SFD Report

Bardibas Municipality
Nepal

Final Report

This SFD Report - SFD level 2 - was prepared by
Environment and Public Health Organization (ENPHO)

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SFD Report Bardibas Municipality, Nepal, 2023

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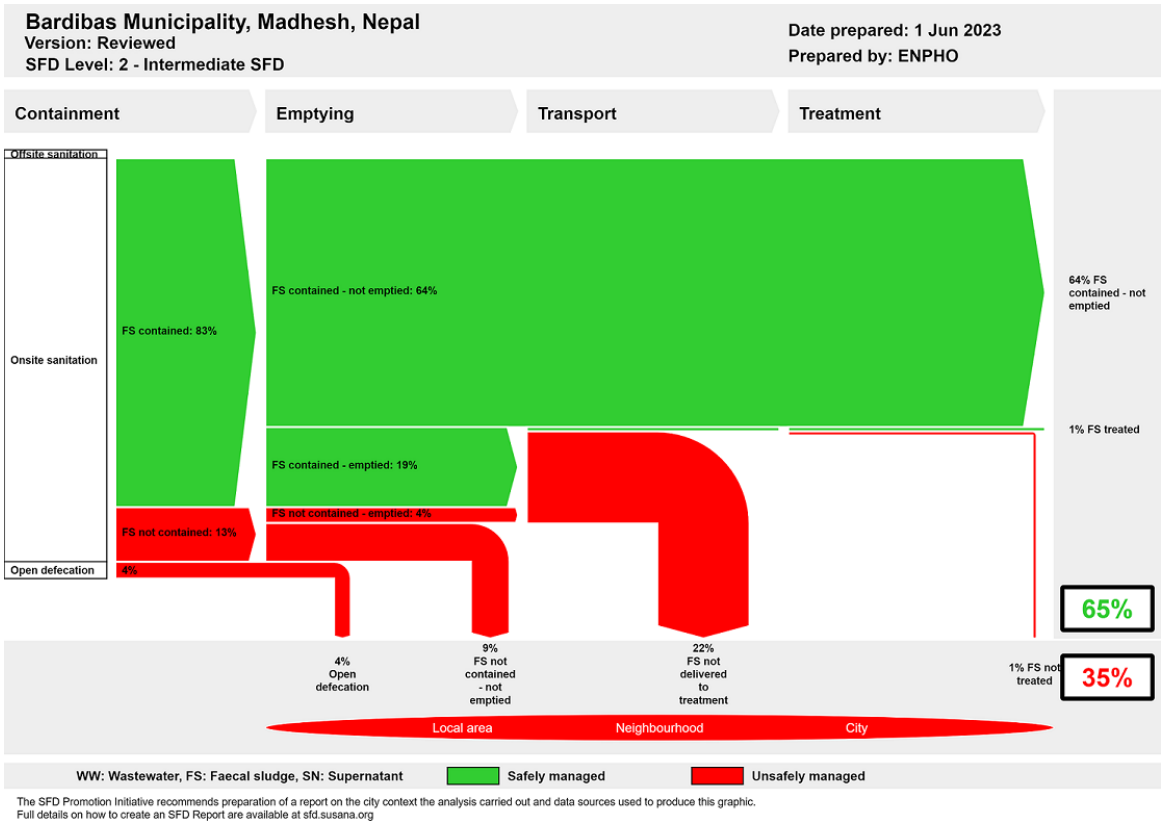
1. The SFD Graphic



The SFD Promotion Initiative recommends preparation of a report on the city context the analysis carried out and data sources used to produce this graphic.
Full details on how to create an SFD Report are available at sfd.susana.org

2. Diagram information

SFD Level:

This SFD is a level 2- Intermediate report.

Produced by:

Environment and Public Health Organization (ENPHO).

Collaborating partners:

Bardibas Municipality, Municipal Association of Nepal (MuAN), United Cities and Local Government- Asia Pacific (UCLG- ASPAC).

Status:

Final SFD report.

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3. General city information

Bardibas Municipality is located in Mahottari District, Madhesh Province of Nepal. It has total 14 wards and covers the area of 315.57 square kilometres. It is surrounded by Kamalamai Municipality of Sindhuli District in North, Aurahi and Bhangaha Municipalities in south, Dhanusha District in the east and Sarlahi District in the west.

According to national population and housing census 2021, Bardibas Municipality has a total population of 74,361 and 16,824 households. The total male and female are 36,711 and 37,650 respectively. The population density of the municipality is 236 people per square kilometre. Ward number 1 has the highest population of 9,198 while ward number 7 has the least population with 3,458 (NSO, 2023).

Bardibas Municipality has hot and wet summers and cool, wet winters. The average annual precipitation amounts to about 1,841 mm and relative humidity is 57%.

4. Service outcomes

The overview of different sanitation technologies across the sanitation value chain in the municipality is briefly explained in this section. All data in this section is from the household and institutional surveys conducted for this study (ENPHO, 2023). 96% of the households in the municipality have a toilet. The 4% of the households without toilet defecate in nearby farms and forest. The municipality has a public toilet in a bus park area. The public toilet was constructed by Bardibas Small Town Water Supply and Sanitation User's Organization and is operated by individual service provider.

Containment:

All of the households with access to a toilet rely on onsite sanitation technologies. 53% of the households have installed lined pits with semi-permeable walls and open bottom. Similarly, 24% and 18% of the households have constructed lined tanks with impermeable wall and open bottom and fully lined tanks instead of a technically appropriate septic tank. Only 1% of the households have a technically appropriate septic tank.

Emptying and Transportation:

According to the assessment of the sanitation situation of the municipality by ENPHO in 2022, only 29% of the households have emptied their containments at least once after used. 76% of these containments were emptied mechanically and the remaining were emptied manually. Private desludging service providers are engaged in emptying and transportation services of faecal sludge.

Treatment and Disposal:

There is no Faecal Sludge Treatment Plant (FSTP) within the municipality for FS treatment (KII_1, 2022). Thus, all emptied FS ends up in the environment untreated.

The SFD graphic shows that 65% of the excreta or faecal sludge generated are safely managed while 35 % are unsafely managed. The safely managed FS generated by 64% of the population is temporary as these FS is only contained. So once the containment gets filled and FS from the containment is emptied, the percentage of unsafely managed excreta would increase. The faecal sludge generated from 1% of the population is contained and safely treated in anaerobic biogas digesters.

The Bardibas Small Town Water Supply and Sanitation Users Organization is main water service provider in the municipality. The scheme serves approximately 5,398 households from ward number 1, 2, 3 and 14. The scheme consists of slow sand filter and chlorination unit to provide safe drinking water to its customers (KII_5, 2022).

Besides, water supply and sanitation committees exist in many community to supply drinking water through small scale water supply schemes.

5. Service delivery context

Access to drinking water and sanitation has been defined as fundamental rights to every citizen by the constitution of Nepal. To respect, protect and implement the rights of citizen embedded in the constitution, the Government of Nepal (GoN) has passed the Drinking Water and Sanitation Act, 2022 which has emphasized on a right to quality sanitation services and prohibited direct discharge of wastewater and sewage into water bodies or public places.

Several policies have been in place to accomplish the sanitation needs of people. Particularly, the National Sanitation and Hygiene Master Plan (NSHMP) 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all levels. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage in sanitation campaigns. The document adopted sanitation facilities as improved, basic, and limited in line with WHO/UNICEF guidelines. The draft Sector Development Plan (SDP) has envisioned the delineation of roles and responsibility of federal, provincial, and local government in an aim to initiate sustainability of Open Defecation Free (ODF) outcomes.

Bardibas municipal council has enforced Drinking Water Quality Monitoring Guideline, 2021 to ensure access to safe drinking water for all people in the municipality. It guides on the water quality testing parameter and procedures along with the steps (Bardibas Municipality, 2021a). However, there are no proper provision such as water quality testing, data keeping and

monitoring mechanism in municipality for implementation of the guideline (KII_1, 2022).

Moreover, Bardibas municipal council has approved Water Safe Communities Declaration Guideline, 2021 which minimum basis for water safe community declaration. Also, it guides for the institutionalization of the monitoring mechanism (Bardibas Municipality, 2021b).

6. Overview of stakeholders

Based on the regulatory framework for Faecal Sludge Management (FSM), the major stakeholders for effective and sustaining service delivery in the municipality are as presented in Table 1.

Table 1: Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply Department of Water Supply and Sewerage Management (DWSSM)
Public Institutions at Provincial Government	Ministry of Physical Infrastructure Development Water Supply and Sanitation Division Office (WSSDO)
Public Institutions at Local Government	Bardibas Municipality Office Bardibas Small Town Water Supply and Sanitation User's Organization
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Public toilet operators, Desludging service providers
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from random household sampling. Altogether, 375 households and 56 institutions were surveyed from 14 wards of the municipality on 23 September 2022. Primary data on current sanitation practices in the municipality are triangulated from Key Informant Interviews (KIIs) with municipal officials, public toilet operators, desludging service providers and water supply committee. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program on 29 December 2022.

8. Process of SFD development

Data on sanitation situation were collected through household and institutional survey (ENPHO, 2023). The local enumerators from each wards of the municipality were trained on all aspects of sanitation service chain starting from user interface, containment, emptying, transport, treatment, end use or safe disposal of excreta and the use of mobile application; *KoboCollect* was used for collection of data from households and institutions. Moreover, KIIs were conducted with officers and the engineer of the municipality, public toilet operators, desludging service providers and water supply service provider to understand the situation practices across the service chain. Types of sanitation technologies used in different locations were mapped using ARCGIS. To produce the SFD graphic, initially a relationship between sanitation technology used in questionnaire survey and SFD PI methodology was made. Then, data were fed in SFD graphic generator to produce the SFD graphic.

8. List of data sources

The list of data sources to produce this executive summary is as follows:

- MoWS. (2017a). Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal. Kathmandu,Nepal: Ministry of Water Supply.
- MoWS. (2022a). Water Supply and Sanitation Act. Ministry of Water Supply; Government of Nepal.
- Bardibas Municipality. (2021a). Drinking Water Quality Monitoring Guideline.
- Bardibas Municipality. (2021b). Water Safe Community Declaration Guideline.

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Abbreviations

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
CFU	Colony Forming Unit
DUDBC	Department of Urban Development and Building Construction
DWSSM	Department of Water Supply and Sewerage Management
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
HH	Household
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometers
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NGO	Non-Governmental Organization
NPC	National Planning Commission
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
NWSSP	National Water Supply and Sanitation Policy
ODF	Open Defecation Free
RWSSNP	Rural Water Supply and Sanitation National Policy
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD PI	Shit Flow Diagram Promotion Initiative
SFD	Shit Flow Diagram
SN	Supernatant
STWSSSP	Small Towns Water Supply and Sanitation Sector Project
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNICEF	United Nations Children's Education Fund
WASH	Water, Sanitation and Hygiene

1 City context

Bardibas Municipality is in Mahottari District, Madhesh Province of Nepal. It has a total of 14 wards and covers the 315.57 square kilometres of area. It is surrounded by Kamalamai Municipality of Sindhuli District in the north, Aurahi and Bhangaha Municipalities in the south, Dhanusha District in the east and Sarlahi District in the west. The emerging urban area of the municipality is located in a junction of national highways. Mahendra highway connects the east and the west of the Nepal and and the BP Highway connects the capital city Kathmandu to the east and west highway in Bardibas (Figure 1).

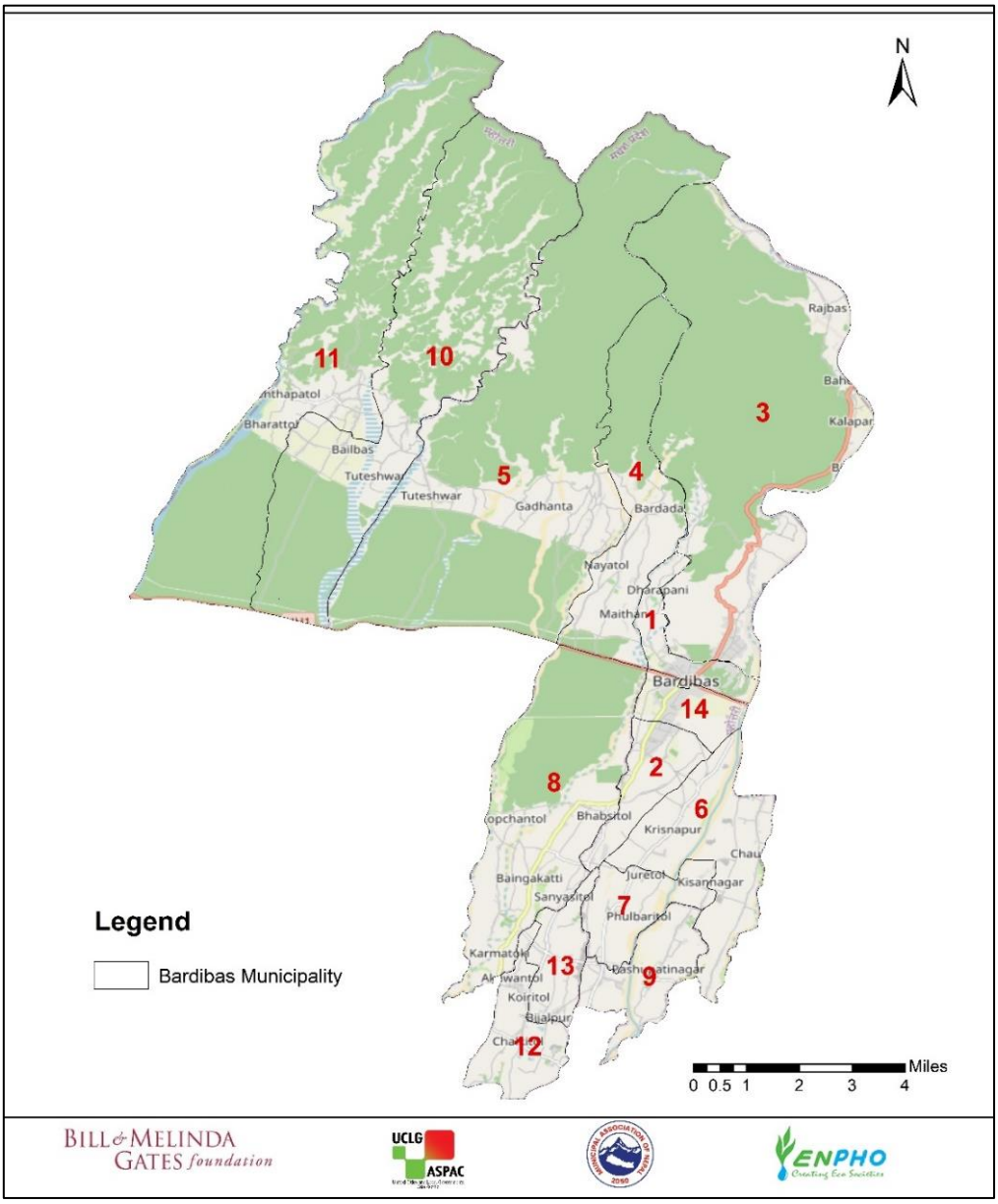

Figure 1: Map of Bardibas Municipality with ward boundaries,

1.1. Population

According to national population and housing census 2021, the municipality has total population of 74,361 and 16,824 households. The total male and female populations are 36,711 and 37,650 respectively. The population density is 236 people per square kilometre. Ward number 1 has the highest population of 9,198 (4,641 male and 4,557 female) and ward number 7 has the least population with 3,458 (1,723 male and 1,735 female) (NSO, 2023).

1.2. Climate

The municipality has hot, dry summers and cool, wet winters. Under the Köppen–Geiger climate classification Bardibas features monsoon-influenced humid subtropical climate (Cwa) (Mindat, n.d.). Figure 2 shows the absolute and average maximum and minimum yearly temperature obtained from Jaleshwar station since 1989 to 2016. The average maximum temperature is 33°C and average minimum temperature is 16°C.The average annual precipitation is 1,841 mm and relative humidity is 57 % (Bardibas Municipality, n.d.).

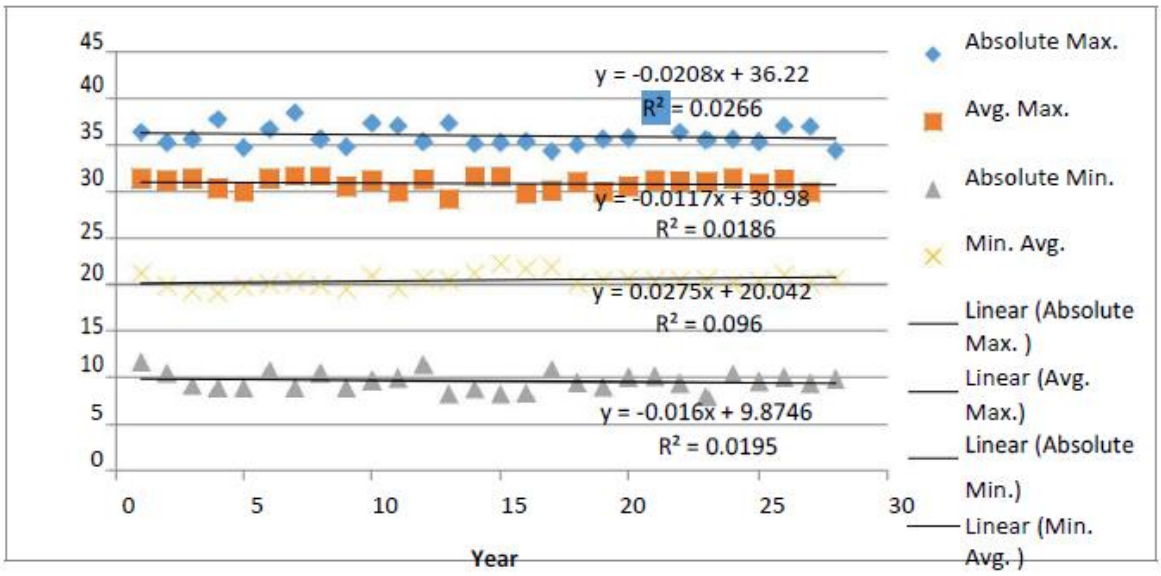

Figure 2: Absolute and Average Maximum and Minimum Yearly Temperature at Jaleshwar (1989-2016) (Shah, 2019).

1.3. Topography

The municipality is located at latitude: 26°54'6.84" to 27°08'46.90" and longitude: 85°47'42.67" to 85°56'42.97". The elevation ranges between 136 metres to 774 metres above mean sea level. A large area of the municipality consists of flat land with alluvial deposits while it also contains the Churiya hills in the north. Ratu River in the east north side of the municipality and situated in ward 3 is a major river flowing in the municipality. The municipality is located in the upper terai region of the Indo-Gangetic plain, with gravel, boulder, sand, and silty loamy soil that is highly fertile (MoUD, 2015). The Indo-Gangetic Plain consists of coarse sand, gravel,

pebble, cobble and boulders in the northern part (Bhabar zone) that becomes finer (up to gravel size) southwards (Pathak D, 2016).

2 Service Outcomes

2.1. Overview

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). A total of 375 households were sampled from 16,824 households distributed in fourteen wards (further details are presented in section 4). The results obtained after the triangulation and validation of the data with all the data sources including literature reviews, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

Particularly over the past 20 years, sanitation has been promoted in Nepal, which led to the nation as Open Defecation Free (ODF) nation on September 30, 2019, with the combine effort of the 3 tiers of the government (MoWS, 2020). The municipality was declared as an open defecation free municipality in May 26, 2017 (KII_1, 2022). However, the household survey reveals that 4 % of the households in the municipality do not have access to toilet and defecate in open spaces such as fields and forests.

2.1.1 Sanitation Systems in Households Building

The onsite sanitation refers to a sanitation technology or sanitation system in which excreta is collected and stored and emptied from or treated on the plot where they are generated (SuSanA, 2018). All the households with access to toilet in the municipality rely on onsite sanitation systems.

Table 1 shows the percentage of households with different types of containment in the municipality.

Table 1: Types of containment in households building in Bardibas Municipality (ENPHO, 2023).

Containment	Wall construction materials	Bottom of containment	Chamber	Number	Connected to	%	Recategorized as SFD	%
Septic Tank	Cemented walls or cemented block / stone wall	PCC or plastered	Two or more than Two	NA	soak pit	1%	Septic Tank	1%
Biogas Digester						3%	Fully lined tank	18%
Fully lined tank	Cemented walls or cemented block / stone wall	PCC or plastered	One or Two	NA	No outlet / overflow	15%		
Lined tank with impermeable wall and open bottom	Cemented walls or cemented block / stone wall	Soiling / nothing	One, Two or More than Two	NA	Open ground No outlet/ overflow	24%	Lined tank with impermeable wall and open bottom	24%
Single pit	Concrete rings piled one	Soiling/ nothing	NA	One	NA	50%	Lined pit with semi-permeable wall and open bottom	53%
Twin pit	Concrete rings piled one	Soiling / nothing	NA	Two	NA	3%		
Open Defecation						4%		4%

An anaerobic biogas digester has been installed in 3% of households to treat the household organic waste and generate energy. Also, excreta from toilet is connected to these digesters along with the cow dung and other organic solid waste, The capacity of these digester 4 m^3, 6 m^3 and 8 m^3. The home biogas digesters are small on-site waste systems that use a process called anaerobic and replace conventional septic systems (Water Online, 2015). The biogas digesters are reclassified as fully lined tanks (sealed) which are regularly emptied, and the Faecal Sludge (FS) is treated for properly functioning digesters (Figure 3).

Alternative Energy Promotion Centre (AEPC) in collaboration with the municipality and private sector is promoting the installation of the household biogas digester. Currently, 50 to 100 biogas digesters are being installed every year. However, the households connecting their toilet waste into the digester is limited (KII_6, 2022).

Figure 3: Biogas digester in households.

A well-designed septic tank is installed in 1% of households. The septic tank is a properly designed technology with sealed wall and bottom having at least two chambers and the effluent discharged into a soak pit or sewer network. Fully lined tanks are constructed by 15% of the households and lined tanks with impermeable walls and open bottom are constructed by 24% of the households.

Single pits are popular in the municipality. More than half of the households (50%) have single pits. The single pits are onsite technologies made from pre-cast concrete rings. There is no lining between rings and allows infiltration from both walls and bottom. These pits are categorized as lined pits with semi-permeable walls and open bottom for the preparation of SFD graphic.

Twin-pits are an upgraded version of pit latrines that allow for the safe treatment and conversion of fecal sludge into a beneficial soil amendment. They basically consist of two pits which are linked, using a Y-junction at a minimum horizontal distance of 1.2m. Only one pit is used at a time, with the other resting while the first is in use. During storage, excreta undergoes decomposition through a combination of anaerobic digestion and composting processes. The end product is sanitized and can be utilized as compost to enhance soil quality, water retention capacity, and fertility. This process usually takes around two years (Elizabeth Tilley, 2014).

3% of the households have constructed twin pits (Figure 4). However, most twin pits installed by the households are not as per the design. The minimum distance between two sets of pits is not maintained. Also, the connection pipes to the pits are in series. Thus, these pits function only as lined tanks with semi-permeable walls and open bottom. Figure 4 shows the design of twin pits and pits installed at household level. In areas where the groundwater table is high or there is a risk of frequent flooding, the twin pit system may not be appropriate since the leachate

may hinder the dewatering process, particularly in the resting pit. Therefore, it is recommended to use this system only in areas with a low groundwater table (Elizabeth Tilley, 2014).

Figure 4: Inappropriate design of the twin pits.

Figure 5 shows a map of the households with the types of containment observed in the survey.

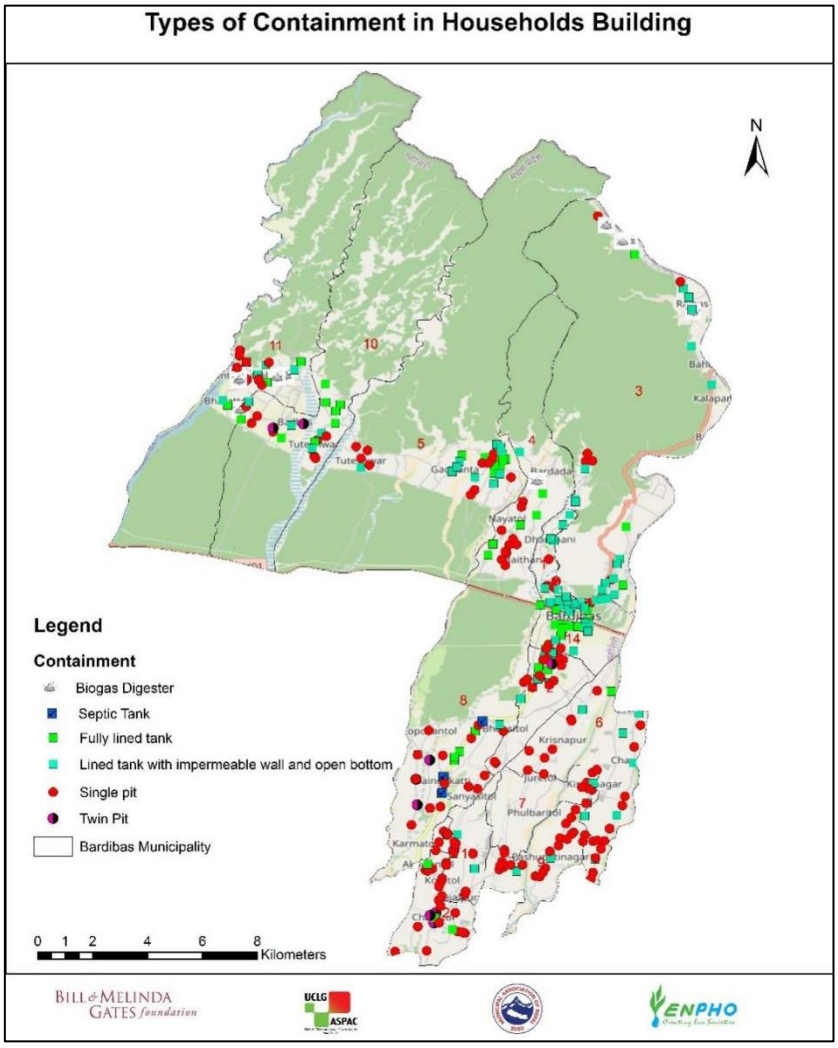

Figure 5: Map showing the households with the types of containments in Bardibas Municipality.

2.1.2. Sanitation Systems in Institutional building

All institutional buildings (56 institutions) surveyed have been connected waste from toilet into onsite sanitation technologies. The fully lined tank is a popular onsite sanitation technology in institutions. 7% of the institutional buildings have constructed technically appropriate septic tanks. Figure 6 shows the different sanitation technologies available in the institutions of Bardibas Municipality.

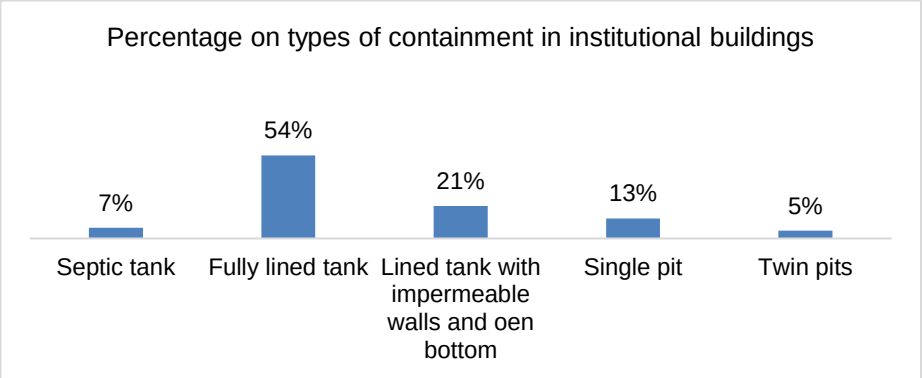

Figure 6: Types of containment in the institutional building of Bardibas Municipality.

Figure 7 shows a map locating surveyed institutional buildings and types of sanitation technologies.

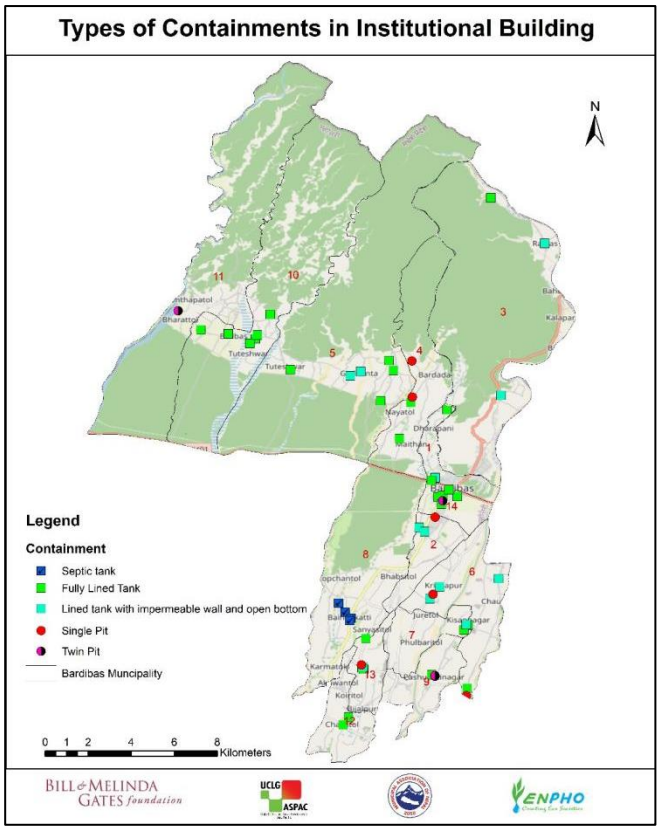

Figure 7: Map locating institutional building with types of sanitation technologies.

2.1.3. Public Toilet

There is a public toilet in buspark of the municipality (Figure 8). It was constructed by Bardibas Small Town Water Supply and Sanitation User's Committee. The operation and maintenance of the toilet is leased to private sector. The toilet is connected to a fully lined tank. It is emptied

every once a week. The water required for cleaning the toilet is fulfilled from a tap connected to Bardibas Small Town Water Supply and Sanitation User's Committee.

Figure 8: The Public toilet in Bardibas Municipality.

2.1.4. Emptying and Transport

Emptying and transporting faecal sludge is an essential service for proper functioning of onsite sanitation technologies (Linda Strande, 2014). Only 29% of the households have emptied their containments at least once since it was used. Among these households, 76%, have emptied them mechanically while the rest rely on self-manual emptying or traditional sanitation workers.

Poor emptying practices can lead to direct exposure of person involved in emptying activities to pathogens (WHO, 2018). Private desludging service providers and traditional labour are engaged in desludging. Two private desludging service providers have their main service area in the municipality and more than 5 desludging service providers come from neighbouring municipalities (KII_3, 2022) (KII_4, 2022). The service providers are informal as these services have not registered in any government agencies (Figure 9).

Figure 9: Faecal sludge desludging service providers.

2.1.5. Treatment and Disposal

The municipality does not have a faecal sludge treatment plant. The mechanically emptied faecal sludge is disposed of in farmlands and nearby forest areas (KII_3, 2022) (KII_4, 2022). Manually emptied FS is either mixed with organic solid waste at household level without following any procedure to produce quality compost manure or directly applied into farmland or discharged into water bodies. The direct use of faecal sludge has the highest level of risk for human health, therefore not recommended to practice it (Strande et. al., 2014). Thus, the handling of the manually emptied FS in the municipality in unhygienic and possess risk to human health.

2.1.6. Risk Assessment of Groundwater Pollution

The risk of groundwater pollution is assessed based on source of drinking water, secondary data on water quality and the vulnerability of the aquifer with regards to lateral spacing between sanitation system and groundwater sources.

a. Sources of Drinking Water

The Bardibas Small Town Water Supply and Sanitation Users Organization is the main water service provider in the municipality. The organization was established in 2001. To enhance functionality of the water supply schemes, Small Towns Water Supply and Sanitation Sector Project (STWSSSP) was implemented for improvements/ rehabilitation works within the service area. It was funded by Asian Development Bank (ADB) and executed by the Ministry of Urban Development and implemented by Department of Water Supply and Sanitation (DWSS) (KII_5, 2022).

The main source of water supply of STWSSSP is Ratu River, which flows from North to South spreading throughout the municipality. The water supply scheme is based on the gravity flow system. It has provided drinking water for wards 1, 2 and 14 completely and partially at ward 3. Approximately 5,398 taps have been installed till the end of 2022 (KII_5, 2022). The system consists of 5 reservoir tanks with a total capacity of 1.1 million litres. The scheme consists of slow sand filtration and chlorination unit. Moreover, the water supply users committee (WSUC) such as Baba Tuteshwar, Gadanta in ward 5, Maithan in ward 4 and 5, Khayarmara in ward 10 and 11, Hathilet in ward 8 have been providing the drinking water services.

16% of households rely on dug wells, hand pumps, tube wells or deep boring in ward numbers 8, 9, 12, 13 (ENPHO, 2023). Also, in many communities, households from a source as shown in Figure 10, convey water through pipelines.

Figure 10: Groundwater use in community level in the municipality.

b. The vulnerability of the aquifer and lateral spacing between sanitation systems and groundwater source

The term aquifer pollution vulnerability is intended to represent the varying level of natural protection afforded by the contaminant attenuation capacity of the unsaturated zone or semi-confining beds above an aquifer, because of physicochemical processes (filtration, biodegradation, hydrolysis, adsorption, neutralization, volatilization, and dispersion) all of which vary with their texture, structure, clay content, organic matter, pH, redox and carbonate equilibria. Groundwater vulnerability is specific to containment type and pollution scenarios (Andreao, 2013). Here, among the various types of onsite sanitation technologies, lined tanks with impermeable walls and open bottom and lined pits are more prone to aquifer pollution as the nature of such containments impose more containment load from the land surface to groundwater.

A key determinants of risk variation of the groundwater are the soil and geological setting. The size of pores in the soil determines the infiltration rate. In the sandy loam soil, the permeability is approximately 2.5 cm per hour (FAO, n.d.). Thus, between 25 and 50 days the pollutant could travel to the depth of approximately 30 metres (98.67 feet) in sandy loam soil. Hence, the people using open bottom tanks and consuming water from the handpumps with the depth up to 100 feet (30.48 m) and horizontal distance of the pump within 25 feet (7.62 m) from the source of pollutants are assumed at significant risk to groundwater pollution.

Figure 11 demonstrates the depth of hand pumps and dug wells and horizontal distance of it with the containment type lined pit with semi-permeable walls and open bottom. Out of the total of households using pits (53%), 14% depend on groundwater for drinking purposes. Among these households, 76% are at high risk of groundwater contamination as the water pumped through handpumps in these households and using the dug wells i.e 76% of 14% = 11% (T2A5C10). Therefore, the rest of the 42% of the pits are located in areas of low risk of groundwater contamination (T1A5C10).

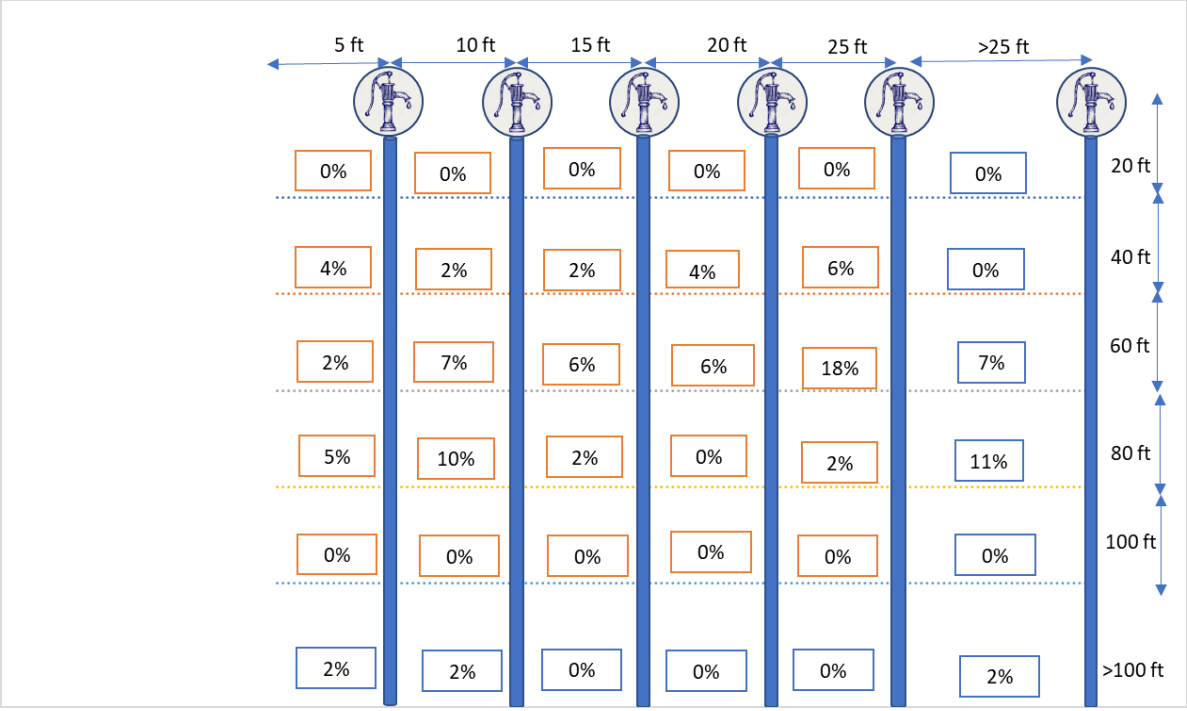

Figure 11: Depth of hand pumps and wells and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.

2.2. SFD Matrix

2.2.1. SFD Selection Grid

The SFD selection grid consists of the types of containment technologies in vertical column in List A, while top horizontal row (List B) consists of a list where each of containment technologies are connected to. The existing containment technology was classified to fit in the SFD grid.

Prior to selection of containment technologies, single pits constructed by assembling pre-cast concrete rings one above another is categorized as lined pit with semi-permeable walls and open bottom. Also, anaerobic biogas digester is categorized as a fully lined tank, which is regularly emptied and treated, as the technology can treat the Faecal Sludge (FS).

The various types of sanitation technologies selected for the SFD graphic generator are shown in the SFD selection grid, as shown in Figure 12 and explained in Table 2.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution T1A2C5					
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution			T1A4C8		Significant risk of GW pollution T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable							T1B11 C7 TO C9		Not Applicable

Figure 12: SFD selection grid of Bardibas Municipality.

Table 2: Explanation of different variables and containment technologies selected in SFD selection grid (SuSanA, 2018).

SN	Variables	Explanation
1	T1A2C5	This is a correctly designed, properly constructed, fully functioning septic tank with an effluent outlet connected to a correctly designed, properly constructed, fully functioning soak pit. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, but since it is captured in the soak pit, all the excreta in this system is considered contained;
2	T1A3C10	A correctly designed, properly constructed and well maintained fully lined tank with impermeable walls and base. Since the tank is not fitted with a supernatant/effluent overflow this system is considered contained.
3	T1A4C8	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to open ground, the excreta in this system is considered not contained.
4	T1A4C10	This is a correctly designed, properly constructed and well maintained lined tank with sealed, impermeable walls and an open, through which infiltration can occur. Since there is not a 'significant risk' of groundwater pollution, the excreta of this system are considered contained.
5	T1A5C10	This is a correctly designed, properly constructed and well maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow so this system is considered contained.
6	T1B11 C7 TO C9	With no toilet, users defecate in water bodies, on open ground and to don't know where; consequently, the excreta is not contained.
7	T2A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.

2.2.2. Proportion of the FS contents of each type of onsite container which is faecal sludge

A detailed instruction from the SFD PI was used as guide to calculate the proportion of the contents of each type of onsite container which is faecal sludge. It stated that the default "100%" value should be used where onsite containers are connected to soak pits, to water bodies or to open ground.

.

This will model the contents as 100% faecal sludge and a proportion of this may be emptied periodically. The remaining not emptied fraction is made up of one or more of the following: faecal sludge which remains in the container, supernatant (when discharging to water bodies or to open ground), and infiltrate. Where onsite containers are connected to a sewer network or to open drains, a value of "50%" is used which means that half the contents are modelled as faecal sludge; a proportion of this may be emptied periodically. The remaining not emptied

fraction will comprise faecal sludge which remains in the container and, in the case of open bottomed tanks, infiltrate. The other half of the contents is modelled as supernatant discharging into the sewer network or to open drains. The formula used for faecal sludge proportion calculation is shown below:

$$\frac{(onsite\ container\ connected\ to\ soak\ pit,\ \ no\ outlet\ ,\ \ water\ bodies\ or\ \ \ open\ ground) * 100 + (onsite\ container\ connected\ to\ sewer\ network\ or\ open\ drain) * 50}{onsite\ containner}$$

The proportion of FS in septic tanks, fully lined tanks, lined tanks with impermeable walls and open bottom and all types of pits was set to 100 % according to the relative proportions of the systems in the municipality, as per the guidance provided by SuSanA.

2.2.3. SFD matrix

SFD matrix is a table which contains the means to calculate the variables for each of the sanitation systems chosen in the SFD selection grid. It comprises of list of possible containment technologies in the first column and list of all possible places to which the containment technology could be connected in the top rows. Figure 13 shows the SFD matrix of Bardibas Municipality.

The sanitation technologies and the corresponding percentage of the population using such technologies are shown in Figure 13. These values are derived from the HH survey (ENPHO, 2023) and KIIs with desludging service providers (KII_3, KII_4, 2022).

Bardibas Municipality, Madhesh, Nepal, 1 Jun 2023. SFD Level: 2 - Intermediate SFD Population: 74361 Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 1				
Containment				
System type	**Population**	**FS emptying**	**FS transport**	**FS treatment**
	Pop	**F3**	**F4**	**F5**
System label and description	Proportion of population using this type of system (p)	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A2C5 Septic tank connected to soak pit	1.0	53.0	0.0	0.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	18.0	22.0	21.0	95.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	22.0	5.0	0.0	0.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	2.0	40.0	0.0	0.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	42.0	32.0	0.0	0.0
T1B11 C7 TO C9 Open defecation	4.0			
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	11.0	27.0	0.0	0.0

Figure 13: SFD matrix of Bardibas Municipality.

2.2.4. Calculation of proportion of FS emptied from containment (Variable F3)

The proportion of faecal sludge emptied (F3) is calculated based on percentage containment emptied (ENPHO, 2023) and amount of FS emptied during the process (KII_3, KII_4, 2022).In average, 80% of total faecal sludge from the containment is emptied during emptying mechanism as per household survey conducted. Thus, actual emptied proportion of faecal

sludge was taken as 80% of the emptied containment. Hence, the proportion of FS emptied from the sanitation technology is calculated as 80% on the sanitation technology emptied.

As biogas digester have been considered as fully lined tank while preparing the SFD graphic, the emptied proportion includes the % of biogas digester emptied. Out of 3% of biogas digester, 40 % of the biogas digester is working properly. So, it was considered that FS from only 40% of functional biogas is treated. The emptied % of the fully lined tank no outlet or overflow mentioned in table 3 is sum of the emptied proportion of biogas digester (5.9%) and fully lined tank (22%). Table 3 shows the calculation of variable F3.

Table 3: Actual emptying proportion for existing containment technologies (ENPHO, 2023 [(1)]; KII_3 and KII_4, 2022[(2)]).

SN	Reference Variables	Containment technologies	Percentage of emptied containment [(1)]	Emptied proportion of FS [(2)]	Actual proportion of emptied FS (F3)
1	T1A2C5	Septic tank connected to soak pit	66.7%	80%	53%
2	T1A3C10	Fully lined tank (sealed), no outlet or overflow	27.9%	80%	22%
3	T1A4C8	Lined tank with impermeable walls and open bottom, connected to open ground	50.0%	80%	40%
4	T1A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow	6.0%	80%	5%
5	T1A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	40.4%	80%	32%
6	T1B11 C7 TO C9	Open defecation	0.0%	80%	0%
7	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	34.0%	80%	27%

2.2.5. Calculation of FS emptied delivered to treatment plant and treated (Variables F4 and F5)

3% of households in the municipality have been using the biogas digesters which have been included as a fully lined tank (sealed) containment while preparing the SFD graphics. 40 % of the biogas digesters are functional. The cow dung has been fed into a 4 m^3, 6 m^3 and 8 m^3 capacity of digester to mix with faecal sludge for biogas production. The home biogas digesters are small on-site waste systems that use a process called anaerobic and replace conventional septic systems (Water Online, 2015)

The actual emptied fully lined tanks with no outlet and biogás digestor is 22% (F3 = 22%). Among them, 21% are biogas digesters that have been used by households. Thus, this

proportion has been considered as transported to treatment plant (F4 = 21%). Then, 95% of the households who have been using biogas digester has been considered as treated (F5 = 95%). However, there is no Faecal Sludge Treatment Plant (FSTP) within the municipality for FS treatment (KII_1, 2022).

2.3. Summary of Assumptions

Offsite sanitation System:

- ✓ There is not any sewer network hence all households in the municipality depend on onsite sanitation in Bardibas Municipality.

Onsite Sanitation System:

- ✓ The proportion of FS in septic tanks was set to 100%, the proportion of FS in fully lined tanks was set to 100% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 100% according to the relative proportions of the systems in the municipality, as per the guidance given in the Frequently Asked Question (FAQs) in the sustainable Sanitation Alliance (SuSanA) website.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the HH survey and cross-checked with KIIs conducted.
- ✓ The municipality does not have any form of treatment plant to treat faecal sludge. Also, the people using twin pits reclassified as lined pits with semi-permeable walls and open bottoms are not using them properly. The FS emptied from the containments is dumped openly in farmland or water bodies. Thus, variables F4 and F5 for all sanitation systems are set to 0%. However, FS from anaerobic biogas digesters, classified as fully lined tanks (system T1A3C10), is considered as transported (F4 = 21%) and treated with a treatment efficiency estimated at 95% (F5 = 95%).

2.4. SFD Graphic

Figure 14 represents the fate and flow of wastewater (WW), faecal sludge and supernatant through each sanitation service chain. It shows that FS generated from 65% of the population is safely managed represented by “Green” colour arrow head. However, 64% resembles the FS stored in the containment without significant risk to groundwater pollution. However, the safely managed percentage of FS generated by this 64% of the population is temporary until the FS from the containment is emptied. Therefore, these systems will require emptying services in the short and medium term as they fill up. Only 1% of the population have treated the FS using biogas digesters.

The FS and supernatant from 35% of the population is unsafely managed, represented by “Red” arrow heads. The percentage of unsafely managed is generated from FS emptied but not delivered to treatment plant (22%), FS from containments where FS is not contained - not emptied (9%) and people practising open defecation (4%).

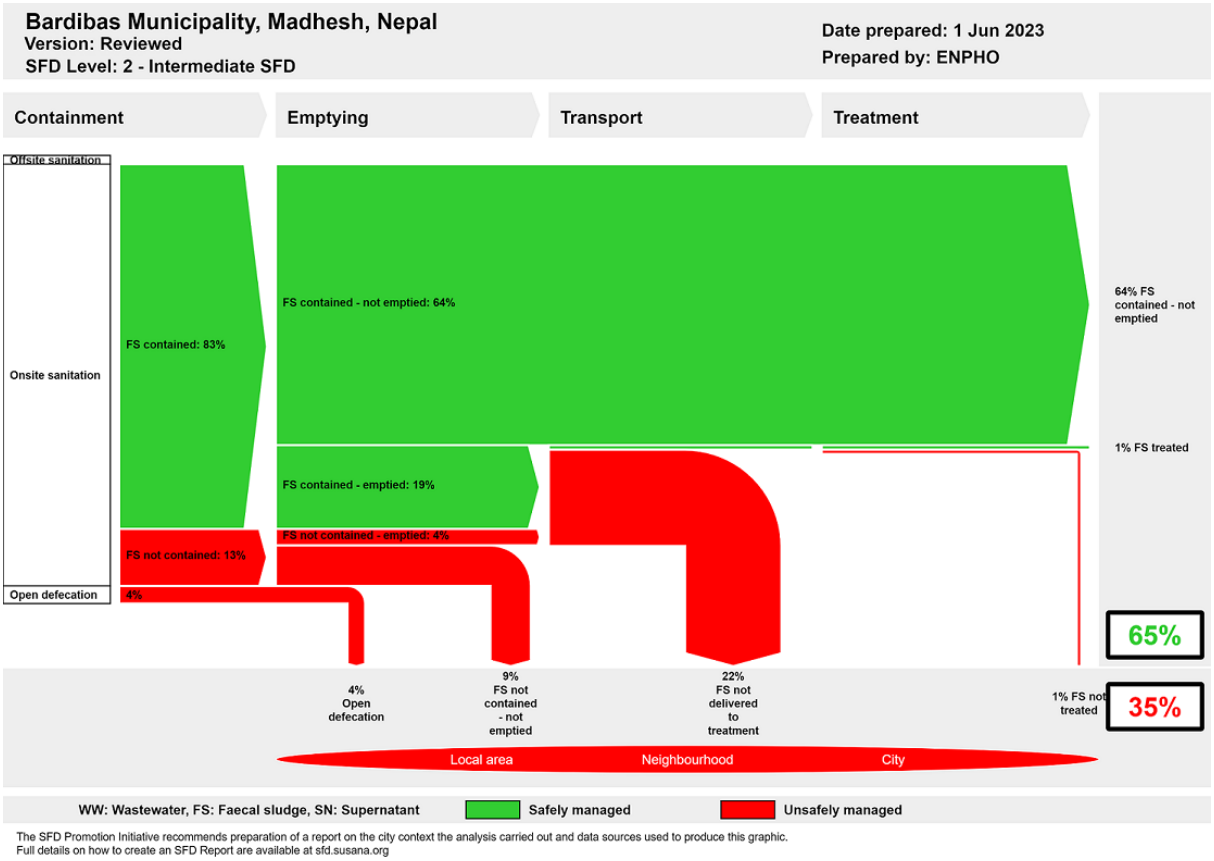

Figure 14: SFD graphic of Bardibas Municipality.

All of the population with access to toilets relies on onsite sanitation systems. As shown on the SFD Graphic (Figure 14), it is estimated that 83% of the population uses systems where the FS is considered contained, while 13% of the population uses systems where the FS is considered not contained.

FS contained

The definition of 'FS contained' is faecal sludge contained within an onsite sanitation technology which ensures safe level of protection from excreta i.e. pathogen transmission to the user or general public is limited. These are tanks or pits that are correctly designed, properly constructed, fully functioning, and/or are causing no risk or only a 'low' risk of polluting groundwater used for drinking (SuSanA, 2018). The value is the summation of the percentage of population using septic tanks connected to a soak pit (T1A2C5), fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10). Thus, the FS generated by 83% of the population is considered contained.

FS not contained

The definition of 'FS not contained' is faecal sludge contained within an onsite sanitation technology which does not ensure safe level of protection from excreta i.e. pathogen transmission to the user or general public is likely. These are tanks or pits that are incorrectly designed, or poorly constructed, or poorly functioning, and/or are causing a 'significant' risk of polluting groundwater used for drinking (SuSanA, 2018).

The value is obtained from the summation of percentage of population using lined tanks with impermeable walls and open bottom, connected to open ground (T1A4C8) and lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10). Thus, the FS generated by 13% of the population is considered not contained.

FS contained - emptied

The value of 19% is obtained from the proportion of the population using sanitation systems where the FS is contained and have emptied their containment.

FS not contained - emptied

The proportion of FS not contained emptied is the summation of the proportion of FS emptied from either technically appropriate or inappropriate containment with potential risk on direct contact with human or contamination of groundwater. Thus, the proportion of FS not contained and emptied is 4%.

FS not delivered to treatment

The municipality does not have treatment facility to treat faecal sludge. So, all the FS emptied from contained and not contained containments is disposed of into farmlands and forest. The proportion of FS not delivered to treatment (22%), is the summation of FS contained - emptied and FS not contained - emptied.

FS treated

The proportion of FS obtained from containments which has been transported to treatment and treated is 1%.

Open Defecation

The Bardibas Municipality was declared as an open defecation free municipality in May 26, 2017. However, 4% of the households are practising defecation at open environment. The toilets have not been constructed because cultural and behavioural factor in the community (KII_1, 2022).

3. Service Delivery Context

3.1. Policy, Legislation and Regulation

3.1.1. Policy

The Constitution of Nepal 2015 in Article 35 related to right to health recognizes citizen's rights to 'access to clean drinking water and sanitation'. In addition, Right to Clean Environment, Article 30 recognizes that every person shall have the right to live in a healthy and clean environment (GoN, 2015). To respect, promote and fulfil the provisions related to right on water and sanitation, Government of Nepal (GoN) has passed Drinking Water and Sanitation Act in 2022 through Ministry of Water Supply. The act elaborates right to clean water as to receive affordable, sufficient, and quality drinking water regularly as well as access to sanitation as affordable access to quality sanitation services (MoWS, 2022a).

Historically, the National Sanitation Policy (1994) was the guideline for the planning and implementation of sanitation programs. The policy had promoted sanitation issues together with issues on water supply in rural communities. Also, Rural Water Supply and Sanitation National Policy (RWSSNP) 2004, has set a new target to provide safe, reliable, and affordable water supply with basic sanitation facilities. The policy focused on delivering quality services on water and sanitation in the marginalized and vulnerable groups. Participatory approach, community leadership project development, optimization of local resources and installation of locally appropriate technologies were major principles in the policy (DWSSM, 2004). However, it was unable to address the complex operational issue of urban water supply and sanitation service delivery (DWSSM, 2009).Thus, National Urban Water Supply and Sanitation Sector Policy (NUWSSSP) was formulated and enforced in 2009. It focused on achieving coherent, consistent, and uniform approaches of development in urban areas with the involvement of different agencies and institutions. Cost recovery principles, public private partnership, and sector effectiveness for improved service delivery are key principles of the policy (DWSSM, 2009). Both these policies were limited to addressing emerging issues and challenges in the rural and urban areas. Thus, National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by the GON to address the emerging challenges and issues with the adoption of new approaches and resolve the inconsistency in RWSSNP and NUWSSSP. The goal of the NWSSP was to reduce urban and rural poverty by ensuring equitable socio-economic development, improving health and the quality of life of the people and protection of environment through the provision of sustainable water supply and sanitation services. It adopted innovative technologies and knowledge emerged in the sector. Remarkably, it was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted the surface water sources in urban areas.

Recently, National Water, Sanitation and Hygiene Policy, 2022 has been drafted and undergone the process for endorsement. The draft policy is updated policy till date which has included the wide range of the sanitation services including treatment, reuse/ safe disposal of faecal sludge / wastewater. It emphasizes on the preparation of the municipal level Water

Sanitation and Hygiene (WASH) plan with the local leadership to ensure the WASH services for all (MoWS, 2022b).

Nepal is a signatory of the historical resolution of 2010 United Nations General Assembly on the Human Right to Water and Sanitation (UNGA, 2010). Nepal committed to Millennium Development Goals (MDGs) for 2000- 2015. The goal was accomplished through declaration of the country as free from open defecation on 30th September 2019. National Sanitation and Hygiene Master Plan, 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional setup tier of government in a participatory approach. In an alignment total sanitation campaign was initiated formally to sustain ODF. The guideline set various indicators to assess the sustainability of sanitation services. Remarkably, it extended sanitation definition as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish the hygienic environment and promote public health (NPC, 2017).

Similarly, Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) was formulated in 2016 for sector convergence, institutional and legal reforms, capacity development and establishing coordination and harmonization in the sector. The SDP classified service system and delineated roles and responsibilities for effective and sustainable service delivery. The SDP highlighted that majority of households rely on onsite sanitation system (70%) that requires effective treatment of faecal sludge. However, there is lack of concrete policies, guidelines, and indicators on Faecal Sludge Management (FSM) in the sector for effective planning, implementation, and service delivery. In alignment, Ministry of Water Supply through its Department of Water Supply and Sewerage Management (DWSSM) articulated and endorsed Institutional and Regulatory Framework (IRF) for Faecal Sludge Management in Urban Areas of Nepal in 2017. The main objective of the IRF is to define the specific roles and responsibilities of key institutions for the effective management and regulation of FSM. It is framed upon existing laws such as Environmental Protection Act (2019) and Environmental Protection Rules (2020), Self-Local Governance Act and Rules 1999, Environmental Standards on Effluent Discharge 2000, Nepal National Building Code 2003, and Land Acquisition Act amendment 2010 (MoWS, 2017a). The framework primarily envisioned featuring FSM in the national policy and issuing policy directives into local government to incorporate FSM in their urban planning along with strengthening and enhancing the capacity of the local government to deliver effective services. A local government has been endowed with overall responsibility to plan, implement, and regulate the FSM services within its jurisdiction. The provision of the ability to engage the private sector and other relevant stakeholders such as Water and Sanitation Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

The constitution of Nepal has provided the right for local government to form acts, rules and regulation based on the national policies and laws. Local Governance Operation Act 2017 has been formed to implement the right of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act has

mentioned the right, roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level.

Bardibas municipal council has approved Drinking Water Quality Monitoring Guideline, 2021 to ensure the access to safe drinking water for all people in the municipality to achieve the sustainable development goal. The guideline has provision to use operational monitoring, compliance monitoring, water quality surveillance to ensure whether the water supply service providers have distributed drinking water as per the national drinking water quality standard considering the public health or not. It guides on the water quality testing parameter and procedures along with the steps for implementation of water safety plan (Bardibas Municipality, 2021a). However, there are no proper provision for implementation of the guideline (KII_1, 2022).

Moreover, Bardibas municipal council has approved Water Safe Communities Declaration Guideline, 2021 to ensure the access to safe drinking water for all people in the municipality (Bardibas Municipality, 2021b). The specific objectives of the guideline are as follows:

a. Describe the minimum basis for water safe communities
b. Explain the procedure for water safe communities and its basis.
c. Accounting the stability of water safe community and institutionalization of monitoring mechanism in local level for regular monitoring and scientific and reliable process of certification.

3.1.2. Institutional Roles

Federal, provincial, and local government are entitled for implementation of water and sanitation programs to ensure the rights on access to safe water and sanitation.

At Federal Level

National Planning Commission: At the federal government, the National Planning Commission (NPC) is the specialized and apex advisory body for formulating a national vision, developing policy, periodic plans, and sectoral policies. The NPC assesses resource needs, identifies sources of funding, and allocates budget. It serves as a central agency for monitoring and evaluating development policy, plans and programs. It supports, facilitates and coordinates with federal, provincial, and local government for developing policy plans and implementation.

Ministry of Water Supply: Ministry of Water Supply is the lead ministry responsible for planning, implementation, regulation, and monitoring and evaluation of sanitation programs in the country (GoN, 2015). Under the MoWS, Department of Water Supply and Sewerage Management (DWSSM) plan and implement water and sanitation projects funded by foreign donors or inter provincial projects or serves at least 15,000, 5,000 and 1,000 people in terai, hilly and mountain region respectively (GoN, 2015). The organizational structure of DWSSM is shown in figure 15.

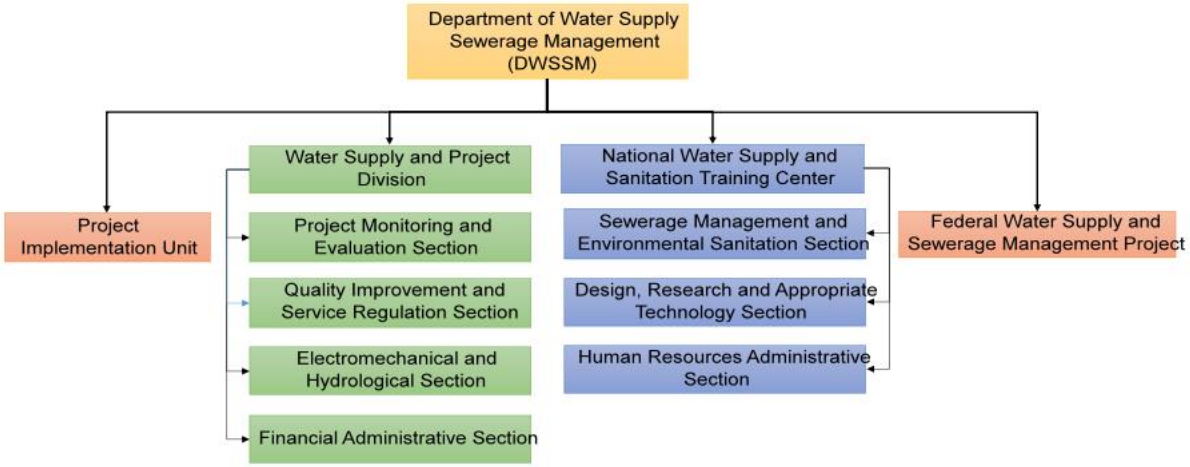

Figure 15: Organizational Structure Department of Water Supply and Sewerage Management.

Ministry of Urban Development: The Ministry of Urban Development (MoUD) works on integrated urban planning and development in municipalities, including faecal sludge management. DUDBC under MoUD is implementing body and sets standards for safe, affordable building construction and implementation for managed residential environment.

At Provincial Level

Ministry of Physical Infrastructure Development: Ministry of Physical Infrastructure Development of provincial government in Madhesh province is major executing body in the province. Planning and implementation of water supply and sanitation infrastructure is the province is executed through Water Supply and Sanitation Divisional Office (WSSDO). WSSDO implements the water and sanitation programs meeting the following criteria:

- Inter local government projects
- Beneficiaries between 5,000 to 15,000 in terai region, 3,000 to 5,000 in hilly region and 500 to 1,000 in Himalayan region.

At Local Government

Municipal council: The municipality consists of 7 section including a sanitation related sub section. The sanitation sub-section lies under the Infrastructure Development and Environmental management section. Figure 16 shows the organizational structure of the municipality. The municipality have contracted with private sector providing for solid waste collection service in the municipality.

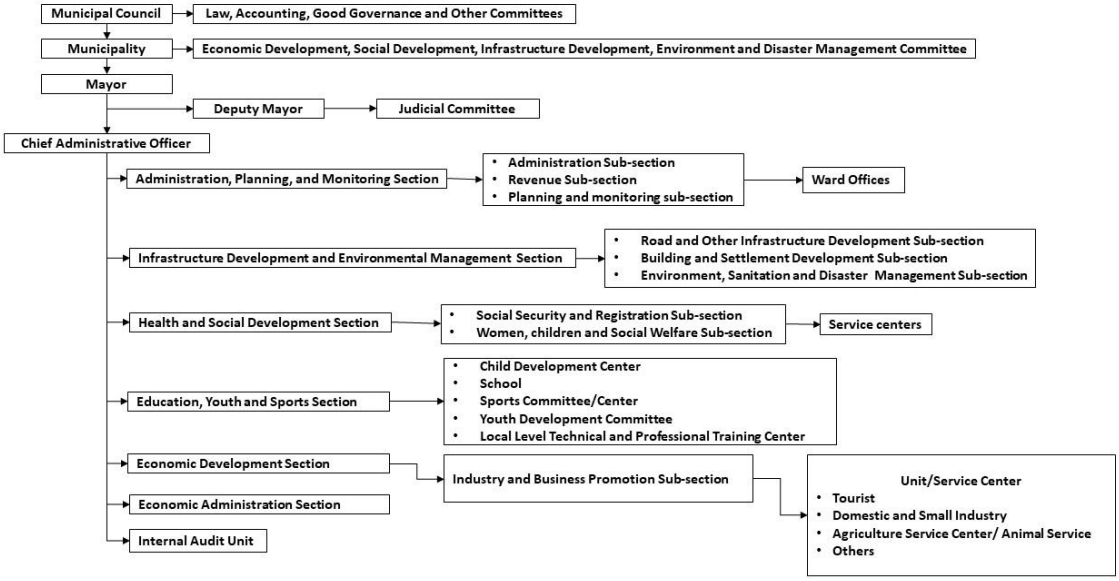

Figure 16: Organizational Structure of Bardibas Municipality.

3.1.3. Service Standards

The sanitation service standards have been set by Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030). It classifies sanitation services as high, medium, and basic based on sanitation facilities in place. The sanitation service levels with indicators are shown in Table 4. However, FSM specific standards have yet to be developed and implemented.

Table 4: Sanitation Service Level and its Components.

SN	Service Components	Service Level		
		High	Medium	Basic
1	Health and Hygiene Education	✓	✓	✓
2	Household Latrine	✓	✓	✓
3	Public and School Toilets	✓	✓	✓
4	Septic tank sludge collection, transport, treatment, and disposal	✓	✓	✓
5	Surface drains for collection, transmission, and disposal of greywater	✓	✓	✓
6	Small-bore sewer collection for toilet and septic tank effluent, low-cost treatment, and disposal		✓	
7	Sanitary sewers for wastewater collection, transmission, non-conventional treatment, and disposal	✓		
8	Sanitary sewers for wastewater collection, the transmission of conventional treatment and disposal	✓		

9	Limited solid waste collection and safe disposal	✓	✓	✓

4. Stakeholder Engagement

4.1. Key Informant Interviews (KIIs)

Key Informant Interviews (KIIs) are qualitative in-depth interviews with people who know what is going on in the community (Figure 17). The purpose of key informant interviews is to collect information from a wide range of people who have first-hand knowledge about the concerned topic. KIIs were conducted with environment and sanitation related stakeholders. The KIIs were conducted with municipal officials, local elected bodies, water supply service provider, and public toilet service provider. The face-to-face interview was conducted and called after the interview to get more required information. The information was collected with key stakeholders about the status of sanitation services and water supply schemes. List of key informant stakeholders from the municipalities along with their organization and purpose are as shown in Table 5.

Table 5: List of key stakeholders for KIIs.

KII code	Name	Designation	Organization	Purpose	Date
KII-1	Mishree Lal Yadav	Information Officer	Bardibas Municipality	Sanitation Status of Bardibas Municipality	23 September, 2022
KII-2		Public toilet operator	Private Sector	Status of public toilet	23 September, 2022
KII-3	Rakesh Mali	Desludging service providers	Private Sector	Faecal sludge desluding service	23 September, 2022
KII-4	Arun Panta	Desludging service providers	Private Sector	Faecal sludge desluding service	23 September, 2022
KII-5	Bidur Bhattarai	Manager	Bardibas small town water supply and sanitation organization	Water supply, coverage, treatment, water quality	28 December, 2022
KII 6	Tilak Shrestha	Chairperson	Nepal Biogas Promotion Association	Biogas promotion in households level and subsides	23 September, 2022

Figure 17: Key informant interview with desludging service provider and public toilet operator.

4.2. Household Survey

In each ward of the municipality, a random household survey was conducted. The two-day orientation was provided to local enumerators chosen by municipality representing each ward. They were oriented on each component of the sanitation service chain, starting from user interface to reuse / safe disposal along with the use of mobile application for data collection. They were mobilized in the community level to gather data from households and institutional level. The list of the enumerator has been attached in appendix 2. The data were collected using the *KoboCollect* application.

Determining Sample Size

The sample size for the household survey in Bardibas Municipality was determined by using Cochran (2963:75) sample size formula $n_0 = \frac{z^2pq}{e^2}$ and its finite population correction for the proportions:

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}}$$

Where,

n_0		Sample size
z	1.96	z value found in z table at 95 % of the confidence level
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied (this was set as 50% since this percentage would yield the maximum sample size as the percentage of the population practising some form of sanitation is not known at the intervention)
q	1-p	
e	± 5 %	desired level of precision or sampling error
n		Reduced sample size

N		Total number of population (households in the municipality)

This is followed by proportionate stratification random sampling such that each ward in the municipality is considered one stratum. The sample size required in each ward of the municipality was calculated as $n_h = \frac{N_h}{N} \times n$ where, N_h is total population of each ward of municipality.

Thus, 375 households out of 16,824 households distributed in 14 wards were sampled using proportionate stratification random sampling. The number of ward wise sample size has been attached in appendix 3. The distribution of sampling points in the municipality are shown in Figure 18.

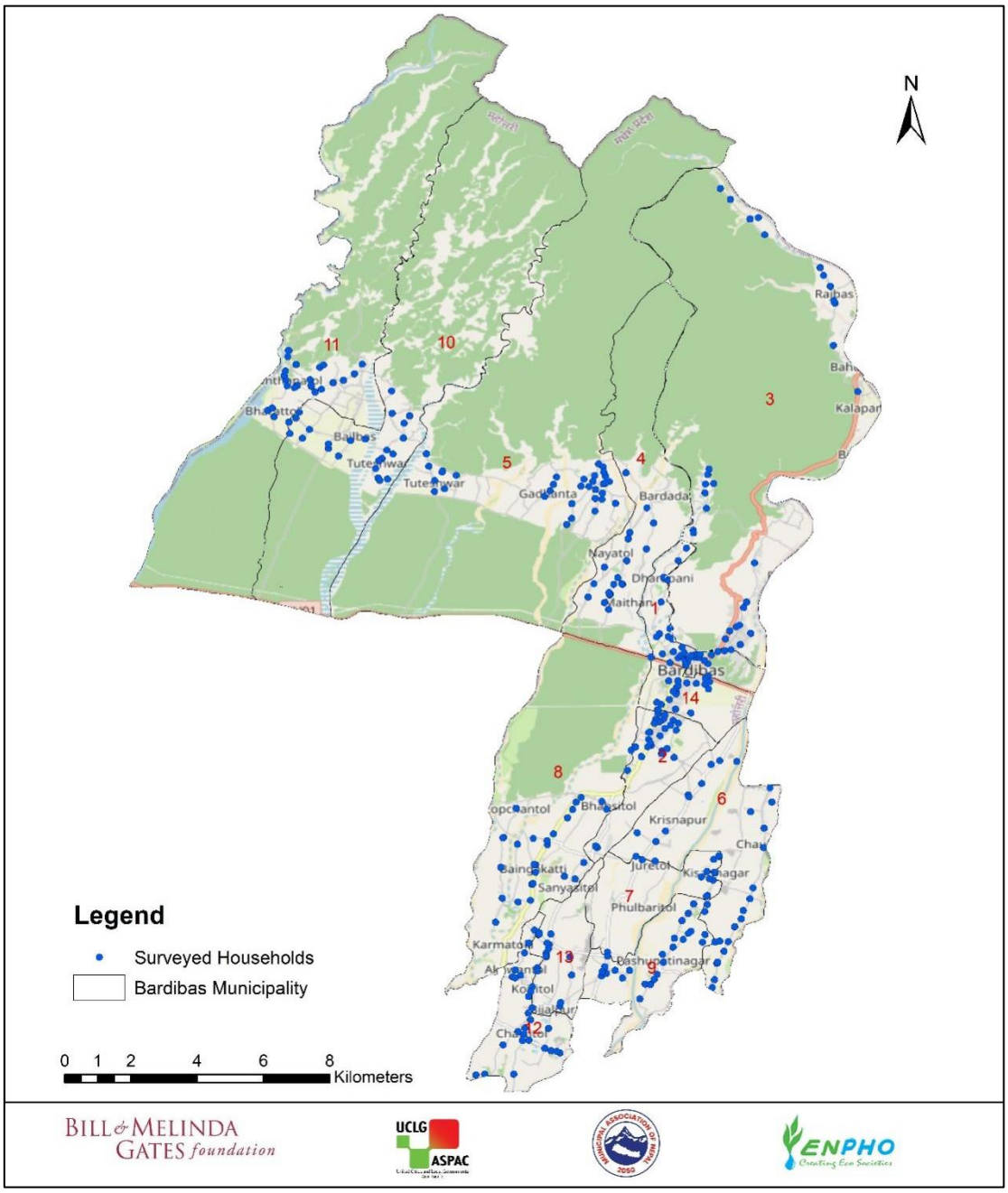

Figure 18: Distribution of sampling points in all wards of Bardibas Municipality.

4.3. Sharing and Validation of Data

On 29 December 2022, SFD validation workshop was organized at municipality hall of Bardibas Municipality, Mahottari (Figure 19). The results of SFD survey in Bardibas Municipality were presented to Deputy Mayor, elected officials and relevant stakeholders. In the workshop, the results including sanitation status of the municipality, containment types in

the municipality, emptying, transport, treatment and re-use or disposal practice of faecal sludge in the municipality were presented and discussed Altogether, 26 participants including the Mayor, ward chairpersons, other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions.

“With the rapid urbanization in the municipality, we are facing sanitation related issues and challenges that the study has reflected. We will raise the agenda to discuss on municipal council meeting and prioritize the sanitation service in our municipality” Tara Devi Mahato, Deputy Mayor of Bardibas Municipality, said. The list of participants with their designation is attached in Appendix 4.

Figure 19: SFD Sharing and Validation Workshop in Bardibas Municipality.

5. Acknowledgements

We would like to acknowledge the executing agency, United Cities Local Government – Asia Pacific (UCLG ASPAC) and implementing agency Municipal Association of Nepal (MuAN) of the Municipalities Advocacy on Sanitation in South Asia – II (MuNASS-II) for coordination with the municipality.

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We are thankful to Mr. Rakesh Mali and Mr. Arun Panta, desludging service providers and public toilet operator for providing valuable information.

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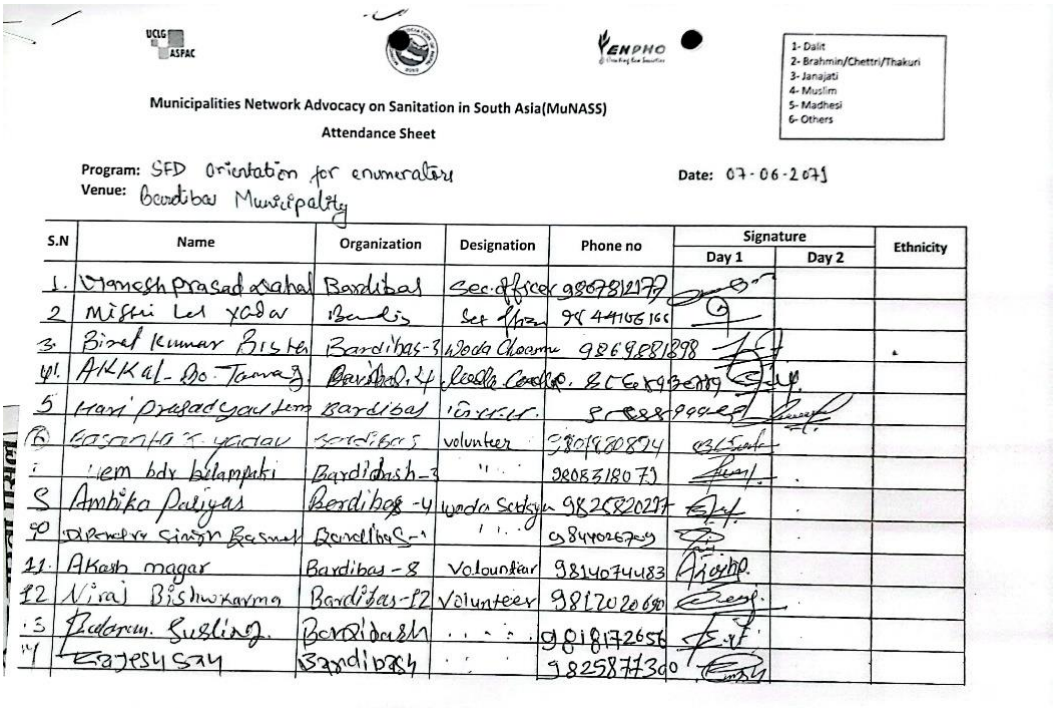
7. Appendix

7.1. Appendix 1: Roles and Responsibility of Various Tiers of Governments Delineated in Drafted SDP 2016 – 2030

System Classification		Minimum Key HR Required	Regulation & Surveillance	Financing & Construction	Ownership of System	Service Delivery	
Size	Sanitation					Provision	Production
Small	Onsite sanitation	Water Supply and Sanitation Technician (WSST)	Federal and or Provincial Government	User+/ community+/ other			
Medium	Septage Management	Sub-engineer	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Users committee/ Utility manager
Large	Septage or FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager
Mega	Septage/ FSM Management	WASH Engineer + finance & admin staff	Federal and or Provincial Government	Provincial+/ Local Govt+/ Community+/ Private Sector		Local Govt	Utility Manager

7.2. Appendix 2: List of participants of SFD orientation



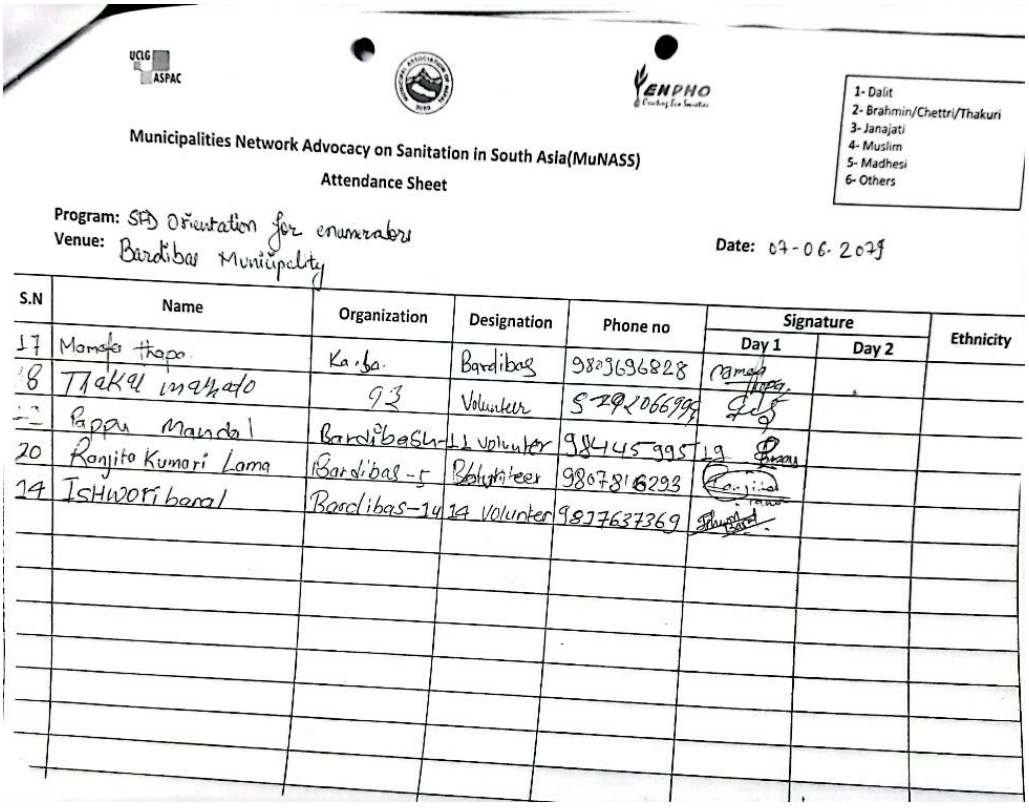
Municipalities Network Advocacy on Sanitation in South Asia(MuNASS)

Attendance Sheet

1- Dalit
2- Brahmin/Chettri/Thakuri
3- Janajati
4- Muslim
5- Madhesi
6- Others

Program: SFD Orientation for enumerators Date: 07-06-2079
Venue: Bardibas Municipality

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
1.	Dinesh prasad Kshal	Bardibas	Sec. officer	9809812179			
2	Mishri Lal Yadav	Bardibas	Sec officer	9744166166			
3.	Binod Kumar Bishta	Bardibas-3	Ward Chairman	9869881898			
4.	ARKal Do Tamang	Bardibas-4	Health Coordinator	9[illegible]			
5	Hari prasad yadav	Bardibas	Director	9[illegible]			
6	Basanta K. yadav	Bardibas	volunteer	9801980874			
7	Hem bdr Bilampaki	Bardibash-3	"	9808318071			
8	Ambika Paliyas	Bardibas-4	Ward Secretary	9825820277			
9	Dipendra Singh Basnet	Bardibas-1	"	9844026799			
11	Akash nagar	Bardibas-8	Volountiar	9814074483			
12	Niraj Bishwakarma	Bardibas-12	Volunteer	9817020690			
13	Pradeep Gurung	Bardibash	"	9818172656			
14	Rajesh Sah	Bardibash	"	9825877390			



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6- Others

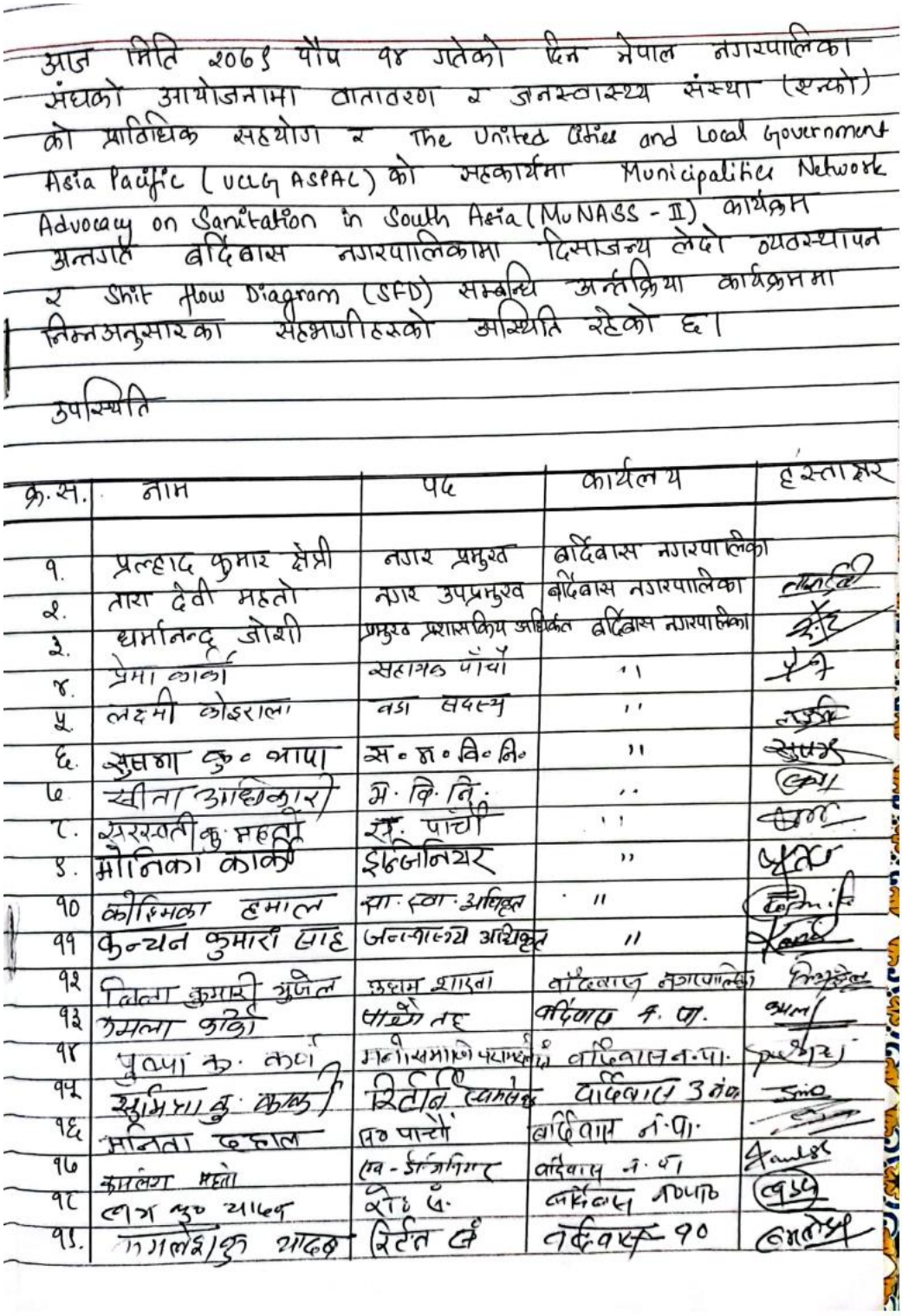
Program: SFD Orientation for enumerators Date: 07-06-2079
Venue: Bardibas Municipality

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity
17	Mamata thapa	Karba	Bardibas	9809696828			
18	Tilak maharjan	93	Volunteer	9-7921066996			
19	Pappu Mandal	Bardibas-11	volunteer	9844599519			
20	Ranjita Kumari Lama	Bardibas-5	Volunteer	9807816293			
14	Ishwori bansal	Bardibas-14	14 Volunteer	9817637369			

7.3. Appendix 3: Ward wise Sample size distribution in Bardibas Municipality

Ward	Population	Households	Proportion	Required Sample
1	9,198	2,360	14%	53
2	3,790	861	5%	19
3	8,602	2,175	13%	48
4	4,846	1,151	7%	26
5	5,815	1,390	8%	31
6	5,388	1,171	7%	26
7	3,458	704	4%	16
8	5,828	1,304	8%	29
9	4,849	1,004	6%	22
10	3,876	828	5%	18
11	4,626	975	6%	22
12	4,550	947	6%	21
13	4,215	887	5%	20
14	5,320	1,067	6%	24
Total	**74,361**	**16,824**	**100%**	**375**

7.4. Appendix 4: List of participants present in Sharing and Validation meeting



आज मिति २०७९ पौष १४ गतेको दिन नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्को) को प्राविधिक सहयोग र The United Cities and Local Government Asia Pacific (UCLG ASPAC) को सहकार्यमा Municipalities Network Advocacy on Sanitation in South Asia (MuNASS - II) कार्यक्रम अन्तर्गत बर्दिवास नगरपालिकामा दिसाजन्य लेदो व्यवस्थापन र Shit flow Diagram (SFD) सम्बन्धि अन्तर्क्रिया कार्यक्रममा निम्नअनुसारका सहभागीहरुको उपस्थिति रहेको छ।

उपस्थिति

क्र.स.	नाम	पद	कार्यालय	हस्ताक्षर
१.	प्रल्हाद कुमार क्षेत्री	नगर प्रमुख	बर्दिवास नगरपालिका	
२.	तारा देवी महतो	नगर उपप्रमुख	बर्दिवास नगरपालिका	
३.	धर्मानन्द जोशी	प्रमुख प्रशासकिय अधिकृत	बर्दिवास नगरपालिका	
४.	प्रेमा कार्की	सदस्य पाँचौं	"	
५.	लक्ष्मी कोइराला	वडा सदस्य	"	
६.	सुसना कु० थापा	स० ज० वि० नि०	"	
७	सीता अधिकारी	मे. वि. नि.	"	
८.	सरस्वती कु महतो	रे. पाचौं	"	
९.	मोनिका कार्की	इन्जिनियर	"	
१०	कोशिमका हमाल	सा.स्वा.अधिकृत	"	
११	कन्चन कुमारी साह	जनस्वास्थ्य अधिकृत	"	
१२	विल्मा कुमारी गुजेल	प्रधान शाखा	बर्दिवास नगरपालिका	
१३	कमला कार्की	पार्श्व नर्स	बर्दिवास न. पा.	
१४	पुष्पा कु. कर्ण	सामाजिक परिचालक	बर्दिवास न.पा.	
१५	सुमित्रा कु. कुर्मी	रिटायर्ड शिक्षक	बर्दिवास ३ नं.	
१६	सविता फुयाल	स्व पाचौं	बर्दिवास न.पा.	
१७	कमलेश महतो	स्व-इन्जिनियर	बर्दिवास न.पा.	
१८	लक्ष्मी कु यादव	रेडि ऊ.	बर्दिवास नगरपा	
१९.	गंगलहरी कु यादव	रिटायर्ड	बर्दिवास १०	

क्र.सं	नाम	पद	कार्यलय	हस्ताक्षर
२०	विनोद ढुङेल	प्र. अ.	बर्दिबास नगरपालिका	[illegible]
२१	सिता कु०सि० बस्नेत	उ. वि. स.	''	[illegible]
२२	मन्जुरी मगराती	MIS operator परियोजना	बर्दिबास नगरपालिका	[illegible]
२३	सोम कुमार जुयाल	IT officer	''	[illegible]
२४	राम स्वगारथ यादव	वडा अध्यक्ष	बर्दिबास - 6	[illegible]
२५	लक्ष्मी खतिवडा	का. स	बर्दिबास -3	[illegible]
२६	ममता थापा	का. स	बर्दिबास - ९	[illegible]

SFD Bardibas Municipality, Nepal, 2023

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SFD Promotion Initiative