move. The movements can be large, but even small movements can break or damage pipe joints, piped utility connections to buildings, the seal between a latrine pit and its superstructure, and more. Flexible joints can help mitigate this problem.

Effects of Freezing on Construction

Cold temperatures affect the construction of sanitation facilities. For example, concrete or mortar that is allowed to freeze before it has properly hydrated and cured will be very weak. In some areas, the weight of snow and ice on structures must be considered. Frozen soil is extremely difficult to excavate, so excavations should be planned for the warm season. Also, structures built on frozen soil may be subject to soil movement when the ground thaws and becomes unstable (Buttle and Smith 2004).

Selection Factors

There is a tendency to think that people will improve their sanitation once they have access the "correct" technology and are informed of its advantages. Experience around the world has shown, however, that many other factors influence people's willingness to invest in sanitation. To choose appropriate, sustainable sanitation facilities, consumers must have access to, and information about, the implications and requirements for construction, use, maintenance, costs, expected life, energy use, and more for each potential option. Ger area residents, however, appear to have little knowledge of possible technologies. For example, some households surveyed in Mongolia want flush toilets outside the house (Roger 2015). They did not realize the cost and difficulty of preventing the water in the fixtures and pipes from freezing.

Available Services

The feasibility of sanitation options depends in part on the municipal services available to the household. For example, people cannot connect to a sewer if there are no sewer mains nearby. They cannot use wet sanitation of any type unless the necessary volumes of water are available, which normally requires access to a piped water system. Thus, for most households in the Ger areas, which lack piped water supply and sewer services, dry sanitation options will be the most appropriate.

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[8] Personal communication with Björn Vinnerås, January 31, 2017

[9] E-mail message from Björn Vinnerås, May 11, 2017.

Geohydrologic and Demographic Conditions

Geohydrologic and climatic factors, including, among others, precipitation, ground slope, depth to bedrock, depth of the water table, and type of soil will affect the type, design, costs, construction, and O&M of sanitation facilities. For example, it is difficult to dig pits or trenches for utilities, including water supply and sewer networks, if the bedrock or the groundwater is close to the surface. This is especially true in cold regions if pipes must be buried below the depth of soil freezing. Almost 25 percent of Ger area residents report that they live on plots that are not optimal for on-site sanitation, because the water table is close to the surface or the plots are prone to flooding (Roger 2015). Moreover, these factors can affect the likelihood of soil and groundwater pollution.

Photo 2-2: Ulaanbaatar Ger Area
Source: World Bank

Population density affects the choice of sanitation. For example, relatively low density housing, as in the Ger areas (see Photo 2-2), can favor on-site options because there is adequate space for sanitation facilities. Also, pits, tanks, or vaults for on-site options may require more space to contain all the excreta generated during the cold season. In densely populated areas, pit latrines may require more space than is readily available, especially if they must be replaced when the pits are full. Large numbers of closely spaced latrines can also pollute the groundwater, which in any case should not be used for human consumption (see Box 2-1).

Box 2.1: Groundwater Contamination

Authorities in Ulaanbaatar have expressed concern about soil and groundwater pollution. Although pit latrines can contaminate soil and groundwater, **eliminating pit latrines will not eliminate pollution of the soil or groundwater**, because there are many other sources of pollution. For example, sewers leak. In cold regions, leakage is often increased when soil movements, caused by the freezing and thawing of water in the soil, damage sewers and exacerbate the leaks. In addition, industries and small businesses such as tanneries, slaughterhouses, gas stations, and construction activities can release a variety of pollutants. Even household wastes can include solvents, paint, used motor oil, used batteries, and other chemicals. Harmful pollutants can include heavy metals such as chromium and lead, volatile organic compounds, pesticides, solvents, and more (U.S. EPA 2012).

Higher population densities may favor sewer networks, because per capita construction and maintenance costs, as well as the environmental impact, for water supply and sewer networks decrease sharply as population density increases (Mara 1996; Roux et al. 2011). However, in densely populated areas, options such as sewers may displace many households, since the infrastructure will require more space than in warmer places. Deep excavations to bury facilities below the depth of soil freezing must be shored or be very large to prevent collapse. Considerable space will be needed to store excavated soil during construction.

Land tenure and housing type and conditions generally have a strong effect on public services, including water and sanitation. Owners are more likely than tenants or squatters to be willing to pay for sanitation and other improvements to their residences. In the Ger areas, rates of ownership of the plots are high and many people expressed willingness to invest in sanitation improvements (Roger 2015). However, a ger is not suitable for the installation of an indoor flush toilet, so dry options such as improved pit latrines will be a more practical option for most households living in gers.

User Preferences and Affordability

People's usual customs and preferences will—or should—influence sanitation options. For example, in countries with strong taboos around excreta, it may be difficult to convince people to use technologies that require any contact with feces, such as EcoSan latrines. Households will also vary in their willingness to invest in improving their sanitation. People may be willing to invest in costlier options that offer a higher level of service. For example, in the Ger areas, a few families are willing to pay the construction and operations costs for fully plumbed houses, with a seepage pit for wastewater (Roger 2015).

Since households' economic means and preferences can vary so much, even within the same area, initiatives to improve sanitation should offer a range of options to suit potential consumers' preferences and means. Promotional activities should be tailored to people's motivations for improving sanitation.

Construction and O&M Requirements

Although people often assume that high-tech solutions are superior to low-tech options, in practice, the less complex and costly a system is to build, operate, and maintain, the more likely it is to be used and operated correctly in the long term. Also, for a sanitation option to be feasible, the materials and skills for construction and O&M should be locally available. Thus, the costs and complexity of construction and of operations and maintenance at all levels should be considered when selecting a sanitation technology.

In practice, households are often responsible for building, operating, and maintaining on-site facilities and the on-site portion of off-site or hybrid sanitation systems. The Government, or its designee, is—or should be—responsible for building, operating, maintaining, and managing off-site facilities, including collection and conveyance, wastewater treatment and disposal, and fecal sludge management (FSM). Even where the private sector performs some functions, the Government should regulate and oversee their work. In the Ger areas, the Government may need to consider support for on-site sanitation, including subsidies.

Expected Costs

Capital Costs

Capital costs, such as the costs of construction and installation, will vary widely depending on the type of facility and user preference. In general, for any level of service, capital costs will be higher in cold regions than in warmer ones of the costs of preventing freezing (e.g., insulation or burying the installations deeply). Larger pits, tanks, or vaults to contain frozen excreta may also be necessary.

Operations and Maintenance (O&M) Costs

Costs will vary according to the sanitation option chosen, but operations and maintenance costs are often higher in cold climates than in warmer climates for similar sanitation systems. For example, wet sanitation systems may need added heat to prevent freezing during the cold season (e.g., by housing facilities in a heated enclosure or by operating heat tapes).

Expected Life

One factor affecting the selection of a suitable sanitation facility is its design life (i.e., how long the facility is expected to last before it must be replaced or undergo major rehabilitation). Residents of the Ger areas place durability high on their list of desirable characteristics of a sanitation facility. The life of a well-built, properly used and maintained on-site sanitation facility depends largely on the life of the pit, tank, or vault. In situations in which the pit fills and cannot be emptied, the latrine must be replaced every time the pit, tank, or vault is full. If the latrine or vault can be emptied periodically, then it can last for years or decades. It may be cost-effective to spend more money on a facility that will last longer, when possible. Not replacing the facility will save space as well as money.

Enabling Environment

Global experience has shown that the identification and promotion of technological solutions for improving sanitation—even appropriate, cost-effective solutions—will not alone lead to widespread, sustained improvements. An enabling environment is also required, consisting of the policy, institutional, and financial framework needed to sustain and replicate large-scale sanitation programs. An enabling environment "allows for innovation through supportive policy, institutions, capable public and private actors, and effective participation. Stakeholder participation, institutional development, and capability development are key elements of an enabling environment that need particular attention…" (Lüthi et al. 2011, p 127)**.** According to the World Bank Water and Sanitation Program (WSP), the enabling environment encompasses eight components (World Bank n.d.):

- Policy, strategy, and direction
- Institutional arrangements
- Program methodology
- Implementation capacity
- Availability of products and tools
- Financing
- Cost-effective implementation
- Monitoring and evaluation

Institutional Framework

Appropriate institutional arrangements are essential for the successful implementation of sanitation interventions. A single agency at the national level, such as a Ministry, is needed to take responsibility for sanitation for all Mongolian citizens. Its responsibilities would include policy making and investment planning; regulation and enforcement of policy; and implementation and operation of development initiatives (Livingstone, Erdenechimeg, and Oyunsuvd 2009). In short, the agency will oversee creation of an enabling environment in which sector stakeholders can work together to improve sanitation. At the Municipal level, a similar entity is needed to be responsible for sanitation for all the residents of Ulaanbaatar, including Ger area residents without access to sewer systems.

Regulatory Framework

Inadequate sanitation can pose a serious risk to public health and the environment, so must be set in a legal context. Regulations for sanitation should (i) set minimum standards for acceptable facilities and their location for various levels of service; (ii) define performance standards for service providers; and (iii) address water pollution and water quality issues (Livingstone, Erdenechimeg, and Oyunsuvd 2009). They should be achievable and allow for innovation and consumer choice, and should be allowed to evolve as the sector evolves. Regulations should cover the entire sanitation service chain, including fecal sludge management (FSM), and must be disseminated and enforced.

Financial Arrangements

According to the World Bank, the water sector globally is not equipped to face the financial challenges of meeting the Sustainable Development Goals (SDGs), including SDG 6: "ensure availability and sustainable management of water and sanitation for all." To do so will require new strategies based on (i) improving creditworthiness by improving sector governance and efficiency; (ii) leveraging capital from private sources; (iii) allocating sector resources to deliver the maximum benefit for every tugrik invested; and (iv) improving planning to reduce unit capital costs and thus overall capital requirements (Kolker, et al. 2016).

Strategic financial planning could be based on Sustainable Cost Recovery (SCR) principles, which recognize that subsidies may be needed to support improved water and sanitation services, at least for a transition period. Financial planning must be part of broader sector planning that addresses policy priorities, the roles and responsibilities of government agencies, and related legislative and regulatory reforms to ensure that the proposed plans are financially viable. Accountability in the water sector will ensure that resources are used to provide appropriate, cost-effective services. Transparency and stakeholder participation in planning, budgeting, expenditure management, implementation, and service delivery are essential for accountability.

Chapter 3 IMPROVING SANITATION IN GER AREAS

What Are Ger Areas

The peri-urban, informal settlements of Ulaanbaatar, called Ger areas, are named after the portable shelters called *gers,* or yurts, in which the nomads of Mongolia usually live. To be designated as a Ger area, 50 percent of the population of the *khoroo* (sub-district) should live on *khashaas* (individual plots) in detached houses or in gers. The Ger areas cover about 95 percent of the city's surface area, although much of the Ger areas are unsettled.

Socioeconomic Conditions

The information in this section is mainly based on the socioeconomic survey report prepared as part of this study (Roger 2015). The survey collected data aimed at identifying the economic, social, and cultural contexts related to sanitation in the Ger areas, thus potentially increasing access to hygienic sanitation and maximizing the net benefits to society. Interviewers from a national survey firm conducted over 1,000 household interviews. The survey generated a large amount of data, and the main findings are summarized in Appendix 3.

Based on the 2013 Household Registry Data provided by the National Statistics Office, an estimated 768,000 people live in about 200,000 households in the Ger areas. This is more than 60 percent of Ulaanbaatar's population of 333,379 households and 1,267,024 inhabitants. Over the past decades, the population of Ulaanbaatar has grown exponentially, from 629,000 in 1997 to about 1.2 million in 2012, mostly in the Ger areas. The City's population is expected to grow to 1.9 million by 2035. The settled Ger areas are very extensive, with a relatively low population density. Families have mostly settled on individual plots, each between 470 square meters and 590 square meters. Not everyone who lives in the Ger areas is poor, but most of the poor live in the Ger areas (Kamata et al. 2010). Additional information on housing and income can be found in Table A3-1 in Appendix 3.

The survey finds that Ulaanbaatar differs from many cities in low-income countries (LICs) in its relatively low population density, especially in peri-urban areas; the high percentage of households that own the property they live on; and the very high percentage of households that build latrines for themselves (only about 1 percent of the population of the Ger areas reports practicing open defecation).

Aspirations

Respondents rank sanitation as the third most important public service to improve. This is unusual globally; sanitation normally has a much lower priority. Approximately 85 percent of survey respondents intend to use their own funds to improve their sanitation facilities within the next two years. This high level of interest is equally spread across all income brackets and all parts of the Ger areas. Table A3-2 in Appendix 3 gives details of water supply while Table A3-3 concerns municipal services in general.

Data on the preferred sanitation options are of limited value because respondents are mostly unfamiliar with the potential options, their costs, or the environments in which they are appropriate. While 76 percent of respondents report that they have used a flush toilet, only about 14 percent have used a ventilated improved pit (VIP) latrine, and 8 percent have used container-based sanitation. Fewer than 2 percent are familiar with other options. About 88 percent of respondents say that their preferred sanitation facility is a flush toilet; however, 73 percent of respondents also say the toilet should be located on their plot but outside of the house. Yet these two are, in practice, mutually exclusive, because a flush toilet must be inside a heated building where it will not freeze. Additional information about existing facilities can be found in Table A3-4 in Appendix 3.

In evaluating sanitation facilities overall, 88 percent of respondents say a long life was very important, healthiness second, and affordability and minimum smell next. Good ventilation is the most popular feature of a superstructure (84 percent of respondents). The second is to equip the facility with a flush toilet (50 percent), or a toilet for sitting rather than squatting (46 percent). Eighty-one percent of respondents say that the most important characteristic of a pit is that it not need to be replaced when full. Fewer than 15 percent rank aesthetic improvements, such as beautiful walls and floors, as important, except for the reduction of bad odors. Table A3-5 (Appendix 3) gives more detail about user preferences.

Willingness and Ability to Invest

Ger area residents currently spend about three times more on water supply than residents of the city center, who have access to water supply and sewer networks (a much higher level of service). In 2014, residents of the city center paid about 12,000 MNT (about US$6.60) per person per month for water and sewer services, while Ger area residents paid an estimated average of 35,633 MNT (about US$19.60) per person per month on water supply, including the use of communal bathhouses for bathing. (About 72 percent of survey respondents report that some or all the adults in their household use public bathhouses.) This was for a much lower level of services, covering water purchased from kiosks and brought to the home and the use of bathhouses. Unlike amounts spent on water supply and sewer services in the city center, the amount spent by Ger area residents covers only water supply and includes no costs for sanitation (e.g., for building or emptying latrines, which are financed entirely by the households). For a Ger area household with an average monthly income of 1,022,089 MNT (about US$550), expenditure on water supply and bathhouse use amounts to around 3 percent of income.

Willingness to invest in improved sanitation by income	**Average amount (May 2014)**
Average highest income group	276,274 MNT (US$152)
Average of all groups	200,379 MNT (US$110)
Average lowest income group	129,274 MNT (US$71)

Table 3-1: Willingness to Invest in a New Non-Flush Latrine in Ulaanbaatar

Source: Roger 2015

Ninety-seven percent of the survey respondents say they would be willing to invest in improving their sanitation facility. Moreover, 86 percent of respondents say they are willing to reduce their current expenditures on other things to do so. Interestingly, 95 percent of the poorest quintile are willing to invest in improved sanitation, but only 79 percent of the wealthiest quintile. Poorer families, as expected, are willing to pay less than wealthier families, as shown in Table 3-1, but a higher percentage of their reported income. This could be because the wealthiest have higher quality sanitation facilities than the poorest. It should be noted that the data on willingness to invest in this survey are merely indicative: asking people to put a price on a product that they have never seen is generally suspect. Similarly, the true cost of a new latrine is indicative, since it is based on generic designs.

Most Ger area residents cannot afford to build any but the most basic options. The estimated costs of building most sanitation facilities exceeds the amount people say they are willing to invest in a new non-flush toilet. It may be possible to increase residents' ability to invest by offering low-cost loans, but even then, it will be challenging to persuade most residents to pay the full cost of a new latrine. This may make the possibility of incremental improvements to existing facilities an attractive option for many households. Table A3-6 gives additional details of Ger area residents willingness to invest in sanitation improvements.

Capital Costs

Construction of a pit latrine, with a wooden pit lining and slab, was estimated at about 550,000 MNT (about US$300) in 2014 (GV Jones & Associates 2015, appendix 1). (Note that in Mongolia, wood may not be the least expensive construction material.) In 2006, the World Bank estimated that the least costly simple pit latrine, with a pit lined with stone masonry, would cost US$95 to US$130 (World Bank 2006). Using the exchange rate of May 2017, this was equivalent to about 260,000 MNT to 314,000 MNT.

Further work is required before policy makers can judge what is affordable, but the results correspond to experience in Alaska, where the high costs of constructing sanitation facilities suitable for an extremely cold environment make them unaffordable for most families (GV Jones & Associates 2015). It is highly likely that a subsidy will be necessary to bridge the gap between what families can afford and unit costs for improved sanitation facilities.

Operation and Maintenance Costs

In responding to questions about operation and maintenance (O&M) costs, survey respondents indicate that, on average, about 28,500 MNT is a "normal," or acceptable, price to pay to have a latrine emptied. They also respond that 12,500 MNT to 15,000 MNT per month was a normal (acceptable) amount to pay for sewer service. However, once subsidies were withdrawn in 2015 for the Action Contre le Faim (ACF) project that piloted container-based ecological sanitation in Ulaanbaatar, very few people signed up for emptying services, which cost 40,000 MNT (about US$17) per year, or about 3,300 MNT (about US$1.50) per month, according to project staff. This may be because the emptying services and construction of the on-site facilities were fully subsidized throughout the project, so people were reluctant to start paying for a formerly free service. In any case, the number of subscribers that signed up were not sufficient to cover costs and the services could not be sustained.

Institutional, Policy, Regulatory, and Financial Issues

Several organizations have made comprehensive studies of the institutional, regulatory, and financial frameworks pertaining to the water sector in Ulaanbaatar, such as the United Nations Children's Fund (UNICEF) (UNICEF 2016), ACF (Donati 2015 and Bock 2014), Helmholtz UFZ (Sigel 2012), and the United Nations Development Program (UNDP) (Livingstone, Erdenechimeg, and Oyunsuvd 2009). This report aims only to summarize those aspects relevant to sanitation in the Ger areas. Appendix 4 give additional details of the institutional, regulatory and financial arrangements pertaining to sanitation in Ulaanbaatar.

The Ministry of Construction and Urban Development (MCUD) has been responsible for sanitation; its focus as of 2014 was on densifying the population of the Ger areas and providing "engineered" services such as electricity, heating, water, and sewers. While this is admirable, implementation of the plan will leave at least 400,000 people without access to sewer networks and in need of other solutions by 2030.

At the Sanitation and Water for All (SWA) conference in 2014, the Government of Mongolia (GoM) committed to (i) increasing investment for the water sector, especially sanitation; (ii) improving monitoring to update the national water and sanitation database; (iii) analyzing national plans and programs and publishing the results; (iv) improving the capacity of water supply, sanitation, and hygiene (WASH) sector organizations as well as legislation and coordination; (v) increasing access to improved water supply and sanitation in peri-urban areas and *soum* (district) centers; and (vi) ensuring that the Ministry of Health (MoH) takes clear leadership of the national sanitation portfolio and promotes sanitation and hygiene (GoM 2015). Figure A4-1 illustrates the relationships between pertinent institutions in the sector as of 2014.

The SWA conference showed that the Government of Mongolia recognizes not only the need for additional investment and increased access to improved water supply and sanitation, but also for sanitation and for sanitation and hygiene promotion. It commits to additional transparency in finances and in data on water and sanitation coverage. It acknowledges the need for improving capacity, legislation, and coordination in the sector. However, the focus was still on moving the Ger area population into apartments and providing sewerage for apartment dwellers. The Government also did not report on progress toward fulfilling these commitments for the mid-term report in 2015 (GoM 2015).

Coordination between WASH actors reportedly include all relevant Ministries and Government Agencies (WHO 2014), although, during field visits, some officials said that the lack of coordination was a barrier to progress in the sector. Stakeholders, including Government officials, reported that the lack of coordination is a major barrier to developing and delivering integrated approaches to infrastructure improvement (Kodoma 2015; Reed 2015). And while there are plans to rehabilitate public toilets and safely empty or replace full latrines, the level of implementation is low, and there are no plans for treatment and reuse of excreta (WHO 2014).

Although clearly defined procedures for user participation are reported to be in place, community or service user participation for planning for sanitation is low. Also, per the 2017 Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) report, the only vulnerable group addressed in policies and plans is people living with disabilities (WHO 2017). And while the Government claimed, in the 2014 GLAAS report, that both poor and remote populations are included in plans, progress in reaching them is not reported (WHO 2014).

Evolution is continuing, so the description in this report of the institutional, legislative, and financial environment can only be a snapshot describing conditions before publication of this report (June 2017). The situation after this report is published will likely differ somewhat. The recommendations presented in this report, however, remain broadly relevant.

Institutional Framework

National-level Institutions

The *Ministry of Environment and Green Development (MEGD)* is responsible for developing policies on national water resources management, coordinating interested stakeholders, setting standards for wastewater disposal, and providing information on services related to water resources management (Basandorj 2008). It also should organize implementation of drinking water supply programs, along with the relevant state administrative organizations. Solid waste management is also one of its duties (Sigel 2012). Reducing air, water, and soil contamination in urban areas, and increasing the appropriate use and conservation of water resources, are among the mid-term goals of MEGD (Tortell, Borjigdkhan, and Naidansuren 2008).

The *Tuul River Basin Authority (TRBA)*, which is part of the MEGD, is responsible for a wide range of issues that includes water quality management and levy of pollution charges.

The *General Agency for Specialized Inspection (GASI)* is the main supervisory agency of the government and reports to the Prime Minister. State inspectors review the implementation of more than 140 laws and 3,600 standards, norms, rules, and resolutions of the Government. The GASI then sanctions organizations and individuals that are not in compliance with environmental legislation. This includes the laws and standards covering sanitation.

The *Ministry of Construction and Urban Development (MCUD)* is the most important ministry regarding sanitation. The MCUD's Department for Policy and Coordination of Construction and Public Utilities is responsible for sanitation activities related to formulating and implementing public utilities policies, preparing a legal system for public services, planning for funding, management, design, and research, and provision of expertise for public services (World Bank 2007). Implementation of the policies in Ulaanbaatar is the responsibility of the Capital City Office, however. MCUD also implements large sanitation projects, especially those that are important to government policy. However, in Ulaanbaatar, operation and maintenance of the infrastructure is the responsibility of the Municipality.

The *National Water Committee (NWC)* coordinates the activities of the water-related ministries. It is tasked with formulating the National Water Program and submitting it to Parliament and Government (Horlemann 2010). It also contributes to the development of sanitation policy.

The *Water Regulatory Committee (WRC)* issues permits for sanitation sector contractors—including private sector operators of tankers that empty septic tanks, wastewater holding tanks, and latrines—and monitors their work.

The *Public Health Institute (PHI)*, which is part of the MoH, conducts research on water quality and hygiene, and develops legal standards for sanitation. It has undertaken several studies concerning sanitation in the Ger areas (Sigel 2012).

Additional information on national level institutions is given in Table A4-1 in Appendix 4.

City-Level Institutions

The *Ulaanbaatar City Office* owns the public sanitation facilities and governs their operation, maintenance, rehabilitation, and financing. It is also responsible for the development of policy and implementation of sanitation in non-sewered areas, including Ger areas. It is involved in (but not necessarily responsible for) City-level sanitation policy development, tariff setting, capital funding, technical design, contract preparation, and bidding and construction supervision (Water Authority 2011). It monitors legislation on sanitation, approves relevant decisions and the budget for improving sanitary conditions, and monitors disbursement. The Engineering Facilities Division of the Mayor's Office and the Master Plan Implementing Agencies are key, but the Department of the Ger Area Development is responsible for planning, designing, and constructing sanitation facilities in the Ger areas.

The *GASI* at the Municipal level is responsible for, amongst other things: compliance with standards; monitoring hygiene, wastewater treatment plant sample quality, and groundwater pollution from private sources; and preventing pollution.

The *Environmental and Green Development Agency of Capital City* is responsible for preventing soil pollution from non-sewered sanitation; monitoring pollution from domestic and industrial sources and from wastewater treatment plants; and ensuring compliance with environmental law. The Agency has recently been given responsibility for developing suitable sanitation options for Ger area households not connected to the sewer network (Reed 2015). Potentially, this agency could lead efforts to implement improved sanitation in the Ger areas (e.g., by promoting a sanitation marketing approach).

Additional information on Municipal institutions can be found in Tables A4-2 and A4-3 in Appendix 4.

District-Level Institutions

Although the District-level government forms part of City Government, it has no formal responsibility for household sanitation, but sometimes provides ad hoc support to users. It is responsible for the construction and operation of bathhouses, although operating them is usually outsourced to the private sector.

Khoroo- ***and*** **Kheseg-*Level Institutions***

Khoroos, or sub-districts, have the lowest level of elected government in Mongolia. A *kheseg* is a grouping of residents based on geographical association. Khoroos are responsible for ensuring that individuals' and businesses' public health facilities in their areas follow the relevant sanitation laws and regulations. In practice, khoroo- and kheseg-level authorities have very little role in sanitation. However, khoroo-level officials expressed an interest in contributing to improving services.

Independent Government-Owned Companies

The *Ulaanbaatar Water and Sewerage Company (USUG)*_was established as a self-financing company, wholly owned by the Ulaanbaatar City Office. USUG is responsible for operating and maintaining sewerage networks and wastewater treatment plants. The assets are owned by Ulaanbaatar City Office (UNDP/UNICEF 2004). The company, however, is currently unable to fully fund all its expenditure.

The *Housing and Communal Services Authority (OSNAAG)* was established self-financing company owned by the City Office. It manages, among other things, the water supply and the collection and disposal of wastewater from Government owned apartment buildings. OSNAAG has outsourced its operational responsibilities to 20 private contractors which pay water and wastewater bills directly to USUG.

Alternative Service Providers

Many, often informal, small enterprises fill the demand for sanitation services from households beyond the reach of the public sewerage network. They provide services such as emptying latrines and latrine construction.

International Donors and Nongovernmental Organizations

International donors work to improve water supply in Mongolia, but very few are working in the sanitation sector. Relatively few nongovernmental organizations (NGOs) appear to be working in the urban sanitation sector in Mongolia. Table A2-1 in Appendix 2 lists donors and NGOs known to be involved.

Policies and Plans

The Government has far-reaching concrete plans and policies to improve sanitation facilities in Ger areas. However, at the time of this report, plans are mainly based on widespread redevelopment and densification of Ger areas, including the provision of centralized water supply and sewerage systems. Even assuming the plans are fully and rapidly implemented, by 2030 an estimated 400,000 residents will still not be connected to the sewerage system (NJS Consultants 2013). Thus, hygienic and affordable on-site sanitation facilities will be needed for many years to come. The main plans and policies are listed below.

Ulaanbaatar City Master Plan. The Japan International Cooperation Agency (JICA) produced a city master plan in 2009 (ALMEC Corp. 2009), which was updated in 2013. With JICA support, the Municipality also developed a study on strategic planning for water supply and sewerage in the city (NJS Consultants 2013).

Millennium Development Goals (MDGs). In 2000, the Mongolian government committed itself to achieving the MDGs. However, improved sanitation coverage decreased between 2000 and 2010, probably due to the rapid urbanization of the population (UNICEF and WHO 2015).

National Water Program. This program aims to integrate the numerous programs and strategies into a consistent water program for the whole country (Horlemann 2010). The overall objectives are to protect water resources; enhance the proper use of available resources; and help to create conditions for Mongolian people to live in a healthy and secure environment (Sigel 2012).

Mongolian Action Program for the 21st Century (MAP-21). The Action Plan for 2008–12 gives considerable attention to water and infrastructure development (Sigel 2012). It explicitly proposes improving sanitation in Ger settlements by expanding the central water and sewer networks and promoting the involvement of private entities in service delivery (UN n.d.).

Program on Sanitation. Developed by MCUD and adopted in 2005, the Program includes 45 proposals for a full spectrum of improvements, both physical and institutional. The Program explicitly recognizes the need to improve Ger area sanitation (World Bank 2007). However, little progress appears to have been made to date.

Regulatory Framework

The national regulatory framework for sanitation is divided into three sections: Law, Standards, and Technical Regulations. In general, the Law section reflects government policy, sets national objectives, and defines roles and responsibilities. The Standards section sets levels of service, such as required drinking water quality or the specifications for a new latrine. The Regulations section sets procedures to for achieving the standards and complying with national law. The central government sets Standards through the Mongolian Agency for Standardization and Metrology (MASM). The General Agency for Specialized Investigation (GASI) is responsible for ensuring compliance with the Standards. In Appendix 4, Tables A4-4 to A4-6 summarize some of the Laws, Standards and other regulations pertaining to sanitation.

Although there has been progress in updating the institutional and legal framework, sanitation still appears to be governed by a wide range of laws, standards, regulations, policies, and plans that apply primarily to wastewater collection and treatment. Moreover, standards for on-site sanitation are prescriptive, specifying a set of allowed facilities in detail. Such prescriptive regulations generally constitute a barrier to innovative new solutions and approaches, and do not allow for variations to meet local conditions. Engineers and other professionals are personally liable if they fail to follow laws, regulations, and standards. Therefore, they often refuse to participate in pilot activities, and government departments are unwilling to use innovative new approaches.

Moreover, regulations and standards for the WASH sector in Mongolia are "aspirational" standards, focused on public and private infrastructure providers rather than households. Application of these high standards is generally costly and complex, and nearly impossible for households to achieve (UNICEF 2016). Thus, in practice, they are widely ignored at the household level.

As an example, the updated Mongolian National Standard, which took effect in 2016 (MNS 5924: 2015) specifies how several models of latrines should be constructed. It provides the exact dimensions for a pit latrine superstructure (Mongolia National Center for Standardization and Metrology 2015), which could safely be left to the users to decide. This does not allow for innovation or lower cost options that may meet the requirements of both users and the law.

Financial Arrangements

Mongolia is a unitary state in which legislative and administrative authority, including taxation, is centrally established, approved, and overseen. Capital costs for major water supply and sanitation infrastructure are raised by the central Government through taxes. These costs are part of the state budget allocated by Ministries, mainly the Ministry of Construction and Urban Development (MCUD) in the case of water and sanitation. In 2014, capital expenditures on water accounted for 0.62 percent of total capital expenditure, and wastewater for 1.06 percent. In 2015, capital expenditures on water and wastewater fell to 0.18 percent and 0.22 percent, respectively, of total capital expenditure (UNICEF/EAPRO 2016).

From 2002 to 2010, the total estimated expenditure for water supply and sanitation programs and infrastructure represented 2.1 percent of total Government expenditure, averaging about US$15 million per year for 2003 to 2011. Government expenditure was focused on large water and sewerage systems, whereas donor assistance, about US$12.2 million, focused on "basic" water supply and sanitation. According to UNICEF, "The consistently low levels of investment in water supply and waste water indicates that WASH is not a strategic priority for the Government of Mongolia…." (UNICEF/EAPRO 2016, p15).

In 2014, although the Government reported that financing plans for sanitation were in place, the estimated percentage of domestic budget commitments expended was estimated to be less than 50 percent. The absorption of donor commitments was between 50 percent to 75 percent (WHO 2014), although absorption of donor commitments reportedly improved in the next two years (WHO 2017).

According to UNICEF, it is extremely difficult to identify the generation and allocation of budgets for the water supply and sanitation sector in Mongolia. Providers incur most recurrent revenues and expenditures, while most capital expenditures are simply captured as "capital works for network infrastructure." Improved budgeting, accounting, and reporting standards will enable better analysis of revenues and expenditures (UNICEF/EAPRO 2016).

In principle, recurrent costs for operations and maintenance are to be paid by service providers' revenues from water and sewer tariffs. However, tariffs are low and poorly designed, and impede the quality and sustainability of the WASH sector in Mongolia. The WSRC (Water Services Regulatory Commission) was created to resolve this problem, but has been unable to secure tariff revisions (Bock 2014). In Ulaanbaatar, the Government has been "loaning" money to USUG to cover the shortfall. Since USUG seems unlikely to be able to repay the loans, they amount to a de facto subsidy for water supply and sewer services, favoring people that have a higher level of service.

There are no specific income or expenditure lines for water supply or sanitation, nor for overall expenditure for Ger area services. There are no specific budget lines for "sewerage" or "sanitation and disposal," although both functions are explicitly assigned to the Ulaanbaatar City Government (Reed 2015). Expenditure reports are not readily available to the public, and do not allow comparison of budgets to expenditures (WHO 2017).

As of 2014, the City of Ulaanbaatar had no consolidated budget report that defined operational budgets by department or services. The City Office managed at least three accounting systems, including one for state services locally managed by the City; the City's own capital and current revenue; and capital projects managed by the City but funded by line Ministries. In any case, households in the Ger areas finance their on-site sanitation facilities themselves, including both construction and maintenance. Figure A4-3 in Appendix 4 presents a diagram showing a simplified flow of funds for Municipal services in Ulaanbaatar.

Human Resources

Officials at USUG expressed concern about the aging work force in the water sector. Human resource strategies for sanitation have been developed, but implementation is low. An insufficient number of skilled graduates is available to the water sector, since most prefer to work in other sectors—especially not in sanitation. Furthermore, financial resources for staff and the availability of training on sanitation, drinking water, and hygiene are all moderately constrained (WHO 2014).

In addition, in Ulaanbaatar, technical staff in the sector told the authors of this report that they were unfamiliar with technologies other than conventional sewerage and pit latrines, so there is a clear need to update their skills and knowledge. Further discussions with USUG senior staff highlighted the non-availability of good quality construction contractors as a constraint on budget expenditure (Reed 2015).

Technical Issues

Existing Water Supply in Ger Areas

In the Ger areas, fewer than 3 percent of residents are connected to a piped water supply. Most households purchase water from kiosks located throughout much of the Ger area and carry it to their homes in containers. Residents purchase and take home an average of 8–11 liters per capita per day (Roger 2015). Households report using, on average, about 9.8 liters per capita per day. Many residents use additional water when they visit bathhouses (about 72 percent of adults surveyed) or bathe at the houses of friends or relatives (about 10 percent of respondents). Some also use or buy water from private wells. Many residents report that they reuse water, for example, using laundry water to clean the house.

This level of water consumption is less than is generally thought necessary to ensure good health. According to the World Health Organization (WHO), 20 liters per capita per day for consumption, handwashing, and food hygiene, but not necessarily for laundry and bathing, is associated with a high health risk. An estimated 50 liters per capita per day is sufficient for consumption, food hygiene, laundry, and bathing, and is associated with a low health risk (Howard and Bartram 2003). The Government intends supply at least 25 liters per capita per day to Ger area residents by 2030 (NJS Consultants 2013).

However, available water supplies may be inadequate to support sanitation technologies that rely on large volumes of water, such as conventional water-borne sewerage, for the entire city. The city anticipates additional water sources will be required in the very near future to meet expected demand (USUG 2014).

Existing Sanitation

Nearly 99 percent of Ger area residents have access to sanitation facilities. Nearly 95 percent of households report that they use a simple pit latrine such as that shown in Photo 3-1; 1.7 percent have access to a VIP latrine; 2.4 percent have a flush latrine, and 1.1 percent do not have access to a latrine but practice open defecation. It seems that most people build a simple pit latrine soon after they have settled on a plot. Around 70 percent of households have their own latrine, while 30 percent share someone else's, usually on the same khashaa (Roger 2015).

Photo 3-1: Pit Latrine with abandoned pit, Ulaanbaatar
Source: World Bank

These latrines are commonly self-financed and they are frequently poorly built and maintained. For some, the floor of the latrine consists of two planks spanning the pit—a clearly unsafe arrangement. Poorly maintained latrines can be unhygienic as well as unsafe, and provide a convenient breeding place for flies and other vectors that transmit disease.

Nearly 25 percent of households are reportedly in areas where it is difficult to dig a pit, either because of high groundwater or rock close to the surface (Roger 2015). This number may increase as the population grows and more people settle on marginal land.

Most of those with flush toilets live in apartment buildings, but a few households have installed running water, plumbing in the kitchen and for bathing, and flush toilets. They haul sufficient water to their household to supply these systems. Pipes convey wastewater to on-site tanks. These tanks are almost certainly not watertight, as users report that after several years they have not yet needed to empty them. These users are willing and able to invest in the systems, pay for the additional water, and put in the effort to haul it and to ensure that pipes and fixtures do not freeze.

Most households surveyed report that they have never emptied their latrine (Roger 2015). Some latrine pits have not yet filled; other households have abandoned latrines when the pits are full and built new ones, while a small number report emptying the latrines. However, as the population increases, and as more and more latrine pits are filled, the demand for pit emptying services is very likely to increase. Emptying by tanker is restricted to the summer months, while in the winter, when pit contents are solid, pits can be emptied by crews that break up the frozen waste and haul it away, reportedly to solid waste disposal areas. However, this may pose a risk to public health and the environment when the waste thaws.

About 48 percent of households report that they dispose of greywater in the toilet facility, while 38 percent report that they have a separate pit for greywater on the khashaa. Three percent throw it on the ground in their khashaa; 1 percent, in drainage canals; 1 percent, in indoor plumbing; and 10 percent, in various other places, including on the ground outside their khashaa (Roger 2015). Despite the lack of a planned drainage system in much of the Ger areas, greywater disposal is currently not considered a major environmental issue. Since water consumption in the household is quite low, the amount of greywater is also quite low. However, greywater disposal is likely to become an issue if water consumption increases.

Chapter 4 : Options to Deliver Improved Sanitation Services in Ger Areas

Enabling Environment

A working group could be created to accelerate improvement of the enabling environment and updates to policies, strategies, and plans and to the institutional, regulatory, and financial frameworks, and to facilitate information sharing. Development of policies, strategies, plans, regulations, and financial arrangements aimed specifically at improving sanitation are needed.

An improved environment would allow stakeholders to use new and innovative approaches and technologies for improving sanitation for the citizens of Mongolia. Reducing political influence on the sector would facilitate development of appropriate legal and financial arrangements as well as policies, strategies, and plans for sanitation.

Institutional Arrangements

The Government could designate, empower, and fund an agency at the national level to be responsible for sanitation for all citizens of Mongolia, including those without access to a sewer network. Although the Ministry of Construction and Urban Development (MCUD) has been responsible for sanitation, its focus is on sewerage. To fill the gap, the Ministry of Health (MoH) could be assigned a greater role.

The designated agency would continue efforts to develop the enabling environment. To ensure that the policies, regulations, and institutional and financial frameworks are appropriate, it would broaden sectoral coordination to include international donors, nongovernmental organizations (NGOs), the private sector, academia, utility companies, local authorities, civic organizations, consumers and other key stakeholders, as well as Government Ministries and agencies.

Regulatory Framework

While Mongolia has made strides in updating Laws, Standards and Technical Regulations, continuing efforts to update and harmonize them are needed. Authorities need to ensure that regulations adequately address the entire service chain, including fecal sludge management (FSM). The establishment of achievable "minimum standards for all," which allow for hygienic, desirable, affordable, and practical facilities for sanitation, would also be more equitable and better protect public health and the environment than the existing "aspirational" standards. Further, standards should define the results that a sanitation facility should achieve, which would encourage innovation. The existing standards that provide detailed guidelines for a preselected set of facilities do not allow for other options or for innovation. Once achievable standards are in place, authorities need to ensure their dissemination to all stakeholders, especially household-level users. They should also enforce the standards, but only if they are realistically achievable and affordable.

Financial Arrangements

Expenditures for non-sewered sanitation and hygiene should be increased, and both domestic and external budget commitments should be more fully absorbed. In addition, innovative approaches are needed, from microfinance to private sector participation, to fund sanitation improvements. The Government may want to consider subsidies for sanitation solutions other than sewerage. Options such as container-based sanitation may be cost-effective alternatives to sewerage and are worthy of consideration. Equity should be considered when deciding what should be subsidized, and how.

Technical Options

Overview

The cold conditions and inaccessibility of piped water supply and sewer networks, and consequent limited water supply, limit the options for improving sanitation in the Ger areas. On the positive side, however, is the high percentage of people who own their land, the relatively large plot size, and the desire of people to improve their sanitation. There is also increasing recognition on the part of the authorities that improvement is needed, and that sewerage is not the only—indeed, not always the most appropriate or cost-effective—option for improving sanitation in the Ger areas. Additional information on each of the recommended options is included in Appendix 5.

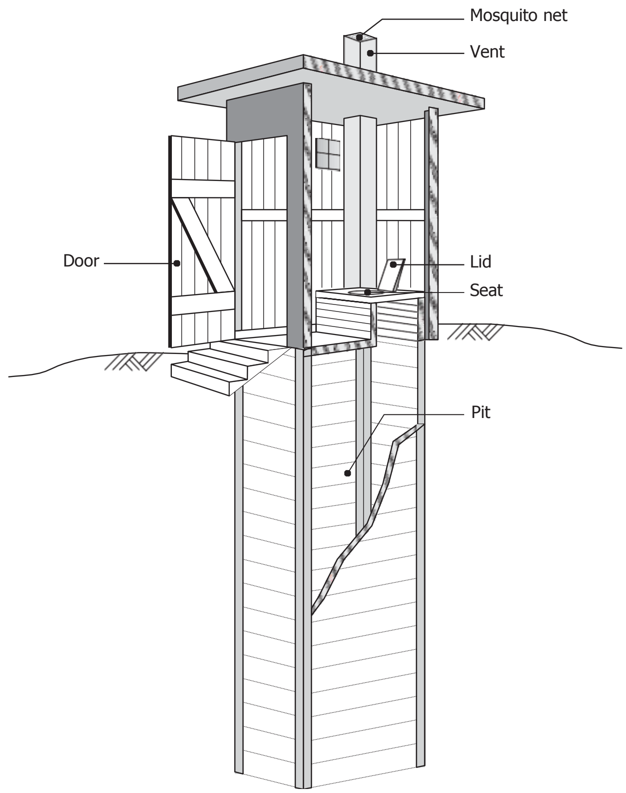

Figure 4-1: Wooden Improved Pit Latrine

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Recommended Options

Improved Simple Pit Latrines

Pit latrines are a simple, familiar low-cost option that can be improved incrementally. They are widely used, and work well in cold regions. However, rather than constructing a new, improved pit latrine, households can improve their existing latrines to make the user experience more agreeable. Pit latrines have the major advantage of supporting an incremental approach to improvement. Families can make small improvements to their latrine over time, gradually making the latrine more comfortable and pleasant, as their finances and wishes allow, without the need for a major capital investment. Although it can be difficult to overcome the idea that pit latrines are unpleasant, smelly, fly-ridden options, pit latrines can be improved to adequately protect human health and the environment while providing comfort and convenience.

Some possibilities for improving a pit latrine include the following:

- Add a squatting pan or pedestal seat made of easy-to-clean, appealing materials, to improve the user experience and make the sanitation facility easier to clean.
- Add a urine-diverting toilet or squatting pan, which, used properly, will reduce odors, but must be designed so that the urine does not freeze and block the toilet or pan.
- Add a tight-fitting lid to the defecation hole or toilet seat to reduce flies and odor.

- Add ceramic tiles or other aesthetically pleasing and easy to clean materials to the floors and walls of the superstructure.
- Provide more protection against wind, rain, and cold, with better roofs or with insulation, for example.
- Ensure that the latrine floor or slab is raised at least 15 centimeters above ground level, and slope the ground around the latrine down from the latrine to prevent rainwater from entering the pit and eroding and weakening the pit walls.
- Seal the latrine slab to the pit walls so there are no cracks between the top of the pit and the superstructure, thus reducing odors and flies.
- If the latrine floor is of wood, add a layer of concrete mortar, sloped slightly down toward the defecation hole, to provide a surface that it is easy to clean and without cracks.
- Add a ventilation pipe to help reduce odors, and add a screen to the upper end of the ventilation pipe, to reduce flies.
- Ensure that emptiers have easy access to the latrine pit.
- Add a second latrine pit that can be used sequentially with the first, so that the pits can be emptied and reused instead of being replaced with new pits and latrines (i.e., double pit latrine).
- If the toilet enclosure is heated, add toilet pan or pedestal seat with a water seal to reduce odors and flies, and a device, such as a basin with water, for washing hands (if the toilet enclosure is not heated, facilities for handwashing should be provided elsewhere).

Photo 4-1: Unimproved Pit Latrine, Ulaanbaatar.
Source: World Bank

Photo 4-2: Pit latrine with slab, Kyrgyz Republic
Source: World Bank

Depending on the users' preferences and the context, other improvements may be possible. Photos 4-1, 4-2 and 4-3 illustrate progressive improvements to pit latrines.

When improving a latrine, users often think of upgrading the above-ground part of the latrine, to enhance the user experience. However, upgrading the pit, generally by constructing walls to line its sides, can make the pit easier to empty, less likely to collapse, and extend its life. Lining existing pits is likely to be a difficult and unpleasant task that can pose a risk to workers' health. However, when building a new latrine, users can easily line the pit with a porous wall of timber, concrete blocks, masonry or other materials. Although such a lining can be costly, the latrine will last longer and will not need to be replaced as often. This can save money in the long term, as well as space for replacement latrines.

Photo 4-3: Pit latrine with seat and finished floor, Alaska
Source: © GV Jones & Associates, Inc. Used with the permission of GV Jones & Associates, Inc. Further permission required for reuse.

Container-Based Sanitation


Photo 4-4: Container-based household sanitation, Ulaanbaatar
Source: World Bank

If appropriate, supportive institutional, regulatory, and financial frameworks are in place, container-based systems could work in cold regions as elsewhere in the world. Container-based systems normally include a container below the toilet fixture to receive the excreta, which drop directly into the container during defecation. Urine can fall into the container as well, or can be diverted into a seepage pit or a separate container. The full containers are periodically replaced by clean, empty containers and taken to a treatment facility. This system can be used where it is difficult to dig a pit, or where there is no space to build a series or replacement latrines.

The international NGO Action Contre le Faim (ACF) finds that container-based sanitation with off-site composting in Ulaanbaatar is technically feasible. ACF implemented a research project in Ulaanbaatar using urine-diverting dry toilets (UDDTs) for 370 households from 2009 to 2015. In most models, the user interface was raised and the container that received the feces placed on a ground-level slab below it, as shown in Photo 4-4. One configuration featured a moveable, ground-level superstructure, with the receptacles for the feces placed below it. However, it was difficult to lift the full containers for collection. For all models, urine was diverted to a soak pit and allowed to seep into the ground. Sawdust was added after defecation. The full receptacles full were taken to a central composting facility and treated there.

ACF concludes that the fecal sludge from the entire year can be successfully composted during the warm season. During the cold season, the collected excreta is simply stored on-site in the container, and then collected in the spring. However, once the project ended, people proved unwilling to pay for the collection of the excreta. The project, established for research purposes, fully subsidized the capital and operating costs during the life of the project. A different approach may be more sustainable. Moreover, regulations prevented the sale of the composted material to offset costs. Even if the sale were allowed, however, there may not have been much demand for it, since few people plant gardens.

Low-Flush Latrines

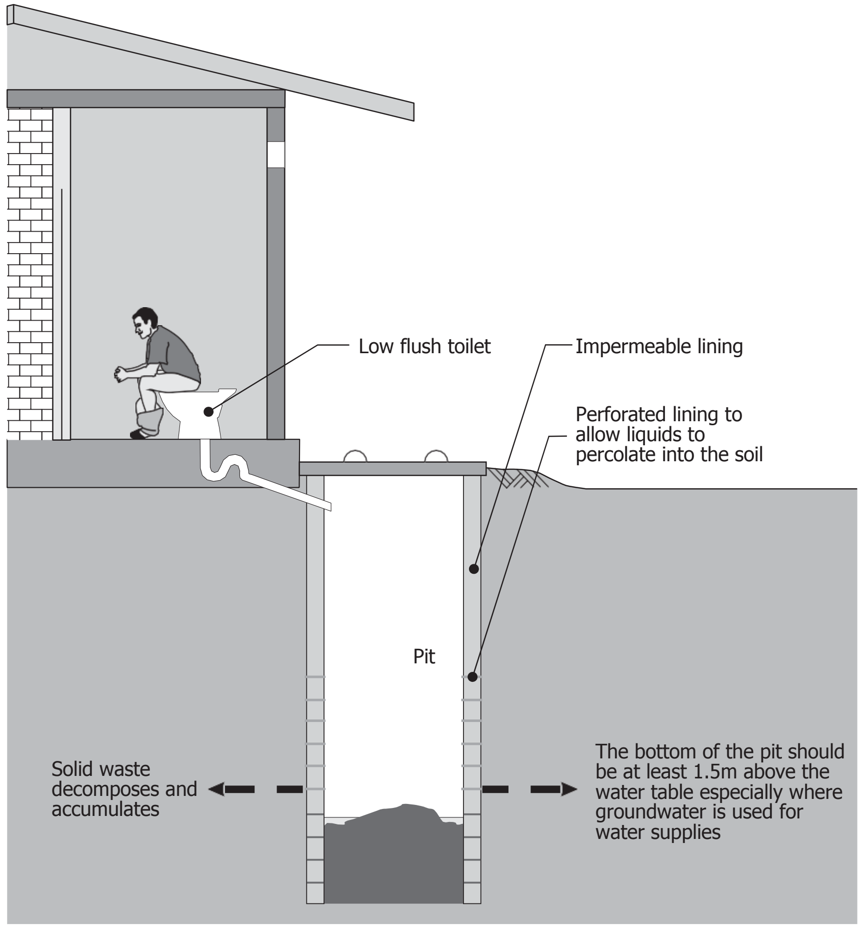

Figure 4-2: Low-flush toilet with soakpit

Source: Adapted from WEDC, Loughborough University

Pour-flush toilets, or low-flush cistern toilets, may be an option in cold regions for people with access to sufficient quantities of water (at least 25 liters per capita per day). Households must be able to pay to build the system and willing to make the effort to ensure that the system remains operational during the cold season. Although this type of system may seem unsuited for cold regions, especially for very cold regions, the authors of this report found a small number (less than 2 percent) of the residents of the peri-urban, informal areas of Ulaanbaatar, Mongolia, who have built small, independent water-borne "sewer" systems for their households. These are aspirational toilets for households who can afford them and have the expertise to construct, operate, and maintain them. The fact that households in one of the world's coldest cities went to the expense and effort involved in using these systems shows that they are feasible and desirable in cold climates. In places where the cold is less intense than in Mongolia, the expense and effort will not be as great, and this may be a more practical option. However, considerable care must be taken in their design, construction, and operation.

Other Options

Other options were considered but not found to be suited for use in low-income cold regions. These include the following: Aqua Privies; Flush toilets with septic systems; double pit and double vault latrines; and most non-conventional sewer systems. Additional details concerning these options can be found in Appendix 5.

Greywater Disposal

Greywater (sometimes called "sullage") must also be treated or safely disposed of. Otherwise grey water can attract rats and insects, and provide a breeding ground for pathogens and mosquitos. In cold climates, greywater disposal poses more problems than in more temperate climates. Greywater discharged into drains can freeze and block the drains; water thrown on the ground freezes and can be slippery; and, if put into soak pits, greywater cannot infiltrate into frozen soil.

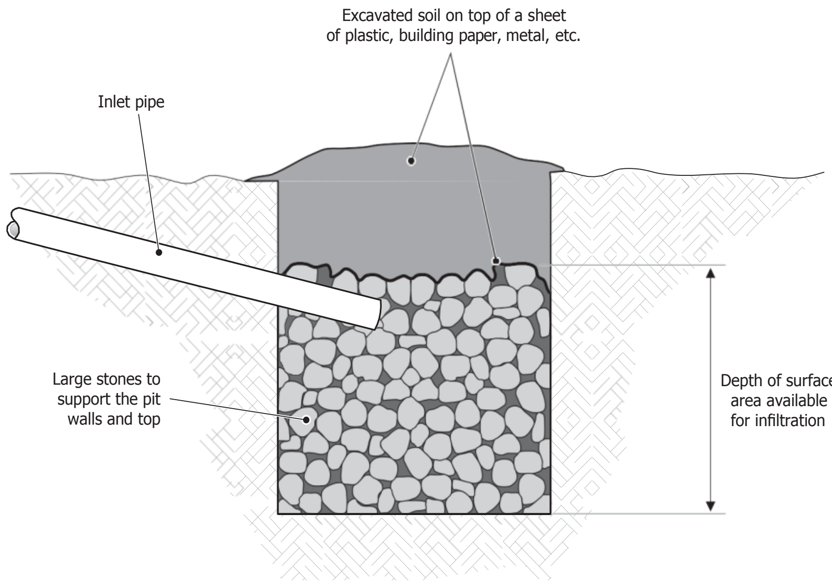

Figure 4-3: Typical Unlined Soak Pit
Source: Adapted from WEDC, Loughbrough University

Nonetheless, soak pits can be suitable for disposing of the greywater from a single home or small institution if the empty volume of the pit is sufficient to contain all the greywater generated during the cold season. When the soil thaws in summer, the liquids can infiltrate into the soil. Flows from groups of houses or large institutions, however, would require a pit too large to be economical.

Soakpits can be lined or filled with rocks or rubble to prevent collapse. If the pit is lined, the lining should be porous, because liquid normally infiltrates into the soil through the sides of the pit, as the bottom tends to plug quickly. The infiltration capacity of the soil and the surface area of the pit walls, along with the amount of time the soil is thawed and permeable, will determine the amount of liquid that the soakpit can absorb.

If it is not possible to dispose of greywater in soakaways below ground, it must be stored in a tank, vault, or some type of container. Otherwise the greywater must be removed immediately and conveyed for safe treatment and disposal.

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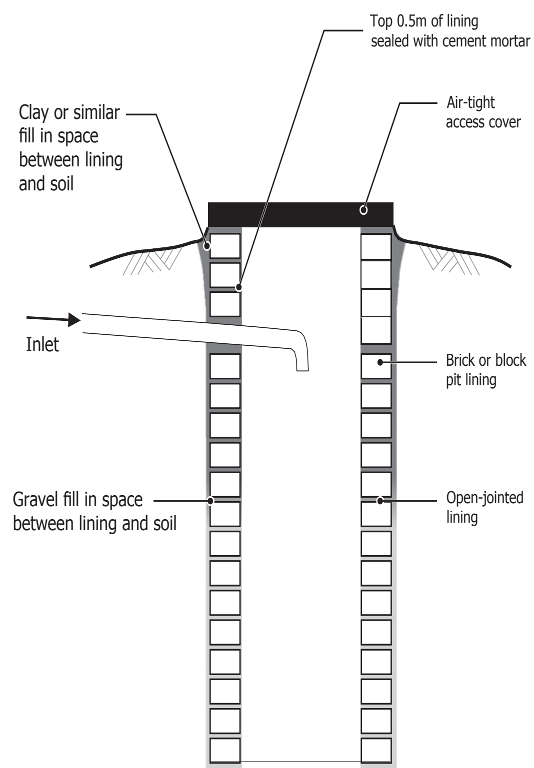

Figure 4-4: Typical Lined Soak Pit
Source: Adapted from WEDC, Loughbrough University

Chapter 5 : CONCLUSIONS

General

- Sanitation is inadequate in the Ger areas of Ulaanbaatar, where virtually all the residents, over 750,000 people, depend on basic pit latrines. These latrines often consist of a few planks over a partially collapsed pit, with a rudimentary wooden cabin for shelter and privacy. Few of these latrines can be considered improved or hygienic sanitation facilities.
- Ger area residents want to improve their sanitation facilities. About 85 percent report that they plan to improve their sanitation facilities within the next two years, using their own funds. Improving sanitation facilities rates third in household ranking of priorities of municipal services needing improvement.
- Without a dedicated effort to improve sanitation in the Ger areas, the problem of inadequate sanitation will continue. Government plans to redevelop the Ger areas will take considerable time and effort to implement. Even when they are implemented, by 2030, an estimated 400,000 people will not have access to municipal water supply and sewer systems. Additional options are, and will be, needed for those people without access to sewers.
- However, there still appears to be little Government support for (i) research, development, and piloting non-sewer solutions; (ii) social mobilization; (iii) information and communication for users of improved facilities; or (iv) improvements to the infrastructure and mechanisms for the collection and disposal of fecal sludge.
- The enabling environment for sanitation needs improvement. Efforts to reform the water sector are ongoing, but problems with the sector as a whole negatively affect the provision of sanitation services. For the delivery of appropriate low-cost sanitation services at scale to be successful and sustainable, households must be supported by appropriate institutional, regulatory, and financial arrangements (i.e., an enabling environment).
- Improving sanitation in the Ger areas should be part of a participatory effort that includes sanitation and hygiene promotion, and offers choices that take users' preferences and economic and sociocultural context into account, as well as technical feasibility. Extensive advocacy and information dissemination campaigns are needed for decision makers as well as the public.

Institutional

- Although steps have been taken to improve the institutional, financial, and regulatory arrangements, continued improvement is needed. For instance, institutional roles and responsibilities for sanitation at the national and municipal level need to be clarified, and coordination and information sharing need improvement. The Government of Mongolia (GoM), in 2014, committed to giving the Ministry of Health (MoH), which had been responsible for hygiene promotion, a clear leadership role for sanitation; however, this does not appear to have been made effective as of March, 2017.
- Moreover, District- and *Khoroo*-level institutions have very little involvement in sanitation planning and implementation. However, their closeness to the community and interest in local matters could make them useful partners in the delivery of improved sanitation. Also, the important but limited role

played by the private sector in sanitation services delivery and operations (e.g., emptying latrine pits) could be expanded.

- Political considerations negatively influence the water and sanitation sector. For example, water and sewer tariffs have been kept too low to cover costs. The Water Services Regulatory Commission (WSRC), was created to set more realistic tariffs, but its proposals have not been accepted by the other Government agencies that must approve them (Bock 2014).

Laws, Regulations, and Standards

- Although there has been progress in updating the institutional and legal framework, sanitation still appears to be governed by a wide range of laws, standards, regulations, policies, and plans that apply primarily to wastewater collection and treatment.
- Moreover, standards for on-site sanitation are prescriptive, describing a set of allowed facilities in considerable detail. Such prescriptive regulations are generally a barrier to innovative solutions and approaches, and do not allow for cost-effective variations to meet local conditions.
- Regulations and standards for the water supply, sanitation, and hygiene (WASH) sector in Mongolia are "aspirational" standards, focused on public and private infrastructure providers rather than on households (Rognerud and Fonseca 2016). Because achievement of these high standards is prohibitively costly and complex for many households, the standards are widely ignored in practice.
- Regulations do not adequately provide for fecal sludge management (FSM). However, the need for safe treatment and reuse of disposal of sludge emptied from latrines and other facilities is likely to increase.

Financial Arrangements

- The national Government controls most taxes and budgets, allocating budges through the Ministries. Budget amounts for various items can be unpredictable; this has a negative effect on planning.
- Government expenditures in the water sector (including sanitation) are low. From 2002 to 2010, spending in the sector was about 2.1 percent of Government expenditures (an average of about US$15 million annually) (UNICEF/EAPRO 2016). Yet expenditures have consistently absorbed less than 50 percent of Government budget commitments and less than 75 percent of donor commitments (WHO 2014).
- As of 2014, the City of Ulaanbaatar, which is responsible for the Ger areas, did not report operational budgets by department or services, and there are no specific income or expenditure lines for water supply or sanitation nor for overall expenditure in the Ger areas. Expenditure reports are not readily available to the public, and do not readily allow comparison of budgeted amounts to expenditures (WHO 2017).
- Tariffs for water supply and sanitation (WSS) are low and poorly designed, yet the Government expects utilities to cover recurrent costs from tariffs and has been "loaning" money to the utility to cover the shortfall. This amounts to a de facto subsidy for water supply and sewer services, favoring those with a higher level of service.
- In general, Ger area residents pay more for a lower level of water supply and sanitation services than do residents of the city center. As mentioned above, loans to the utility company (USUG) are a de

facto subsidy for sewers, and capital costs are financed by the Government. Nevertheless, the Government expects Ger area households to pay all costs for their own sanitation facilities and services, as well as paying more per liter for water than people with piped water supplies to their homes. Therefore, to improve sanitation in the Ger areas, innovative financing strategies are needed, possibly including some form of targeted subsidies.

Technical Options

- Technology alone will not provide a solution to improving sanitation and public health in the Ger areas. An integrated approach that considers water supply and hygiene is needed, as is an improved enabling environment with appropriate institutional, regulatory, and financial arrangements.
- Until a piped water supply at the household level is available to supply the requisite volumes of water, sewer systems are not feasible for Ger area residents living on a *khashaa*. Conversely, significant increases in water consumption require increased wastewater emptying, containment, conveyance, and treatment capacity to handle the increased volumes of wastewater.
- Physical conditions for water supply and sanitation services in the Ger areas are very difficult. Technological options are limited by the extreme cold, which freezes soil to about 4 meters, on average. Moreover, adapting some sanitation solutions to the cold climate would be prohibitively complex and expensive, even if they work well in more moderate climates.
- Ger area residents, as well as local authorities, seem to have little knowledge of how they could improve their sanitation facilities, and few options are available on the market. Further, the costs and complexity of building and operating many potential technological options, such as EcoSan toilets, are beyond the current capacity of many Ger area households.
- The simplest, most affordable, and sustainable method of improving Ger area sanitation is to improve the design and quality of existing pit latrines. They are universally accepted and highly appropriate for communities with low water consumption, and many latrines can be improved incrementally over time.
- Container-based sanitation may be a cost-effective alternative to conventional sewers in parts of the Ger areas; the recent Action Contre le Faim (ACF) project showed that it is technically feasible. However, a supportive institutional, regulatory, and financial environment is essential.
- For families willing and able to make the additional effort and expenditures, hauling additional water for low-flush toilets connected to holding tanks or soak pits may be an option. Such systems are, however, relatively costly and complex to construct and to operate.
- Current arrangements for fecal sludge management are inadequate, consisting of points through which sludge removed from on-site facilities can be discharged into sewer main lines. As the population grows, the quantity of sludge will increase. Discharging it into sewers can block them and disrupt treatment processes; other solutions are needed.
- Finding sufficient qualified staff is a problem. There are few if any educational opportunities for people who want to enter the sector. Moreover, most people do not want to work in sanitation.
- There are large gaps in knowledge about sanitation in cold regions. Consequently, there is an ongoing need for research and development into low-cost, appropriate sanitation systems for cold regions.

Chapter 6 : RECOMMENDATIONS

Sanitation, including on-site sanitation, should be considered as a system, not just a facility. The entire service chain needs to be considered, including management of the wastes from collection to containment to conveyance to treatment and potential reuse to final disposal. Improper reuse or disposal of excreta poses a risk to public health and the environment. The selected technologies should be the least complex and costly that will provide the desired level of services; this will generally be the most cost-effective and sustainable option. However, costs to users and to providers over the entire life of the facilities must be considered.

Immediate

- A designated institution is needed at the national level to be responsible for sanitation for all Mongolian citizens. This institution—possibly the Ministry of Health (MoH)—should be given the powers, resources, and capacities that it needs to clarify roles and responsibilities at all levels, establish policies and strategies, support research and development, and coordinate and monitor the sector. This institution, in collaboration with other actors, should continue to update and develop the institutional, financial, and regulatory arrangements, as follows:
    - Continue to improve regulations and standards for sanitation to ensure that they are achievable, flexible, allow for innovation and user choice, and incorporate best practice.
    - Consider innovative financial arrangements for household sanitation, potentially including microfinance and targeted subsidies.
    - Explore ways to fulfill future staffing needs as the current workforce is aging.
- At the level of the City of Ulaanbaatar, a single entity (e.g., the City Office of the Environment and Green Development) should be designated or created to be responsible for sanitation for the entire City, including both sewered and non-sewered sanitation, with guidance from the responsible agency at the national level. It should be provided with the resources and powers it needs, and its capacity strengthened so that it has the required skills and knowledge.
- The responsible City-level entity should develop a strategy and plans for fecal sludge management for Ulaanbaatar, in collaboration with stakeholders, including authorities responsible for water supply and water resources, consumers and private sector actors. It is important to set up a program for fecal sludge management before demand overwhelms the current limited capacity for fecal sludge treatment and disposal. According to Government officials, measures for safe disposal of sewage sludge from the wastewater treatment plant are required as well as for sludge from on-site sanitation, since current measures are inadequate. Innovative solutions could be explored, such co-composing or the reuse of the treated sludge as fuel.
- While creating the enabling environment, the City of Ulaanbaatar, in collaboration with the Districts and Khoroos, could develop, finance, and implement an outreach program to assist households in improving their sanitation. The program would identify concrete, affordable, appropriate, detailed technological options for improving existing pit latrines; develop approaches for delivering the improvements to users, such as sanitation marketing; and promote hygiene behaviors, such as handwashing, that break the cycle of disease transmission. Potential technologies for sanitation improvement include the following:

  - The simplest, most affordable, and sustainable way to improve Ger area sanitation is to improve the design and quality of simple pit latrines. Although construction of the most basic improved latrine costs more than most residents can afford, many existing pit latrines can be improved incrementally, spreading the costs over time.
  - Another potentially cost-effective option is container-based sanitation, consisting of a urine-diverting dry toilet (UDDT) with off-site sanitation. The Government should support efforts such as the Asian Development Bank (ADB) project, which explores this option.

Medium-Term Options

- As the sector evolves, continued review and updating of institutional frameworks, laws, regulations, standards and norms, and financial arrangements related to sanitation could be led by responsible agencies at all levels, if they are given the powers and resources needed to be effective. They would also ensure information sharing and coordination of sector plans and activities, both internally and with donors and other external actors.
- Staffing requirements for the whole water and sanitation sector should be analyzed, skills gaps identified, and a road map for improvement developed and implemented. A permanent institutions for training engineers, technicians, planners, and other staff should be created.
- The Government should support the private sector in designing and marketing sanitation facilities that suit the local context while protecting public health and the environment. Sharing responsibility for activities such as sanitation marketing, financial management (such as small loans), and technical support would reduce the burden on government departments and promote the local economy.
- A thorough review of sector financing should be undertaken to confirm the source and adequacy of existing capital and operational spending for the city as a whole and the Ger areas in particular. Financial planning should include District and Khoroo officials.
- With the world's coldest national capital, Mongolia is in a unique position to immediately take steps to develop a Center of Excellence for research into water supply and sanitation (WSS) in cold regions. There are many unanswered questions about sanitation in cold regions and growing interest in the subject. To answer them, Mongolian universities and Ministries could work with donors and partners (e.g., the University of Alaska and Swedish or Norwegian institutions). The center could help to educate a cadre of engineers and technicians to ensure a new cadre of technical staff to replace them, not just in Mongolia but in other low-income countries (LICs) as well. This Center of Excellence will take time to establish, but first steps could be taken now.

GLOSSARY

Aimag; Aymag (province)	Second level of government administration, just below the national level. *Aimags* do not include the Capital City of Ulaanbaatar, which is a second level administrative unit in itself.
Blackwater	Waste from a toilet facility that contains feces or urine.
Cold regions	Places in which the ground seasonally freezes and thaws to depths of 1 meter or more; or places with significant permafrost. The design of water and sanitation facilities in these regions must consider the thermal implications of cold temperatures.
Compost	Biological process in which microorganisms, such as bacteria and fungi, aerobically decompose organic matter to produce an earthlike material, often called humus. Also, the earthlike material produced by composting.
Composting toilet	Dry, waterless toilet into which carbon rich material (such as vegetable waste, straw, grass, sawdust, or ash) is added to the excreta. Special conditions are maintained so the material decomposes (composts) into inoffensive compost, also called humus. The toilet may or may not have a urine separation device. This toilet is one version of an ecological sanitation (EcoSan) toilet.
Dehydrating (drying) toilet	Like a composting toilet; however, the excreta are treated by dehydration (drying) rather than decomposition (composting). Urine is normally diverted, or separated, from the feces. Drying toilets are a type of EcoSan latrine, since the dried excreta can be used as a soil conditioner. However, additional treatment is often required, since dehydrating toilets are not likely to destroy all pathogens. The urine can be collected and used as a fertilizer, since it contains high levels of nutrients.
District	First level of administrative division of the Capital City of Ulaanbaatar.
Ecological sanitation (EcoSan)	Approach to waste treatment that aims to safely recycle the nutrients, water, or energy contained in excreta to minimize the need to use non-renewable resources for energy, nutrients, and water.
Excreta	Human feces, urine, or a mixture of both.
Glaciation	Process in which ice builds up gradually over time, for example, in water or sewer pipes, as well as on land.
Ger	Portable, round dwelling used by nomadic Mongolians; it is often the first dwelling set up on household plots when families move to the city.
Greywater	Domestic liquid waste without any excreta, for example, water from washing, bathing, laundry or other household uses.
Improved sanitation facility	One that protects and promotes human health by providing a clean environment and breaking the cycle of disease while promoting sustainability by being economically viable, socially acceptable and technically and institutionally appropriate (WHO/UNICEF 2012).
Khashaa	Individual household plot of land.
Kheseg	Small community of households; *Khoroos* are divided into *Khesegs*.

Khoroo	Subdistrict of the Capital City of Ulaanbaatar.
Latrine	For this report, applicable to Ulaanbaatar and similar peri-urban locations in cold regions, latrine refers to an unheated outside structure where people defecate. It usually has a waste pit, vault, or storage container under the structure or offset from it. It is equipped with a user interface (squatting slab or seat pedestal) for the user's convenience. The superstructure (sometimes called a cabin) is a shelter made of wood, plastic, metal, concrete, or other materials. The latrine can store waste permanently, or the waste can be removed periodically for later treatment by a variety of processes
Permafrost	Layer of soil or rock beneath the surface of the ground, in which the temperature is continuously below 0 degrees Celsius for two or more years.
Pit	For the purposes of this report: hole in the ground used for the disposal of human excreta or sullage. Walls are porous so excess liquid can soak away into the surrounding ground. Pit walls can be lined, unlined, or partially lined.
Quintile	Twenty percent of the total number of households interviewed, grouped according to income.
Sanitation	For the purposes of this report: management of human excreta.
Soak pit	Hole in the ground used for the disposal of liquids. Walls are porous so excess liquid can soak away into the surrounding ground. Also called soakaway, seepage pit, or cesspit.
Soum / Sum	Third Government administrative level, a subdivision of the *Aimag*.
Sullage	See *greywater*.
Sustainable sanitation	Sanitation system that is economically viable, socially acceptable, durable, and technically and institutionally appropriate. It should functional properly throughout its design life, protecting the environment and natural resources as well as public health.
User interface	Fixture into which the user defecates.
Vault	Watertight container (tank), above or below ground, used for the collection of human excreta or greywater. Vault is periodically emptied and the waste taken away for treatment and reuse or disposal.
Ventilated improved pit (VIP)	Form of pit latrine that includes a ventilation pipe to reduce odors in the toilet cubicle and requires the superstructure to be kept dark to minimize problems with flies.
Wastewater	Waste that includes both toilet wastes (blackwater) and domestic liquid waste (greywater).

Appendix 1: Practical Experience in Cold Regions

Experience in Alaska and Canada

There are similarities between the historic development of sanitation improvements in many remote Canadian and Alaskan communities and potential approaches to improving sanitation in the Ger areas of Ulaanbaatar. In Alaska and Canada, Arctic communities needed improved sanitation as their traditional nomadic lifestyle was being replaced by permanent settlements in regions with harsh environmental conditions. The homes in Canada and Alaska (like the Ger areas) are single family dwellings with limited road access and infrastructure. The people also collect their drinking water from communal water points and carry it home in containers.

Photo A1-1: Underground Communal Waste Tank, Alaska

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Bucket Latrines

Initially, in Alaska and Canada, excreta were deposited in bucket latrines inside the houses. The buckets, when full, were emptied into pit latrines constructed near each house. The pits soon filled and some families excavated new ones, while other families just abandoned the pits and reverted to randomly dumping the excreta onto the ground.

Photo A1-2: Emptying Wastes into Intermediate Tank, Alaska

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To improve the situation, large underground wood frame structures, or bunkers, were built away from the house. Individual homeowners could dump the contents of their bucket latrines into them. They were filled within a few years, and then waste was deposited on top of them, posing a serious risk to public health and the environment, as shown in Photo A1-1.

Another method was to provide mobile collection tanks made of high-density polyethylene (HDPE), a type of plastic, close to homes, in which excreta from bucket latrines could be discharged, as shown in Photo A1-2. The waste was then collected from the tanks and conveyed for treatment. In winter, the waste would freeze into a large, solid, “ice waste brick”, which could be removed for conveyance. Once removed, the frozen waste could be hauled to a remote site for disposal. Problems occurred when the tanks were overfilled and excreta splashed on the boardwalks during summer months. During the winter months, the HDPE plastic tanks were occasionally broken when people pounded on them to remove the frozen waste.

Truck Haul Systems

A newer haul system uses 750-liter to 1,000-liter closed holding tanks attached to the house (Photo A1-3). Indoor fixtures such as toilets, sinks, or showers use small amounts of water that empties into the holding tanks. Small vehicles with trailer-mounted tanks pump out the waste and haul it to ponds that provide biological treatment (Photo A1-4). Improved roads allow year-round truck access to the homes. This system is currently being used in approximately 20 communities in Alaska (approximately 1,000 homes). Because the houses are heated, the waste doesn't freeze.

Photo A1-3: Closed Vehicle Haul System, Canada
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A modification uses a vacuum system and small insulated above-ground storage tanks, which can use smaller haul vehicles. The advantages of such closed tank pump-out systems include minimal spillage and reduced risk of disease transmission within the community; lower capital cost than conventional sewerage; and quick, easy setup. Installation costs were covered by Government grants and operational costs were also subsidized. Operating this type of system may be too expensive for users if there is no subsidy.

Photo A1-4: Emptying a Small Closed Haul Vehicle, Alaska
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Sewerage

Many communities in Alaska have replaced the haul systems with piped water and sewer networks, which provide excellent service to the consumer. Nonetheless, the piped systems generally require subsidies to construct and to operate. Sewer systems that can operate in very cold conditions are generally more expensive and complex to construct and operate than in more moderate climates.

Composting

Successful use of ecological sanitation at scale requires good logistics and management and appropriate regulatory, institutional, and financial arrangements, often including subsidies and technical support.

Successful examples of large-scale composting systems in cold climates include Fairbanks, Alaska, and Edmonton, Canada, which co-compost sewage sludge from wastewater treatment facilities (Alaska Rural Water and Sanitation Working Group 2015).

Other facilities to compost human excreta in cold regions, including composting toilets, and facilities in rural communities, have had limited success. The required land, storage buildings, fuel, electrical power, equipment, carbon and bulking materials, and storage buildings, can be costly and difficult to procure, especially if there are no economies of scale. Effective operations require constant monitoring and implementation of corrective measures by trained employees, supported by management. Poorly managed biological processes can be disrupted due to inadequate or excess moisture, lack of air, or poor carbon to nitrogen ratios. Freezing can also disrupt the processes, and is more likely with smaller volumes of excreta in small scale facilities. After disruption, processes can be difficult to restart, and the sludge can smell bad. If the quality of the product (compost) is poor and does not meet regulatory standards, or if there is little demand for the compost, then costs will not be offset by the sale of the product (GV Jones & Associates 2015, appendix 3).

Alaska Water and Sewer Challenge

In 2013, the State of Alaska Department of Environmental Conservation launched the Water and Sewer Challenge to address the water and sanitation needs of rural Alaskan households. Its goal is to significantly reduce the capital and operating costs of in-home running water and sanitation in rural Alaska homes. Criteria include constructability, health benefits, affordability, and other operational considerations. In the past, agencies have funded conventional, community-wide piped systems or truck haul systems. However, funding has declined severely while costs have risen sharply. Capital and operating costs of traditional approaches have become unsustainable (Alaska DEC 2015b).

The Water and Sewer Challenge demonstrates that even a relatively wealthy state is considering replacing expensive and complex truck haul or piped sewerage systems with decentralized water and wastewater treatment, including recycling and water use minimization for individual homes and housing clusters. However, the solutions selected for development in Alaska are likely to require considerable institutional and logistical support, reliable electrical power, specialized spare parts, and expert maintenance (Alaska DEC 2015a). There will still be a need for solutions suited to low-income countries (LICs).

Erdos Project, China

The Erdos Project was a very large-scale, multi-year project constructed in Erdos City, Inner Mongolia (China). The project was intended to showcase the use of ecological sanitation (EcoSan) toilets in an urban setting. It focused on separating the waste streams (feces, urine, greywater, and solid waste) for recycling and reuse (McConville and Rosemarin 2012).

According to McConville and Rosemarin (2012), the project served 3,000 residents in 832 apartments in 43 four or five story buildings. The total investment for the project was 30 billion MNT (12 million EUR) of which 2.5 billion MNT (1 million EUR) was for dry toilets, greywater treatment, and composting systems. Households paid 70 percent of the investment, with 25 percent from the regional government and 5 percent from international development agencies. The project was completed in 2009, and the residents started lobbying to change to flush toilets immediately. Ultimately, consumer complaints about the EcoSan system resulted in it being replaced by a conventional sanitation system. Some of lessons learned:

- The user interface between the family and the collection system is key.

- This type of technology puts sanitation systems closer to the users, so it is important to involve people in planning and design. Continuous, truthful communication with the users is needed. The residents were relatively well off and expected a “westernized” standard of living, i.e., a flush toilet.
- Developers must accept that it takes time to change people’s preferences and practices.
- Supervision of construction is important.
- A proper study should be carried out.
- Technologies and approaches must be tested at a small scale before spending millions on large-scale projects; a mature technology is needed.
- Proximity to agriculture is important: 30 kilometers might have been too far to transport humus.
- Continuing government support clearly declined over time. Once this happened, there was not much incentive to use this new sanitation technology.

Also, an economic analysis of the EcoSan sanitation system showed that it was more expensive to build and maintain than a conventional sanitary sewer system. However, the system would have provided several benefits from recycling, use of solid waste products, and excreta reuse, along with external benefits such as improved health and an improved environment (McConville and Rosemarin 2012).

Sanitation in Greenland

Greenland has a climate similar to Ulaanbaatar’s. It has a very scattered population with isolated communities, mainly along the coast. In towns, residents have either a conventional flush toilet or bucket toilets (depending largely on the community’s water supply). In scattered communities, use of bucket toilets is almost universal. Those with a flush toilet are either connected to a sewerage system or have a holding tank for excreta, while greywater is discharged to the land. Virtually all sewage (residential and industrial) is discharged untreated to the sea. Holding tanks are pumped out by municipalities or private companies, with the waste being discharged to sewers. Bucket toilets are sometimes emptied by municipalities and private companies, but also by individuals. Some of the waste is disposed of in sewers but some are thrown onto open land.

Bucket toilets have been considered a problem for many years because of pollution and health risks, and a few pilot projects are currently underway to test alternatives. Two designs of improved toilets, connected to a urine diversion pedestal, are undergoing tests in which the excreta are stored in a porous container below the pedestal. The urine soaks into the ground and the containers full of feces are removed and emptied into the sea. The new toilets were considered an improvement over the previous bucket latrines, but were unsuccessful because of problems with odor and sludge. A low flush (1-liter) toilet connected to an underground holding tank was also tested, but poor installation caused operational difficulties (Gunnarsdottir 2012).

Appendix 2: Recent Sanitation Projects in Mongolia

Title	Description	Lessons learned
Managing Soil Pollution in Ger Areas through Improved On-site Sanitation Project ADB	Will support livelihoods through improved household sanitation and strengthen on-site (decentralized) fecal waste management, including the collection, transport, and composting, in collaboration with communities, the private sector, and civil society organizations (CSOs). The project will serve as a model to scale up on-site sanitation in Mongolia and complement infrastructure development in core urban areas.	Ongoing project.
Urban Services & Ger Areas Development Investment Program - Tranche 2 - ADB	Will improve economic and public services in targeted areas; strengthen institutional capacity for program management and urban development.	Ongoing project
Dambadarjaa Water and Sewerage Project (part of USIP2) World Bank 2010–11	Planned to serve 96 houses with piped services and a wastewater treatment plant.	• Electricity cost for heating pipes was unaffordable for many residents. • Few households connected to the sewer in the first 2 years. Water use and wastewater flow rates were lower than expected. • The treatment plant had to be modified, partly due to low wastewater flows. • The treatment process used is not appropriate for the extreme cold • Neglecting socioeconomic factors and willingness to pay caused problems.
In-house composting Norwegian Lutheran Mission 2002–6	31 EcoSan toilets installed in various cities. A urine diversion squatting pan separated urine and feces into different containers below the pan. Feces were stored by householders for 6 months then used as garden fertilizer.	• There was little interest in using the composted humus—still strong nomadic culture. • Many users preferred a pedestal toilet. • Toilets produced offensive odors. • Users had no wish to handle excreta. • Users received inadequate training.
VIP latrines Mongolian Red Cross	VIP latrines for schools and households	No evaluation
In-house bucket – on-site composting. Humanure 2006	Humanure bucket toilets for indoor use plus outdoor composting bins were installed in 21 households.	Only funded for 4 weeks so no evaluation.

Title	Description	Lessons learned
School septic tank and leach field GIZ 2012	A 5m^3, three compartment septic tank was built for a school with 352 pupils & teachers. Tank was 4m below ground with 50mm insulation to pipes. Leach field was 5m below ground.	No evaluation as of May 2014.
Greywater treatment ACF	Two projects for communal greywater disposal, not including any blackwater, were constructed.	Both systems rapidly failed because they couldn't cope with local greywater without high levels of maintenance and they suffered from bad odors.
On-site vault toilet; off-site communal composting ACF 2009–14	EcoSan toilets with pedestal and urine diversion to a soak pit were installed in 370 households. Feces were deposited directly into a container below the pedestal toilet. Feces were collected every three months and transported to indoor composting facility. The was closed and handed over to a local NGO for operation and management, but users did not want to pay for collection and the initiative ended.	• Urine froze in diversion pipe in early models. • Mongolian law doesn't allow the use of composted excreta on food crops. • Compost could not be sold. Operations were to be funded from fecal sludge collection fees. • Users were ultimately unwilling to pay for collection of fecal sludge after subsidized services ended
On-site "iPits" toilet; off-site sludge treatment at municipal facility or biogas reactor Bauhaus University 2014	Refinement of the ACF EcoSan project. Twelve units were constructed in Darkhan. Consisted of an elevated user interface over two concrete vaults. Urine and feces were collected separately and transported for treatment.	• Handling of fecal matter is difficult. • Biogas reactor and contents freeze in winter. • Discontinuous operation of treatment processes needs further research.
Urine-Diverting Dry Toilet (UDDT) GTZ 2006–12	Approximately 40 prefabricated UDDT toilets were constructed in a variety of settings.	• Only two units were used long-term. • Units were too costly, so unaffordable. • Small collection chamber required frequent emptying. • Toilets could not be emptied so could not be used in winter when excreta froze. • Users objected to handling excreta. • There was no demand for the final product (compost). • Toilets produced offensive odors. • Toilets didn't dispose of greywater. • Users preferred toilets with seats.
Bathhouse ACF/World Bank 2014	Multi-use facility including shops, laundry, and toilets. Mains water and sewage holding tank.	No evaluation

Title	Description	Lessons learned
Public toilet JSDF/World Bank	Operated by the City, the public toilet facility also contains showers and facilities for hand washing. Water is from the Municipal water system; wastewater flows to a holding tank which is emptied periodically. Users are charged for use.	No evaluation
200-house connection project, Bayanzurkh GoM 2012–14	Water supply, sewerage and wastewater treatment project to test the viability of connecting existing homes to shallow sewer lines. Households are responsible for their own in-house plumbing.	No evaluation

Table A2-1: Recent Sanitation Demonstration Projects in Mongolia

Note:

ACF = Action Contre le Faim;
EcoSan = ecological sanitation;
GoM = Government of Mongolia;
GTZ = Gesellschaft für Technische Zusammenarbeit (German Organisation for Technical Cooperation);
JSDF = Japan Social Development Fund;
NGO = nongovernmental organization;
O&M = operation and maintenance;
UDDT = urine-diverting dry toilet;
VIP = ventilated improved pit (latrine).

APPENDIX 3: SUMMARY OF SOCIOECONOMIC SURVEY RESULTS

Tables A3-1 to A3-7 summarize the data collected from the socioeconomic survey conducted in Ulaanbaatar in 2014. Full details of the survey are in Roger (2015).

Housing and Income					
Length of stay in dwelling (%)	0–4 yrs 37.2	5–9 yrs 25.5	10+ yrs 37.3		
Type of dwelling (% households)	Ger 50.1	Detached house 47.3	Apartment 0.9	Other 0.9	
Household features (%)	Car owner 47	Garden 10.4	Business 6.3		
Terrain (%)	Flood-prone 4.9	Flat 52.1	Gentle slope 30.3	Steep slope 13.7	
Soil type (%)	Natural 51	Bare 24.1	Wet 4.5	Rocky 20.2	
Business activity (% of households with business activities on *khashaa*)	Farming 7.5	Small industry 22.4	Commerce 44.8	Services 25.4	
Number of rooms/segments in ...	Detached house 2.06	Ger 4.94			
Area of ... (m^2)	*Khashaa* 642	Dwelling 57.1			
Khashaas with detached house (%)	71.4				
Khashaas with house and ger	44.7				
Khashaa ownership status (%)	Owned 70.5	Rented 5.5	Free occupied 20.4	Other 3.6	
Dwelling ownership status (%)	Owned 92.3	Rented 2.1	Free occupied 4.7	Other 0.9	
Households with *khashaa* legal tenure (%)	Cert. immovable property 62.7	Governor's order to own land 9.8	Land occ. cert. 7.7	No document 13.9	Don't know 5.9

Housing and Income					
Persons per dwelling	Adults 2.77	Children (3–15 yrs.) 0.91	Babies (<3 yrs.) 0.34	Total 4.02	
Consumption units per dwelling[a]	Adults 1,88	Children (3–15 yrs.) 0.46	Babies (<3 yrs.) 0.1	Total 2.44	
Persons per *khashaa* (plot)	6.63				
Number of household members with paid employment	Cold season 1.52	Warm season 1.66			
Households with no members with regular employment (%)	Cold season 4.4	Warm season 0.7			
Average monthly income (MNT)	Household 1,022,089	Per consumption unit 435,378	Ger residents 909,611	Detached house 1,139,453	
Monthly income per consumption unit (MNT)	Quintile 1 46,053–254,464	Quintile 2 254,464–344,203	Quintile 3 344,203–445,952	Quintile 4 445,952–583,333	Quintile 5 583,333–2,191,305
Average monthly income per household (MNT)	Quintile 1 516,866	Quintile 2 733,226	Quintile 3 970,367	Quintile 4 1,175,759	Quintile 5 1,711,427
Average monthly income per consumption unit per income group (MNT)	Quintile 1 192,587	Quintile 2 295,763	Quintile 3 390,266	Quintile 4 500,953	Quintile 5 796,076
Population living in each income bracket (%)	Quintile 1 20.1	Quintile 2 19.7	Quintile 3 20.1	Quintile 4 20.1	Quintile 5 20

Table A3-1: Household Housing and Income, Ulaanbaatar, Mongolia

Note:

Warm and cold refer to seasons.

Q = quintile.

a. A consumption unit measures the expenditure of different family members. It is used to compare standards of living between households of different sizes and compositions:

1.0 person equivalents for the household head;

0.5 for other adults and children over three years;

0.3 for children under three years.

Water Supply in the Ger Areas of Ulaanbaatar						
Dwelling type with running water (%)	Apartment 100	Detached house 4.2	Detached outside 2.0	Ger 0		
Avg. number of taps per house with a tap	Apartment 1.9	Detached house 1.2	Detached outside 1.7			
Water source (% of all households)	House connection 0.9	Water kiosk 96.2	Other paid 1.8	Other free 1		
Water kiosks	Avg. distance from home 337 m	Collection time 18 min.	Child collects 38%	Husband collects 37%	Wife collects 10%	Combination 5%
Mode of water transport (%)	Cart 71	Hand 16	Car 12			
Per capita water consumption (lcd)	No connection at home (cold season) 8.8	No connection at home (warm season) 10.8				
Monthly cost of water supply (MNT)	Water/sewer connection[a] 11,769	No connection (cold season)[b] 1,102	No connection (warm season) 1,346			
Water supply cost as % of household income	Water/sewer connection[c] 1.4	No connection (cold season)[d] 0.15	No connection (warm season) 0.17			
Bathhouse use	Households using bathhouses (%) 73	Monthly cost (MNT) (warm / cold season) 30,332/34,531	% average income (warm/cold season) 3.72/3.85)	Visits/week/ household (warm/cold season) 3.24/3.66		

Table A3-2: Water Supply in Ger Areas, Ulaanbaatar, Mongolia

Note:

Warm and cold refer to seasons.

a. Data from OSNAAG.

b. Not including the use of bathhouses.

c. Data from OSNAAG.

d. Not including use of bathhouses.

Municipal Services in the Ger areas					
Electricity	Connected (%) 99.3	Monthly cost (MNT) (cold/warm season) 28,066/24,811	% of income (cold/warm season) 3.28/2.44		
Heating	Centralized system (%) 4.2	Single household (%) 95.8	Monthly cost (MNT) (cold/warm) 114,743/30,453	% of income (cold/warm) 14.5/3.7	
Solid waste disposal	Bury in *khashaa* (%) 10.9	Bin collection (%) 82.2	Dump (%) 4.4	Other (%) 2.5	
Ranking for utility improvement	1st Electricity	2nd Water	3rd Sanitation	4th Health care	5th Education

Table A3-3: Municipal Services in Ger Areas, Ulaanbaatar, Mongolia

Note:

Warm and cold refer to seasons.

Current sanitation							
Bathroom (%)[a]	Yes, with running water 3.3	Yes, no running water 2	No 94.7				
Toilet type (%)	Simple pit 94.8	VIP 1.7	Flush toilet 2.4	None 1.1			
Toilet location (%)	Inside dwelling 3.7	In *khashaa* 95.9	Outside *khashaa* 1.4				
Households sharing toilet	(%) 52.4	Avg. number users per shared toilet 8.88	Households sharing with problems (%) 30.9				
Causes of complaints from sharing (%)	Pit filling 53	Waiting at peak times 22	Dirty facility 11	Garbage in pit 9			
Current self-built pit latrine	Self-built (%) 59.1	Avg. year built 2007	Single pit cost (MNT) 108,932	VIP cost (MNT) 227,805	Flush toilet cost (MNT) 1,787,001		
Sullage disposal (%)	In-house plumbing 1.1	Into latrine 47.5	Into pit 6	Hole dug in *khashaa*[b] 38	On ground 2.9	Drainage ditch 3.3	Other 2.8
Toilet components (%)	Pedestal 4.5	Squat 95.5	Wood floor 94.2	Concrete 3.0	Ceramic 1.1	Other 1.7	
Pit	Avg. depth 2.89 m	Lined (%) 46.3					
Lining type (% of lined)	Precast concrete 1	Cement blocks 5	Burnt clay bricks 0.2	Wood 81.9	Local stone 0.4	Iron 9.2	Other 2.2
Pit emptying	Pits emptied (%) 4.5	Frequency of emptying 16.2 months	Truck emptying (%) 43.4	Manual emptying, paid (%) 47.5	Manual emptying, unpaid 5.4	Dig another pit 3.7	Avg. emptying cost (MNT) 62,603[c]
Using chemical additives (%)	Cold season 8.7	Warm season 71.2					
Reason for using additives (%) (cold/warm)	Reduce odor 19.5/32	Disinfection 39/51.5	Reduce volume 36.4/11.1	Other 5.1/5.4			
Adding other material (%) (cold/warm)	Garbage 5.5/5.6	Sanitary napkins 13.2/13.0	Used toilet paper 81.1/79.6	Other 5.7/7.4			

Current sanitation							
Pits with problems and causes (%)	Problems 34.7	Overflow 10.4	Odor in summer 31.7	Flies, insects 25.3	Collapse 22.4	Rapid fill 3.5	Other 5.7
General level of dissatisfaction with toilet (%)	61						
Common reasons for dissatisfaction (%)	Smell, flies in summer 70	Difficult of use for disabled 70	Unhealthiness 68	Having to squat 58	Unclean 56	Comfortable to use 55	
Priority improvements (in decreasing priority)	Sitting rather than squatting	Comfortable environment	Clean toilet	Healthiness	Longer pit life	Ease of use for disabled person	No flies or smell in summer
Concerned about environment (%)	96						
Health problems in children in last two wks. (%)	Diarrhea 2.4	Strong fever 3.1					
Preference for alternative latrine (%)	No preference 1.4	VIP 7.7	EcoSan 3.4	Flush toilet 88.3			

Table A3-4: Current Sanitation in the Ger Areas of Ulaanbaatar, Mongolia

Note: Warm and cold refer to seasons.
EcoSan = ecological sanitation;
VIP = ventilated improved pit.

a. A bathroom is defined as a shower, bathtub, or shower cabin.

b. The difference between a “pit” and a “hole dug in the *khashaa*” in the socioeconomic survey is not defined; presumably the pit refers to a hole dug for general disposal whereas the “hole dug in the *khashaa*” refers to one dug specifically for sullage disposal.

c. 46,826 MNT for truck emptying and 77,000 MNT for manual emptying.

Sanitation Preferences					
Willing to improve current latrine (%)	84.3				
Preferred location of toilet (%)	Inside dwelling 25.7	Within *khashaa* 73	Outside *khashaa* 1.3		
Households planning to improve the toilet in next two yrs.	Yes 85.2				
Top 5 desired general features in new toilet	1st Long lasting	2nd Healthy	3rd No smell in summer	4th Affordable	5th Safe for all users
Top 5 desired features in superstructure	1st Good ventilation	2nd Flush toilet	3rd Pedestal	4th Electric light	5th Waterproof roof
Top 5 pit features (for nonflush toilets)	1st Pit that can be emptied	2nd Flood protection	3rd Min. 4 m deep	4th Easy to empty	5th Brick/cement lining

Table A3-5: Sanitation Preferences in Mongolia

Willingness to invest in sanitation					
Amount willing to pay monthly for sewerage (MNT) / % income	Avg. highest 22,300/2.42	Avg. lowest 9,706/1.03	Average 14,809/1.6		
Willingness to contribute to improved nonflush latrine, average[a]	Willing (%) 81.9	Willing to pay (MNT) 200,379	Pay with loan (%) 45.9	Pay from savings (MNT) 87,508	Installment (MNT) 37,566
Willing to pay for a VIP, average	Willing (%) 67.1	Willing to pay (MNT) 182,320	Pay with loan (%) 49.1	Pay from savings (MNT) 81,168	Installment/month (MNT) 38,638
Average amount willing to pay for pit emptying (MNT)	Too expensive 42,737	Too cheap 19,579	Normal 28,569		
Average monthly savings (cold/warm season)	Zero savings (%) 76.1/52.1	Amount saved (MNT)[b] 221,102/274,098	% of income 15.1/20.6		
Sources of loans other than a bank (%).	Able to borrow 44.9	Family[c] 56.2	Friend[d] 21.6	Employer[e] 22.2	
Confirmation of willingness to pay for new toilet (%)	Willing to pay 97	Willing to reduce household expenditure 86	Willing to reduce food, drink[f] 21.3	Willing to reduce clothing, footwear[g] 41.2	Willing to reduce transport/comms[h] 16.7

Table A3-6: Willingness to Invest in Sanitation in Mongolia

Note: Cold and warm refer to seasons.
VIP = ventilated improved pit.
a. Only households who expressed willingness for a non-flush toilet were asked this question.
b. Average of households who declared monthly savings.
c. Share of households declaring a loan source.
d. Share of households declaring a loan source.
e. Share of households declaring a loan source.
f. Share of households willing to reduce expenditure.
g. Share of households willing to reduce expenditure.
h. Share of households willing to reduce expenditure.

Use of Mass Media					
Listening to radio (%)	Total pop. 15.8	Daily 56.2	Several times a week 38.8	Less frequently 5	
Popular radio channel (%)	Radio 104.5 19.5	Mongolia national 17.6	Radio 95.7 6.3	Radio 107.5 5.7	
Watch television (%)	Total pop. 99	Daily 94.1	Several times a week 5.7	Less frequently 0.3	
Popular TV channels (%)	MNB 35.1	Educational TV 13.7	TV9 13.1	TV5 7.5	Mongol HD 6.9
Reading newspapers (%)	Total pop. 23.9	Daily 31.7	Several times a week 60.7	Less frequently 7.6	
Popular newspapers (%)	Daily news 41.1	*Unuudur* 18.5	*Zar medee* 7.9	*Zuunii medee* 5.9	*Seruuleg* 3.7

Table A3-7: Use of Mass Media in Mongolia

Percent

Appendix 4: Summary of Institutional Framework

Unless otherwise stated, the contents of this section have been taken from the Institutional, regulatory, and financial report prepared as part of this program (Reed 2015) in May 2015.

Institutional Structure Governing Ulaanbaatar

Mongolia is a parliamentary republic, which consists of a central government and four levels of local government. Mongolia is still essentially a centralized system and, while some responsibility has been devolved (an ongoing process), most resources and power are under the control of the central Government (Livingstone, Erdenechimeg, and Oyunsuvd 2009). Tables A4-1 to A4-3 describe the roles and responsiblitities of some key actors in the sector, and Figure A4-1 shows the relationships between them.

Role	Responsible institution
General sanitation policy	Ministry of Environment and Green Energy
Monitor environmental pollution	General Agency for Specialized Inspection
Policy framework for urban development (including sanitation) including operation and maintenance	Ministry of Construction and Urban Development
Plan and implement of large-scale water and sanitation projects	Ministry of Construction and Urban Development
Implement policies for sewerage and low-cost sanitation	Ministry of Construction and Urban Development
Prepare legal and regulatory framework	Ministry of Construction and Urban Development
National funding planning	Ministry of Construction and Urban Development
Manage design and research	Ministry of Construction and Urban Development
Standards for educational infrastructure	Ministry of Education
Design, construction, operation and maintenance of Government-owned educational institutes	Ministry of Education
Design, construction, operation and maintenance of Government owned health facilities	Ministry of Health
National hygiene promotion	Ministry of Health
Assist private sector companies in delivering new Government infrastructure	Ministry of Labor
Sector coordination (water supply and possibly sanitation)	National Water Committee
Develop standards for sanitation	Public Health Institute

Table A4-1: Roles for State-Level Institutions in Sanitation Service Provision, Mongolia

Note: O&M = operation and maintenance.

Role	Responsible institution
City-level sanitation policy	Ulaanbaatar City Governor's Office; Strategic Policy and Planning Division
Monitor implementation of legislation	Ulaanbaatar City Office[a]
Allocate budget for capital and operational expenses	Ulaanbaatar City Office[a]
Maintain existing infrastructure and manage USUG	Ulaanbaatar Mayor's Office; Engineering Facilities Department
Plan, design, and construct facilities in the Ger areas	Ulaanbaatar Mayor's Office; Ger Area Development Department
Finance of construction and fund management	Ulaanbaatar Mayor's Office; Procurement Department
City asset management including PPP agreements for new infrastructure	Ulaanbaatar Mayor's Office; Properties Relations Department
Monitor compliance with standards, levels of hygiene, effluent from wastewater treatment plants, and groundwater pollution at City level	General Agency for Specialized Inspection (Ulaanbaatar)
Prevent soil pollution from nonsewered sanitation and monitor pollution from domestic and industrial sources; enforce environmental law	Environmental and Green Development Agency of Capital City
Operate and routine maintenance of sewerage network and wastewater treatment plants	Ulaanbaatar Water and Sewerage Company (USUG)

Table A4-2: Institutional Roles and Responsibilities for Sanitation for Ulaanbaatar

Note:
PPP = public-private partnership;
USUG = Ulaanbaatar Water and Sewerage Company.
a. Specific division or department is unknown.

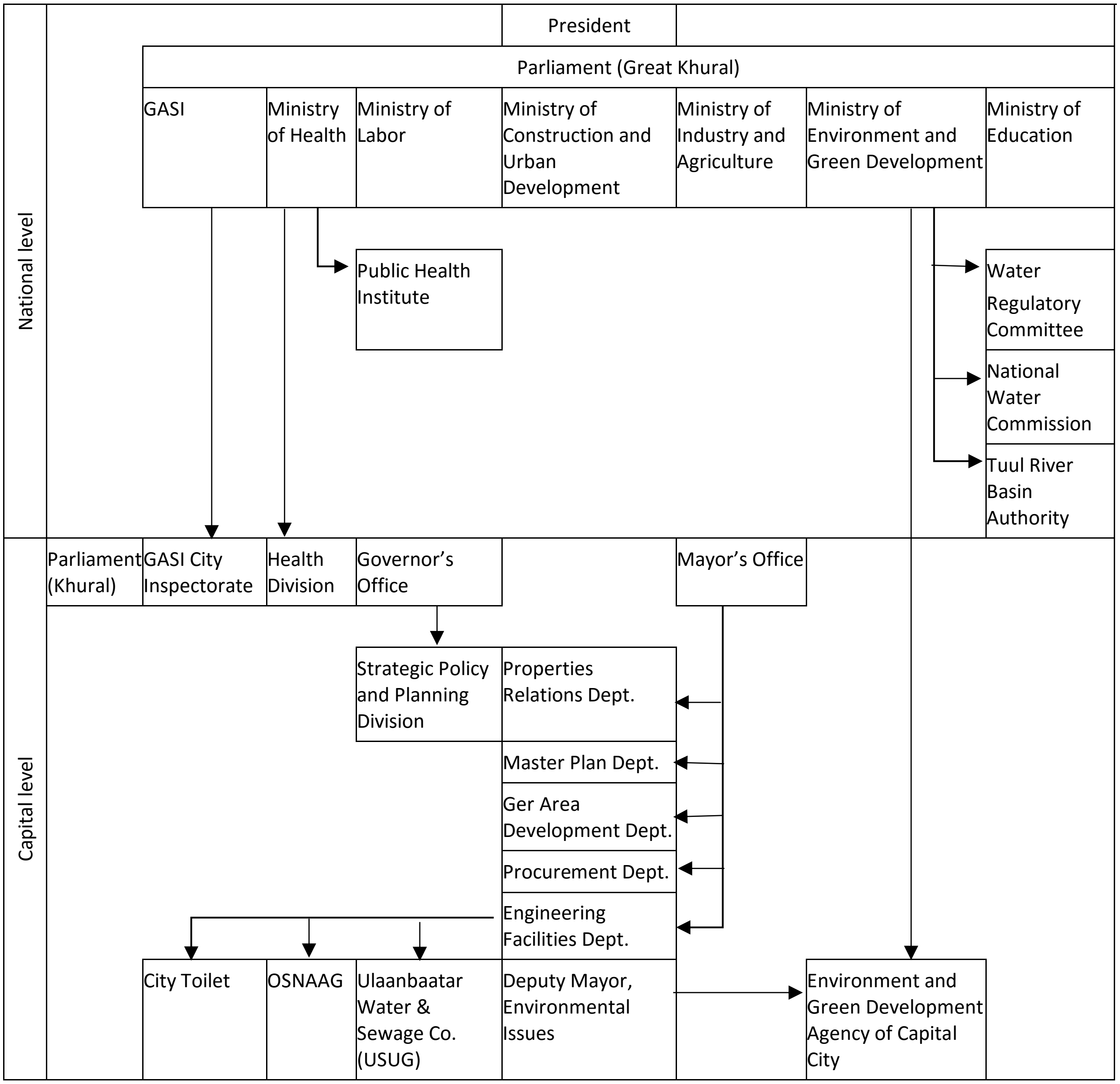

Figure A4-1: Sanitation Sector Institutions, Ulaanbaatar, Mongolia
Source: Sigel 2012.

Note:
GASI =General Agency for Specialized Inspection;
OSNAAG = Housing and Communal Services Authority

Category	Department/division	Assigned function
Governor's Office	Strategic Policy and Planning Division	Develop and coordinate urban development policies including the development of new approaches to non-sewered sanitation
Mayor's Office	Engineering Facilities Department	Manage and coordinate responsible departments at implementing stage of urban development policies; maintain existing infrastructure; and manage USUG
	Deputy Mayor for Environmental Issues	Believed to have overall responsibility for sanitation (As of 2014, no one had been assigned to this position)
	Ger Area Development Department	Plan, design, and construct facilities in the Ger areas
Implementing Agencies	Master Plan Department	Plan, design, and construct new facilities
	Procurement Department	Finance construction and manage necessary funds for new capital projects
	Properties Relations Department	Manage assets owned by the City of Ulaanbaatar; responsible for PPP agreements to construct infrastructure

Table A4-3: Municipal Departments and Divisions of Ulaanbaatar in Charge of Sanitation Services

Note: PPP = public-private partnership; USUG = Ulaanbaatar Water and Sewerage Company.

Regulatory Framework Summary

Regulatory Framework

The national-level regulatory framework for sanitation is divided into three sections: Law, Standards, and Technical Regulations. In general, the Law section reflects government policy, sets national objectives, and defines roles and responsibilities. The Standards section sets levels of service, such as required drinking water quality or the specifications for a new latrine. The Regulations section sets the procedures to be followed to achieve the standards and comply with national Law. The way they interact in Mongolia is shown in Figure A4-2. However, technical regulations and standards may be combined in the near future. The report does not comment on municipal regulations concerning sanitation, because the authors found very little information on them.

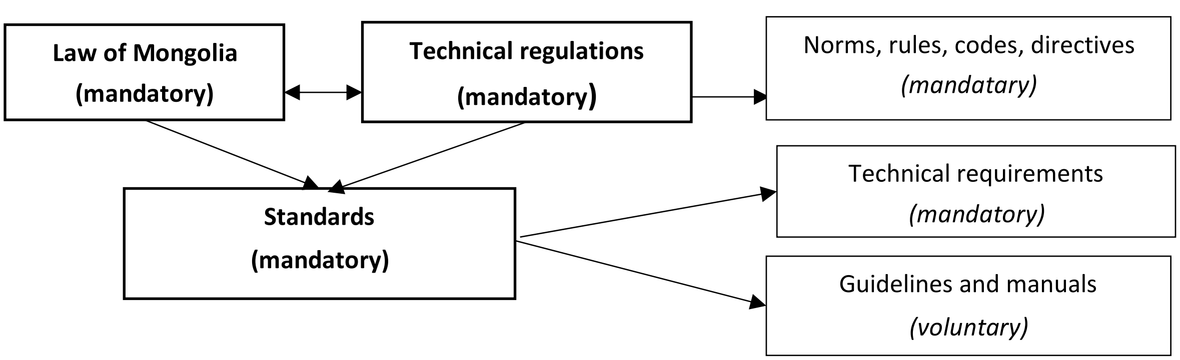

Figure A4-2: Regulatory Framework in Mongolia

National Laws

Table A4-4 summarizes the principle laws related to sanitation. The list includes only laws with English translations. There may be other relevant regulations published in Mongolian or Russian that have not been included. Also, this snapshot pertains mostly to the situation in 2014, although some laws have been amended since then.

Law	Remarks
Environmental Protection Law Approved 30 March 1995; updated 2012 and 2016	Regulates relations between the State, citizens, economic entities, and organizations to guarantee the right to live in a healthy and safe environment. The main clauses related to sanitation include the following: • Assigns to MEGD the powers to coordinate activities to protect the environment, develop and adopt standards, and administer their implementation • Assigns to K*horoo* or City Office the powers to establish the boundaries of special zones to meet sanitary requirements and protect the environment. • Assigns to *Khoroo* or City Governors the powers to ensure the implementation of hygienic and sanitary regulations in their territory
Water Law, 1995 Revised 17 May 2012; amended March 2016	An amendment of the original Water Law regulates effective use, protection, and restoration of water and water basins.
Law on the Usage of Water Supply and Sanitation Facilities in Urban Area Approved 6 Oct 2011	Governs relations between various stakeholders concerned with facilities for • supplying urban users with clean water meeting standard requirements, and • disposing of and treating wastewater. Currently being upgraded.
Law on Prohibition of Disposal of Household and Industrial Waste Approved 7 May 1998	An amendment of Law on Household and Industrial Waste approved on 28 November 2003, governs the collection, transportation, storage, and disposal in landfills of household and industrial waste; governs re-using waste as a source of raw materials to eliminate hazardous impacts of household and industrial waste on public health and the environment.
Law on Concessions Approved 28 January 2010	Regulates matters related to the organization of tenders, adjudication, revision, and termination of concession agreements and the settlement of disputes.
Law on Sanitation Approved 7 May 1998; revised March 2016	Governs relationships (between principle stakeholders) concerning (i) the maintenance of sanitary conditions; (ii) defining the general requirements for sanitation to ensure the right of an individual to healthy and safe working and living conditions, to ensure normal sanitary conditions, and to define the rights and duties of individuals, economic entities and organizations in this respect.
Law on Charges for the Contamination of Water Approved May 2012	Requires polluters to pay a charge based on their annual pollution load discharged to public water bodies or sewers. The law had not been put into practice as of August 2013, because the applicable pollution load, exemptions, and application of penalties have not been defined. Also, the effective date of the law has not been set.

Law	Remarks
Law of Mongolia on Hygiene Amended February 2016	Defines the roles and responsibilities for matters relating to hygiene. Waste disposal and destruction is the responsibility of individuals, businesses or organizations that own or occupy properties. The relevant central administrative organizations shall cooperate to develop standards for decentralized sanitation facilities. Governors of Aimags, the Capital City, soums and districts must implement the hygienic requirements for sanitation facilities and are also responsible for waste collection points. Schools and NGOs should provide hygiene training.

Table A4-4: Laws Related to Sanitation, Mongolia

Source: Adapted from NJS Consultants 2013.

Note: MEGD = Ministry of Environment and Green Development.

National Standards

Table A4-5 contains a partial list of Mongolian standards concerning sanitation, followed by a summary of the content of the most important ones. Many standards were produced during the period that Mongolia was strongly influenced by the Soviet Union. It has not been possible to obtain details of these standards in English, so their relevance to this review could not be determined.

Standard	**Description**
MNS900-2005	Environment, health protection, safety, drinking water, hygienic requirements, assessment of quality and safety.
MNS494300-1980	Standards on water quality, wastewater, and general technical requirements.
MNS4943-2011	Effluent treated wastewater, general requirements.
MNS4288-1995	General requirements for selecting a site for wastewater treatment plants and treatment technologies and effectiveness.
MNS4236-2003	Water supply: requirements on central wastewater treatment plant and water supply.
MNS5924-2008	Toilet and sewage pit technical requirements to ensure a safe living environment, to prevent environmental pollution, and to provide information about the technical design and use of pit latrines and greywater pits. It explicitly focuses on settlements that are not connected to a piped water supply and sanitation system.
MNS 5924: 2015	Pit latrine and sewage pit: technical requirements for the assembling, operating, maintaining, and designing of sewage pits and pit latrines for households and organizations not connected to the central or piped sewer systems. Provides details of the design and construction of some on-site sanitation options.

Table A4-5: Partial List of National Standards Related to Sanitation, Mongolia

Sources: Adapted from NJS Consultants 2013; Sigel 2012.

An updated Mongolian national standard took effect in 2016 (MNS 5924: 2015) covering latrines and sewage pits. Its purpose is to ensure a safe living environment, prevent environmental pollution, and prevent the spread of infectious diseases. It applies to soak pits and latrine pits for households and organizations not connected to piped sewer systems. It provides standards for the technical design, construction, and use of pit latrines and of disposal pits for greywater. Most latrines in the Ger areas of Ulaanbaatar do not meet the revised standards, which include guidelines for the size and construction of the superstructures and pits. This shows the need for standards and regulations that are effective but achievable, which can be adapted to local conditions.

The revised standards do allow for raised latrines, which can be used in areas where it is difficult to dig a pit or where there is danger of flooding. They also allow for composting latrines and for double-pit dehydrating latrines. However, both composting latrines and double pit latrines should be tested further, as, in Ulaanbaatar's climate, it is extremely unlikely that the excreta will compost or dry sufficiently in the latrines to be safe for handling, reuse, or disposal. Additional treatment of sludge emptied from the latrines is thus required to ensure that it poses no threat to the environment or to human health (Mongolia National Center for Standardization and Metrology 2015).

Government Orders and Regulations

Table A4.6 contains a partial overview of government orders (up to 2007) relevant to urban sanitation, from unofficial translations. Details of more recent orders were unavailable.

Approving organization	Year	No.	Legal Acts
Joint order of MEGD and MoH	1995	169/171	Rules on construction material for domestic wastewater treatment facilities and tankers
Joint order of MEGD and MoH	1995	167/335a/171	Order on hygiene and protection zone for drinking water sources
Joint order of MEGD and MoH	1997	a./11/05/a.18	Allows limits of industrial wastewater composition before letting effluents into the central wastewater treatment systems
Order of MEGD		127	Rules for registering and reporting about poisonous wastewater
Order of MEGD	2006	180	Obligations and duties of professional organizations.

Table A4-6: Government Orders and Regulations Related to Sanitation (Partial), Mongolia

Source: Adapted from Sigel 2012.

Note: MEGD = Ministry of Environment and Green Development; MoH = Ministry of Health.

Summary of Financial Framework

The Ulaanbaatar City Office is required to manage multiple accounting systems. In principle, these include the following:

- State services (such as health and education) locally managed by Ulaanbaatar
- Ulaanbaatar's own capital and current revenue
- Capital projects managed by Ulaanbaatar but funded by line Ministries

The lack of a unified accounting system has led to fragmentation of the City's budgetary operations. There is no consolidated budget report for the City that defines operational budgets by department or services. Furthermore, there is no sanitation sector financing plan, little analysis of budget or financial flows, and no apparent strategy for increasing sector allocations. While some project finance for improving urban services is provided by the government and external partners, most of the approved programs lack comprehensive plans and financing strategies (UNDP 2010). In very general terms, Ulaanbaatar City revenue and expenditure is shown in Figure A4-3.

The low level of execution of the budget is a serious problem across all budgetary sectors (77 percent average across all Ulaanbaatar expenditure) and could have many causes. It is recommended, as a matter of urgency, that the issues around low budgetary expenditure be investigated and strategies put in place to improve matters. Senior staff of the Ulaanbaatar Water Supply and Sewerage Authority (USUG) highlighted the lack of high quality construction contractors as a serious constraint on budget expenditure (Reed 2015).

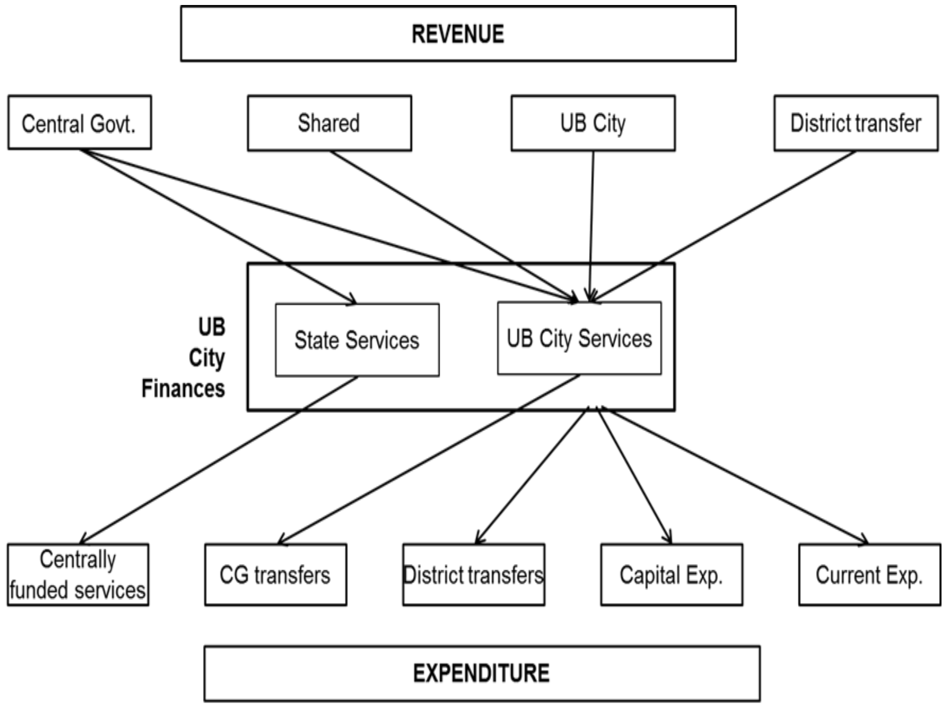

Figure A4-3: Simplified Revenue and Expenditure for Ulaanbaatar City

Note: CG = central government; UB = Ulaanbaatar.

Ulaanbaatar Water and Sewerage Corporation

USUG is expected to cover all current expenditure from revenue received for water supply and wastewater treatment services. USUG does not receive any subsidy from either the Mongolian Government or the Ulaanbaatar City Office (NJS Consultants 2013). The company has operated at a loss since 2000, in part because of high levels of non-revenue water and low tariffs, which are set by the Central Government. The City has been loaning money to USUG to cover the difference between costs and revenues. Consequently, USUG is reportedly heavily in debt.

APPENDIX 5: DETAILS OF RECOMMENDED SANITATION OPTIONS

Common Elements in a Sanitation Service System (Links in the Sanitation Service Chain)

Superstructure

The superstructure, or shelter, is the component with which users have the most contact, and can be used to indicate a family's status and prestige. The superstructure's form and materials depend on climate, affordability, material availability, user preference, and the type of user interface. It can be can be very basic or upgraded according to the users' preferences; it can be a room in a house, or a lightweight, moveable structure, for example. Most superstructures are built at ground level. Some sanitation facilities can be raised above ground level, if it is difficult to dig a pit or if containers for receiving the excreta are located beneath the user interface. However, stairs can cause difficulties for older or handicapped people. In cold climates, the superstructure should provide users with as much shelter as possible. The roof may need to be built to shed snow or to withstand snow loads.

User Interface

The user interface also depends on user preference and affordability, and on the other elements of the sanitation system. Some toilet fixtures are for use when squatting, while others are designed for use when seated, which can be easier, for example, for the elderly. Toilet fixtures with traps for water seals can be used only if the liquid in the seal can be prevented from freezing. Thus, in most cases toilet fixture for a wet sanitation system must be in a heated building. Otherwise, the frozen liquid can block the toilet fixture, or damage it by expanding as it freezes. Toilet fixtures without traps may be best suited for dry sanitation facilities.

Containment

The receptacle which receives and contains the excreta is very important to the function and duration of the facility, although users often pay more attention to the user interface and the shelter. The receptacle can be located directly below the user interface, or offset from it. If located below a heated building, it will be less likely to freeze, but must be built at the same time as the building. Pits and vaults must be dug during the warm season, because of the difficulty of digging frozen ground, especially manually. Common options for containment include the following:

- A pit, or hole, excavated into the ground. Solids are retained in the pit, while liquids infiltrate into the surrounding soil. The pit can be lined, or, in stable soils can be partially lined. If the pit is fully lined, the lower portion of the lining should be porous to allow for infiltration of liquid waste into the soil. Lining pits can be expensive, but can prevent collapse and facilitate emptying.
- A tank or chamber that has an inlet and outlet for liquid effluent but is otherwise watertight, such as a septic tank. Solids settle out and must be emptied periodically from the tank. The liquid portion of the waste, that is, the effluent, flows to a leach pit or leach field where it soaks into the soil, or flows through sewer pipes to a wastewater treatment facility for treatment.
- Watertight vaults, below or above the surface of the ground, without any outlet. They are emptied when full and their contents, which can include greywater, are taken to a treatment facility. Since they retain both liquid and solid wastes, they fill more quickly than pits or tanks with porous walls.

- Smaller, movable containers, for a container-based system. Full containers are replaced with clan empty containers, and removed and emptied off site for treatment or safe disposal of the sludge. Urine can be diverted and stored in containers or allowed to infiltrate into the surrounding soil.
- Another option is to build two pits, tanks, or vaults, which are used sequentially. While one is in use, the contents of the other are decomposing. When full, the pit, tank, or vault in use is closed; the other is emptied of its decomposed contents and put into use. The removed matter is treated further so it is safe for reuse. This cycle can continue for many years if it is managed properly. The pits, tanks, or vaults can be contiguous or not; they are commonly known as twin, or double, pits or vaults.

Soakpits and leach fields work best in porous soils that will readily absorb the liquid part of the wastewater. Soils must be tested to ensure that they are porous enough to allow adequate infiltration of liquid wastes. Soak pits should not be built in high traffic areas, so that the soil above and around it does not become compacted.

In all cases, containment methods should isolate the excreta to protect public health and the environment. In cold climates, containments may need to store more excreta, since liquid wastes cannot infiltrate into frozen ground. Also, it can be difficult to empty frozen waste from pits, tanks, vaults, or other containers.

Emptying and collection

There are a number of ways to empty or collect sludge from sanitation facilities and convey it to treatment facilities. Unfrozen, low viscosity sludge can often be removed mechanically by vacuum pumps and collected in tankers for transport to a treatment facility. Thick, highly viscous, unfrozen sludge, from a pit latrine for example, can be removed manually and conveyed to a treatment facility. Frozen sludge can be broken up and removed by workers with compression hammers and conveyed by truck for disposal or treatment after it has thawed. Manual emptying can pose a risk to workers' health and to the environment. Special pumps for highly viscous sludge can reduce these risks (Tilley et al. 2014), but require expertise and spare parts to operate and maintain (Strande 2014), and will not work on frozen sludge.

In a container-based system, the user deposits excreta directly into a movable container. Full containers can be conveyed to a treatment facility and replaced by a clean, empty container. The excreta could also be emptied into a larger container for conveyance to a treatment facility. Container-based systems can have a high capital and operational cost, so may not be financially sustainable without subsidies (GV Jones & Associates 2015). However, these costs may be lower than the costs of building and operating sewers, which are also high, particularly in cold regions.

Conveyance

Waste can be conveyed in tanks or containers by vehicle, or by sewer pipes. Waste can be conveyed from the household directly to a final treatment or disposal facility, or to an intermediate facility for temporary containment and from there to a facility for treatment, to a final disposal point, or for reuse. Any conveyance method involves risks to public health and the environment from spills or leaks.

A major risk with haul systems, which involve conveyance by some type of vehicle, is that haulers will not take the waste to a facility for treatment or safe disposal but will deposit it in a nearby water body or on empty land. This is especially likely if the haulers must pay to deposit the waste at treatment facilities, or if the facilities are far from the point at which the hauler collects the waste. Use of intermediate containment facilities can reduce distances for haulers, but must be emptied regularly and maintained well. It can also be difficult to find convenient sites that are acceptable to nearby residents (Strande 2014). Also, it can be difficult or impossible to remove frozen waste from intermediate containment facilities, so they should accommodate all the waste discharged into them for the entire cold season.

Treatment

Human excreta require proper treatment and safe disposal, since untreated excreta contain a high organic load, including pathogens and other microbes, nitrogen, and other chemicals, which can spread disease and pollute surface water, groundwater, and the environment. In cold temperatures, biological process slow and stop, so decomposition and sanitization of sludge left in latrine pits, vaults, tanks, or other containers will take longer than in warmer climates. Many pathogens are able to survive freezing conditions. They become dormant or convert to a spore or cyst, which revives in warmer conditions. In moderate climates, two years is often used as the minimum time for on-site treatment, but further research is required to understand the conditions needed for sanitization of excreta in cold regions.

Therefore, fecal sludge that has been treated on-site will need additional treatment to stabilize and sanitize it before it is safe for reuse or disposal, especially in cold regions. In fact, sewage sludge from wastewater treatment facilities generally needs additional treatment, such as dewatering or composting, before it can be safely re-used or disposed of. Treatment requirements depend on the sludge characteristics and the intended end use of the treated sludge (biosolids). Sludge that is to be used on food crops, for example, must be treated to a high standard (Strande 2014). Common low-cost technology options for treating fecal sludge include the following:

- Dewatering on unplanted or unplanted drying beds. Freezing and thawing under certain conditions can help to dewater sludge.
- Biodigestion in a domed or geobag-type biodigester, which is meant to produce biogas for energy. However, at temperatures below about 5 degrees Celsius, the production of gas is negligible, so biodigestion is generally not suited to cold climates.
- Lagoons, which can function in cold regions: all treatment occurs in the warm season. The treated wastewater is released at the start of the cold season. However, lagoons are better suited to treating sewage or septage with a relatively high water content, rather than fecal sludge taken from dry toilet facilities, since the solids can collect near the point where they are discharged.
- Co-composting with a suitable organic material, which is used successfully at large scale to treat sewage sludge in Fairbanks, Alaska, and Edmonton, Canada, which are quite cold. It requires considerable effort, but much of the cost can be recovered by the sale of the resulting humus if there is a demand for it.

End Use or Disposal

There are many ways to use the resources contained in excreta. One of the most common, producing humus for use as a soil conditioner or fertilizer, may not be very appropriate for Ulaanbaatar, since few people practice gardening. In warmer climates, a few projects have used excreta to make fuel briquettes, which may be worth exploring in Mongolia. Urine can also be used as a fertilizer, since it contains most of the nutrients in the excreta. However, it can only be applied when the ground is not frozen. Figure A5-1 shows potential products from fecal sludge and the technologies that can produce them. However, some of the treatment methods may not be suited to use in cold regions. WHO (2006) provides parameters for the safe reuse of wastewater and excreta, including urine and composted or treated feces or excreta.

Treatment and goal			End product or use
Solid-liquid separation	Dewatering	Stabilization and further treatment	
Imhoff tanks Settling/thickening Tanks	Mechanical dewatering Unplanted drying beds	Co-composting Deep row entrenchment Lime or ammonia addition Sludge incineration Anaerobic digestion Vermicomposting or black soldier flies	Soil conditioner Irrigation Proteins Fodder and plants Building material Biofuels
	LaDePa pelletizing machine Thermal drying Solar drying Planted drying beds		
		Co-treatment with wastewater	

Table A5-1: Possible Sludge Treatment Technologies and End Uses
Source: Strande 2014.

Improved Pit Latrines

Recommendation

Improved pit latrines are the recommended option for many households in cold regions. As a dry option, pit latrines are suitable for use in areas in which choices are limited by low water availability. They can be upgraded incrementally to match the household's aspirations and financial means. They are familiar to many, simple and inexpensive to build and maintain, and function well in a cold climate.

Description

Pit latrines can be an acceptable option to protect human health and the environment. Pit latrines can be upgraded to provide a pleasant user experience. However, it can be difficult to overcome the idea that latrines are smelly, unhealthy, fly-ridden, dirty, and scary places that pollute their surroundings. In fact, latrines often consist of unsteady platforms over partially collapsed pits, with a basic, poorly built superstructure.

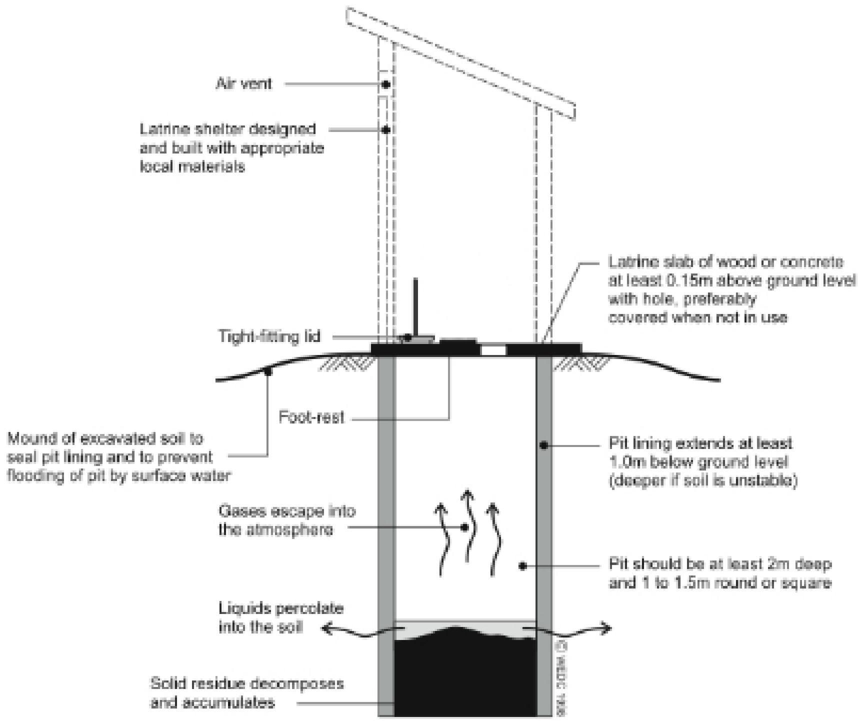

Figure A5-1: Improved Pit Latrine
Source: Adapted from WEDC, Loughbrough University.

Pit latrines have the major advantage of supporting an incremental approach to improvement. Families can make small individual improvements to their latrine over time, gradually making the latrine more comfortable and pleasant, as their finances and wishes allow, without the need for a major capital investment. Some possibilities for improving a pit latrine include the following:

- Add a squatting "pan" made of easy-to-clean, appealing materials to improve the user experience and make the toilet fixture easier to clean.
- Add a pedestal seat if the users prefer to sit, made of (or covered with) materials suitable for use in cold temperatures.
- Add a urine-diverting seat or squatting pan. Used properly, urine diversion will reduce odors, but the toilet fixture must be designed so that the urine does not freeze and block the diversion pipes.
- Add footrests to the slab that supports the user when squatting.
- Add a tight-fitting lid to the defecation hole or toilet seat, to reduce flies and odor.

- Improve the superstructure by adding a ceramic tiles or other aesthetically pleasing and smooth, easy to clean materials to the walls and to the floors of the superstructure. Floors should be sloped slightly down toward the defecation hole, for easy cleaning.
- Ensure that the latrine floor or slab is raised at least 15 centimeters above ground level, and slope the ground around the latrine down away from the latrine. This prevents rainwater from entering the pit, thus reducing erosion and the risk of weakening the pit walls.
- Seal the latrine slab to the pit walls, so that there are no cracks between the top of the pit and the superstructure, thus reducing odors and flies.
- If the latrine floor is of wood, add a layer of concrete mortar, sloped slightly down toward the defecation hole, to provide a surface that it is easy to clean and without cracks.
- Add a ventilation pipe to help reduce odors, with a screen at the upper end of the ventilation pipe to reduce flies.
- If the toilet enclosure is heated, add a water-seal toilet pan or pedestal seat to reduce odors and flies.
- If the toilet enclosure is heated, add a device, such as a basin with water, for washing hands. If the toilet enclosure is not heated, facilities for handwashing should be provided elsewhere.
- Ensure that there is a mechanism for emptiers to have easy access to the latrine pit.

When users think of upgrading a latrine, they often think of upgrading the above-ground part of the latrine to improve the user experience. However, upgrading the pit can make the pit easier to empty, less likely to collapse, and last longer. When replacing a latrine, users can line the walls of the new pit with concrete blocks, masonry, or other materials to prevent collapse and allow easy emptying. Lining existing pits is likely to be a difficult and unpleasant task that can pose a risk to workers' health.

Depending on the users' preferences, and the context, other improvements may be possible. Marketing research can help to determine what the users' preferences and priorities are, as well as their willingness to invest in each of the potential improvements.

Photo A5-1: Toilet Pan for Pit Latrine
Source: World Bank

Components

User Interface and Containment

The user interface can be a pedestal toilet, to be used while seated, or a toilet pan or slab for use when squatting, as shown in Photo A5-1. It can also consist of a simple hole in the slab, which covers the pit and supports the user. Toilet fixtures can be made of a variety of materials, such as plastic, ceramics, or concrete. The toilet fixture can be designed to separate or divert the urine from the feces, for separate containment, disposal, and treatment. Innovative solutions, such as the low water use toilet pans that use a flap instead of a water seal to control flies and odors like the SaTo pan, could be tested for use in cold climates.

The latrine floor or slab, also called a platform, is part of the user interface and supports the user and the toilet and other fixtures. The slab should cover the entire pit, be free of cracks, and be sealed to the pit walls. It should be easy to keep clean and solid, so that the user feels safe while using it. If the pit is to be replaced when full, a mechanism to move the slab, such as lifting rings, should be built into it. If the pit is to be emptied, access to the pit must be provided through some type of access point or by making the slab and superstructure movable.

The pit receives and contains wastes, and is normally wholly or partially below ground level, and located directly below the user interface. If the pit is to be covered with soil and abandoned without emptying, it should be as deep as possible. If it is to be emptied, it should be large enough to hold all of the waste that accumulates during the cold season.

Superstructure

The superstructure, or shelter, can be built of locally available materials, according to user preferences and affordability. Its main function is to provide privacy and protect the user from the weather. Its design and materials can be left largely to the user. If the latrine is to be moved when the pit is full, the superstructure should be built so that it can easily be moved. Also, some users may move the slab and superstructure to empty the pit manually.

Improvements to the superstructure are common ways of upgrading an existing latrine. It improves the user experience, increases the esthetic quality of the latrine, and raises the prestige of the owner. However, there is no point in constructing an improved superstructure on a badly built pit or platform, since it will be unstable and have a limited life.

Operational and Maintenance Requirements

Household Level

Pit latrines are familiar to users in the Ger areas. However, users may need training if they choose, for example, urine diverting dry toilets (UDDTs) as their user interface. When a latrine pit is full, users have two choices: (i) the pit must be closed, covered with soil, and abandoned, and a new latrine built over a new pit; or (ii) the full pit must be emptied and reused. Emptying the latrine must be done with care, so as not to endanger the environment or human health, including the health of the workers who empty the latrines.

Users should not use latrines for disposal of trash, especially non-organic waste, such as batteries, glass, plastic or metal containers, or clothing. They will fill the pit quickly and make it more difficult to empty, especially by vacuum truck. Also, chemicals put into the pit can seep into the ground and pollute the groundwater.

Adding ash or sawdust to the pit can help control odors and insects. However, a large amount of inert material, such as ash, in the sludge can hamper further treatment, such as composting or treatment in a sewage treatment plant. Also, ash tends to solidify the contents and make them more difficult to empty mechanically. The contents of pit latrines may be quite solid even without the addition of ash or other organic material, so manual emptying may be required in any case.

Users need to safely store and dispose of anal cleansing materials that are not put into the pit. Otherwise they can pose a risk to public health and the environment.

Institutional Level

Local authorities must manage sludge emptied from latrines, as it is rarely, if ever, safe for disposal in the environment without additional treatment and sanitization for safe disposal or reuse. Even if it is emptied by private sector entities, the Government must monitor and regulate them.

Local authorities can promote latrine improvements, and build demonstration latrines that show that latrines can be clean, comfortable, and attractive, without flies or odors, at a low or moderate cost.

Cold Climate Considerations

Simple pit latrines are well-suited to cold climates, although when they are located outdoors, they may be cold in winter. Pit latrines do not function very differently in cold climates than in warmer ones. However, there are some differences. New latrine pits should be dug in the summer because frozen ground is difficult to dig, especially manually. Pits may be affected by movements in the soil as it freezes and thaws. Pit linings, user interfaces and superstructures, must be designed to accommodate this soil movement. Also, provision should be made to protect the latrine from water from melting snow and ice, which should not be allowed to enter the pit.

The bottom of the pit should be 1.5–2 meters above the groundwater table. If possible, the groundwater should flow from the well toward the leach field or pit. It is common to require about 31 meters between a leach pit and a private well or lake or river, and 62 meters from a public well. These distances may be decreased for some advanced on-site water treatment systems, or increased where fractured or jointed bedrock is within 2 meters of the surface of the ground where the latrine is sited.

Pits must be large enough to contain everything put into the pit during the cold season, plus any accumulated solids from previous years. Since liquid wastes cannot infiltrate into the frozen soil, urine and feces will both accumulate, with any anal cleansing materials, greywater, or trash. Even when the pit contents thaw, liquids will not infiltrate into the soil until it thaws as well. Latrine pits may need to be emptied at the start of the cold season, before the pit contents freeze, to ensure that there is enough containment space for excreta that will accumulate during the cold season. As mentioned earlier, it may be possible, although not recommended, to empty frozen waste from some latrines during the cold season.

Excreta production globally ranges from about 200–500 grams of feces per person per day, and 0.6–1.1 liters of urine per person per day (Franceys, Pickford, and Reed 1992). (Note that production rates may differ and should be measured locally.) If the ground is frozen for seven or eight months, and households produce an estimated average of 1.25 liters of excreta per person per day, then a household of four might be expected to produce 5 liters per day, or 1,200 liters over 240 days (eight months). This means that the pit would need at least 1.2 cubic meters of free space at the beginning of the cold season. A shared latrine with eight users would need almost 2.5 cubic meters. Moreover, expected accumulation over time is 60 liters per person per year in moderate climates (Franceys, Pickford, and Reed 1992). However, since the breakdown and resulting reduction in volume in cold regions is slowed, accumulation rates could be as much as twice that (Buttle and Smith 2004). An accumulation of 120 liters per person per year for four people means that each year, approximately 0.5 cubic meters of sludge would accumulate in the latrine, or 1 cubic meter for a shared latrine with eight users. Although these may be conservative figures, decomposition and breakdown could be expected to take at least three times longer than in a warm climate if the excreta are thawed for four months of the year. It also takes time to restart decomposition.

In cold regions, waste falling into the pit freezes, resulting in piles of frozen excreta extending upward to the defecation hole or seat (see Figure A5-2). As much depth as possible should be available at the start of the cold season to accommodate the piled excreta. Some latrines have a long opening for defecation, running between the planks that constitute the floor of the latrine, so that the excreta can be deposited evenly along the opening, and will not reach as high as when they are deposited in a single spot. Users in Mongolia reported knocking the piles down with sticks.

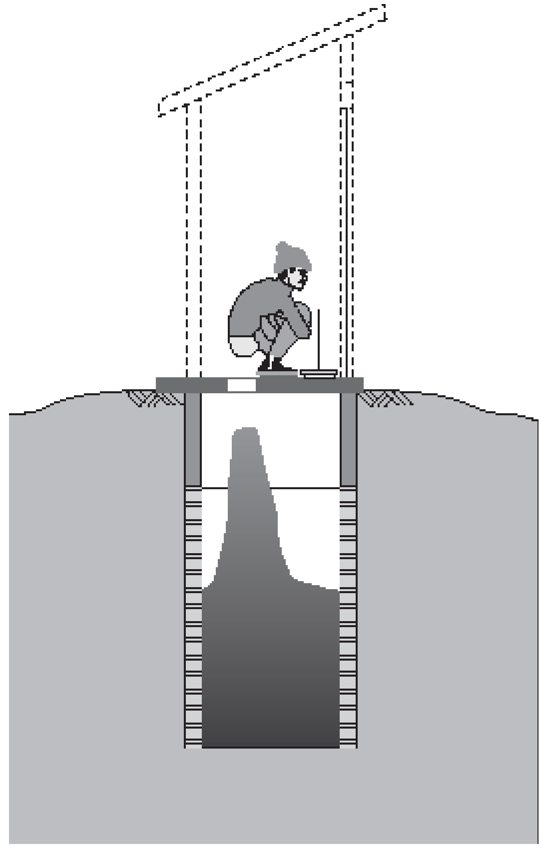

Figure A5-2: Pit Latrine with Frozen Excreta
Source: Adapted from WEDC, Loughbrough University.

Construction and Installation Requirements

Pit latrines are familiar, inexpensive, and easy to construct of local materials using local skills.

If possible, pits should be at least 3 meters in depth, and 1.2–1.5 meters in diameter or width. Pits that are too narrow are difficult to dig. Round pits tend to be more stable and less likely to collapse than square or rectangular pits, and use fewer materials to construct per unit of volume.

The top 0.5 meter of the pit walls should be lined with wooden or masonry walls to prevent pit collapse; help keep out surface water; make the pit easier to empty; and support the weight of the cover slab, users, and superstructure. The remaining depth of the pit should be lined if the soil is unstable, including when it is wet, and therefore likely to collapse. The top 0.5–1 meters below the ground surface should be impermeable, but the lining of the lower part of the pit should be porous to allow infiltration of liquids into the surrounding soils. The liner can be made from concrete rings, blocks or slabs, bricks, stone, wood, or other materials. Metal is not recommended, since it will corrode quickly. Finally, pits for simple pit latrines may be difficult to excavate in areas in which bedrock or the water table is near the surface. In those cases, other options, such a raised pit latrine, can be considered.

Practical Experience in Cold Regions

Pit latrines are common around the world, in cold areas as well as warm ones. However, many smell bad and breed vectors and vermin because they are poorly sited, designed, constructed, used, and maintained. The consequent negative image can be difficult to change.

Other Requirements

Pit latrines require no water or added energy to function. Users who would like the latrine to be lighted at night could explore the use of solar lanterns. A pit latrine does not normally require more than 3–4 square meters of space. However, if the household chooses to close the latrine and build a new one when the latrine pit is full, eventually the requirements for space will be quite large.

Greywater Disposal

Most pit latrines can handle very small amounts of greywater. However, in the winter when the soil is frozen and liquids cannot infiltrate into the ground, users must take care not to exceed the capacity of the pit. Also, grease, fats, and oils should not be put into the pit, because they will clog the pores in the soil, making it unable to absorb liquids from the pit.

Potential for Reuse of Excreta

Excreta can potentially be reused. However, users are often reluctant to excavate pits and reuse the decomposed excreta, even after decomposition has degraded them into an inoffensive, humus-like material. Also, as mentioned earlier, the sludge will require further treatment before reuse. The treatment required depends on the intended use (Strande 2014). For example, use on crops requires a high level of treatment.

An option is to divert, collect, and reuse only the urine, which is rich in nutrients, although it can be reused only during the warm season. The treatment required for urine depends on the degree of contamination with feces as well as the end use. WHO (2006) provides parameters for the safe reuse of wastewater and excreta, including urine. In cold regions, it might be interesting to explore the use of excreta to make fuel pellets.

Expected Life

The life of a pit latrine usually depends on the amount of time that it takes for the pit to fill and on whether it can be emptied. The time for a pit to fill will be a function of the pit volume, the number and type of users, and the climate, among other things. If trash, especially nonorganic trash such as plastics, is put into the latrine pit, it will fill faster and emptying will be more difficult. The type of anal cleansing material will also have an effect if those materials are put into the pit.

Decomposition reduces the volume of the excreta in the pit over time, so a larger pit lasts longer in relation to its size. That is, normally, a pit twice as large as another pit will last *more* than twice as long as the smaller pit. Thus, a very large, deep pit can last quite a long time, thanks to the breakdown of the excreta. Or, if the pit is emptied periodically, a latrine can last for many years. A well-designed, well-constructed, and well-maintained latrine with a concrete slab and a pit lined with masonry can last for decades.

Expected Costs

Capital Costs

Capital costs for a basic pit latrine can be very low, particularly if the household constructs its own latrine. The costs can also be spread over time if the household upgrades the latrines incrementally. If pits are not emptied, however, costs will be incurred each time a new latrine replaces a full one.

Lining the pit can add substantially to the cost of the latrine, and should be used only if the latrine is going to be emptied rather than replaced. However, a pit latrine pit that is emptied periodically will normally last longer if it is lined, especially if it is lined in durable materials such as masonry. Construction of a pit latrine, with a wooden pit lining and slab, was estimated at about 550,000 MNT (about US$300) in 2014 (GV Jones & Associates 2015, appendix 1). In 2006, the World Bank estimated that the least costly simple pit latrine, with a pit lined with stone masonry, would cost US$95 to US$130 (World Bank 2006). Using the exchange rate of May 2017, this was equivalent to about 260,000 to 314,000 MNT.

Maintenance Costs

The maintenance costs for a pit latrine relate mostly to the cost of emptying the latrine. Emptying can be by vacuum truck during summer months, or by manual emptying in summer or winter. Estimated costs in Ulaanbaatar in 2014 were about 70,00 MNT (US$26) for truck emptying and about 120,000 MNT (US$43) for manual emptying (Roger 2015). These are significant costs for many households.

Other Advantages and Disadvantages

Poorly sited and constructed latrines can pollute groundwater around the pit, especially in areas of high groundwater. The extent of the pollution depends on hydrogeological characteristics of the area. As a rule, wells within 30 meters of pit latrines should not be used for human consumption without testing for contamination; this distance should be increased to 200 meters or more if the latrines and wells are sited in fractured bedrock (Inspectapedia 2017). Seasonal runoff can flood latrines and pollute surface water and soil around the pit if they are not properly sited, designed, constructed, or maintained.

Variations

Pit latrines can be varied in many ways. They can be constructed with a single pit, double pit, or a single or double raised pit. The pits can be ventilated, or the urine diverted, possibly for use as a fertilizer.

Raised Pit Latrine

Raised pit latrines are recommended for areas prone to flooding or where the water table or bedrock are close to the surface of the ground, making it difficult to dig a pit, but there are no cost-effective alternatives to a pit latrine. This latrine is very similar to a simple pit latrine. The difference is that the pit is raised wholly or partially aboveground. The elevation can also help protect the latrine against some flooding.

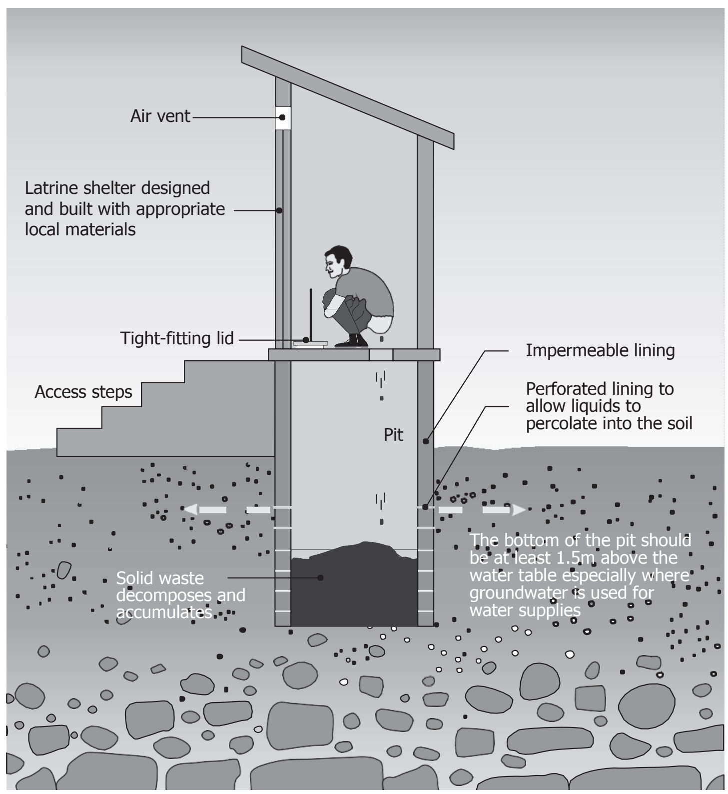

Figure A5-3: Raised Pit Latrine

Source: Adapted from WEDC, Loughborough University

The aboveground part of a raised pit latrine consists of walls, normally made of masonry or concrete, which can be surrounded by a mound of soil (see Figures A5-3 and A5-44). The pit can extend below ground level, although it normally does not need to extend as deeply into the ground as a simple pit latrine. This can help maintain the required vertical separation between the bottom of the pit and the groundwater, and so reduce the risk of polluting the groundwater.

Cold climate considerations are much the same as for simple pit latrines, except that the materials in an aboveground pit can be expected to freeze and thaw more quickly than in an in-ground pit.

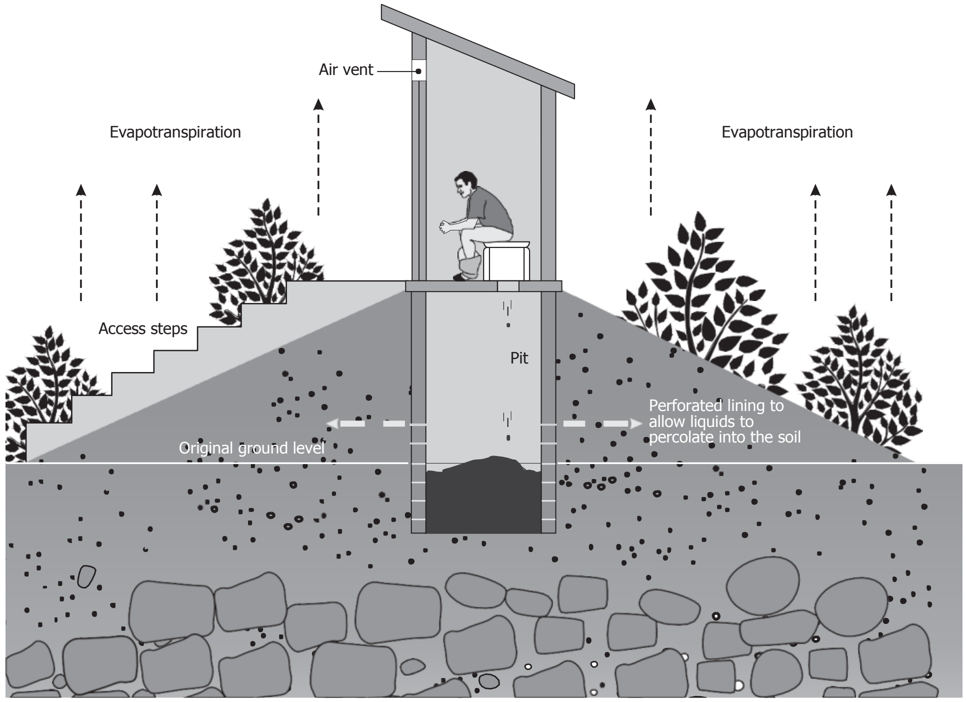

Figure A5-4: Raised Pit Latrine with Mound

Source: Adapted from WEDC, Loughborough University

Arborloo

An Arborloo is a latrine with a shallow unlined pit and a movable cabin, which rests on a ring beam or other support that can also be moved (Figure A5-5). When the pit fills, the cabin and the ring beam are moved to another site with a new pit. The full pit is covered with soil and a tree planted on top of it (Tilley et al. 2014). Because the pit will be used for a relatively short time, it does not need to be lined. An Arborloo is recommended for households who wish to plant trees and have the space to build new latrines every year or two.

The Arborloo can also be considered as a type of ecological sanitation (EcoSan), because the trees use some of the nutrients from the excreta in the pit as fertilizer. However, such latrines would have to be tested to see whether the heaping of frozen excreta prevents the use of shallow pits in cold regions, and whether people in Ulaanbaatar would like to plant trees near their homes.

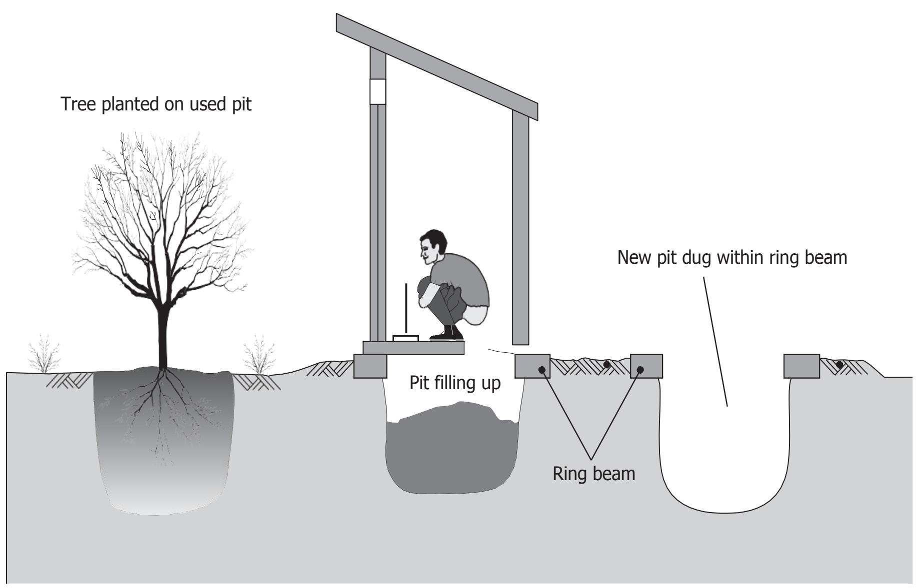

Figure A5-5: Arborloo

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Ventilated Improve Pit Latrine

The Ventilated Improved Pit (VIP) latrine is not recommended except in the rare case when users, designers, and builders understand and accept the proper way to design, build, and use it so that it functions as intended. The VIP latrine is included here because it is sometimes perceived as offering a higher level of service than a simple pit latrine, so there is often some demand for it.

In a properly built and operated VIP latrine, odors are reduced because the air that enters the superstructure passes into the pit through the seat or defecation hole, and then out of the pit through the ventilation pipe, exiting the end of the pipe above the latrine. Air carrying odors from the pit does not enter the cabin. Flies are reduced because the cabin is kept dark, so the flies in the pit are attracted to the light at the top of the ventilation pipe. They fly up the ventilation pipe toward the light, but the screen at the end of the pipe prevents them from exiting, so they remain in the pipe and die (Figure A5-6).

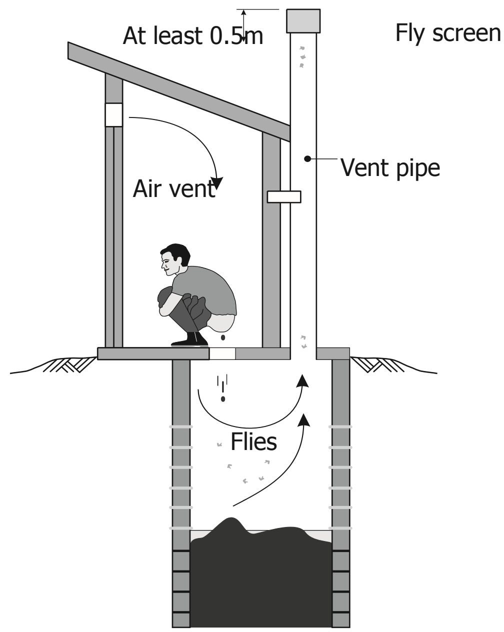

Figure A5-6: Ventilated Improved Pit (VIP) Latrine

Source: Adapted from WEDC, Loughborough University.

The screen at the top of the pipe must be kept clean and free of ice and snow. It should be inspected regularly and replaced as needed, and the vent pipe should be kept clear of cobwebs or other obstructions. Although screen maintenance is important for controlling flies, it is often neglected. There appears to be little harm equipping a simple pit latrine with a ventilation pipe, aside from the additional cost. However, adding a ventilation pipe will not control odors or flies effectively if the design and construction of the latrine do not meet the requirements for a VIP latrine.

Cold climate considerations include most of the same considerations as simple pit latrines. Additional considerations include the following:

- Although cold ground temperatures will freeze the contents of any unheated pit, the induced air flow through a ventilated pit is will cool the pit contents and cause the waste to freeze more quickly than in an unventilated pit (GV Jones & Associates 2015, Appendix 4).
- VIP ventilation systems do not work well in still air, particularly if the air is colder than the pit contents. These conditions can induce a reverse air flow, through the pipe into the pit and out into the cabin, increasing odors in the superstructure (Reed 2014).

Double Pit Latrines

Double pit latrines consist of latrines with two pits that are repeatedly used in turn, and emptied and used again (Figure A5-7, below). While one pit is in use, the excreta in the other decompose. This cycle can continue over many years if the latrines are well maintained. Even in warmer climates, however, experience shows that people are unlikely to be willing to enter the pit and handle the humus, unless they wish to reuse it.

Double pit latrines are not recommended for use in cold regions unless the sludge removed from the latrine pits undergoes additional treatment before disposal or reuse. The additional costs for conveyance and more treatment may make this option unattractive in cold regions, where it would have few, if any, advantages over container-based sanitation systems.

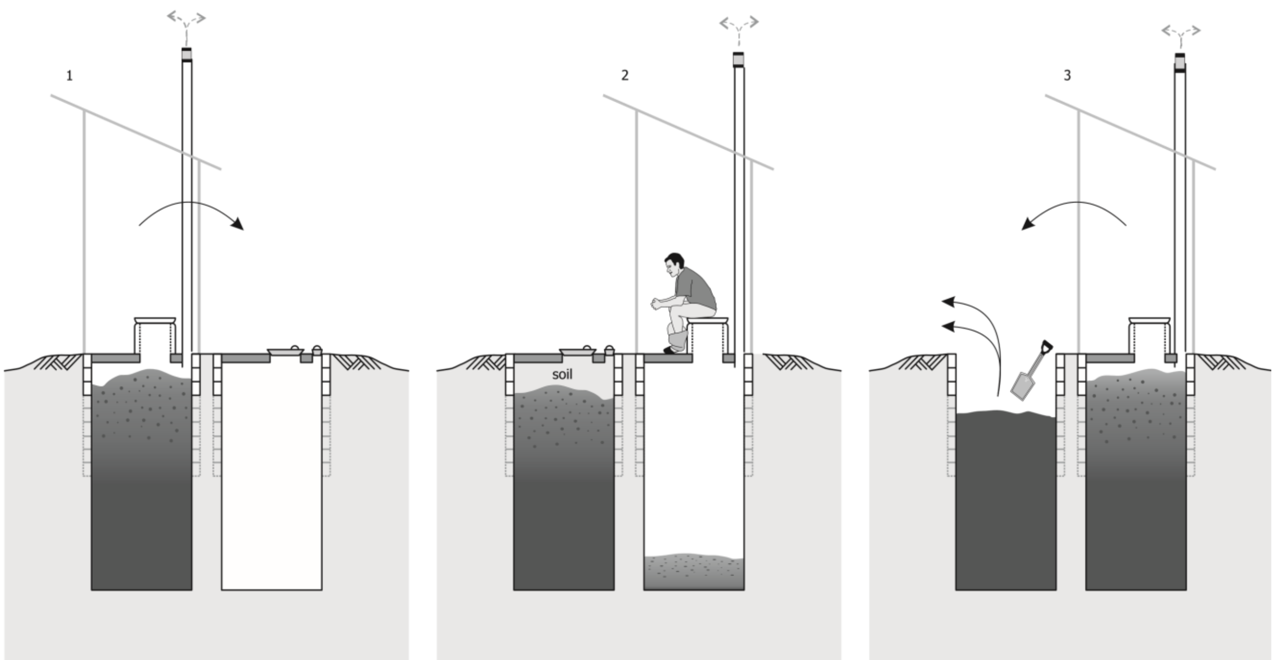

Figure A5-7: Double Pit Latrine

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Container-Based System: Urine Diverting Dry Toilet (UDDT) with Off-Site Treatment

Recommendation

Container-based sanitation involving urine-diverting dry toilets (UDDTs) with off-site treatment system is a practical solution recommended for cold regions with the capacity to collect, convey and treat the waste. Users defecate directly into a container that is collected and conveyed for treatment at a central facility. Container-based sanitation is recommended only if there are effective, appropriate institutional, regulatory, and financial arrangements to support it. Supporting container-based sanitation may, in some cases, be cost effective and less onerous than supporting sewerage, which governments routinely find acceptable.

Ideally, the sludge will be treated to produce sanitized humus or compost that can be reused as a soil conditioner or fertilizer. This is called ecological sanitation or EcoSan, because the nutrients in the excreta are reused. It may also be possible to treat the excreta to produce fuel pellets or briquettes for use at the household level, although this is an emerging technology that needs further exploration before it can be recommended.

Description

The urine diverting latrine (UDDT) with off-site treatment collects feces in a portable container (see Photo A5-2). The urine is separated from the feces in a urine-diverting toilet or pan, and either soaks into a pit in the ground or is collected in a separate container. Periodically, the containers holding the feces, and possibly the urine containers as well, are collected and replaced with clean, empty containers. The full containers are conveyed to a central facility. There, the feces and urine are removed from the containers, treated, and safely reused or disposed of. Alternatively, the contents of the containers can be emptied at the household level into larger containers for conveyance to the treatment facility. It is possible to mix the urine and feces in the same container, but the containers will fill more quickly and be heavier to handle and convey.

Photo A5-2: Container-based sanitation, household toilet facility, Ulaanbaatar

Source: World Bank

If the excreta are composted, properly composted waste, or humus, is an excellent soil conditioner. Composting is most suitable where there is demand for the composted product, which can be sold to defray costs. However, in many countries, regulations may restrict the use of compost made from excreta. Further, people may be unwilling to use it. Yet the income from compost sales will help finance the conveyance and treatment operations. Therefore, an appropriate regulatory framework is critical, as is user education.

Composting in cold regions takes special attention. Composting is a temperature-dependent biological process, which will slow and stop as the material gets colder and freezes. The process may take time to restart after the weather warms. Composting in a heated building is an option, but is likely to be expensive.

Allowing extra space to contain excreta collected during the cold season, and ensuring that the composting facility has the capacity to compost all the excreta during the summer, may be a better option. The WHO (2006) provides parameters for the safe reuse of wastewater and excreta, including composted or treated excreta.

Components

User Interface

In most UDDTs, the toilet pedestal or pan is designed to divert feces from urine so that they can be collected separately. The urine diversion pipes must be carefully designed to function in winter. If the pipe diameter is too small, or the pipe slope too flat, the urine will freeze and block the pipe. Other details of the user interface should be left to user preferences (see Photo A5-3).

Photo A5-3: Interior of Urine-Diverting Dry Toilet, Ulaanbaatar
Source: World Bank

Superstructure

The superstructure usually consists of a cabin with floor and toilet fixture positioned above a space that holds the removable feces containers, as shown in Photo A5-4. The superstructure can also be built with the user interface at ground level and the containers in a pit below ground level. However, in this case, it may be difficult to retrieve the containers for conveyance.

Collection Containers

The storage containers should be watertight and large enough to accommodate the excreta that accumulate between collections. Containers must be made of a material that can withstand cold temperatures and the expansion of liquids during freezing. If full containers are to be stored, either on-site or off-site, then they should be sealed against insects, rats, and other vermin. Containers should not be too large or heavy for workers to handle safely. Containers large enough to contain the feces that accumulated during a three-month period for an average family of four are suggested. Urine can also be allowed to infiltrate into the ground instead of being collected in containers.

Photo A5-4: Receptacles for feces, Ulaanbaatar
Source: World Bank

Collection

Generally, the full containers are collected and taken to the treatment facility or disposal site where they are emptied. Workers must have access to the household sanitation facility to collect the containers and replace them with clean empty containers. The collection agency and household members must collaborate to ensure efficient collection. It may also be possible for the households to empty their containers into a larger intermediate storage container for collection and conveyance. The larger container will then be hauled to the treatment site for emptying, or will be emptied and its contents conveyed to a treatment or disposal facility.

Conveyance

Generally, in a container-based system, the full containers are conveyed by vehicle from the sanitation facility to the treatment facility or disposal site. Many types of vehicle are possible, from carts, to small vehicles with trailers, to large trucks.

Treatment

In a container-based system, the excreta or sludge from the toilet facility requires further treatment off-site before it can be reused or safely disposed of. Treatment often consists of composting; other treatment methods are also feasible. Additional details on potential treatment methods can be found in the section on Common Elements in On-Site Sanitation Systems, above.

Reuse or disposal

Reuse or disposal depends partly on the treatment method, and is discussed in greater detail on the section on Common Elements in On-Site Sanitation Systems, above.

Operational and Maintenance Requirements

Household Level

Consumers must be trained to use UDDTs and to collaborate with the organization that collects the waste. When the feces container is full, the users must arrange collection of the container. One potential barrier to implementing this system is that some households may not be easily accessible by larger vehicles, or even by smaller ones.

Users may also have to clean the container if it is emptied rather than being taken away and replaced with a clean one. Care is required to prevent the water used for cleaning from spreading fecal matter into the environment, which would be a public health risk. It will also be necessary to occasionally replace worn or broken containers.

Institutional Level

Users and the agency collecting the feces should collaborate to determine the collection schedule. Both users and the collection agency and staff should then adhere to the schedule. The agency must collect the excreta promptly as agreed and convey it to a treatment facility. This organization is responsible for maintaining and operating the fleet of vehicles that convey the waste, and must also train, equip, and manage the workers to reduce the risk to public health and the environment—as well as their own health—from the collection of feces. The vehicles and containers used for collection must be cleaned regularly to control odors, limit corrosion, and prevent the spread of excreta and

Photo A5-5: Platform for composting in warm season, Ulaanbaatar
Source: World Bank

pathogens into the environment. However, used cleaning water should not be allowed to spread into the environment.

Operations and maintenance of off-site treatment facilities depends on the type of treatment. The organization treating the waste must ensure the safety of its workers and must protect public health and the environment.

There should be enough households using the emptying system to pay for the operation and maintenance of the vehicles. However, support from the Government may be necessary to cover treatment costs.

Appropriate financial, institutional, and legislative arrangements to regulate and support the system must be in place. Even if a private sector organization collects and treats the waste, the Government must oversee it.

Cold Climate Considerations

Urine can and will freeze, so facilities must be designed to avoid blockage by frozen urine.

Reaching the thermophilic temperatures required to sanitize excreta is extremely difficult for small-scale composting, especially in cold regions in the winter,[10] so treated excreta should be tested to ensure that they are safe for reuse or disposal. It may be best to compost smaller amounts of waste during the warm season and use the humus the next year (Seefeldt 2011). A project in Ulaanbaatar that collected fecal sludge from about 370 latrines led Action Contre le Faim (ACF) to conclude that composting there is possible during the winter only if heat is added, for example, by composting in a heated building (ACF/USTB 2015). In the end, the project composted the sludge only in summer (ACF/USTB 2015). Full containers of fecal sludge that accumulated during the winter were stored at the household level.

If the volumes of excreta to be treated are large enough, and the process carefully maintained, active thermophilic (or hot) composting can be sustained throughout the winter. In Fairbanks, Alaska, for example, sewage sludge is co-composted, that is, composted along with other organic waste, throughout the year.[11] However, even in moderate climates, thermophilic composting requires the proper balance of feedstocks, water, and air, which can be difficult to monitor and maintain.

It can be difficult to remove frozen excreta from containers, so containers should be designed to be emptied in the cold season. Or, if enough containers are available, the frozen excreta can be stored in the containers until the excreta thaws in the warmer weather. Full containers that are not in use should be sealed shut. Reliable collection service during winter depends on a usable street system with snow removal service, and suitable vehicles equipped for operation in bad weather (e.g., with four-wheel drive and tire chains). Smaller motorized vehicles may have access where larger vehicles cannot go.

If waste is not collected during the winter, users must be provided with sealable storage containers with a total volume sufficient to hold all the excreta disposed during the cold season. If the storage containers are not sealed well, odors after the waste thaws in the spring can be pervasive and obnoxious, and the waste may attract flies, rats, and other vectors.

[10] E-mail from **Björn** Vinnerås, **January 29,** 2017.

[11] See the Utility Services of Alaska's website, "Compost," http://www.akwater.com/compost.shtml.

If the containers in which the waste is initially deposited are emptied into intermediate storage containers, the contents of the storage containers will freeze unless insulated or heated. Frozen containers are difficult to empty and can be damaged by efforts to clear frozen material. If the collected sludge is to be discharged to a sewer or treatment facility, frozen sludge must be thawed, and very thick sludge may need to be mixed with water.

Cleaning vehicles and containers will use substantial quantities of water. The cleaning water will be contaminated and must be safely disposed of. This can be a major issue in very cold conditions because of the dangers from frozen run-off. It can also be an issue in warmer weather: if dirty cleaning water is not correctly disposed of, it can spread excreta and pathogens into the environment.

Construction and Installation Requirements

The latrine must designe and built to be accessible for emptying. The enclosure for the containers should prevent rats and other vermin from reaching the excreta. If the superstructure is at ground level with the container placed below ground level, the superstructure must be designed to give access to the container for collection. If the superstructure is above the containers, the structure must be strong enough to support the superstructure, user interface, and users.

Construction requirements for treatment facilities depend on the method of treatment chosen. However, it may be necessary to provide space for containment of waste collected during the winter but treated only during the warm season, either at the treatment facility or at the household level.

Practical Experience in Cold Regions

This system has been piloted by the international nongovernmental organization (NGO) Action Contre le Faim (ACF) in Ulaanbaatar. However, experience since the end of the pilot project indicates that people may not be willing or able to pay for emptying and collection of the wastes.[12]

Container-based systems, as well as other haul systems, have been used in Alaska and Canada for many years; however, the costs of installation, or of operations and maintenance, or both, have generally been subsidized. In 2013, Alaska launched the “Alaska Water and Sewer Challenge” to find more sustainable methods for water supply and sanitation (Alaska Dept. of Environmental Conservation, Division of Water Undated).

Water Requirement

Container-based sanitation with UDDTs is a dry system that needs no water. The space requirements are about the same, or slightly larger, than a simple pit latrine. At the household level, this system requires no added energy. However, energy is required to convey the waste. Depending on the type of treatment, added energy may be needed to treat the waste.

Greywater Disposal

Container-based sanitation will not handle greywater.

Potential for Reuse

The potential for reuse of the excreta depends on the method of treatment.

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[12] E-mail from Robert A. Reed **March 14,** 2017.

Expected Life

A properly constructed and maintained container-based household sanitation facility should last for many years. However, it will be useful only if there is a working system in place for collection and treatment of the waste.

Expected Costs

Capital Costs

In Mongolia, UDDTs used with container-based sanitation cost about 550,000 MNT (about US$300) in 2014 (Donati 2015). However, this system involves other costs. The costs of a fleet of vehicles for waste emptying and collection can be considerable. The cost of building a treatment facility depends on its size, type of process, location, and support facility requirements. Containers will also need to be replaced occasionally.

Operations and Maintenance Costs

When the feces container is full, the users pay a private or public sector organization to empty it and haul the waste away, or to collect the full container and replace it with a clean, empty one. Costs will depend, in part, on the frequency of collection, which will depend on the number and type of users. The unit cost of each collection visit depends on number of homes served, home access, road system, location, type of vehicles, the distance between users and the treatment facility, and other variables. Also, costs will increase if haulers must pay for disposal or treatment of the waste. Consumers may not be willing or able to pay the full costs of collection and treatment. If the waste is treated by composting, sale of the composted material may help defray the costs. In some cases, authorities may need to consider subsidies. In ACF's pilot project, the estimated cost to empty a container was about 10,000 MNT (US$7); this would cover costs only if all the 370 users subscribed to the system of emptying (Donati 2015).

Operations and maintenance costs for waste treatment and disposal mainly depend on the type of treatment or disposal.

Other Advantages and Disadvantages

There is a risk that if disposal points are not near the areas where the tanks are emptied, haulers will empty the sludge into the environment, either on land or into surface water bodies.

Variations

Bucket Toilet

Bucket toilets are not recommended unless they constitute an element of a carefully designed container-based system. They are included here because they have been commonly used in Arctic environments. Alaskans in small settlements have used bucket toilets, but disposal of the excreta has often been unsatisfactory, posing a risk to public health and the environment. The Alaska Rural Water and Sanitation Working Group (2015, p. 14) characterizes bucket toilets as "Truly the bottom of the scale" with regards to sewage disposal. However, bucket toilets are generally kept indoors, so can easily be used by people with limited mobility, such as the elderly or the disabled, or for children.

The bucket toilet consists of a plastic bucket, usually with a 20-liter capacity, set in a box with a seat, or simply equipped with a commercial toilet seat (Photo A5-6). Bucket toilets can smell, but odors can be reduced by adding sawdust or ash to the bucket after each use. When the bucket is nearly full, it is removed and emptied of its contents, risking spillage and other accidents. Both users and collection workers can be exposed to pathogens in the excreta. They should be trained to follow safe practices and wear suitable protective clothing and equipment.

Other components of this system can include the following options: an on-site pit, vault, or container for disposal or for temporary containment; an off-site communal pit, vault, or container for disposal or for temporary containment; and vehicles for hauling to a final off-site treatment or disposal facility.

Photo A5-6: In-House Bucket Toilet
Source: © GV Jones & Associates, Inc. Used with the permission of GV Jones & Associates, Inc. Further permission required for reuse.

Plastic bags can be used to line the bucket. When full, the bags are removed and conveyed to a treatment facility. Using plastic bags makes collection more hygienic (unless they break and spill waste), but can also complicate the disposal process. It is difficult to remove waste from plastic bags for treatment, especially if the waste is frozen. The bags need not be removed if the wastes are to be deposited in a solid waste pit or landfill, or if the bags are biodegradable (GV Jones & Associates 2014). However, experience has shown that sludge disposal at solid waste sites is complex and requires careful management to prevent health and environmental issues (UN-HABITAT 2009). Some solid waste disposal sites may not allow disposal of raw sewage, including in plastic bags.

A more hygienic option, suitable for use with container-based systems, is to use containers can be sealed and replaced with a clean, empty bucket. The full bucket is collected and conveyed to a treatment facility where it is emptied and the excreta treated for safe reuse or disposal.

A very small pilot project was implemented in Mongolia to test bucket toilets with on-site composting (Bio-Toilets). The wastes were composted in wooden bins located on the household plots (Jenkins 2006). However, because of the high risk of spreading excreta and pathogens into the environment, the use of open bins near residential housing cannot be recommended.

In some Scandinavian countries, “ice” toilets are available for use in winter. These are bucket toilets that are kept cold in unheated spaces; the cold reduces the unpleasant odors. A small amount of electrical energy can be used to keep the seat warm for the users’ convenience.

Double Vault EcoSan Latrine with On-Site Treatment

Ecological Sanitation with on-site treatment is not recommended for use in cold regions. As mentioned earlier, on-site treatment is not adequate to sanitize the excreta and make it safe for reuse. The excreta therefore will require additional treatment off-site before it is safe for reuse. The need for conveyance and off-site treatment will increase operational costs significantly, so this option will have few if any advantages over container-based sanitation. Moreover, ecological sanitation is recommended mainly where people desire to reuse the decomposed excreta or humus. The cost of double-vault latrines is normally more than the cost of a simple pit latrine, and correct use requires training, attention, and effort, so people must be motivated by the desire to reuse its products.

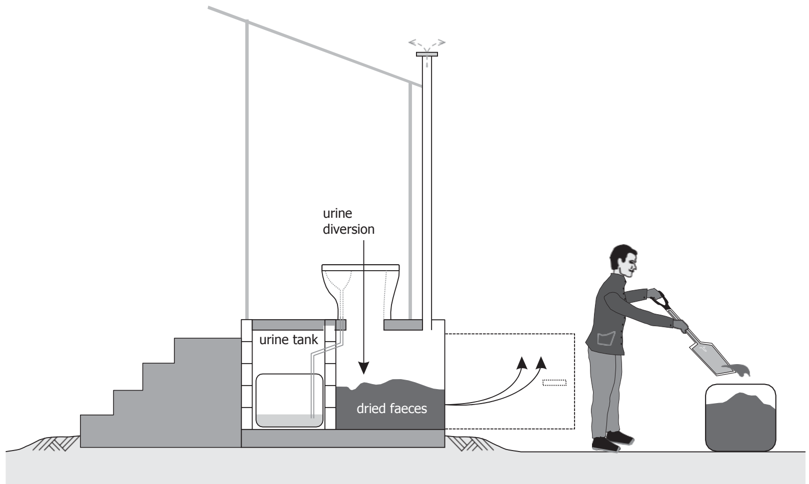

Figure A5-8: Urine-Diverting Dry Toilet (UDDT)
Source: © Eawag. Used with the permission of Eawag. Further permission required for reuse.

Aboveground double vault latrines with on-site treatment, as shown in Figure A5-8, consist of two adjacent watertight vaults, above ground level, in which the waste decomposes or dehydrates in the vault. Treatment can involve (i) dehydration, in which the excreta dry to a powdery substance; or (ii) decomposition, in which the excreta degrade into a humus-like material. The treated waste can then be used as a soil conditioner for agriculture. The vaults are meant to be used one at a time, in sequence. The first vault is used until it is full, then it is closed. The second vault is used while the excreta in the first decompose or dry. When the second vault is full, the first is emptied of the decomposed or dehydrated matter. The full vault is then closed and the first pit, now empty, is put back into use. This cycle can continue for many years.

If the latrine depends on dehydration of the feces, urine diversion is required to facilitate drying. If the excreta decompose rather than dehydrating, urine can be diverted or not. Organic material, such as sawdust or leaves, can also added after defecation to assist decomposition and help control feces. Urine contains more nutrients than feces, so urine can be used separately for agriculture and other purposes.

In-House Composting Toilets

An in-house composting toilet is a manufactured unit and is not recommended unless the spare parts and expertise to maintain it are readily available. There are many types and sizes of in-house composting toilet units, and many manufacturers. Some units dry the waste by heating the waste and evaporating the liquids. Others use aerobic digestion (composting) to treat all the excreta; some divert the urine and compost only the feces. They usually consist of a single unit that combines a toilet (user interface) with a composting chamber or chambers. Generally, in a cold climate, these toilets must be located inside the house or other heated enclosure. Ambient temperatures in the compost chamber should be kept above 10 degrees Celsius, which may be costly and require a constant power supply. Normally they produce an inoffensive humus, which can be used as a soil conditioner or fertilizer. However, there may be little demand for the humus in cold regions; and local regulations may not allow its use in agriculture.

These units are complex, and users need training in their use, operation, and maintenance. Acceptance has been limited, in part because of the need for frequent attention to operations and for the periodic addition of bulking agents, which may not be readily available. Also, if the waste cools or freezes, aerobic microbiological processes can stop. Such disturbance of the biological processes often results in obnoxious odors, and restarting the processes can require manual removal of the accumulated mass of waste, which is also obnoxious (Smith 1996). Finally, in many countries, units will need to be imported; suppliers would need to maintain a stock of spare parts and have the expertise to assist consumers with operations and maintenance. For that, suppliers would need to be assured of a sizable market for the units.

Low-Flush Toilet with Soak Pit

Recommendation

A low flush toilet uses a very small amount of water to flush. In cold regions, it is recommended only if the toilet is in a heated building and if users are willing to put in the effort to keep the water and wastewater from freezing in the fixtures and pipes.

Description

Low flush toilets use a small amount of water to convey excreta through sewer pipes, normally to a soak pit, as shown in Figure A5-9 and described in this section. Many low flush toilets are manually flushed by users pouring water into the toilet fixture. Such pour-flush toilets can use as little as one liter per flush. Low-flush toilets are normally used when the toilet is not connected to a piped water supply or to a sewer[13]. The technology produces no offensive odors and does not attract flies or mosquitoes. It has been widely adopted around the world; however, experience in cold regions appears to be quite limited. Also, some users may be reluctant to use in-house sanitation facilities. Users may need to be trained to use pour flush facilities.

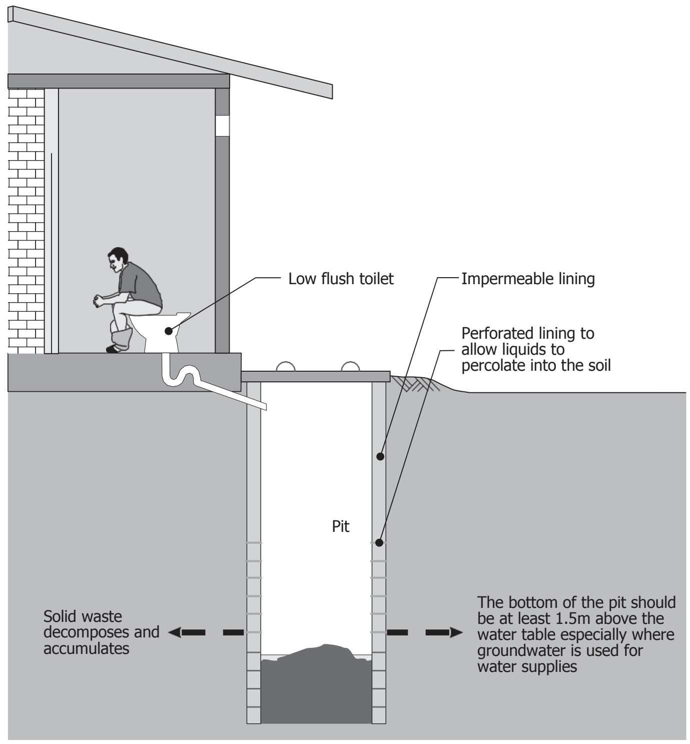

Figure A5-9: Pour Flush Toilet with Soak Pit

Source: Adapted from WEDC, Loughbrough University

Components

User Interface

Low flush toilets are available in a range of materials and models. Many fixtures are designed specifically to be flushed with very little water. They are available in models that do or do not divert urine. Most have a water seal to control odors and flies, which can be part of a floor-level pan for use when squatting, as shown in Figure A5-10, or of a low flush pedestal toilet with a seat.

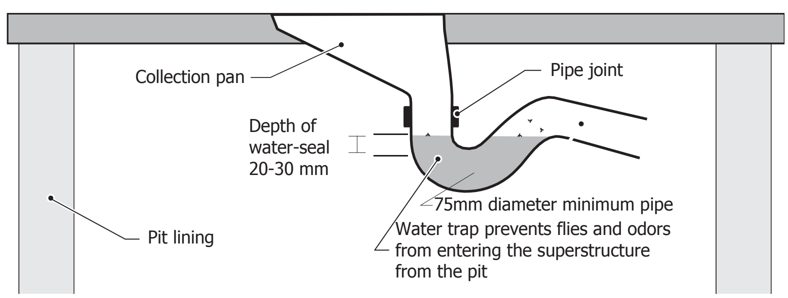

Figure A5-10: Typical Pour Flush Toilet Pan with Water Seal

Source: Adapted from WEDC, Loughbrough University

[13] Cistern flush toilets and even many "low flush" models often use 6 liters or more per flush, with cisterns filled by a connection to a piped water system.

Superstructure

In cold regions, the toilet fixture must be located inside a heated superstructure, often the house or other building, so that the water seal does not freeze.

Containment

Containment often consists of a soak pit, also known as a soakaway, cesspit, or leach pit. This covered pit retains the solid portion of the waste while the liquid portion soaks into the surrounding soil. It is connected to the toilet fixture by pipes. Liquids infiltrate into the ground during the warm season when the soil is not frozen. Solids are retained in the pit and must be emptied periodically. The pit should be lined to prevent collapse and the lower part of the pit lining should be porous, to allow infiltration.

Watertight vaults can be used for containment, but must be emptied more often than a soak pit. Vaults must also be protected from freezing, and may also leak into the surrounding soil. Septic tanks can also be used with low flush toilets. As in a cesspit, the solids are retained in the tank, but the liquid effluent flows through pipes to a soakpit or leach field where it infiltrates into the soil. It is essential to protect the leach field from freezing, which can be difficult and costly, so this solution may not be practicable in places as cold as Ulaanbaatar.

Collection and Emptying

The soakpit, vault, or septic tank, must be emptied and its contents collected periodically, normally by vacuum truck.

Conveyance

Normally, the waste will be conveyed from the soakpit or vault to a facility for treatment or safe disposal by the vacuum truck after emptying the soakpit. Currently, in Ulaanbaatar, the truck conveys the waste to a disposal point on a sewer main pipeline, where it is discharged into the sewer. From there, it is conveyed by sewer to the Municipal sewage treatment plant. However, there is a risk of blocking the sewer if a large volume of highly viscous waste is discharged into it.

Treatment

The waste emptied from the toilet facility requires further treatment before it can be reused or safely disposed of. Treatment is off-site, and can be at a sewage treatment plant, waste treatment pond, or other facility. At a sewage treatment plant, attention is needed to ensure that the sludge does not disrupt treatment processes, because it is often very concentrated. Additional details on potential treatment methods can be found in the section on Common Elements in On-Site Sanitation Systems, above.

Reuse or disposal

Reuse or disposal depends partly on the treatment method, and is discussed in greater detail in the section on Common Elements in On-Site Sanitation Systems.

Operational / Maintenance Requirements

Household Level

The low flush volume and small size of the water seal means that only soft toilet tissue or water can be flushed through the system. If other anal cleansing materials are used, such as office paper or newspaper, it must be disposed of separately, and safely.

Users need to purchase and haul more water to operate low-flush latrines than pit latrines, which require no water to operate. Greywater can be used for flushing, however, users must ensure that it does not contain much grease, oil, or fats, which can block soil pores and prevent the infiltration of liquid wastes. Once the pores are blocked, the pit must be abandoned and replaced. This is especially important in places where people's diet includes large amounts of grease, oil, or fat.

Users must take care that the system does not freeze, in whole or in part, unless it is designed and built to allow for freezing. Solids will accumulate in pits, so they will need periodic emptying. The required frequency of emptying will vary depending on the type and size of containment and the number of users.

Since pits must be lined, users will likely prefer to empty full pits instead of replacing them, which would be quite expensive. The pits must be accessible to vacuum trucks or other equipment for emptying.

Institutional Level

Emptying pits can be done by private sector suppliers or government agencies. However, the Government is responsible for ensuring that there are options for the treatment and safe disposal of the sludge, as well as an appropriate regulatory and institutional framework. The Government should also regulate and monitor conveyance, treatment, reuse, and disposal of wast.

Cold Climate Considerations

The development and testing of prototypes is needed, but low-flush toilets should be able to function successfully in cold regions provided precautions are taken, as follows:

- The water seal must be in a heated space to prevent the water from freezing.
- The sewer pipe that connects the toilet fixture to the exterior pit should be short and insulated or heated to prevent ice or frozen waste from building up in the pipe and blocking it.
- The slope of the sewer line from the house to the tank must be designed so that the lower volume of liquid will carry solids through the pipe in one flush, without plugging the pipes or leaving wastes in the pipe to be frozen. The pipe should be as short as possible: 1–2 meters is best.
- The soak pit should be large enough to contain all the waste that will be generated during the cold season, plus any accumulated solids. The waste is likely to freeze, and cannot easily be emptied from the pit. In addition, the liquid portion of the waste cannot infiltrate into frozen soil. Therefore, all waste will remain in the pit until it has thawed, along with the soil around it.
- A mechanism such as a heat cable or hot water thermal loop should be provided to thaw the contents of the pipes in case of accidental freezing.

The water seal in either the squat or seat toilet fixture can sometimes be winterized with a small amount of nontoxic antifreeze poured into the water seal. The homeowner should do this if the house is allowed to cool below freezing, for example, when the house will be unoccupied for some time.

Construction and Installation Requirements

The low-flush toilet fixture (pedestal toilet or squatting pan) is usually within the resident's house or other permanent structure. Low-flush toilets generally use less water than a conventional cistern-flush toilet, but require a toilet pan or pedestal seat specifically designed for low water volume flushing. The soak pit or vault may be placed directly under the toilet fixture or offset and connected to the toilet fixture by a pipe. It can be wholly or partially under a building, provided there is access to the pit for emptying.

The pits are generally 1.5–4 meters deep and must have a porous lining to support the pit cover and prevent pit collapse. To minimize contamination, the bottom of the pit should be at least 2 vertical meters above the water table if the groundwater is used for human consumption. The pits should also be located a safe horizontal distance (ideally more than 30 meters) from any groundwater source used for human consumption. If possible, the groundwater should flow from the leach field or pit away from the source. If the location has rock or groundwater close to the surface, the facility can be raised on a mound. These separations also apply to leach fields.

Practical Experience in Cold Regions

Low flush toilets with soakpits or septic tanks have not had extensive use in Alaska or other cold regions, due to problems with freezing. Toilet fixtures that are flushed with a small amount of water to insulated vaults have been used with hauled water systems. These tanks may require that the pipes and vaults be heated, so the waste does not freeze and can be pumped out (GV Jones & Associates 2014).

A small number of users in Ulaanbaatar have constructed household-level water supply and sanitation systems, using trucked water, with flush toilet fixtures and tanks that receive the wastewater. Greywater and blackwater alike are conveyed through pipes to tanks that are very close to the house. None of the owners report having emptied the tanks, although some have been in use for several years. Most likely, the tanks are not watertight, and liquids infiltrate into the ground during the warm season.

Water Requirement

Low-flush toilets require an estimated 3–5 liters per capita per day of water to flush, and low flush latrines require 20–40 liters per capita per day (Sphere Project 2011). The toilet will require a space in the house or other heated building; most people will prefer a dedicated space, to protect users' privacy.

Depending on its design, a system using a low-flush toilet should not require added energy, unless pipes are frozen accidentally and need to be thawed.

Greywater Disposal

Systems of this type may be able to handle some greywater. The amount will depend on the dimensions of the pit and the porosity of the soil. However, in cold regions, the soak pit will need to be large enough to hold both greywater and blackwater generated during the winter months.

Potential for Reuse

Waste emptied from the pit, vault, or septic tank will require further treatment before it can be reused. Treatment requirements will vary with the intended reuse or disposal methods as well as the quality of the waste to be treated.

Expected Life

A well-designed, well-built, and well-maintained low-flush system should last for many years. However, considerable effort may be required to prevent a low-flush system in a cold region from freezing.

Expected Costs

Capital Costs

The cost of indoor plumbing is moderate to high, depending on user preferences. The cost of lining a soakpit is often high, but soakpits are likely to collapse if they are not lined.

Operations and Maintenance Costs

Users must be willing to pay for the water required for flushing the toilets. They must also be willing to pay to periodically empty the pit of accumulated solids.

Variations

Low Flush Toilet with Holding Tank

A low flush toilet connected to a watertight vault cannot be recommended unless there is a reliable system to empty, convey and treat the wastes, including during the cold season. Moreover, experience in Alaska and Canada show that these systems often must be heavily subsidized (GV Jones & Associates, Inc. 2015).

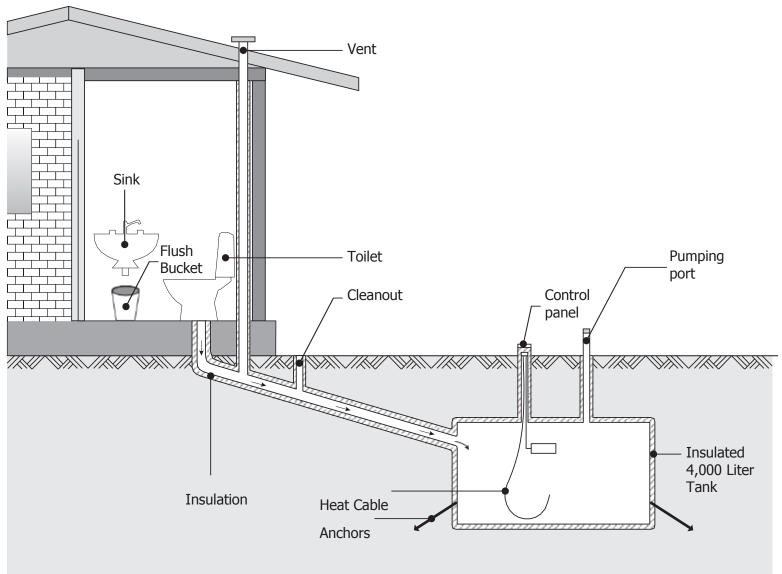

Figure A5-11: Low Flush Toilet with Off-Set Buried Holding Tank

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The user interface is connected by pipe to a watertight vault (holding tank) rather than a soak pit (Figure A5-11). As in other types of flush toilets, if the toilet has a water seal or a cistern, then it must be in a heated enclosure, such as a room in a house, or the water could freeze and damage the fixture.

The vault can be above ground or buried, and only contains the waste, without treating it. The vault must be protected from freezing by insulation or added heat, or by burial below the depth of soil freezing. The vault cannot be emptied of frozen waste. Also, liquid expands when it freezes, and the expansion could damage the vault. All tanks should be equipped with a mechanism for emergency thawing, as well as access points for maintenance. Pipes must be insulated to prevent freezing (GV Jones & Associates 2014).

Holding tanks can be used at the household level, or can serve a small group of households. However, such communal holding tanks are only feasible where the volume of wastewater is enough carry the solids through the longer pipes. When the tank is full, it is emptied usually by a mechanized device such as a vacuum truck. Its contents (blackwater from flush toilets and greywater from other household uses) are conveyed to a treatment facility or designated disposal site. The tanks must be accessible for vehicles, and can be equipped with quick connection couplings to allow the pumping truck to minimize spillage.

These systems are expensive to construct and operate. The tanks must be kept from freezing by being heavily insulated, having heat added, or being located under or next to the house. A fleet of appropriate vehicles must be purchased, maintained, and fueled. In addition, facilities for treatment or safe disposal will be required.

Double Pit Pour Flush Toilets

Double pit pour flush latrines are not recommended for use in cold regions because of the risk that the contents of pits and pipes will freeze. These facilities consist of a manually flushed toilet connected by pipe to two shallow pits (Figure A5-14). The pits are used sequentially, one at a time; when the first pit is full the second is brought into use. By the time the second pit is full the contents of the first pit will have decomposed, and many of pathogenic organisms destroyed. The first pit is then emptied and the pit reused while the contents of the second pit decompose. This cycle can be repeated many times.

However, the pits are usually shallower than for a pour-flush toilet with one pit, and the connecting pipework longer. Both these factors will make protection against freezing more challenging. Moreover, since the pipes are longer, double pits generally require higher volumes of flush water than single pour flush latrines, so the pits need to be larger to accommodate a greater volume of wastewater generated during the cold season. Because the biological treatment slows and stops during the cold season, the sludge emptied from the pits will require additional treatment before it is safe for reuse or disposal.

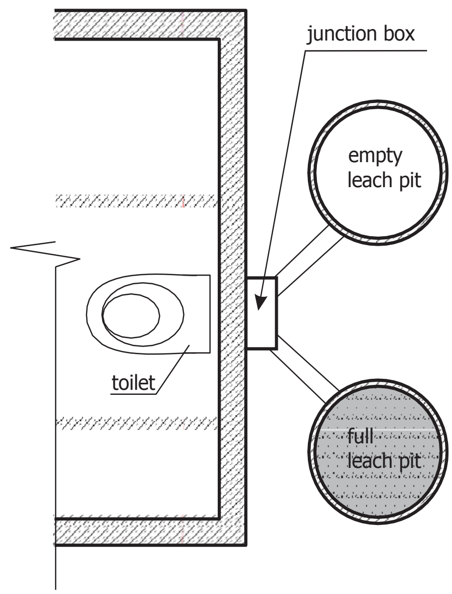

Figure A5-12: Double Pit Pour Flush Sanitation Facility – Plan View

Source: Adapted from © Eawag. Used with the permission of Eawag. Further permission required for reuse.

Other Sanitation Technologies

Flush Toilet with Septic System

In moderately cold climates, flush toilets with septic systems that empty to leach fields or leach pits may be an option. In climates as intensely cold as Ulaanbaatar's, household-level septic tanks are likely to be prohibitively expensive because of the cost of preventing the freezing of their contents. The contents are likely to freeze unless heat is added, and freezing can damage the tank. Leach fields will also freeze, so liquids cannot seep into the soil unless the field is buried below the depth of freezing. Freezing can cause effluent to back up into the tank, with disastrous consequences for the system. Similarly, liquid in soakpits will not infiltrate into the soil unless the pit extends below the depth of freezing. Moreover, the pit will act as a conduit for the cold, so the soil around the pit will freeze to a greater depth than undisturbed soil.

Sewers

The Ger areas have a relatively low population density and are very extensive. Piped water supply networks are unavailable for the great majority of households, and most households use less than 11 liters per capita per day of water. This amount of water is insufficient to move solid wastes through sewer pipes.

Providing sewers for the extended Ger areas would be technically very complex and prohibitively expensive, even if there were enough wastewater for sewers to function. To avoid freezing in climates such as Ulaanbaatar's, conventional sewers must often be buried deeply, below the depth of soil freezing.

This is especially true for long pipelines with low flows, in which heat losses can be very great. In Ulaanbaatar, the average depth of soil freezing is about 4 meters, and a number of households are on hillsides or near streambeds. Deep burying can be very expensive, and can also be difficult on hillsides where bedrock is often close to the surface, or in valleys where the groundwater can be close to the surface. These factors make sewerage a costly, unsuitable option for the Ger areas that have not been redeveloped.

Alternate sewer systems (e.g., condominial sewers, pressure sewers, vacuum sewers, and small diameter sewers) and settled sewage systems are vulnerable to freezing. They are often not buried at great depth, have smaller diameters and shallower gradients, and some operate with small volumes of wastewater. These factors make them prone to freezing, and adding heat by heat cables or other means is very costly, so they cannot generally be recommended.

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