# SFD Report

# Bheriganga Municipality
# Nepal

## Final Report

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

Date of production: 01/11/2023

Last update: 26/01/2024

SFD Report Bheriganga Municipality, Nepal, 2024

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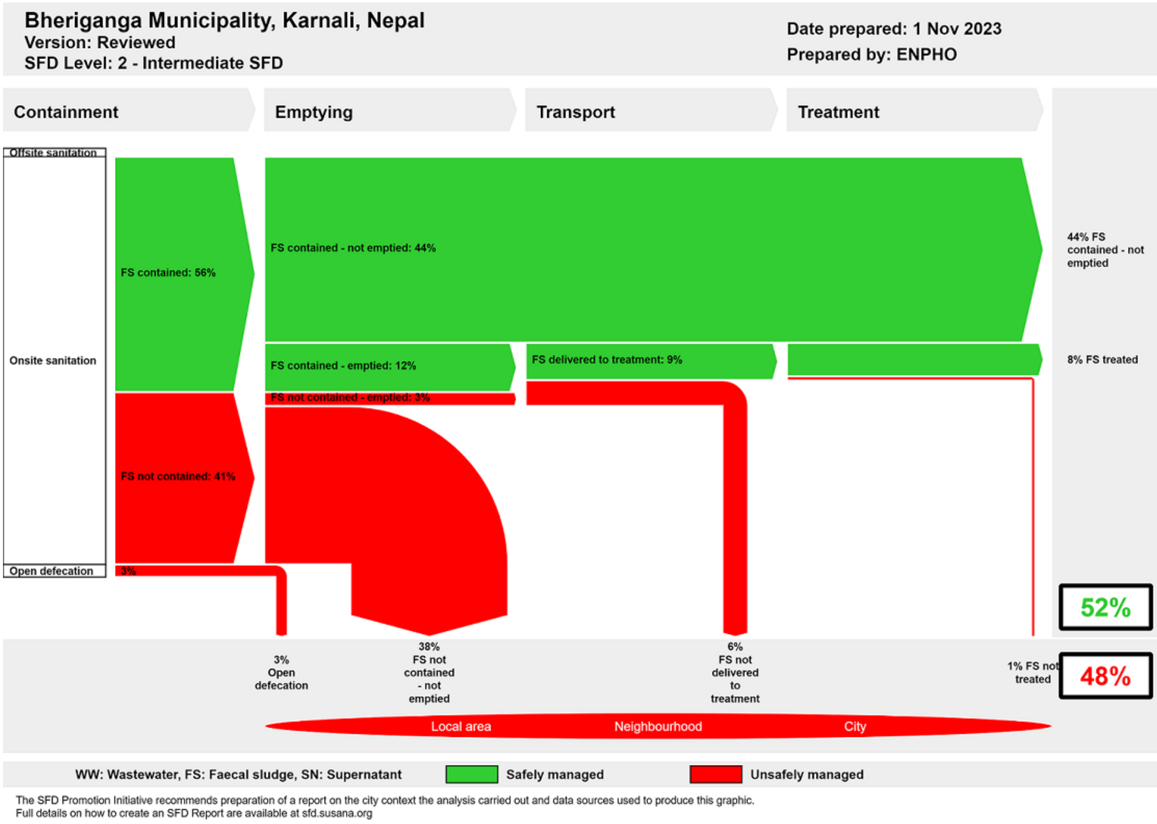
## 1. The SFD Graphic




## 2. Diagram information

### SFD Level:

This SFD is a level 2- Intermediate report.

### Produced by:

Environment and Public Health Organization (ENPHO)

### Collaborating partners:

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

### Status:

Final SFD report.

**Date of production:** 01/11/2023

## 3. General city information

Bheriganga Municipality is in Surkhet District, Karnali Province of Nepal. It has a total of 13 wards and covers an area of 256.2 km$^2$. It was established on 2 December 2014. It is surrounded by Birendranagar and Lengbashi Municipality in the north, Bardia National Park and Basgadhi Municiplaity of Bardia District in the south, Gurbhakot Municipality and Kalimati Rural Municipality of Salyan Districts in the east and Barahalake Rural Municipality in the west.

According to national population and housing census 2021, the municipality has a total population of 48,203 and 11,539 households. Ward number 10 has the highest number of households with 1,306 and the highest population of 5,491 (NSO, 2023). Beriganga Municipality has temperate climate. The maximum temperature in the municipality is approximately 42°C and the minimum temperature is approximately 1°C (Bheriganga Municipality, 2023). Bheriganga Municipality is located at latitude: 28° 22' 11" N to 28° 34' 08" N and longitude: 81° 31' 51" E to 81°50'16" E. The elevation of the municipality is 1,400 m above mean sea level.

## 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). 97% of the households in the municipality have a toilet. The 3% of the households without toilet defecate in nearby farmlands and use the toilet of neighbours. The municipality has public toilets in market areas and nearby school. The public toilets were constructed by the municipality ad development partner and are operated by individual service providers.

*Containment:*

All of the households in the municipality rely on onsite sanitation technologies. Unlined pits are most popular containment in the municipality. 67% of the households have constructed unlined pits. Similarly, 17% of the households have constructed fully lined tanks (8% corresponds to biogas digesters also modelled as fully lined tanks). 8% of the households have constructed lined tanks with impermeable walls and open bottom. Only 5% of the households have installed lined pits with semi-permeable walls and open bottom.

*Emptying and Transportation:*

According to the assessment of the sanitation situation, only 8% of the households have emptied their containments at least once after used. The containments were emptied both manually and mechanically. 93% of these containments have been emptied manually while remaining have been emptied mechanically. There are no private desludging service providers within municipality however, the service providers from neighbouring municipality 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. However, mechanically emptied FS is treated in the faecal sludge treatment plant in Birendranagar Municipality.

*Water Supply:*

According to the household survey conducted in Bheriganga Municipality, 56% of households rely on private taps, while only 2% depend on public or community taps. 22% of the households depend on dug well, hand pumps, tube wells, or deep boring and 20% depends on spring sources (ENPHO, 2023). The Chhinchu, Ramghat and Hattisude Water Users and Sanitation Committee (WUSC) are major water supply service providers in Bheriganga Municipality.

The SFD graphic shows that 52% of the excreta generated are safely managed while 48% are unsafely managed. The safely managed excreta generated by 44% of the population is temporary. So, once the containments get filled and FS from the containments is emptied, the percentage of unsafely managed excreta would increase. The faecal sludge generated from 8% of the population is contained and safely treated in anaerobic biogas digesters as well as in the FSTP in Birendranagar Municipality.

## 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.

Bheriganga Municipal Council approved the Sanitation and Waste Management Guidelines on September 23, 2022, focusing on waste reduction, reuse, treatment, and safe disposal to safeguard public health and promote a clean environment. The guidelines stress an integrated approach with active participation from the private and public sectors (Bheriganga Municipality, 2022a).

On December 3, 2022, the Council ratified the Water Supply Management Procedure, ensuring the right to access safe drinking water and sanitation. This procedure establishes user committees for sustainable and high-quality water and sanitation services.

Additionally, Bheriganga Municipality developed a WASH plan for enduring water, sanitation, and hygiene services. This initiative is pivotal for long-term sustainability and aligns with the targets of the Sustainable Development Goals (SDGs).

## 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<br>Department of Water Supply and Sewerage Management (DWSSM) |
| Public Institutions at Provincial Government | Ministry of Water Resource and Energy Development<br>Water Supply and Sanitation Division Office (WSSDO) |
| Public Institutions at Local Government | Bheriganga Municipality Office<br>Chhinchu Water Users and Sanitation Committee<br>Ramghat Water Users and Sanitation Committee |
| Non-governmental Organizations | Environment and Public Health Organization (ENPHO) |
| Private Sector | Public toilet operators |
| Development Partners, Donors | MuAN, BMGF, UCLG ASPAC, WASH Alliance International |

## 7. Credibility of data

The major data were collected from random household sampling. Altogether, 372 households and 53 institutions were surveyed from 13 wards of the municipality on 28-29 April, 2023 (ENPHO, 2023). Primary data on current sanitation practices in the municipality were triangulated from Key Informant Interviews (KIIs) with municipal officials, public toilet operators, desludging service providers and water users and sanitation committee. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program 4 December 2023.

## 8. Process of SFD development

Data on sanitation situation were collected through household and institutional survey. The local enumerators from each ward 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:


- Bheriganga Municipality. (2017). Comprehensive Municipal Development Plan (Part 1); Situation of Bheriganaga Municipality.
- MoWS. (2022a). Water Supply and Sanitation Act. Ministry of Water Supply; Government of Nepal.

- NSO. (2023). National Population and Housing Census 2021. National Statistics Office.
- Bheriganga Municipality. (2022a). Sanitation and Waste Mangement Guideline. Bheriganga Municipality.
- Bheriganga Municipality. (2022b). Water Sanitation and Hygiene (WASH) Plan 2020-2030. Bheriganga Municipality, Surkhet District.


SFD Bheriganga Municipality, Nepal, 2024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## Abbreviations

| | |
|---|---|
| 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 |
| MoUD | Ministry of Urban Development |
| MoWS | Ministry of Water Supply |
| MuAN | Municipal Association of Nepal |
| NGO | Non-Governmental Organization |
| NPC | National Planning Commission |
| NSO | National Statistic Office |
| NUWSSSP | National Urban Water Supply and Sanitation Sector Policy |
| NWSC | Nepal Water Supply Corporation |
| NWSSP | National Water Supply and Sanitation Policy |
| ODF | Open Defecation Free |
| RVT | Reservoir tank |
| 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 |
| UCLG ASPAC | United Cities and Local Governments Asia Pacific |
| UNICEF | United Nations Children's Education Fund |
| WASH | Water, Sanitation and Hygiene |
| WUSC | Water Users and Sanitation Committee |

## 1 City context

Bheriganga Municipality is in Surkhet District, Karnali Province of Nepal. It has a total of 13 wards and covers an area of 256.2 square kilometres. It was established on 2 December 2014. It is surrounded by Birendranagar and Lengbashi Municipality in the north, Bardia National Park and Basgadhi Municiplaity of Bardia District in the south, Gurbhakot Municipality and Kalimati Rural Municipality of Salyan Districts in the east and Barahalake Rural Municipality in the west (Figure 1).

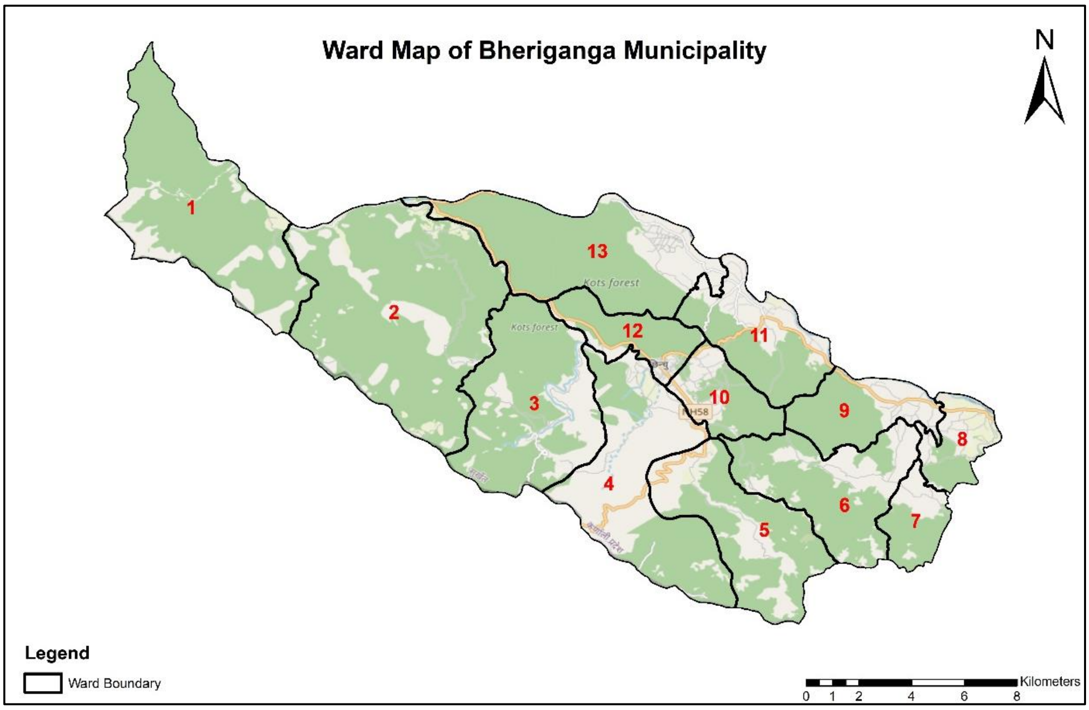


**Figure 1: Map of Bheriganga Municipality with ward boundaries.**

### 1.1. Population

According to national population and housing census 2021, the municipality has a total population of 48,203 and 11,539 households. The total male and female populations are 22,538 and 25,665 respectively. The population density is 188 people per square kilometre. A ward number 10 has the highest number of households with 1,306 and the highest population of 5,491 (2,614 male ad 2,877 female) and ward number 3 has the least households with 481 and ward 7 has the least population with 1,967 (867 male and 1,100 female) (NSO, 2023).

### 1.2. Climate

Bheriganga Municipality has temperate climate. Temperate climates are characterized by relatively moderate mean annual temperatures, with average monthly temperatures above 10°C in their warmest months and above −3°C in their colder months (Trewartha and Horn, 1980). The maximum temperature in the municipality is approximately 42°C and the minimum temperature is approximately 1°C (Bheriganga Municipality, 2023). Bheriganga of the Surkhet District of Karnali province is in Siwalik range (Budha and Bhardwaj, 2019). The rainfall in these Siwalik is in the range of 2,000-2,500 mm per year. Rainwater significantly affects the soft and loose Siwalik strata leading to flash floods and debris flows (Dhital MR, 2015). Siwalik falls under sub-tropical to temperate climate, with temperature ranges from 20-24 °C (Karki et.al., 2016), having dry winters and hot summers.

## 1.3. Topography

Bheriganga Municipality is located at latitude: 28° 22' 11" N to 28° 34' 08" N and longitude: 81° 31' 51" E to 81°50'16" E. The elevation of the municipality is extended from 500 to 1,400 m above mean sea level. The municipality has major rivers systems such as Bheri River, Babai River, Goche Khola, Chhinchu Khola, Muralikhola, Bhingi khola, Nachne Khola, Kalpani Khola. The municipality was named after Bheriganga River, one of the major attractions of the Karnali Province (Bheriganga Municipality, 2017). The Karnali province encompasses a narrow expanse of Siwalik, situated along the meandering Bheri River, to the south of Birendranagar and in close proximity to Bardia National Park. The Siwalik region represents only 6% of the province’s total land area and consists of the youngest Himalayan range, characterized by sedimentary rock and substantial boulders. Most of the Siwalik terrain is unsuitable for both agriculture and human habitation. Surkhet, within the province, exemplifies such a productive dun valley (MITFE, 2020). The soils of the Dun Siwalik were developed on the deep alluvial deposits with parent material derived from the Dun alluvium. It consists of accumulated beds of clays, boulders, pebbles, and sand with the admixture of water-borne small to big size stones in the subsoil in varying proportions (Shinghal , 1982).

# 2 Service Outcomes

## 2.1. Overview

Data on sanitation situation were collected by Environment and Public Health Organization (ENPHO) through household and institutional surveys (ENPHO, 2023). A total of 372 households were sampled from 11,539 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 2015 (KII_1, 2023). However, the household survey reveals that 3% of the households in the municipality do not have access to toilet and defecate in open spaces such as farmlands and use the toilets of neighbours.

### *2.1.1 Sanitation System 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 in Bheriganga Municipality (ENPHO, 2023).**

| Containment | Wall construction Materials | Bottom of containment | Chamber | Number | Connected to | % | Recategorized as SFD | % |
|---|---|---|---|---|---|---|---|---|
| Biogas Digester | | | | | | 9% | Fully lined tank | 17% |
| Fully lined tank | Cemented walls or cemented brick / stone wall | PCC or plastered | One or Two | NA | No outlet/ overflow | 8% | | |
| Lined tank with impermeable wall and open bottom | Cemented walls or cemented brick / stone wall | Soiling / nothing | One ,Two or More than Two | NA | Open ground<br><br>No outlet/ overflow | 8% | Lined tank with impermeable walls and open bottom | 8% |
| Single pit | Concrete rings piled one | Soiling/ nothing | NA | One | NA | 5% | Lined pit with semi-permeable walls and open bottom | 5% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Unlined pit | Mud mortar stone/ brick wall/ dry stone wall/ no lining | Soiling / nothing | One | NA | No outlet/ overflow | 67% | Unlined pit | 67% |

Unlined pits are most common containment type in the municipality. 67% of the households in the municipality have constructed unlined pits. Unlined pits are constructed with mud mortar brick / stone wall or dry-stone wall and soling or nothing at bottom as shown in Figure 2. There are permeable walls and base, through which infiltration can occur.

**Figure 2: Unlined pit under construction in Bheriganga Municipality.**

An anaerobic biogas digester has been installed in 9% of households to treat the household organic waste and generate energy (Figure 3). Also, excreta from toilet are connected to these digesters along with the cow dung and other organic solid waste. The capacity of these digesters is 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: Toilets connected to biogas digester in households.**

Fully lined tank, constructed by 8% of the households, is an onsite sanitation technology which is used to safely store faecal sludge. The walls and bottom of the tank are totally lined and sealed.

Lined tank with impermeable walls and open bottom is an onsite sanitation technology where the walls of the tank are lined, and the bottom of tank is not lined and allows infiltration of leachate. The lined tanks with impermeable walls and open bottom are constructed by 7% of the households.

5% of the households have single pits (Figure 4). 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 the SFD graphic.

**Figure 4: Toilets connected to single pit in households.**

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

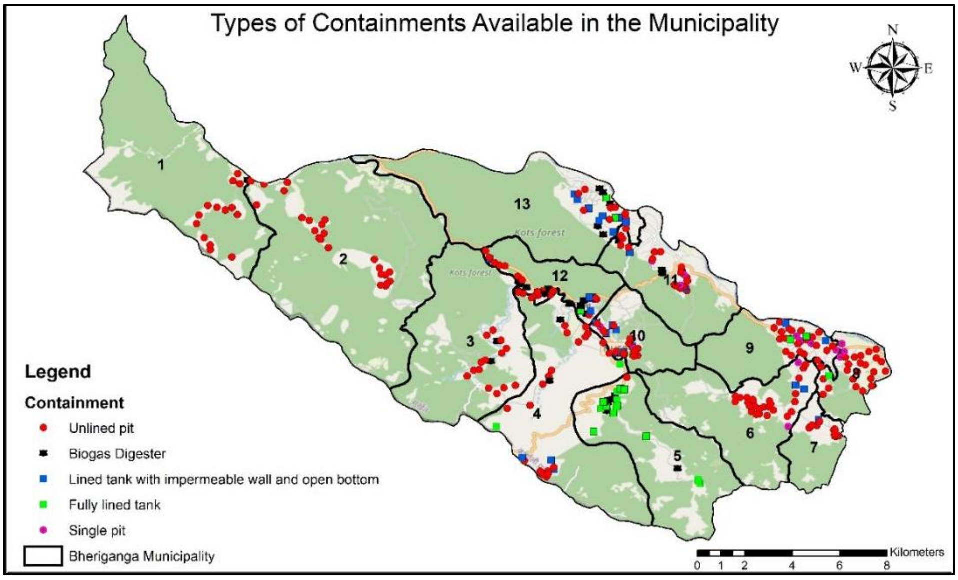


**Figure 5: Map with households with the types of containments in Bheriganga Municipality.**

### *2.1.2. Sanitation System in Institutional buildings*

All institutional buildings (53 institutions) such as educational institutions, health institutions and government and non-government organizations surveyed have connected toilets to onsite sanitation technologies. The lined tank with impermeable wall and open bottom is a popular onsite sanitation technology in the institutions. Figure 6 shows the different sanitation technologies available in the institutions of Bheriganga Municipality.

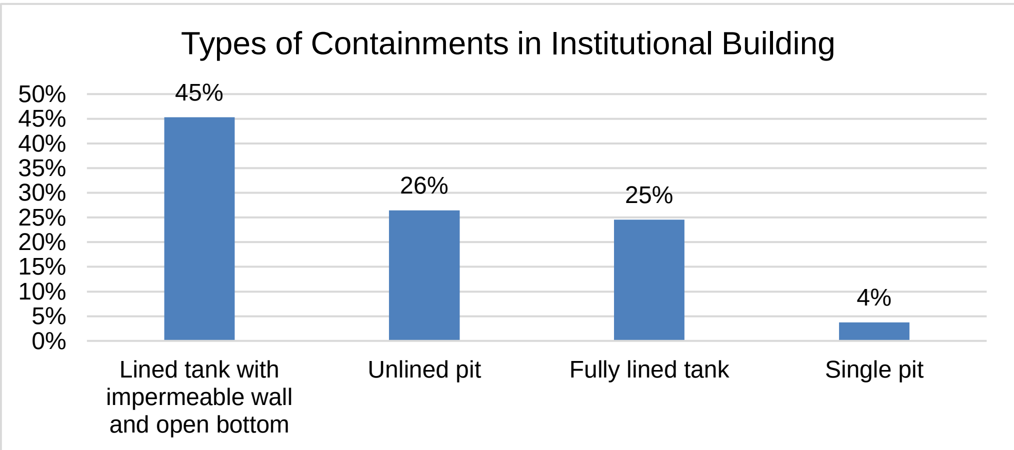


**Figure 6: Types of containment in the institutional building of Bheriganga Municipality.**

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

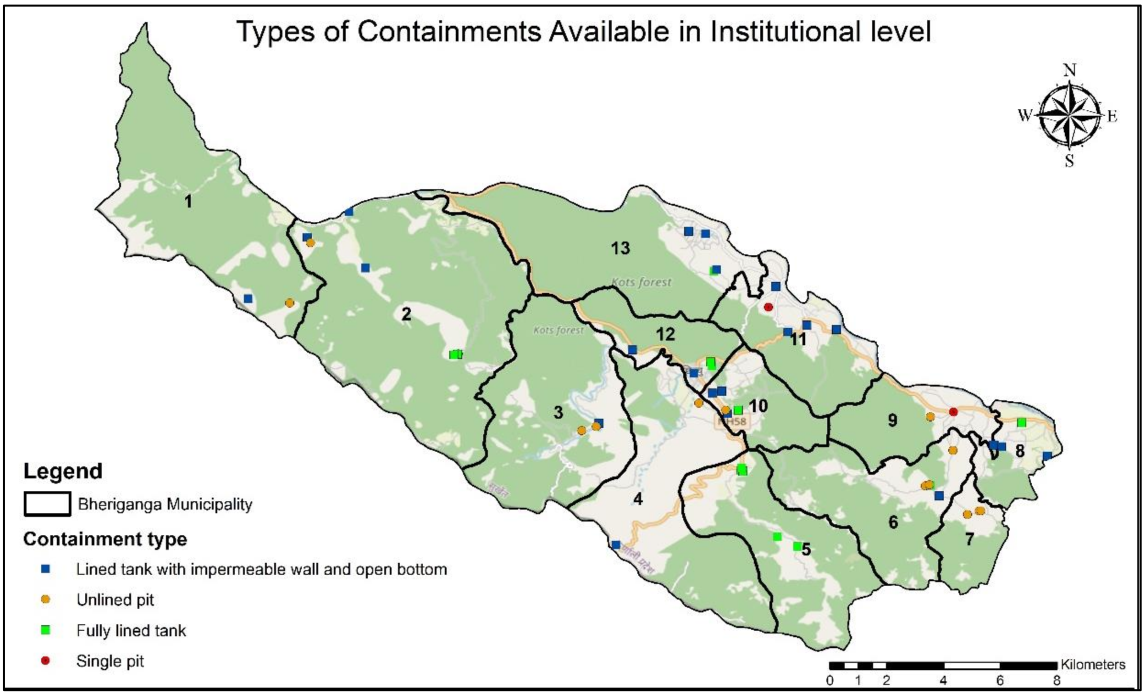


**Figure 7: Map locating institutional building with types of sanitation technologies.**

### *2.1.3. Public Toilets*

There are five major public toilets existing in the municipality, and two of them were assessed as illustrated in Figures 8 and 9. The public toilet (Figure 8) situated in Chinchu Dobato (junction of Ratna Highway and Chhinchu-Jajarkot road) was constructed by the municipality. The construction of this facility took place in 2018, and the operation and maintenance responsibilities have been handed over to an individual caretaker who owns the small soap nearby the public toilet (KII_5, 2023).

There are two pans for male users, while two pans available for female users. Approximately 50 individuals utilize these facilities daily. The public toilet is connected to a circular containment system. Notably, the containment has not reached full capacity. The water is stored in two tanks, each with a capacity of 1,000 litres through the pipeline. Only 500 litres of water are consumed daily because of lesser flow of the users.

**Figure 8: Public toilet in Chhinchu Dobato of Bheriganga Municipality.**

A public toilet (Figure 9) situated in the market area near Sharada Secondary School, ward 12 was constructed through a collaboration between the municipality and ENPHO. Ownership of the public toilet rests with Sharada Secondary School. The construction of this facility took place in 2022, and the operation and maintenance responsibilities have been leased to an individual caretaker (KII_6, 2023).

Within the male compartment, there are two pans and urinals, while the female compartment is equipped with two pans. Approximately, 400 individuals utilize these facilities daily. The public toilet is connected to a standard septic tank with a two-chamber sealed wall and bottom, connected to a soak pit. Notably, the containment has not reached full capacity.

Furthermore, the primary water source for this public toilet is groundwater, accessed through deep boring installations by the school. The water is stored in two tanks, each with a capacity of 1,000 litres. An estimated 2,000 litres of water are consumed daily. The toilet is well-appointed with amenities such as a handwashing station, dustbins, lights, and other essentials.

s


**Figure 9: Components of a public toilet in nearby Sharada Secondary School in Bheriganga Municipality.**

### *2.1.4. Emptying and Transport*

Emptying and transporting faecal sludge are crucial services for the proper operation of onsite sanitation technologies (Linda Strande, 2014). A mere 8% of households have undertaken the emptying of their containment systems at least once since installation. Among these households, 93% have opted for manual emptying, while 7% have utilized mechanical methods. Notably, the municipality lacks private desludging service providers, leading to external support from Birendranagar Municipality, a neighbouring municipality (KII_1, 2023).

Birendranagar Septic Tank Cleaning Services (Figure 10) registered in Birendranagar Municipality is providing services to Birendranagar Municipality and its neighbouring municipalities since 2015. It owns two vehicles of 8,000 L capacity. This service provider has emptied faecal sludge approximately 30 trips per month. Occasionally, demand has been generated from Chhinchu Bazar (ward 12) of the municipality. For rectangular containments, the service provider charges NRS 8,000-9,000 (USD 60-68) and NRS 7,000 (USD 53) for local households (KII_4, 2023).


**Figure 10: Vehicle of Birendranagar desludging service provider.**

### *2.1.5. Treatment and Disposal*

The municipality does not have a faecal sludge treatment plant. However, the mechanically emptied faecal sludge has been treated at Faecal Sludge Treatment Plant (FSTP) Birendranagar Municipality (KII_1, 2023). The private service providers from Birendranagar have transported mechanically emptied faecal sludge to FSTP at Birendranagar Municipality (Figure 11). The faecal sludge treatment plant operator charges a tipping fee of NRS 800 (USD 6) per trip (KII_4, 2023). The Birendranagar FSTP began service on 30 September 2021. It has a design capacity of 50 $m^3$ of faecal sludge per day and a lifespan of fifteen years. It is equipped with treatment elements to separate solids and liquids, and to treat and reuse products. Other elements include a screening unit, a vertical flow constructed wetland, compost curing houses, and composting unit (SNV, 2021). Operation and maintenance of the FSTP has been conducted by the Birendranagar Municipality.

Of the 93% of households that manually emptied faecal sludge, 33% have engaged in composting, 30% dispose of it in farmland, and another 30% have practised the dig-and-dump method (ENPHO, 2023).

**Figure 11: Birendranagar Faecal Sludge Treatment Plant.**

### *2.1.6. Risk Assessment of Groundwater Pollution*

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

**a. Sources of Drinking Water**

The household survey conducted by ENPHO shows that 56% of households in the municipality rely on private taps while 2% of households depends on public or community tap. 22% of the households depend on dug well, hand pumps, tube wells, or deep boring and 20% depends on spring sources (ENPHO, 2023).

The Chhinchu Water Users and Sanitation Committee (WUSC), Ramghat Water Users and Sanitation Committee, Hattisude Water Users and Sanitation Committee are major water supply service providers in Bheriganga Municipality (KII_1, 2023). Moreover, Sanimor, Thulo Harre, Tatopani Chamare, Jhngnibazar, Bhulke, Karki gaun, Chisapani, Thulojatri, Swocha, Shanti Tole, Durga Tole, Madanichau, Chadani tole, Kalikhola water supply schemes have been implemented for providing the water services within the municipality.

**Chhinchu Water Supply Users and Sanitation Committee:**

The Chhinchu Water Supply Users and Sanitation Committee plays a crucial role in providing drinking water to wards 10 and 12. The water supply system is comprised of deep boring machines, along with five reservoir tanks, each boasting a capacity of 0.15 million litres, 0.13 million litres and 2,500 thousand litres. This comprehensive scheme incorporates automatic chlorination units. As of the date of the interview, approximately 1,150 taps have been installed, contributing to the effective distribution of water throughout the designated areas (KII_2, 2023)
.

**Figure 12: Reservoir tank with automatic chlorination unit.**

**Ramghat Water Supply Users and Sanitation Committee:**

The Ramghat Water Supply and Sanitation Committee plays a pivotal role in supplying drinking water to wards 11 and 13. The gravity-based water supply system has been implementing since 1980 through Maseri Khola water supply schemes. To fulfil the increased demand of water supply, new water supply system has been implemented since 2017. The water supply system is designed with sump well and deep boring from Bheri River and includes two reservoir tanks, each with a capacity of 0.165 million litres (Figure 13). The water quality testing reports reveals that, the water from the sources is contaminated with faecal matter. The water quality reports obtained have been attached to Appendix 2. The flooding in the Bheri River has caused damage to the infrastructure of water supply schemes. Consequently, the water sourced from the Bheri River becomes turbid each year during the rainy season. To ensure water quality, this comprehensive scheme plans to construct additional reservoir tank with filtration units and automatic chlorination units. As of the date of the interview, approximately 1,000 taps have been installed, contributing to the effective distribution of water throughout the specified areas (KII_3, 2023).

**Figure 13: Deep boring sump well nearby Bheri River and filtration unit under construction at Ramghat.**

**b. Water Quality Testing Laboratory**

ENPHO with support of Water Sanitation and Hygiene (WASH) Alliance International (WAI) under WASH SDG program have implemented capacity enhancement of local government through establishing water quality test labs in Bheriganga Municipality (Figure 14). The local staffs have been trained on sampling technique, testing method, quality control/assurance procedures, reporting system and provide support for quality control and assurance through testing of duplicate samples from each mini lab. Mini lab has been operated and marketed by Sana Kisan Krisi Sahakari Sanstha Ltd. The water samples from different water supply schemes and households have been tested since 2021 (KII_7, 2023).


**Figure 14: Water quality testing mini laboratory in Bheriganga 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 (Andreo, 2013). Here, among the various types of onsite sanitation technologies, lined tank with impermeable walls and open bottom and lined pits are more prone to contribute to aquifer pollution as the nature of such containments impose more containment load from the land surface to groundwater.

A key determinant of risk variation is the soil and geological setting. Especially for consolidated hard rock sediments with poor soil cover and shallow water tables, the risk is higher. According to WHO criteria, if the travel time of pollutant to groundwater source is less than 25 days, there is significant risk to contamination; low risk, if the travel time is between 25 and 50 days; and very low risk if the travel time is greater than 50 days (Krishnan, 2011). The size of pores in the soil determines the infiltration rate.

Bheriganga falls within the Siwalik range dun valley. The sediments in this area consist of beds of clays, boulders, pebbles and sand with the admixture of water-borne small to big size stones in the subsoil in varying proportions (Shinghal, 1982). 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/ tubewells 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 15 demonstrates the depth of hand pumps and tube wells and horizontal distance of it with the containment type lined tank with impermeable walls and open bottom. Altogether 9% of the households have installed lined tanks with impermeable walls and an open bottom with no outlet or overflow. Among them, 9% of households rely on groundwater for drinking water. Upon assessing the depth of groundwater and horizontal distance of the hand pumps/ tube wells from the source of pollution, it was found that 100% of these households are at higher risk. Thus, the population with lined tanks with impermeable walls and open bottom without outlet or overflow with significant risk to groundwater pollution is 1% i.e (9% x 9% x 100% = 1%).


**Figure 15: Depth of hand pumps and tubewells and lateral spacing of it with containment lined tank with impermeable walls and open bottom.**

Figure 16 demonstrates the depth of hand pumps and tubewells and horizontal distance of it with the containment type lined pit with semi-permeable walls and open bottom. Altogether 5% of the households use lined pits with semi-permeable walls and open bottom. Among these, 44% of them use groundwater for drinking. Upon assessing the depth and horizontal distance between the source of water and the location of the containment, it was observed that 50% of these have higher potential on consuming contaminated groundwater. Thus, the population with lined pits with semipermeable walls and open bottom with significant risk to groundwater pollution is calculated as (5% x 44% x 50% = 1%).

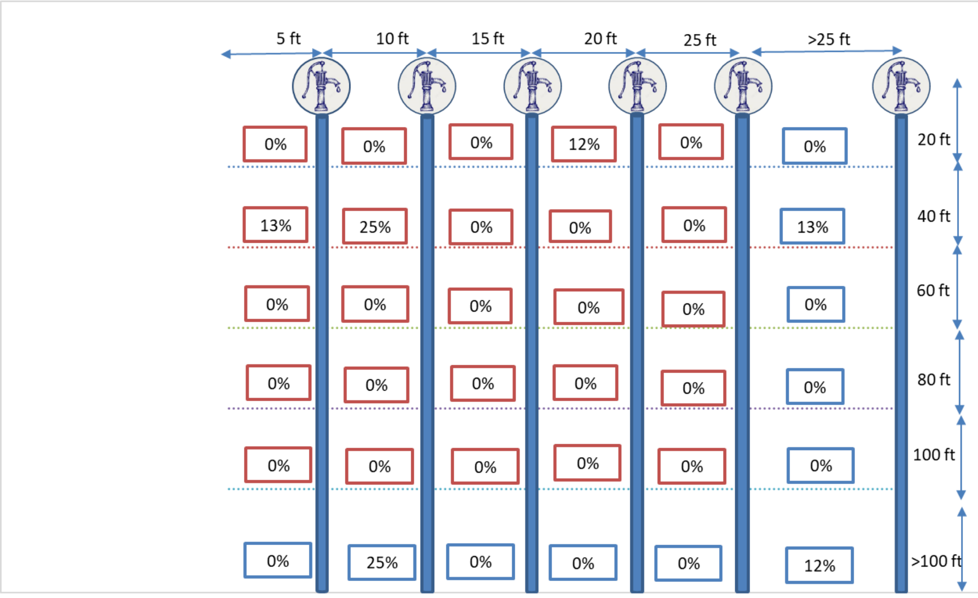


**Figure 16: Depth of hand pumps and tubewells and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.**

Figure 17 demonstrates the depth of hand pumps and tubewells and horizontal distance of it with the containment type unlined pit. Altogether 67% of the households used unlined pits Among these, 25% of them use groundwater for drinking. Upon assessing the depth and horizontal distance between the source of water and the location of the containment, it was observed that 56% of these have higher potential on consuming contaminated groundwater. Thus, the population with unlined pits with significant risk to groundwater pollution is calculated as (67% x 25% x 56% = 9%).

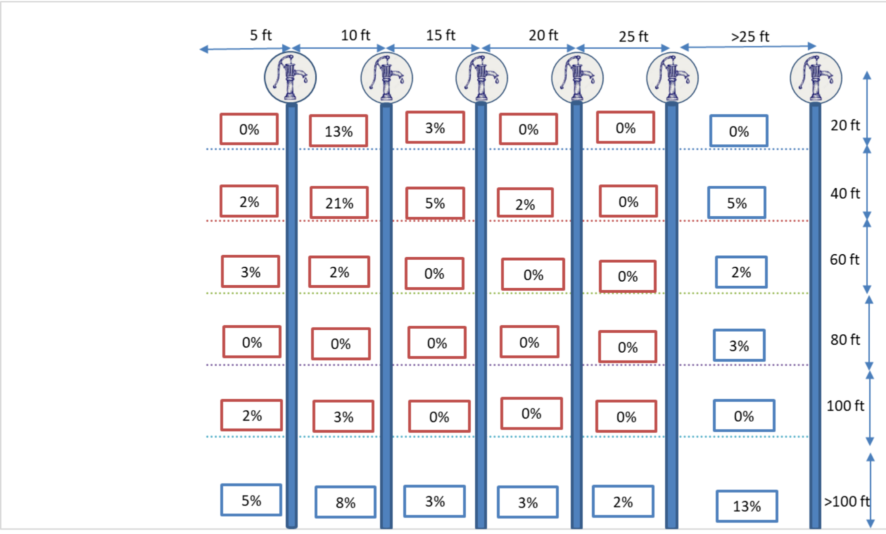


**Figure 17: Depth of hand pumps and tubewells and lateral spacing of it with containment types unlined pits.**

Based on the literature review on water resources and water quality testing reports, information obtained from stakeholders and observation, the risk of the water contamination has been assumed as stated in Table 2.

**Table 2: Containment type and potential risk for water contamination.**

| Containment Type | Drinking water sources | High risk | Low risk |
|---|---|---|---|
| Lined pits with semipermeable wall and open bottom (No outflow/outlet) | Groundwater sources | 1% | 1% |
| | Private/Yard Tap | 1% | 2% |
| | Spring source | 0% | 0% |
| | **Total** | **2% (T2A5C10)** | **3% (T1A5C10)** |
| Lined tank with impermeable wall and open bottom (No outflow/outlet) | Groundwater sources | 1% | 0% |
| | Private/Yard Tap | 0% | 6% |
| | Public/Community Tap | 0% | 0% |
| | Spring source | 1% | 0% |
| | **Total** | **2% (T2A4C10)** | **6% (T1A4C10)** |
| Unlined pits (No outflow/outlet) | Groundwater sources | 9% | 7% |
| | Private/Yard Tap | 14% | 23% |
| | Public/Community Tap | 1% | 0% |
| | Spring source | 13% | 0% |
| | **Total** | **37% (T2A6C10)** | **30% (T1A6C10)** |

## 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 technologies were 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 were categorized as lined pits with semi-permeable walls and open bottom.

The various types of sanitation technologies selected for the SFD graphic generator are shown in the SFD selection grid, as shown in Figure 18 and explained in Table 3.

| 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<br>Low risk of GW pollution | | | | | Not Applicable |
| Septic tank | | | | | Significant risk of GW pollution<br>Low risk of GW pollution | | | | | |
| Fully lined tank (sealed) | | | | | Significant risk of GW pollution<br>Low risk of GW pollution | | | | | T1A3C10 |
| Lined tank with impermeable walls and open bottom | Significant risk of GW pollution<br>Low risk of GW pollution | Significant risk of GW pollution<br>Low risk of GW pollution | Significant risk of GW pollution<br>Low risk of GW pollution | Significant risk of GW pollution<br>Low risk of GW pollution | Significant risk of GW pollution<br>Low risk of GW pollution | | | | | T2A4C10<br>T1A4C10 |
| Lined pit with semi-permeable walls and open bottom | Not Applicable | | | | | | | | | T2A5C10<br>T1A5C10 |
| Unlined pit | | | | | | | | | | T2A6C10<br>T1A6C10 |
| Pit (all types), never emptied but abandoned when full and covered with soil | | | | | | | | | | Significant risk of GW pollution<br>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 18: SFD selection grid of Bheriganga Municipality.**

**Table 3: Explanation of different variables and containment technologies selected in SFD selection grid (SuSanA, 2018).**

| SN | Variable | Explanation |
|---|---|---|

| | | |
|---|---|---|
| 1 | 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. |
| 2 | 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. |
| 3 | 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. |
| 4 | T1A6C10 | This is 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 not fitted with a supernatant/effluent overflow, the excreta in this system are considered contained. |
| 5 | 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. |
| 6 | T2A4C10 | A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur - the excreta is therefore likely to be partially treated. 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. |
| 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. |
| 8 | T2A6C10 | This is a correctly designed, properly constructed and well-maintained unlined pit with permeable walls and base, through which infiltration can occur. Since there is a ‘significant risk’ of groundwater pollution, the excreta of this system are 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 the 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 19 shows the SFD matrix of Bheriganga Municipality. The sanitation technologies and the corresponding percentage of the population using such technologies are shown in Figure 19. These values are derived from the HH survey (ENPHO, 2023) and KIIs with desludging service providers (KII_4, 2023).

Bheriganga Municipality, Karnali, Nepal, 1 Nov 2023. SFD Level: 2 - Intermediate SFD
Population: 48203
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 |
| T1A3C10<br>Fully lined tank (sealed), no outlet or overflow | 17.0 | 51.0 | 97.0 | 90.0 |
| T1A4C10<br>Lined tank with impermeable walls and open bottom, no outlet or overflow | 6.0 | 12.0 | 33.0 | 90.0 |
| T1A5C10<br>Lined pit with semi-permeable walls and open bottom, no outlet or overflow | 3.0 | 8.0 | 0.0 | 0.0 |
| T1A6C10<br>Unlined pit, no outlet or overflow | 30.0 | 7.0 | 11.0 | 90.0 |
| T1B11 C7 TO C9<br>Open defecation | 3.0 | | | |
| T2A4C10<br>Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 2.0 | 0.0 | 0.0 | 0.0 |
| T2A5C10<br>Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 2.0 | 0.0 | 0.0 | 0.0 |
| T2A6C10<br>Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 37.0 | 9.0 | 0.0 | 0.0 |

**Figure 19: SFD matrix of Bheriganga 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 the percentage containment emptied (ENPHO, 2023) and the amount of FS emptied during the process (KII_4, 2023)). In average, 92% 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 92% of the emptied containment. Hence, the proportion of FS emptied from the sanitation technology is calculated as 92% on the sanitation technology emptied.

As biogas digester have been considered as fully lined tanks while preparing the SFD graphic, the emptied proportion includes the percentage of biogas digester emptied. The emptied percentage of the fully lined tank with no outlet or overflow mentioned in Table 4 is the sum of the emptied proportion of biogas digester and fully lined tank. Table 4 shows the calculation of variable F3.

**Table 4: Actual emptying proportion for existing containment technologies.**

| SN | Reference Variables | Containment technologies | Percentage of emptied containment[1] | Emptied proportion of FS[2] | Actual proportion of emptied FS (F3) |
|---|---|---|---|---|---|
| 1 | T1A3C10 | Fully lined tank (sealed), no outlet or overflow | 55.56% | 92% | 51% |
| 2 | T1A4C10 | Lined tank with impermeable walls and open bottom, no outlet or overflow | 13% | 92% | 12% |
| 3 | T1A5C10 | Lined pit with semi-permeable walls and open bottom, no outlet or overflow | 9% | 92% | 8% |
| 4 | T1A6C10 | Unlined pit, no outlet or overflow | 7.27% | 92% | 7% |
| 5 | T1B11 C7 TO C9 | Open defecation | NA | NA | NA |
| 6 | T2A4C10 | Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 0% | 92% | 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 | 0% | 92% | 0% |
| 8 | T2A6C10 | Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution | 9.42% | 92% | 9% |

Source: (ENPHO, 2023)[1,2]; (KII_4, 2023)[2]

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

9% 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 graphic. The cow dung has been fed into a 4 $m^3$, 6 $m^3$ and 8 $m^3$ capacity of digesters to mix with faecal sludge for biogas production.

The actual emptied fully lined tanks with no outlet or overflow and biogas digesters is 51% (F3 = 51%). All the households using biogas digesters have been considered as transported to treatment plant. Thus, the faecal sludge transported to the treatment plant is the combined percentage of households using biogas digesters and fully lined tanks (sealed), no outlet or overflow (T1A3C10) (F4 = 97%). Thus, 90% of the households who have been using biogas digester has been considered as treated (F5 = 90%).

Similarly, the percentage of FS emptied from lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) and unlined pit, no outlet or overflow (T1A6C10) which is delivered to Birendranagar FSTP were found to be 33% (F4 = 33%) and 11% (F4 = 11%) respectively. Moreover, the treatment efficiency of the treatment plant has been assumed as 90% based on the observation and secondary data review. Thus, FS delivered to treatment plant and treated was calculated as 90% (F5 = 90%).

Currently, there is no Faecal Sludge Treatment Plant within the municipality for treating faecal sludge (KII_1, 2023). Mechanically emptied FS is transported and treated at the FSTP located in Birendranagar Municipality. On the other hand, manually emptied FS is directly disposed of in farmlands without undergoing any treatment. Consequently, the percentages of FS transported to the treatment plant (F4) and FS treated (F5) for all containment systems, excluding biogas digesters, as well as FS transported to the Birendranagar FSTP, have been designated as 0%.

## 2.3. Summary of Assumptions

**Offsite sanitation Systems**

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

**Onsite Sanitation Systems**

- ✓ The proportion of FS in 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 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. The FS emptied manually from the containments is dumped of untreated in farmlands. However, FS from anaerobic biogas digesters, classified as fully lined tanks (system T1A3C10), is considered as transported (F4 = 97%) and treated with a treatment efficiency estimated at 90% (F5 = 90%).
- ✓ Mechanically emptied FS has been transported to Birendranagar Faecal Sludge Treatment Plant where the emptied FS from lined tanks (T1A4C10) and unlined pits (T1A6C10) is disposed of and treated at Birendranagar FSTP. Values for variable F4 for these sanitation systems (F4 = 33% for T1A4C10 and F4 = 11% for T1A6C10) are calculated based on the household survey and KIIs.
- ✓ The FS from lined tanks with impermeable walls and open bottom and unlined pits is treated in the Birendranagar treatment plant with an efficiency of 90% (F5 = 90%) for both systems.

## 2.4. SFD Graphic

Figure 20 represents the fate and flow of FS and supernatant through the sanitation service chain. It shows that FS generated from 52% of the population is safely managed and represented by “Green” colour arrowhead.

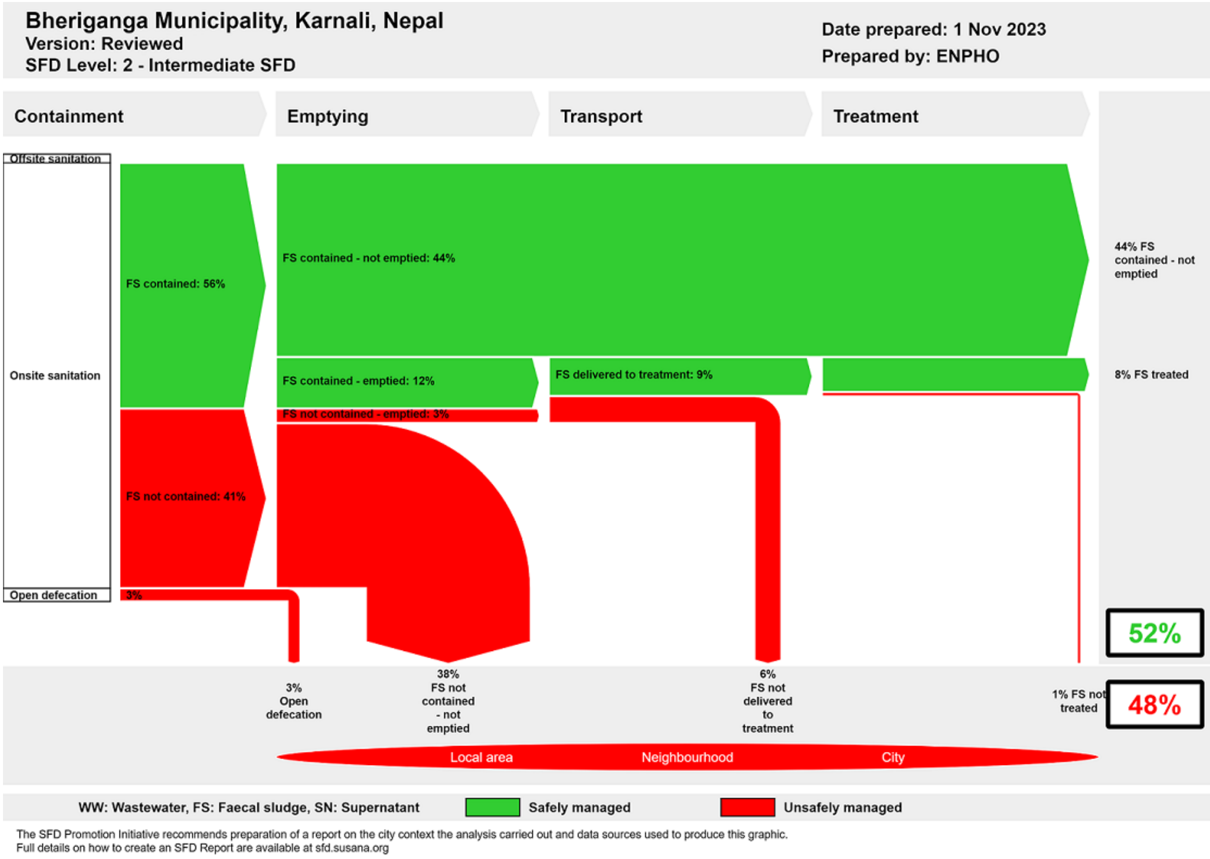


**Figure 20: SFD graphic of Bheriganga Municipality.**

However, 44% of the safely managed FS resembles the FS stored in the containment without significant risk to groundwater pollution. Thus, the safely managed percentage of FS generated by this 44% of the population is temporary until the FS from the containment is emptied. Consequently, these systems will require emptying services in the short and medium term as they fill up. Additionally, 8% of the population have treated the FS using biogas digesters.

The FS from 48% of the population is unsafely managed, represented by “Red” arrow heads. The percentage of unsafely managed FS is generated from FS not treated (1%), FS emptied but not delivered to treatment plant (6%), FS from containments where FS is not contained - not emptied (38%), and people practising open defecation (3%).

All the population with access to toilets relies on onsite sanitation systems. As shown on the SFD graphic (Figure 20), it is estimated that 56% of the population uses systems where the FS is considered contained, while 41% 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 fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10), lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10) and unlined pits, no outlet or overflow (T1A6C10). Thus, the FS generated by 56% 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, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A4C10), lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10) and unlined pits, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A6C10). Thus, the FS generated by 41% of the population is considered not contained.

**FS contained - emptied**

The proportion of FS contained - emptied is the summation of the proportion of FS emptied from fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10), lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10) and unlined pits, no outlet or overflow (T1A6C10). Thus, the proportion of FS contained - emptied is 12% and emptied either mechanically or manually.

***FS not contained - emptied***

The proportion of FS not contained - emptied (3%) is FS that is not contained in onsite sanitation technologies and emptied either mechanically or manually.

**FS not delivered to treatment**

The municipality does not have a treatment facility to treat faecal sludge. Manually emptying practice is most popular within municipality. So, the FS emptied from contained and not contained containments is disposed of untreated into farmlands. The proportion of FS not delivered to treatment (6%) is the summation of FS contained - emptied and FS not contained - emptied.

**FS delivered to treatment**

The FS from biogas digesters used by households has been considered as delivered to treatment plant. Thus, the total proportion of FS delivered to treatment is 9% (FS from fully lined tanks (sealed), lined tanks and unlined pits).

**FS treated**

The proportion of FS obtained from containment which has been transported to treatment and treated is 8%.

**FS not treated**

The proportion of FS obtained from containment which has been transported to treatment and not treated is 1%.

**Open Defecation**

Bheriganga Municipality was declared as an open defecation free municipality in 2015. However, 3% of the households are without access to toilet. They are practising open defecation and using the toilet of neighbour.

# 3 Service Delivery Context

## 3.1 Policy, legislation and regulation

The constitution of Nepal 2015 has established right to access to clean drinking water and citizen as fundamental right. In Article 35 (4) 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 (1) recognizes that every person shall have the right to live in a healthy and clean environment (GoN, 2015). To respect and promote the right of citizens to wards accessing clean drinking water and sanitation services, the government has promulgated and amended necessary laws. The most relevant legislation for promotion of safe sanitation services is discussed here.

**Local Government Operation Act, 2017**

Local Governance Operation Act 2017 has promogulated to implement the rights of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act defined roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level. Regarding the management of sanitation, the act entitles local government to conduct awareness campaigns, design and implement sanitation programs at the local level.

**Environment Protection Act, 2019**

Environment protection act 2019 is promogulated to prevent and control pollution from different development activities. It defines "Pollution" as the activities that significantly degrade, damage the environment, or harm the beneficial or useful purpose of the environment, by changing the environment directly or indirectly because of wastes, chemical, heat, noise, electrical, electro-magnetic wave, or radioactive ray. It provides the mechanism for appointing environmental inspector to control pollution by federal, provincial, and local government.

**Water Supply and Sanitation Act, 2022**

The act was promogulated to ensure the fundamental right of citizen to easy access on clean and quality drinking water, sanitation services and management of sewerage and wastewater. It defines sewerage and wastewater management as construction of sewer networks and treatment plants to preserve sources of water. It has entitled federal, provincial, and local level for the operation and management of water and sanitation services. The act also explicitly defines the responsibility of every citizen to preserve, conserve and maintain the sources of water and use responsibly (MoWS, 2022a).

**Environment Friendly Local Governance Framework 2013**

The environment-friendly local governance framework 2013 has been issued to add value to environment-friendly local development concept encouraging environmental protection through local bodies. The framework has set basic and advanced indicators for households, settlement, ward, village, municipality, and district levels for declaration of environment friendly. The use of water sealed toilets in households as basic indicators for sanitation and health. Provision of toilet with safety tank and use as advanced indicators for sanitation. Provision of gender, children and disabled friendly public toilets in parks, petrol pumps and main market as basic indicator for municipal level. Advance indicators such as drainage discharged only after being processed through biological or engineering technique. While it has failed to identify the necessity of faecal sludge treatment plants as it has assumed safety tank in the households is sufficient for treating faecal sludge.

**Institutional and Regulatory Framework for Faecal Sludge Management, 2017**

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 Faecal Sludge Management (FSM). 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 the Water Users and Sanitation Committee in the framework reflects a participatory approach that would help in sustaining the interventions (MoWS, 2017a).

### *3.1.1 Policy*

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 to 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, the 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. Both these policies were limited to addressing emerging issues and challenges in the rural and urban areas. National Water, Sanitation and Hygiene Policy (NWASHP), 2023 resolves both Rural Water Supply and Sanitation National Policy, 2004 and National Urban Water Supply and Sanitation Sector Policy, 2009.

The National Water, Sanitation, and Hygiene Policy, endorsed by the Government of Nepal in 2023, aims to safeguard the universal right to access safe water and sanitation and upholds the right to reside in a clean and healthy environment. This policy advocates for a sectoral distribution of responsibilities among the three tiers of government, grounded in the principles of collaboration, cooperation, and coexistence. The goal is to ensure the effective management of water, sanitation, and hygiene development across the nation. It emphasizes to formulate Water, Sanitation, and Hygiene plans at the federal, provincial, and municipal levels. The policy prioritizes the integration of climate and disaster-resilient development, along with a focus on research and institutional capacity building. It advocates for the delivery of WASH services that are of high quality, transparent, and accountable, with the goal of ensuring universal access to these services for all. Further, the policy encompasses a broad spectrum of sanitation services, incorporating the treatment and safe disposal or reuse of faecal sludge and wastewater (MoWS, 2023).

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).

Together with a national commitment to pursuing and achieving the Sustainable Development Goals (SDGs) by 2030, National Planning Commission formulated targets and indicators for coordinated efforts to achieve the goals. This commitment has been reaffirmed in key policy documents, such as the current 15th Development Plan. Furthermore, Nepal has undertaken various initiatives to localize the SDG indicators by developing the SDG Status and Roadmap, which includes baselines and targets for 2030 (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 in the sector for effective planning, implementation, and service delivery. Nepal achieved the commendable milestone of being declared an Open Defecation Free nation on September 23, 2019.

However, the overarching target of connecting 90% of households to either a sewer system or implementing proper FSM is yet to be achieved.

Total Sanitation Guideline was promulgated by the Ministry of Water Supply in April 2017 after the successful implementation of National Sanitation and Hygiene master Plan (NSHMP) 2011. It provides guidelines for sustaining ODF outcomes and initiating post-ODF activities through an integrated water, sanitation and hygiene plan at municipalities and districts. The guideline redefined sanitation as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish a hygienic environment and promote public health. Indicators are set to guide total sanitation movement with an arrangement for resource management, monitoring and evaluation, capacity building.

National Drinking Water Quality Standard 2022 has been published by Ministry of Water Supply in National Gazette with standards values for physical, microbiological, and chemical parameters. Altogether, 19 parameters have been set as mandatory parameters to be test by the water service providers (MoWS, 2022b) .

**Local Acts, Policies and Procedures**

Bheriganga Municipal Council officially approved the Sanitation and Waste Management Guidelines on September 23, 2022, with the aim of efficiently managing waste through methods such as reduction, reuse, treatment, and safe disposal. The primary goal is to mitigate the adverse impacts on public health and foster a clean and healthy environment. The guidelines emphasize an integrated approach to waste management, encouraging active participation from both the private and public sectors (Bheriganga Municipality, 2022a).

Additionally, on December 3, 2022, the Bheriganga Municipal Council ratified the Water Supply Management Procedure. This procedural framework is designed to uphold the fundamental right to access safe drinking water and sanitation. It establishes water supply and sanitation user committees responsible for delivering sustainable and high-quality water and sanitation services to the community (Bheriganga Municipality, 2022c).

Furthermore, Bheriganga Municipality has formulated a comprehensive WASH plan. Developed in collaboration with the Department of Water Supply and Sewerage Management (DWSSM) and with technical assistance from ENPHO under the SDG project, the plan is geared towards providing enduring services and facilities related to water, sanitation, and hygiene. This initiative is a crucial step towards achieving long-term sustainability and meeting the targets outlined in the Sustainable Development Goals (Bheriganga Municipality, 2022b).

### *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 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 21.

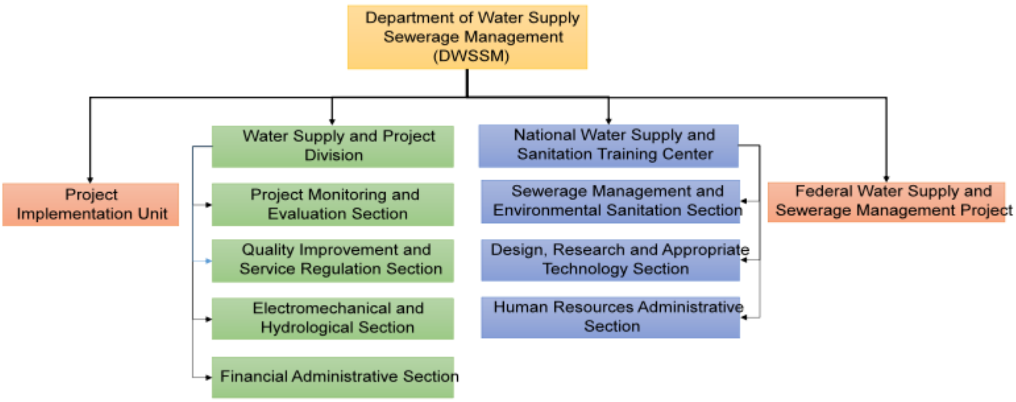


**Figure 21: Organizational Structure Department of Water Supply and Sewerage Management.**

**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 Water Resource and Energy Development:** Ministry of Water Resource and Energy Development of provincial government in Karnali province is major executing body in the province. The provincial government is working to ensure the access to safe water, sanitation and hygiene for public focusing on marginalized community. It emphasizes on the policy making, planning, monitoring and regulation. Planning and implementation of water supply and sanitation infrastructure in 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 is organized into divisions and sections. Municipality have established separate Water, Sanitation and Hygiene Unit under Environment, Physical Infrastructure and Sanitation Section. This unit is particularly focused on effective implementation the planning, policy and procedure regarding WASH sector.

### *3.1.3 Service Provision*

Urban Water Supply and Sanitation Policy 2009 has emphasized the Public-Private Partnership (PPP) in water supply and sanitation to improve service delivery (MoPIT, 2009). Also, Public-Private Partnership Policy, 2015 encourages private sector investment in the development and operation of public infrastructure services for comprehensive socioeconomic development. The policy has aimed to remedy challenges such as structuring of projects, land acquisition, coordination and approval, payments to private sectors and approval for environment impact (MoF, 2015).

To ensure the safe, sustainable, and equitable use of water sanitation and hygiene by all, the municipality have been collaborating with local, nation and international development partners. It focuses on improving behaviour change intervention for improved WASH facilities and practices, WASH service provision leading to increased availability and affordability of WASH products and services which contributes to sustainable and equitable access to WASH for all. However, it is noteworthy that there is no private sector involvement in desludging service provision within the municipality, with these services currently being outsourced to a neighbouring municipality.

### *3.1.4 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 5. However, FSM specific standards have yet to be developed and implemented.

**Table 5: Sanitation Service Level and its Components.**

| S.N. | 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

Key Informant Interviews (KIIs) are qualitative in-depth interviews with people who know what is going on in the community. 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, desludging service providers and public toilet service provider (Figure 22). Face-to-face interviews were conducted to get the 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 6.

**Table 6: List of key stakeholders for KIIs.**

| KII code | Name | Designation | Organization | Purpose | Date |
|---|---|---|---|---|---|
| KII_1 | Chitra Bahadur KC | Sub Engineer (WASH focal person) | Bheriganga Municipality | Sanitation Status of Bheriganga Municipality | 30 April, 2023 |
| KII_2 | Bindu Regmi | Accountant | Chhinchu Water Supply Consumers and Sanitation Committee | Water supply, coverage, treatment, water quality | 30 April, 2023 |
| KII_3 | Kul Bahadur KC | Chairperson | Ramghat Water Supply Consumers and Sanitation Committee | Water supply, coverage, treatment, water quality | 29 April, 2023 |
| KII_4 | Mohan Malla<br>Sagar Khadka | Accountant<br>Driver | Birendranagar Desludging service providers | Faecal sludge desluding service | 31 April, 2023 |
| KII_5 | | Public toilet Operator | Individual Caretaker | Status of Public Toilet | 30 April, 2023 |
| KII-6 | Prem GC | Public toilet Operator | Individual Caretaker | Status of Public Toilet | 28 April, 2023 |
| KII_7 | Deepa Pun Magar | | Water Quality Mini Lab | Status of Water Quality in Bheriganga Municipality | 29 April, 2023 |


**Figure 22: Key informant interviews with public toilet operator and water service provider.**

## 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 (Figure 23). 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 3. The data were collected using the *KoboCollect* application.


**Figure 23: Photos of enumerators during their orientation on effective data collection techniques.**

### Determining Sample Size

The sample size for the household survey in Bheriganga 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, 372 households out of 11,539 households distributed in 13 wards were sampled using proportionate stratification random sampling. The number of ward wise sample size has been attached in Appendix 4. The distribution of sampling points in the municipality are shown in Figure 24.

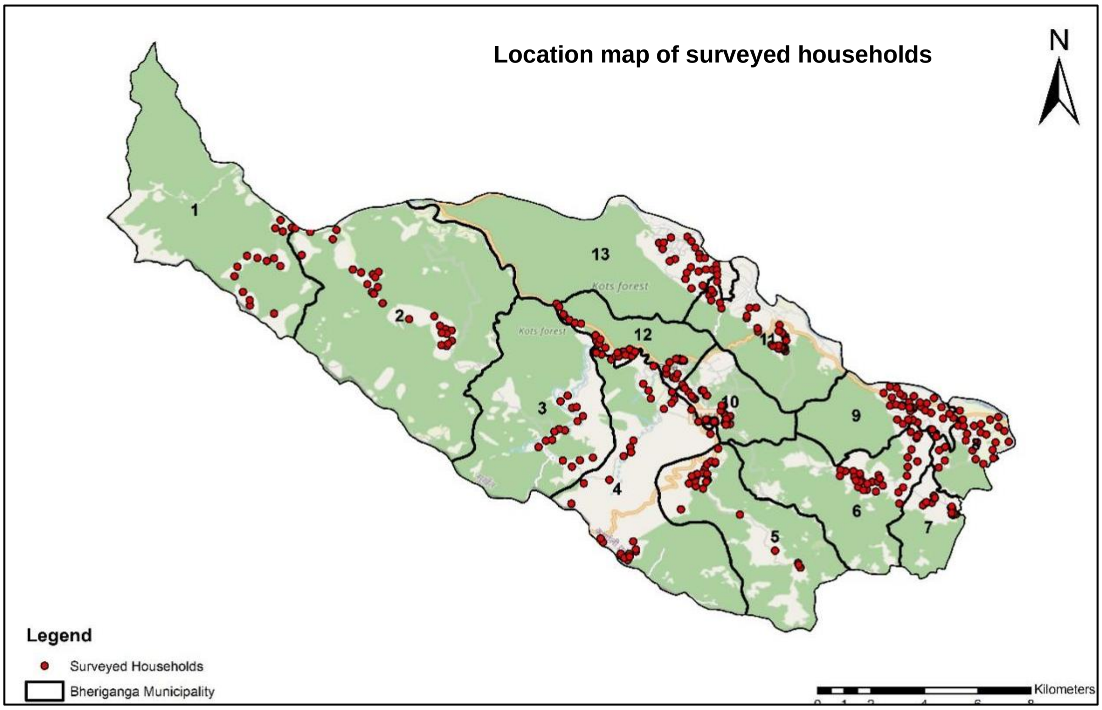


**Figure 24: Distribution of sampling points in all wards of Bheriganga Municipality.**

## 4.3. Direct Observation and Monitoring

Different sanitation technologies within households were observed, and visual documentation was maintained. Additionally, assessments were conducted on toilets, water sources, containment facilities, and the transportation of fecal sludge, public toilets. The overall process conducted by the enumerators were monitored by municipal official. Figure 25 illustrates the observation and monitoring of a household survey conducted.

**Figure 25: Field observation and monitoring the households survey.**

## 4.4. Sharing and Validation of Data

On 4 December, 2023, an SFD validation workshop was organized at meeting hall of Bheriganga Municipality. The results of households and institutional survey in the municipality were presented to Mayor, 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, 33 participants including the Mayor, Deputy Mayor, ward chairpersons, other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions (Figure 26).

Mr. Yagya Prasad Dhakal, Mayor, expressed concern about faecal sludge management issues in the municipality. He shared that a detailed plan for a solid waste treatment plant has been prepared, and the municipality will strive to integrate the co-treatment of solid waste and faecal waste in upcoming fiscal year plan. Mayor Dhakal underscored the importance of the WASH plan prepared by the municipality, emphasizing the municipality's keen interest in establishing sustainable and equitable WASH facilities within its jurisdiction. The list of participants with their designation is attached in Appendix 5.


**Figure 26: SFD Sharing and Validation Workshop in Bheriganga 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.

We offer our sincere gratitude to Mr. Yagya Prasad Dhakal, Mayor, Ms. Dhansara Bohara, Deputy Mayor, Mr. Krishna Prasad Pokhrel, Chief Administrative Officer, Mr. Chitra Bahadur KC, Sub Engineer, Mr. Kul Bahadur Khadka, Information Officer, Mr. Anil Chapai, IT Officer and entire staffs of municipality for their remarkable support during the study.

We are thankful to Mr. Kul Bahadur KC, Chairperson, Ramghat WUSC, Ms. Bindu Regmi, Accountant, Chhinchu WUSC, Mr. Mohan Malla, and Mr. Sagar Khadka desludging service providers and Mr. Prem GC and other public toilet operators, Ms. Deepa Pun Magar from water quality testing lab for providing valuable information.

We would like appreciate Dr. Roshan Raj Shrestha, Deputy Director of Bill and Melinda Gates Foundation (BMGF), Mr. Ashok Kumar Byanju Shrestha, Former President, UCLG ASPAC, Dr. Bernadia Irawati Tjandradewi, Secretary General, UCLG ASPAC and Mr. Satish Jung Shah, Knowledge Management Officer, UCLG ASPAC. Similarly, we are very much obliged to Mr. Bhim Prasad Dhungana, President, MUAN and Co. President, UCLG ASPAC, Mr. Kalanidhi Devkota, Executive Director, MUAN Mr. Muskan Shrestha, Sanitation Advocacy Specialist, MuAN for their gracious support during the study.

We are very much grateful to Ms. Bhawana Sharma, Executive Director, ENPHO and Mr. Rajendra Shrestha, Program Director, ENPHO, Mr. Anil Maharjan, Project Coordinator, ENPHO for tremendous support and guidance during the entire process of the study. Together, we would like to thank entire team of ENPHO for their gracious support and MuNASS-II team without whom the study would not have been possible.

We are grateful towards the enumerators Ms. Tirtha Basnet, Ms. Kalpana BC, Ms. Laxmi Khatri, Ms. Durga Pariyar, Ms. Pabitra Budha, Ms. Debaki Bista, Ms. Nirmala Sunar, Ms. Durga BC, Mr. Pradip Rawat, Ms Maima Kala Nepali, Ms. Pratiksha Chunara, Mr.TR Bibash BK for their support during the survey.

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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: Water Quality Testing Report

### Sample Analysis Report

**Lab Sample ID: 354 [078-079]** ***ENPHO/QR/7.8.1/01/2078-079***

**Client:** ENPHO/WASH SDG Programme/WAI
**Client Address:** Thapagaun, Kathmandu
**Received On:** Friday, September 17, 2021
**Completed On:** Tuesday, October 26, 2021
**Sampled By:** Client
**Client's Sample Code:** Su-1, Ramghat Khanepani Upovokta Tatha Sarsafai Samiti
**Sample Volume and Condition**: 3125mL and Ice Box, Sample Bottle from Lab

**Sample Category:** Drinking water
**Sample Location:** Bheriganga, Bheriganga Municipality, Surkhet
**Point of Sample Collection:** Stream
**Source of Sample:** Stream
**Treated/Untreated:** Untreated

PHYSICO-CHEMICAL AND MICROBIOLOGICAL ANALYSIS

| Parameters | Unit | Result | Standard | Test Methods |
|---|---|---|---|---|
| *Cyanide | mg/L | ND(<0.05) | **0.07** | APHA, AWWA, WEF, 4500-CN E, 23rd Edition |
| *Taste | TFN | Non objectionable | **-** | APHA, AWWA, WEF, 2160 B, 23rd Edition |
| Aluminium | mg/L | ND(<0.05) | **0.2** | APHA, AWWA, WEF (2017), 3500-Al B |
| Ammonia | mg/L | 0.43 | **1.5** | APHA, AWWA, WPCF (1985), 417 B |
| Arsenic | mg/L | ND(<0.005) | **0.05** | APHA, AWWA, WEF (2017), 3114 C |
| Cadmium | mg/L | ND(<0.003) | **0.003** | APHA, AWWA, WEF (2017), 3111 B |
| Calcium | mg/L | 28.1 | **200** | APHA, AWWA, WEF (2017), 3500-Ca B |
| Chloride | mg/L | 2.0 | **250** | APHA, AWWA, WEF (2017), 4500-Cl- B |
| Colour | TCU | ND(<5) | **5(15)** | APHA, AWWA, WEF (2017), 2120 B |
| Copper | mg/L | ND(<0.02) | **1** | APHA, AWWA, WEF (2017), 3111 B |
| *E. coli* | CFU/100mL | **192** | **0** | APHA, AWWA, WEF (2017), 9222 |
| Electrical Conductivity | µS/cm | 192 | **1500** | APHA, AWWA, WEF (2017), 2510 B |
| Fluoride | mg/L | **ND(<0.50)** | **0.5-1.5** | APHA, AWWA, WEF (2017), 4500-F D |
| Free Residual Chlorine | mg/L | **ND(<0.10)** | **0.1-0.2** | APHA, AWWA, WEF (2017), 4500-Cl- B |
| Iron | mg/L | **8.01** | **0.3(3)** | APHA, AWWA, WEF (2017), 3111 B |
| Lead | mg/L | ND(<0.01) | **0.01** | APHA, AWWA, WEF (2017), 3111 B |
| Manganese | mg/L | **0.29** | **0.2** | APHA, AWWA, WEF (2017), 3111 B |
| Mercury | mg/L | ND(<0.001) | **0.001** | APHA, AWWA, WEF (2017), 3112 B |
| Nitrate | mg/L | ND(<0.2) | **50** | APHA, AWWA, WEF (2017), 4500-$NO_3^-$ B |
| Odour | TON | No Odour Observed | **-** | APHA, AWWA, WEF (2017), 2150 B |
| pH | - | 8.35 | **6.5-8.5** | APHA, AWWA, WEF (2017), 4500-H B |
| Sulphate | mg/L | 13.0 | **250** | APHA, AWWA, WEF (2017), 4500-Sulphate D |
| Total Chromium | mg/L | ND(<0.020) | **0.05** | APHA, AWWA, WEF (2017), 3111 B |
| Total Coliform | CFU/100mL | **324** | **0** | APHA, AWWA, WEF (2017), 9222 |
| Total Dissolved Solids | mg/L | 98 | **1000** | APHA, AWWA, WEF (2017), 2540 C |
| Total Hardness as CaCO3 | mg/L | 125.3 | **500** | APHA, AWWA, WEF (2017), 2340 C |
| Turbidity | NTU | **54.0** | **5(10)** | APHA, AWWA, WEF (2017), 2130 B |
| Zinc | mg/L | ND(<0.05) | **3** | APHA, AWWA, WEF (2017), 3111 B |

**Remarks:**
Parameters not meeting National Drinking Water Quality Standards (2062 B.S.) at the time of analysis :

**E. coli** **Fluoride** **Free Residual Chlorine** **Iron** **Manganese** **Total Coliform** **Turbidity**

ENPHO Laboratory Accredited by Nepal Bureau of Standards and Metrology (NBSM), Govt. of Nepal, Accreditation No. Pra. 05/057-058

References: Standard Methods for the Examination of Water and Wastewater, 23 rd Edition, APHA, AWWA, WEF (2017).
**Standard= National Drinking Water Quality Standards (2062 B.S.)**
*Sub-contracted to other accredited lab.
**()** : Maximum Concentration Limit TNTC-Too Numerous To Count(>1000) ND : Not Detected
CFU- Colony Forming Unit NTU- Nephelometric Turbidity Unit TCU- True Colour Unit TON- Threshold Odour Number
Result with '<' indicate that the concentration was below the detection limit. The limit is indicated by the number following '<' sign.

## Sample Analysis Report

**Lab Sample ID: 355[078-079]** *ENPHO/QR/7.8.1/01/2078-079*

**Client:** ENPHO/WASH SDG Programme/WAI
**Client Address:** Thapagaun, Kathmandu
**Received On:** Friday, September 17, 2021
**Completed On:** Tuesday, October 26, 2021
**Sampled By:** Client
**Client's Sample Code:** Su-2, Maseri khola Water Supply Scheme, Ramghat Khanepani Upovokta Tatha Sarsafai Samiti
**Sample Volume and Condition**: 3125mL and Ice Box, Sample Bottle from Lab

**Sample Category:** Drinking water
**Sample Location:** Bheriganga, Bheriganga Municipality, Surkhet
**Point of Sample Collection:** Stream
**Source of Sample:** Stream – Maseri Khola
**Treated/Untreated:** Untreated

PHYSICO-CHEMICAL AND MICROBIOLOGICAL ANALYSIS

| Parameters | Unit | Result | Standard | Test Methods |
|---|---|---|---|---|
| *Cyanide | mg/L | ND(<0.05) | **0.07** | APHA, AWWA, WEF, 4500-CN E, 23rd Edition |
| *Taste | TFN | Non objectionable | **-** | APHA, AWWA, WEF, 2160 B, 23rd Edition |
| Aluminium | mg/L | ND(<0.05) | **0.2** | APHA, AWWA, WEF (2017), 3500-Al B |
| Ammonia | mg/L | ND(<0.05) | **1.5** | APHA, AWWA, WPCF (1985), 417 B |
| Arsenic | mg/L | ND(<0.005) | **0.05** | APHA, AWWA, WEF (2017), 3114 C |
| Cadmium | mg/L | ND(<0.003) | **0.003** | APHA, AWWA, WEF (2017), 3111 B |
| Calcium | mg/L | 12.0 | **200** | APHA, AWWA, WEF (2017), 3500-Ca B |
| Chloride | mg/L | ND(<1.0) | **250** | APHA, AWWA, WEF (2017), 4500-Cl- B |
| Colour | TCU | ND(<5) | **5(15)** | APHA, AWWA, WEF (2017), 2120 B |
| Copper | mg/L | ND(<0.02) | **1** | APHA, AWWA, WEF (2017), 3111 B |
| *E. coli* | CFU/100mL | **68** | **0** | APHA, AWWA, WEF (2017), 9222 |
| Electrical Conductivity | µS/cm | 86 | **1500** | APHA, AWWA, WEF (2017), 2510 B |
| Fluoride | mg/L | **ND(<0.50)** | **0.5-1.5** | APHA, AWWA, WEF (2017), 4500-F D |
| Free Residual Chlorine | mg/L | **ND(<0.10)** | **0.1-0.2** | APHA, AWWA, WEF (2017), 4500-Cl- B |
| Iron | mg/L | ND(<0.05) | **0.3(3)** | APHA, AWWA, WEF (2017), 3111 B |
| Lead | mg/L | ND(<0.01) | **0.01** | APHA, AWWA, WEF (2017), 3111 B |
| Manganese | mg/L | ND(<0.05) | **0.2** | APHA, AWWA, WEF (2017), 3111 B |
| Mercury | mg/L | ND(<0.001) | **0.001** | APHA, AWWA, WEF (2017), 3112 B |
| Nitrate | mg/L | 1.5 | **50** | APHA, AWWA, WEF (2017), 4500-$NO_3^-$ B |
| Odour | TON | No Odour Observed | **-** | APHA, AWWA, WEF (2017), 2150 B |
| pH | - | 8.15 | **6.5-8.5** | APHA, AWWA, WEF (2017), 4500-H B |
| Sulphate | mg/L | 2.7 | **250** | APHA, AWWA, WEF (2017), 4500-Sulphate D |
| Total Chromium | mg/L | ND(<0.020) | **0.05** | APHA, AWWA, WEF (2017), 3111 B |
| Total Coliform | CFU/100mL | **132** | **0** | APHA, AWWA, WEF (2017), 9222 |
| Total Dissolved Solids | mg/L | 54 | **1000** | APHA, AWWA, WEF (2017), 2540 C |
| Total Hardness as CaCO3 | mg/L | 51.8 | **500** | APHA, AWWA, WEF (2017), 2340 C |
| Turbidity | NTU | ND(<1.0) | **5(10)** | APHA, AWWA, WEF (2017), 2130 B |
| Zinc | mg/L | ND(<0.05) | **3** | APHA, AWWA, WEF (2017), 3111 B |

**Remarks:**
Parameters not meeting National Drinking Water Quality Standards (2062 B.S.) at the time of analysis :

**E. coli** **Fluoride** **Free Residual Chlorine** **Total Coliform**

ENPHO Laboratory Accredited by Nepal Bureau of Standards and Metrology (NBSM), Govt. of Nepal, Accreditation No. Pra. 05/057-058

References: Standard Methods for the Examination of Water and Wastewater, 23 rd Edition, APHA, AWWA, WEF (2017).
**Standard= National Drinking Water Quality Standards (2062 B.S.)**
*Sub-contracted to other accredited lab.
**()** : Maximum Concentration Limit TNTC-Too Numerous To Count(>1000) ND : Not Detected
CFU- Colony Forming Unit NTU- Nephelometric Turbidity Unit TCU- True Colour Unit TON- Threshold Odour Number
Result with '<' indicate that the concentration was below the detection limit. The limit is indicated by the number following '<' sign.

## 7.3. Appendix 3: List of Participants of SFD orientation

UCLG ASPAC ENPHO

**Municipalities Network Advocacy on Sanitation in South Asia(MuNASS) - II**

**Attendance Sheet**

**Program:** SFD orientation
**Date:** 15,16 Baisakh, 2080
**Venue:** Bheri ganga Municipality.

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

| S.N | Name | Organization | Designation | Phone no | Signature Day 1 | Signature Day 2 | Age | Ethnicity |
|---|---|---|---|---|---|---|---|---|
| 1 | Tirtha Basnet | 12 ward | Enumerator | 9844859768 | [illegible] | [illegible] | 27 | |
| 2. | Kalpana B. C. | 9 " | " | 9749254926 | Kalpana | Kalpana | 26 | |
| 3. | Laxmi Khatri | 4 " | " | 9824540137 | [illegible] | [illegible] | 20 | |
| 4 | Durga Pariyar | 4 " | " | 9812588700 | [illegible] | [illegible] | 20 | |
| 5 | Pabitra Budha | 10 " | " | 9812475651 | [illegible] | [illegible] | 21 | |
| 6 | Debaki Bista | 5 " | " | 9840153461 | Debaki | Debaki | 27 | |
| 7 | Nirmala Sonar | 11 " | " | 9842657965 | [illegible] | [illegible] | 26 | |
| 8 | Durga B.C | 6 " | " | 9861672113 | [illegible] | [illegible] | 31 | |
| 9 | Pradip Rawat | 1 " | " | 9868349731 | [illegible] | [illegible] | 26 | |
| 10 | Maima kala Nepali | 7 " | " | 9823000069 | [illegible] | [illegible] | 35 | |
| 11 | Pratiksha Chunara | 13 " | " | 9804591098 | [illegible] | [illegible] | 19 | |
| 12 | T. R. BIBASH B.K. | 8 " | " | 9848224330 | [illegible] | [illegible] | 30 | |
| 13 | Rupak Shrestha | ENPHO | Engineer | 9849463540 | [illegible] | [illegible] | | |
| 14 | Sabuna Gamal | ENPHO | APO | 9843412596 | [illegible] | [illegible] | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

## 7.4. Appendix 4: Ward Wise Sample Size Distribution in Bheriganga Municipality

| Ward No. | Population (NSO, 2023) | Households (NSO, 2023) | Proportion | Required sample HH | Sample difference |
|---|---|---|---|---|---|
| 1 | 2,472 | 555 | 5% | 18 | 31 |
| 2 | 3,301 | 751 | 7% | 24 | 31 |
| 3 | 2,133 | 481 | 4% | 15 | 31 |
| 4 | 4,270 | 981 | 9% | 32 | 31 |
| 5 | 3,939 | 901 | 8% | 29 | 31 |
| 6 | 3,542 | 896 | 8% | 29 | 31 |
| 7 | 1,967 | 530 | 5% | 17 | 31 |
| 8 | 3,948 | 984 | 9% | 32 | 31 |
| 9 | 4,217 | 1,026 | 9% | 33 | 31 |
| 10 | 5,491 | 1,306 | 11% | 42 | 31 |
| 11 | 4,546 | 1,101 | 10% | 35 | 31 |
| 12 | 4,347 | 1,082 | 9% | 35 | 31 |
| 13 | 4,030 | 945 | 8% | 30 | 31 |
| | **48,203** | **11,539** | | **372** | |

## 7.5. Appendix 5: List of participants present in SFD sharing and validation workshop

आज मिति २०८० साल मंसिर १८ गतेका दिन भेरी गंगा नगरपालिकामा नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग र The United Cities and local Government Asia Pacific (UCLGASPAC) को सहकार्यमा तथा Bill and Melinda Gates Foundation (BMGF) को आर्थिक सहयोगमा मानव मलमुत्र प्रवाह रेखाचित्र (Shit Flow Diagram - SFD) सम्बन्धि प्रमाणीकरण तथा अन्तर्क्रिया कार्यक्रममा निम्न अनुसार सरोकारवालाहरूको उपस्थिति रहेको छ।

उपस्थिति :-

| क्र.सं. | नाम | पद | कार्यालय | फोन नं. | हस्ताक्षर |
|---|---|---|---|---|---|
| १. | यज्ञ प्रसाद ढकाल | नगर प्रमुख | भेरी गंगा नगरपालिका | ९८५८०६४११० | |
| २. | धनसरा बोहोरा | नगर उप.प्रमुख | भेरी गंगा नगरपालिका | ९८५८०६४११२ | |
| ३. | कृष्ण प्रसाद पोखरेल | प्र. प्र. अ. | भेरी गंगा नगरपालिका | ९८५८०६४१११ | |
| ४. | गोमाया खत्री | का. पा सदस्य | भेरीगंगा नगरपालिका | [illegible] | |
| ५. | अमृता वि.क. (विष्ट) | का.पा सदस्य | भेरीगंगा नगरपा | [illegible] | |
| ६ | जय ब० नेपाली | वडाअध्यक्ष | भेरीगंगा ११ | [illegible] | |
| ७. | शेर बहादुर कामी | का.पा.स. | " — " | [illegible] | |
| ८ | [illegible] | १८ अध्यक्ष | भेरीगंगा न.पा.१० | [illegible] | |
| ९ | [illegible] | [illegible] | " -- १२ | [illegible] | |
| १० | [illegible] | का. पा. स. | - - - 6 | [illegible] | |
| ११ | पवित्रा घर्ति | कार्यपालिका | — — —२ | [illegible] | |
| १२ | खगीसरा पुन मगर | का. पा. सदस्य | - - १० | [illegible] | |
| १३ | मान सिंह परियार | का पा सदस्य | ३ | [illegible] | |
| १४ | पुसे कामी | वडा अध्यक्ष | ८ | [illegible] | |
| १५ | गंगा बहादुर खत्री | वडा अध्यक्ष | भेरीगंगा नं.पा.४ | [illegible] | |
| १६ | राम ब० बुढा | वास प्राविधिक (SUSWA) | भेरीगंगा २ | [illegible] | |
| १७ | शर्मिला बुढा मगर | वास प्राविधिक (SUSWA) | भेरीगंगा, १० | [illegible] | |
| १८ | [illegible] | [illegible] | भेरीगंगा - १२ | [illegible] | |

| क्र.सं. | नाम | पद | कार्यालय | फोन नं. | हस्ताक्षर |
|---|---|---|---|---|---|
| १६ | मित्र प्र. कु. (?) | wash out | भेरीगंगा न.पा. | ९८४८०२३१६९ | |
| १७ | श्यामलाल कोइराला | अध्यक्ष | रेडियो भेरीगंगा | ९८४८०२२१८८ | |
| १८ | [illegible] उपाध्याय | कर्मचारी | भेरीगंगा न.पा. | ९८४८०४८६७० | |
| १९ | पीताम्बर पौडेल | प्र.प्र.अधिकृत | भेरीगंगा न.पा. | ९८४८०६४०८ | |
| २० | [illegible] | [illegible] | " " | ९८४४०९१८२७ | |
| २१ | अनिल महर्जन | संयोजक | एन्फो | 9851233125 | |
| २२ | डिल कुमारी खत्री | [illegible] | भेरीगंगा | ९८६८९५२७११ | |
| २३ | जुपेन्द्र पौडेल | सरसफाई कर्मी | " " | ९८४८००८२२६ | |
| २४ | वीरबहादुर चुनारा | का.स. | | ९८६३५९२३५९५ | |
| २५ | [illegible] शाही | सरसफाईकर्मी | " | ९८६८१७८५ | |
| २३ | [illegible] | P.O | ENPHO | 9803685981 | |
| २४ | [illegible] | AFO | " | 9855028202 | |
| २५ | [illegible] | [illegible] | भेरीगंगा ५ | ९८६२९१९२६ | |
| २६ | यमुना गिरि | [illegible] | भेरी गंगा | ९८४८२३३६७ | |
| २७ | [illegible] रावत | [illegible] | भेरीगंगा | ९८६८०३१०२६ | |
| २८. | [illegible] चौधरी | | | 9865752533 | |
| ३५. | अनिता भुजेल | A.F.O. | ENPHO | 9849358197 | |
| ३६ | [illegible] | Engineer | ENPHO | 9849463840 | |
| 26 | [illegible] वज्राचार्य | Program Coordinator | ENPHO | 9849132020 | |
| | | | | | |

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