SFD Report

Tilottama Municipality
Nepal

Final Report

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SFD Report Tilottama Municipality, Nepal, 2024

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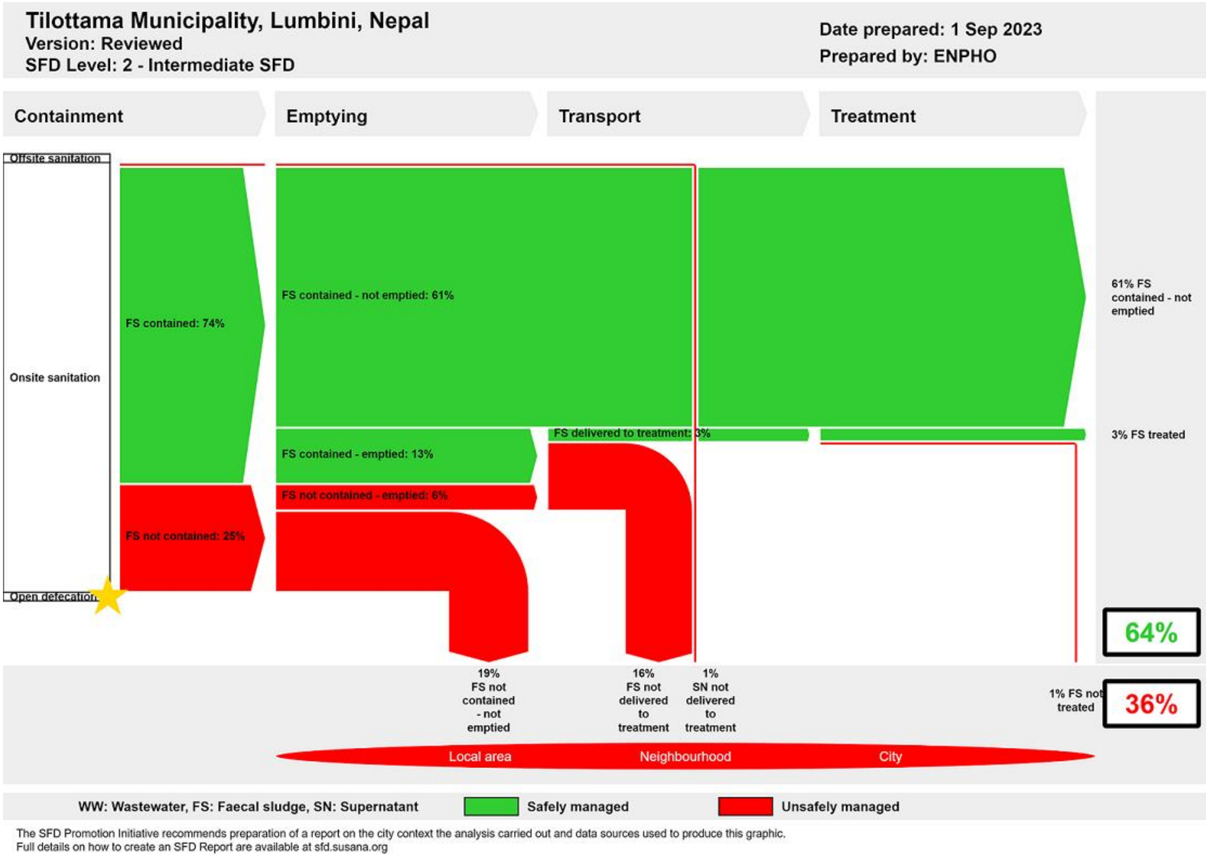
1. The SFD Graphic



2. Diagram information

SFD Level:

This SFD report is a level 2- Intermediate report.

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

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3. General city information

Tilottama Municipality is located in Rupandehi District, Lumbini Province of Nepal. It has a total of 17 wards and covers 126.19 km^2 of area. It is surrounded by Butwal Submetropolitan City in the north, Siddharthanagar Municipality and Omsatiya Rural Municipality in the south, Rohini River and Devdaha Municipality in the east and Tinau River, Sudhdhodhan Rural Municipality and Siyari Rural Municipality in the west. The municipality is located at latitude: 27°33'N to 27°39'N and longitude: 83°25'E to 83°33'E. The elevation ranges between 160m to 175m above mean sea level.

The municipality has total population of 149,479 and 35,991 households (NSO, 2023). It has hot and wet summers and cool, wet winters, featuring a monsoon-influenced humid subtropical climate (Cwa) (Mindat, n.d.). The average annual daily temperature is 26.2°C and the average annual precipitation is 2,907 mm (DHM, 2010).

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). All the households in the municipality have a toilet. Moreover, 22 biotech public toilets are installed along the Sidhartha highway between the main lane and the service lanes. The public toilets were constructed and are operated by the Water Supply and Sanitation Organizations of the municipality.

Containment:

All of the households in the municipality rely on onsite sanitation technologies. 39% of the households have constructed lined tanks with impermeable walls and open bottom. 29% of the households have installed lined pits with semi-permeable walls and open bottom. Similarly, 26% of the households have constructed fully lined tanks instead of a technically appropriate septic tanks (2% corresponds to biogas digesters also modelled as fully lined tanks). Only 6% of the households have their toilet connected to a septic tank.

Emptying and Transportation:

According to the assessment of the sanitation situation of the municipality by ENPHO in 2023, only 23% of the households have emptied their containments at least once after used. 78% of these containments were emptied mechanically and the remaining were emptied manually. Private desludging service providers are engaged in emptying and transportation services of faecal sludge.

Treatment and Disposal:

There is no Faecal Sludge Treatment Plant (FSTP) within the municipality for FS treatment (KII_1, 2023). However, the private service provider *Butwal Sanitary Pvt Ltd* has constructed and operated a faecal sludge treatment plant in Ramnagar Community Forest which is situated in Butwal Submetropolitan City.

7 private service providers dispose of the faecal sludge into that treatment plant which treats FS from different municipalities including Tilottama Municipality (KII_5, 2023). Other desludging service providers dispose of the untreated emptied faecal sludge in farmlands, forest areas and water bodies (KII_4, 2023) (KII_5, 2023).

According to the household survey conducted in Tilottama Municipality, 64% of households rely on private taps, while only 1% depend on public or community taps (ENPHO, 2023). The primary water supply service providers in the municipality include the Shankarnagar Water Supply Consumers and Sanitation Association, Karahiya Water Supply Consumers and Sanitation Association, and Anandaban Shankarnagar Water Supply Consumers and Sanitation Association. Furthermore, in the Tilottama Municipality, 35% of households depend on hand pumps, tube wells, or deep boring, primarily in ward numbers 10 to 17.

The SFD graphic shows that 64% of the excreta generated are safely managed while 36% are unsafely managed. The safely managed FS generated by 61% of the population is temporary as these FS is only contained. So once the containment gets filled and FS from the containment is emptied, the percentage of unsafely managed excreta would increase. The faecal sludge generated from 3% of the population is contained and safely treated in anaerobic biogas digesters as well as in the FSTP at Ramnagar community forest in Butwal SMC.

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.

Tilottama Municipality has endorsed the Environment and Natural Resources Conservation Act of 2020, with a focus on preserving fundamental human rights for a healthy and clean environment, proper resource utilization, and sustainable management. The Act emphasizes several areas such as environmental protection, impact studies, pollution control, solid waste management, and collaboration with the private sector. However, there is a notable omission concerning attention to faecal sludge management (Tilottama Municipality, 2020).

Furthermore, Tilottama Municipality has released the Waste Management, Zero Polyethene, and Total Sanitation Municipality Campaign Implementation Procedure of 2019. This initiative aims to institutionalize, sustain, and effectively implement *Clean and Green Tilottama* campaign. The strategy underscores the active involvement of the public, civil society, private sectors, and other relevant stakeholders (Tilottama Municipality, 2019).

The Building Code Permit Standards 2017 (revised in 2019) mandate households to include a septic tank, water tank, and rainwater harvesting plan in their maps. However, there is currently an absence of an efficient monitoring system to ensure that households have complied with these standards.

6. Overview of stakeholders

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

Table 1: Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply Department of Water Supply and Sewerage Management (DWSSM)
Public Institutions at Provincial Government	Ministry of Water Supply, Rural and Urban Development Water Supply and Sanitation Division Office (WSSDO)
Public Institutions at Local Government	Tilottama Municipality Office Shankarnagar Water Supply Consumers and Sanitation Association (WSCSA) Karahiya WSCSA Anandaban Shankarnagar WSCSA
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Butwal Sanitary Pvt Ltd Desludging service providers
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from random household sampling. Altogether, 1,036 households and 58 institutions were surveyed from 17 wards of the municipality on 11-12 May 2023. Primary data on current sanitation practices in the municipality are triangulated from Key Informant Interviews (KIIs) with municipal officials, public toilet operators, desludging service providers and water supply committee. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program on 15 August, 2023.

8. Process of SFD development

Data on sanitation situation were collected through household and institutional survey (ENPHO, 2023). The local enumerators from each wards of the municipality were trained on all aspects of sanitation service chain starting from user interface, containment, emptying, transport, treatment, end use or safe disposal of excreta and the use of mobile application; *KoboCollect* was used for collection of data from households and institutions. Moreover, KIIs were conducted with officers and the engineer of the municipality, water supply and sanitation service providers, public toilet operators, private desludging service providers, treatment plant operators 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:

- DHM. (2010). Climate Data of Tilottama Municipality, Department of Hydrology and Materology, Butwal, Index No 0703.
- ENPHO (2023). Assessment of Sanitation status of Tilottama Municipality.
- Mindat. (n.d.). Climate of Tilottama Municipality, Nepal. Retrieved from Mindat.org: https://www.mindat.org/feature-7967216.html
- MoWS. (2017a). Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal. Kathmandu,Nepal: Ministry of Water Supply.
- MoWS. (2022a). Water Supply and Sanitation Act. Ministry of Water Supply; Government of Nepal.
- NSO. (2023). National Population and Housing Census 2021. National Statistics Office.
- Tilottama Municipality. (2019). Waste Management, Zero Polyethene and Total Sanitation Municipality Campaign Implementation Procedure.
- Tilottama Municipality. (2020). Environment and Natural Resources Conservation Act; Tilottama Municipality

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Abbreviations

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

1. City context

Tilottama Municipality is in Rupandehi District, Lumbini Province of Nepal (MoLFM, 2016). The municipality was established on 8 May 2014. It has a total of 17 wards and covers 126.19 square kilometres of area. It is surrounded by Butwal Submetropolitan City in the north, Siddharthanagar Municipality and Omsatiya Rural Municipality in the south, Rohini River and Devdaha Municipality in the east and Tinau River, Sudhdhodhan Rural Municipality and Siyari Rural Municipality in the west. The municipality was named after Tilottama River (also popularly known as Tinau River) (Tilottama Municipality, n.d) (Figure 1).

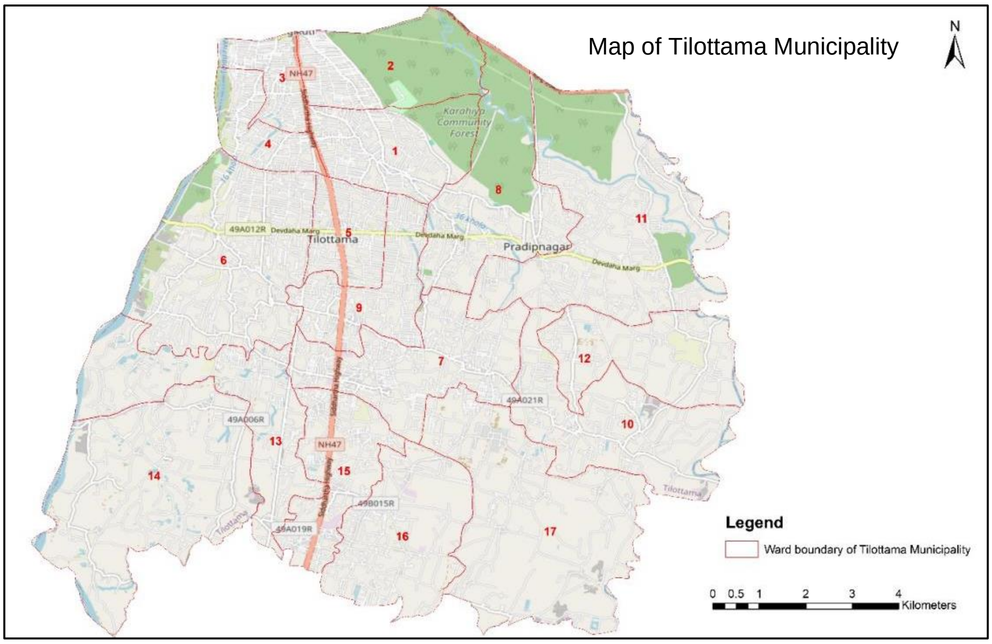


Figure 1: Map of Tilottama Municipality with ward boundaries.

1.1. Population

According to national population and housing census 2021, the municipality has a total population of 149,479 and 35,991 households. The total male and female populations are 71,526 and 77,953 respectively. The population density is 1,185 people per square kilometre. Ward number 3 has the highest population of 12,180 (5,848 male and 6,332 female) and ward number 12 has the least population with 5,039 (2,431 male and 2,608 female). Ward number 10 has the least number of households i.e. 1,156 and ward number 3 has the highest number of households i.e. 3,202 (NSO, 2023).

1.2. Climate

The municipality has hot, dry summers and cool, wet winters. Under the Köppen–Geiger climate classification, Tilottama Municipality features monsoon-influenced humid subtropical climate (Cwa) (Mindat, n.d.). The average annual daily temperature in the municipality is 26.2°C. April is the warmest month with an average temperature of 32.4°C (max 43°C and min 20°C and January is the coldest one with average temperature of 14 °C (max 25°C and min 7°C). The average annual rainfall in the municipality is 2,907 mm. November, December, January, February and March are the driest months with no rainfall and most precipitation falls in July, with an average of 941 mm (DHM, 2010) .

Figure 2 shows the absolute and average maximum and minimum yearly temperature obtained from Bhairawa Airport Station from 1995 to 2015.

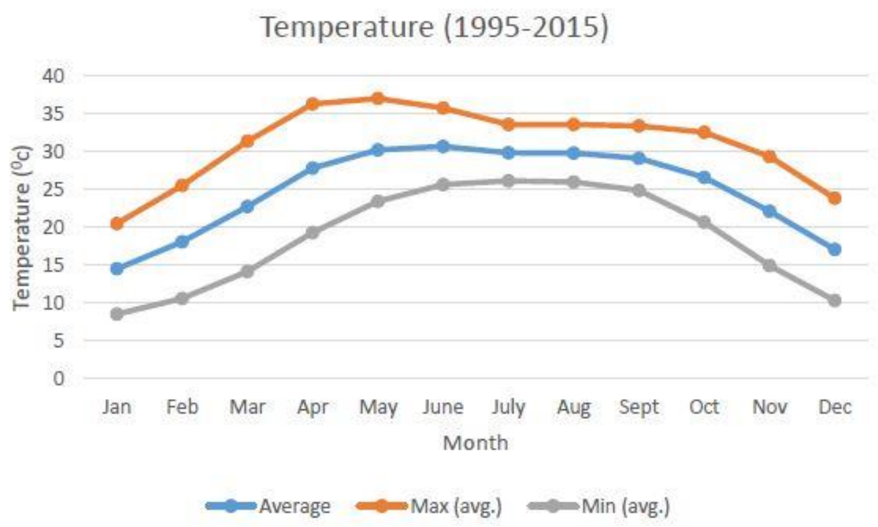


Figure 2: Average, Maximum and Minimum Yearly Temperature at Bhairawa Airport Station (1995-2015) (MoLFM, 2017).

1.3. Topography

The municipality is located at latitude: 27°33'N to 27°39'N and longitude: 83°25'E to 83°33'E. The elevation ranges between 160 metres to 175 metres above mean sea level. Tinau River and Rohini River are the major rivers flowing on west and east boundary of the municipality. Tinau River originates from the Mahabharat Mountains and flows through the Siwalik Hills and Terai Plain. Quaternary alluvial sedimentary deposits represent the materials of the municipality. Bedrock geology cannot be found in the municipality. Only the gravel of sandstone, mudstone with silty clay, sand, silt, and gravel from Siwalik were found along the stream beds. Alluvium in Terai is predominantly loamy textured, slightly acidic and stone free (MoLFM, 2017).

From a geological standpoint, the extensive Nepal-Terai region is considered part of the Indo-Gangetic plain. These flat areas at the foothills of the mountains experience floods and accumulate sediments over different time scales. Geologically, Makrahar of Tilottama Municipality falls within the Indo-Gangetic Plain (Middle Terai Plain). The sediments in this area are characterized by the presence of alluvial deposits, primarily silty sand and clays. These sediments primarily comprise unconsolidated sands and clays, some sub-rounded to rounded, well-sorted cobble and pebble layers interspersed with sands and silty clay (MoLFM, 2016).

2. Service Outcomes

2.1. Overview

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). A total of 1,036 households were sampled from 35,991 households distributed in 17 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). Shankarnagar of Tilottama was the first to declare Open Defecation Free zone in Rupandehi District which was declared in January 2011. Tilottama Municipality was declared as an open defecation free municipality in 2017 (KII_1, 2023) (KII_2, 2023). The household survey reveals that all the households in the municipality have access to toilets.

2.1.1 Sanitation Systems in Households Building

The onsite sanitation refers to a sanitation technology or sanitation system in which excreta are collected and stored and emptied from or treated on the plot where they are generated (SuSanA, 2018). All the households with access to toilets in the municipality rely on onsite sanitation systems. Table 1 shows the percentage of households with different types of containment in the municipality.

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

Containment	Wall construction materials	Bottom of containment	Chamber	Number	Connected to	%	Recategorized as SFD	%
Septic Tank	Cemented walls or cemented brick/ stone wall	PCC or plastered	Two or more than two	NA	Open drain, Soak pit	6%	Septic Tank	6%
Biogas Digester	-	-	-	-	-	2%	Fully lined tank	26 %
Fully lined tank	Cemented walls or cemented brick / stone wall	PCC or plastered	One	NA	No outlet Open drain Open ground	24%		
			Two		No outlet Open ground			

Lined tank with impermeable walls and open bottom	Cemented walls or cemented brick / stone wall	Soiling / nothing	One, Two, more than Two	NA	Open ground, No outlet/ overflow	39%	Lined tank with impermeable walls and open bottom	39 %
Single pit	Concrete rings piled one	Soiling/ nothing	NA	1	NA	17%	Lined pit with semi-permeable walls and open bottom	29 %
Twin pit	Concrete rings piled one	Soiling / nothing	NA	2	NA	12%		

An anaerobic biogas digester has been installed in 2% of households to treat household organic waste and generate energy. Also, excreta from toilets are connected to these digesters along with the cow dung and other organic solid waste. The capacities of these digesters are: 6 m^3, 8 m^3, 12 m^3 and 16 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 of the digesters (Figure 3).

Figure 3: Biogas digester in a household.

A septic tank is installed in 6% of households. The septic tank is a properly designed technology with sealed wall and bottom having at least two chambers and the effluent discharged into a soak pit or sewer network. As there is no technically designed sewer system, the containments have been connected to an open drain or stormwater drain. Fully lined tanks are constructed by 24% of households. A fully lined tank 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 tanks with impermeable walls and open bottom are the most popular system in the municipality and have been constructed by 39% of the households. A 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.

17% of the households have connected toilets to single pits. The single pits are onsite technologies made from pre-cast concrete rings. There is no lining between rings and allows infiltration from both walls and bottom. These pits are categorized as lined pits with semi-permeable walls and open bottom for the preparation of the SFD graphic.

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

12% of the households have constructed twin pits. However, most twin pits installed by the households are not as per the design (Figure 4). The minimum distance between two sets of pits has not been maintained. Also, the connection pipes to the pits are in series. Thus, these pits function only as lined pits with semi-permeable walls and open bottom. Figure 4 shows the design of twin pits and pits installed at household level. In areas where the groundwater table is high or there is a risk of frequent flooding, the twin pit system may not be appropriate since the leachate may hinder the dewatering process, particularly in the resting pit. Therefore, it is recommended to use this system only in areas with a low groundwater table (Elizabeth Tilley, 2014).

Figure 4: Inappropriate design of a twin pit.

The households survey and field observation reveal that some households in the municipality have installed appropriate design of the twin pit as shown in Figure 5. Basically, two pits are linked using a Y-junction at a minimum horizontal distance of 1.2m.

Figure 5: Appropriate design of the twin pits constructed in household.

Figure 6 shows a map of the households with the types of containment observed in the survey.

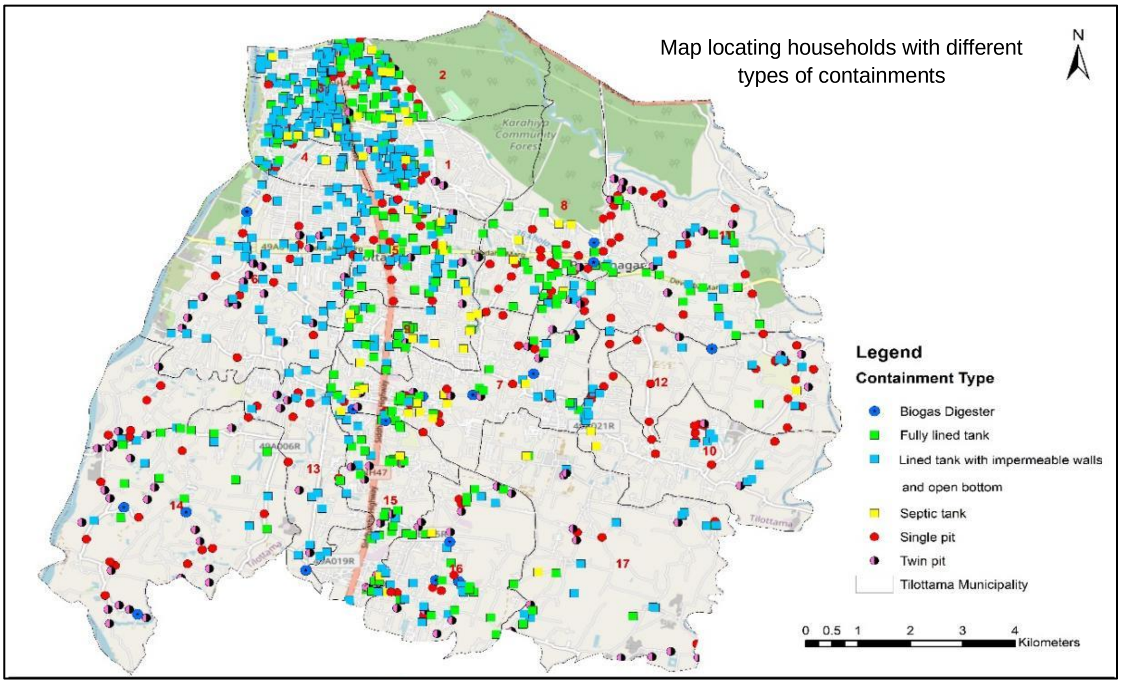


Figure 6: Map showing the households with the types of containments in Tilottama Municipality.

2.1.2. Sanitation Systems in Institutional building

All institutional buildings (58 institutions) surveyed have their toilet connected to onsite sanitation technologies. The fully lined tank is a popular onsite sanitation technology in institutions. 3% of the institutional buildings have constructed technically appropriate septic tanks. Figure 7 shows the different sanitation technologies available in the institutions of Tilottama Municipality.

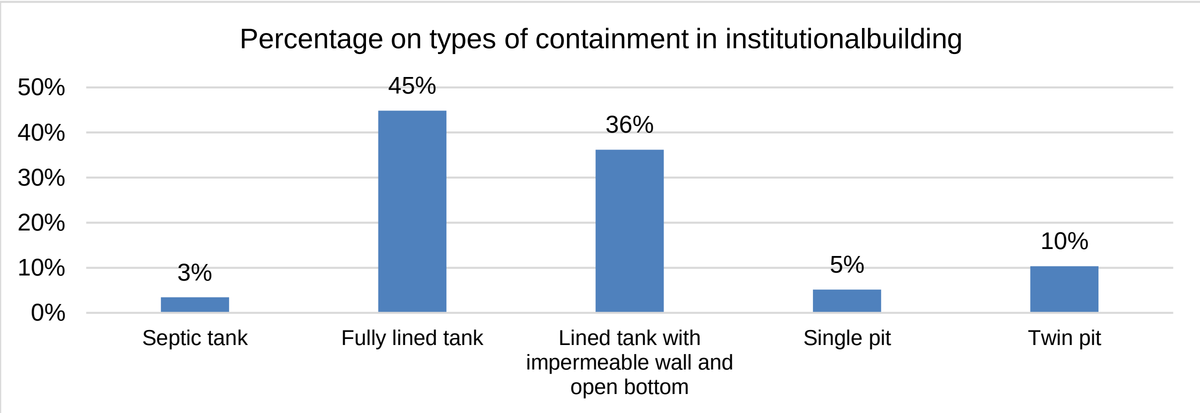


Figure 7: Types of containment in the institutional building of Tilottama Municipality.

Figure 8 shows a map locating surveyed institutional buildings and types of sanitation technologies.

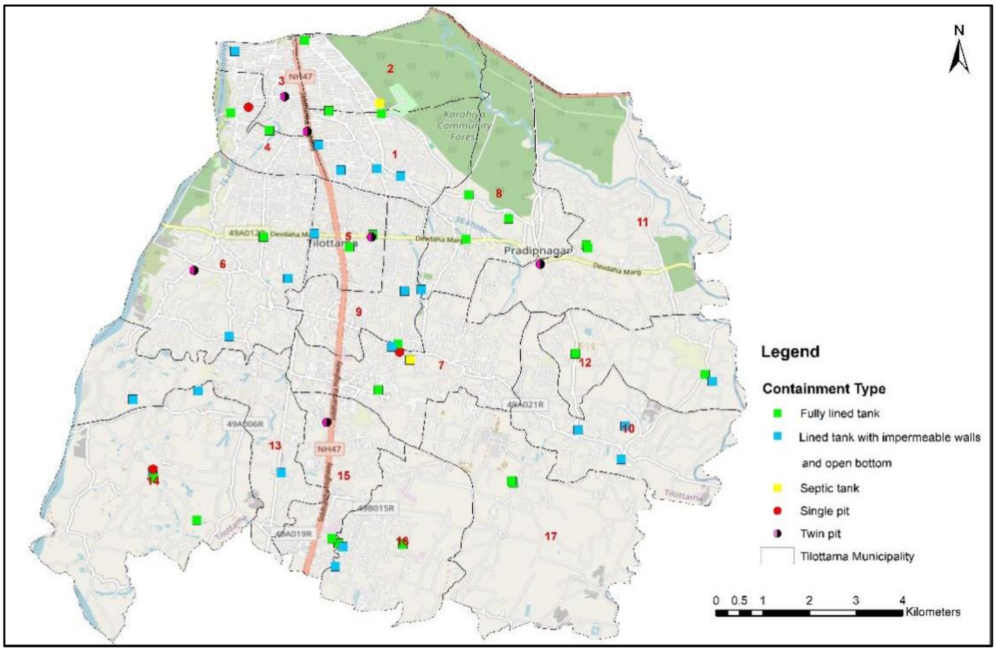


Figure 8: Map locating institutional buildings with types of sanitation technologies.

2.1.3. Public Toilet

Twenty-two biotech public toilets (Figure 9) have been strategically installed along the Sidhartha highway, spanning both the main lanes and service lanes (KII_1, 2023) (KII_6, 2023). The public toilets were constructed by Shankarnagar Water Supply Consumers and Sanitation Association (WSCSA) Anandaban Shankarnagar WSCSA and Karahiya WSCSA. The operation and maintenance of the toilets also have been conducted by WSCSA. The single-seated public toilets have been connected to a biogas digester. A biogas digester is a technology which disposes the human waste in an eco-friendly manner. Bacterial consortium degrades night soul and produces colourless, odourless fertile water and biogas. Some toilets have been connected to a septic tank of size 17 m^3 (15 feet length, 8 feet width and 5 feet depth) (KII_6, 2023) (KII_7, 2023).

Water supply organizations have facilitated regular water provision to these public toilets. The facilities are well-equipped with essential amenities, including water, soaps, dustbins, and mirrors. To maintain cleanliness, dedicated personnel have been assigned by the organizations for regular cleaning purposes.

Figure 9: Biotech public toilet along with Sidhartha highway.

Moreover, there are some public toilets existing in areas with higher flow of people such as market areas with separate compartment for males and females.

Figure 10: Public toilet in Tilottama Municipality.

2.1.4. Emptying and Transport

Emptying and transporting faecal sludge is an essential service for proper functioning of onsite sanitation technologies (Linda Strande, 2014). Only 23% of the households have emptied their containments at least once since it was used. Among these households, 78% have emptied them mechanically while the rest rely on self-manual emptying or traditional sanitation workers.

Poor emptying practices can lead to direct exposure of person involved in emptying activities to pathogens (WHO, 2018). Private desludging service providers are more engaged in desludging services. More than 12 private desludging service providers are providing service in the municipality which also provide the services in the neighbouring municipality (KII_2, 2023). However, no desludging service providers have been registered in Tilottama Municipality (KII_1, 2023).

Butwal Sanitary Private Ltd has been working on the sanitation sector located in Tilottama Municipality ward 2 and providing the service to different municipalities of the Lumbini Province (Figure 11). It has 7 desludging vehicles with 3 vehicles of 4,500L capacity and 4 vehicles with 3,800L capacity. They charge for services 19 USD (NRS 2,500) per trip for emptying the containment. 7 drivers, 7 helpers and an office support staff are working for the company. Office support staff receive the demand for desludging services from customers through a phone call and communicate with drivers for mobilizing to provide the services.

Figure 11: Faecal sludge desludging service provider transporting the empting faecal sludge to the treatment plant.

In addition to *Butwal Sanitary Private Ltd*, which is actively engaged in desludging, there are five more private sector entities offering services in Tilottama Municipality. This information has been gathered through key informant interviews and follow-up phone calls with these private sector entities, as identified in the local newspaper advertisement list. *Bhairav Sanitary Pvt Ltd* (Figure 12) is one of these private service providers having a vehicle with 3,500 L capacity and emptying a trip per day in average from the municipality.

Figure 12: Faecal sludge desludging service provider.

2.1.5. Treatment and Disposal

The municipality itself has not established a faecal sludge treatment plant. However, *Butwal Sanitary Pvt Ltd* has taken the initiative to construct and operate a faecal sludge treatment plant located in the Ramnagar Community Forest, situated within the Butwal Submetropolitan City, which serves as a border site for ward 2 of Tilottama Municipality. The office of the company is situated in ward 2 of Tilottama Municipality. They have been providing treatment services since 2021. This treatment facility is utilized by seven private service providers for the disposal of faecal sludge collected from various municipalities of Lumbini province including Tilottama Municipality (KII_5, 2023).

The treatment plant consists of the bar screen, thickening tank, dewatering machine, compost plant, settler, constructed wetland (CW) and polishing pond as shown in the conceptual design of the FSTP (Figure 13 and Figure 14). 25 -30 tons per month of manure are produced. However, the process such as testing of Nitrogen, Phosphorus and Potassium (NPK) and other parameters is planned for the future commercialization of the produced manure (KII_5, 2023).

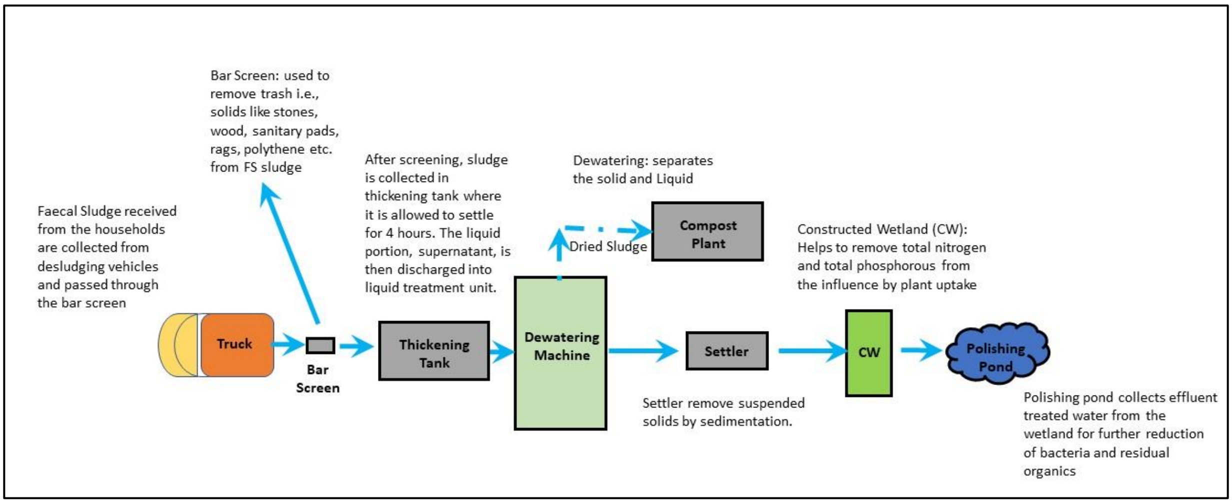
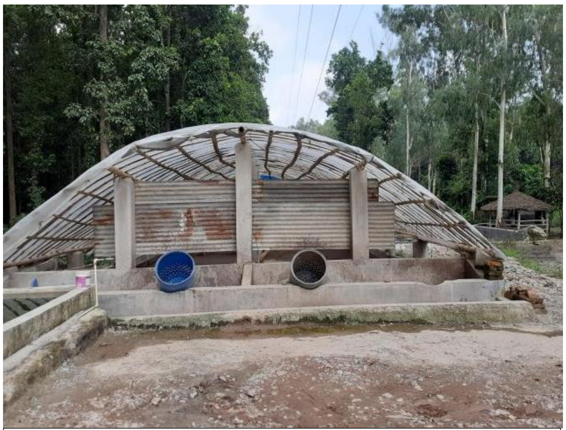


Figure 13: Conceptual design of FSTP at Ramnagar Community Forest (ENPHO, 2023).



Bar Screen

Dewatering Machine

S

Composting Plant

Constructed Wetland

Figure 14: Faecal Sludge Treatment Plant at Ramnagar Community Forest.

Conversely, other desludging service providers opt to dispose of the emptied faecal sludge untreated in farmlands, forest areas and water bodies (KII_4, 2023) (KII_5, 2023).

Manually emptied FS is either dig and dump or directly applied to farmlands. The direct use of faecal sludge has the highest level of risk for human health, therefore not recommended to practice it (Strande et. al., 2014). Thus, the handling of the manually emptied FS in the municipality is unhygienic and possesses risk to human health and considered to be unsafely managed.

2.1.6. Risk Assessment of Groundwater Pollution

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

a. Sources of Drinking Water

The household survey indicates that 64% of households in the Tilottama Municipality rely on private taps, whereas only 1% depend on public or community taps (ENPHO, 2023). The Shankarnagar Water Supply Consumers and Sanitation Association, Karahiya Water Supply Consumers and Sanitation Association and Anandaban Shankarnagar Water Supply Consumers and Sanitation Association are major water supply service providers in Tilottama Municipality. Besides that, Madhabaliya, Banbatika, Makrahar and Simanagar Water Users and Sanitation Committees (WUSC) are also providing the services in their respective wards.

Shankarnagar Water Supply Consumers and Sanitation Association:

The Shankarnagar Water Supply Consumers and Sanitation Association plays a crucial role in providing drinking water to wards 2 and 3 in their entirety, and wards 1 and 4 to a partial extent. The water supply system is comprised of seven deep boring machines with a depth of 120 metres each, along with three reservoir tanks, each boasting a capacity of 0.450 million litres. This comprehensive scheme incorporates automatic chlorination units, with plans under way for the installation of a filtration unit.

To ensure water quality, a dedicated laboratory for water quality testing has been established, facilitating regular assessments before water distribution. As of the date of the interview, approximately 7,600 taps have been installed, contributing to the effective distribution of water throughout the designated areas (KII_6, 2023). The water quality reports obtained have been attached to Appendix 2.

Figure 15: Overhead tank and pipeline connection of Shankarnagar WSCSA.

Anandaban Shankarnagar Water Supply Consumers and Sanitation Association:

The Anandaban Shankarnagar Water Supply Consumers and Sanitation Association plays a pivotal role in supplying drinking water to wards 5 and 6 in their entirety, while partially serving wards 1, 3, 4, 8, and 9. The water supply system is designed with deep boring of 150 m depth and includes three reservoir tanks, each with a capacity of 0.450 million litres. This comprehensive scheme incorporates automatic chlorination units (KII_7, 2023).

To ensure water quality, a dedicated laboratory for water quality testing has been established, facilitating regular assessments before water distribution. As of the date of the interview (KII_7, 2023), approximately 8,200 taps have been installed, contributing to the effective distribution of water throughout the specified areas. The water quality reports obtained have been attached to Appendix 3.

Figure 16: Overhead tank and deep boring of Anandaban Shankarnagar WSCSA.

Karahiya Water Supply Consumers and Sanitation Association:

The Karahiya Water Supply Consumers and Sanitation Association plays a role in partially supplying drinking water to wards 6, 7, 9, 13, and 15, and has plans for extending coverage to ward 17. The water supply system is comprised of four deep boreholes with a depth of 203 metres, alongside a reservoir tank boasting a total capacity of 0.225 million litres. The scheme is equipped with automatic chlorination units to maintain water quality (KII_8, 2023).

To ensure the quality of the water supplied, a dedicated laboratory for water quality testing has been established. Regular testing is conducted before the distribution of water to maintain high standards of water quality (KII_8, 2023). The water quality reports obtained have been attached to Appendix 4.

Figure 17: Overhead tank and chlorination unit of Karahiya WSCSA.

According to National Drinking Water Quality Standard 2022, the maximum concentration limit for *E.coli* is 0 CFU/ 100ml (MoWS, 2022b). The water quality testing reports of the Shankarnagar Water Supply Consumers and Sanitation Association, Karahiya Water Supply Consumers and Sanitation Association and Anandaban Shankarnagar Water Supply Consumers and Sanitation Association reveals that these water service providers have met the quality standards.

Furthermore, in the Tilottama Municipality, 35% of households depend on hand pumps, tube wells, or deep boring, primarily in ward numbers 10 to 17 (ENPHO, 2023).

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.

Tilottama Municipality falls within the Indo-Gangetic Plain (Middle Terai Plain). The sediments in this area are characterized by the presence of alluvial deposits, primarily sand, silt and clays (MoLFM, 2016). A typical loam soil will consist of roughly 50% soil solids (a combination of sand, silt, and clay) and 50% pore spaces and water (Patricia J. Vittum, 2009). 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 18 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 38%

of the households have installed lined tanks with impermeable walls and an open bottom with no outlet or overflow. Among them, 24% 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 22% of these households are at lower risk to consumption of contaminated water while 78% 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 (T2A4C10) is 7% i.e (38% x 24% x 78% = 7%). Therefore, the remaining 31% of the people using lined tanks with no outlet or overflow are in areas of low risk of groundwater contamination (T1A4C10).

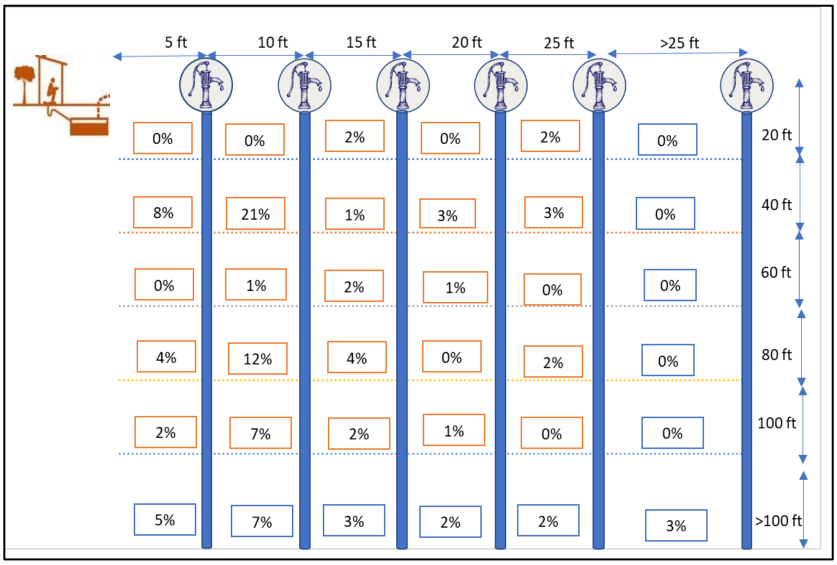


Figure 18: Depth of hand pumps and tube wells and lateral spacing of it with containment lined tank with impermeable walls and open bottom.

Figure 19 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 29% of the households used lined pits with semi-permeable walls and open bottom. Among these, 59% 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 82% 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 (T2A5C10) is calculated as (29% x 59% x 82% = 14%.). Therefore, the remaining 15% of the pits are located in areas of low risk of groundwater contamination (T1A5C10).

Figure 19: Depth of hand pumps and tube wells and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.

2.2. SFD Matrix

2.2.1. SFD Selection Grid

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

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

The various types of sanitation technologies selected for the SFD graphic generator are shown in the SFD selection grid, as shown in Figure 20 and explained in Table 2.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution T1A2C5	T1A2C6				Not Applicable
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution			T1A3C8		T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution			T1A4C8		T2A4C10 T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil	Not Applicable									
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									Not Applicable

Figure 20: SFD selection grid of Tilottama Municipality.

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

SN	Variables	Explanation
1	T1A2C5	This is a correctly designed, properly constructed, fully functioning septic tank with an effluent outlet connected to a correctly designed, properly constructed, fully functioning soak pit. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, but since it is captured in the soak pit, all the excreta in this system is considered contained.
2	T1A2C6	This is a correctly designed, properly constructed, fully functioning septic tank with an outlet connected to an open drain or storm sewer. The supernatant/effluent flowing from the tank is only partially treated and is still hazardous, therefore all the excreta in this system is considered not contained.
3	T1A3C8	A correctly designed, properly constructed and well maintained fully lined tank with impermeable walls and base. Since the tank is fitted with a supernatant/effluent overflow connected to open ground the excreta in this system is considered not contained.
4	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.

5	T1A4C8	A correctly designed, properly constructed and well-maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. Since the tank is fitted with a supernatant/effluent overflow connected to open ground, the excreta in this system is considered not contained.
6	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.
7	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.
8	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.
9	T2A5C10	A correctly designed, properly constructed and well-maintained pit with semi-permeable, honeycombed lined walls and an open, permeable base, through which infiltration can occur. The tank is not fitted with a supernatant/effluent overflow but since there is a 'significant risk' of groundwater pollution this system is considered not contained.

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

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

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

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

The proportion of FS in septic tanks was set to 75%, the proportion of fully lined tanks, lined tanks with impermeable walls and open bottom and all types of pits was both 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 21 shows the SFD matrix of Tilottama Municipality.

The sanitation technologies and the corresponding percentage of the population using such technologies are shown in Figure 21. These values are derived from the HH survey (ENPHO, 2023) and KIIs with desludging service providers (KII_4, KII_5, 2023).

Tilottama Municipality, Lumbini, Nepal, 1 Sep 2023. SFD Level: 2 - Intermediate SFD
Population: 149479
Proportion of tanks: septic tanks: 75%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	FS emptying	FS transport	FS treatment	SN transport	SN treatment
	Pop	F3	F4	F5	S4e	S5e
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	Proportion of supernatant in open drain or storm sewer system, which is delivered to treatment plants	Proportion of supernatant in open drain or storm sewer system that is delivered to treatment plants, which is treated
T1A2C5 Septic tank connected to soak pit	3.0	5.0	0.0	0.0		
T1A2C6 Septic tank connected to open drain or storm sewer	3.0	9.0	0.0	0.0	0.0	0.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	25.0	20.0	52.0	95.0		
T1A3C8 Fully lined tank (sealed) connected to open ground	1.0	0.0	0.0	0.0		
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	31.0	7.0	35.0	95.0		
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	1.0	0.0	0.0	0.0		
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	15.0	39.0	0.0	0.0		
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	7.0	16.0	0.0	0.0		
T2A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	14.0	35.0	0.0	0.0		

Figure 21: SFD matrix of Tilottama Municipality.

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

The proportion of faecal sludge emptied (F3) is calculated based on percentage containment emptied (ENPHO, 2023) and amount of FS emptied during the process (KII_4, 2023) (KII_5, 2023). In average, 85% 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 85% of the emptied containment. Hence, the proportion of FS emptied from the sanitation technology is calculated as 85% on the sanitation technology emptied.

As biogas digesters have been considered as fully lined tanks while preparing the SFD graphic, the emptied proportion includes the % of biogas digester emptied. Thus, 2% of the biogas digesters was considered as emptied and treated. The emptied percentage of the fully lined tanks with no outlet or overflow (T1A3C10) mentioned in Table 3 is the sum of the emptied proportion of biogas digesters and fully lined tanks. Table 3 shows the calculation of variable F3.

Table 3: Actual emptying proportion for existing containment technologies (ENPHO, 2023 (1); KII_4 and KII_5, 2023(2)).

SN	Reference Variables	Containment technologies	Percentage of emptied containment (1)	Emptied proportion of FS (2)	Actual proportion of emptied FS (F3)
1	T1A2C5	Septic tank connected to soak pit	6.45%	85%	5%
2	T1A2C6	Septic tank connected to open drain or storm sewer	10.71%	85%	9%
3	T1A3C8	Fully lined tank (sealed) connected to open ground	0.00%	85%	0%
4	T1A3C10	Fully lined tank (sealed), no outlet or overflow	23.66%	85%	20%
5	T1A4C8	Lined tank with impermeable walls and open bottom, connected to open ground	0.00%	85%	0%
6	T1A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow	8.00%	85%	7%
7	T1A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	46.20%	85%	39%
8	T2A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	18.40%	85%	16%
9	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	40.94%	85%	35%

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

2% 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 6 m^3, 8 m^3 ,10 m^3 and 16 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 20% (F3 = 20%). All the households using biogas digesters have been considered as transported to treatment plant. Moreover, some of the desludging vehicles have transported the faecal sludge from fully lined tanks to the Faecal Sludge Treatment Plant at Ramnagar Forest (ENPHO, 2023) (KII_5, 2023).

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) transported to Ramnagar Treatment Plant (F4 = 52%). Similarly, the percentage of FS emptied from lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) which is delivered to treatment plan was found to be 35 % (F4 = 35%).

95% of the households who have been using a biogas digester have been considered as treated. Moreover, the treatment efficiency of the treatment plant has been assumed as 95% based on the observation and KII with key stakeholders as no data on the treatment efficiency of the treatment plant (KII_5, 2023) . Thus, FS delivered to treatment plant and treated was calculated as 95 % (F5 = 95%).

2.3. Summary of Assumptions

Offsite sanitation System:

- ✓ There is not any sewer network and hence all households depend on onsite sanitation systems in Tilottama Municipality. However, some of the households have their septic tank connected to open drain or storm sewer (considered as an offsite sanitation system).

Onsite Sanitation System:

- ✓ The proportion of FS in septic tanks was set to 75%, the proportion of FS in fully lined tanks was set to 100% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 100% according to the relative proportions of the systems in the municipality, as per the guidance given in the Frequently Asked Question (FAQs) in the sustainable Sanitation Alliance (SuSanA) website.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the household survey and cross-checked with KIIs conducted.

- ✓ The municipality does not have faecal sludge treatment plant constructed and operated by desludging service provider. Also, the people using twin pits reclassified as lined pits with semi-permeable walls and open bottom are not using them properly. The FS emptied from the containments is dumped openly in farmlands by some desludging service providers and thus, variables S4e, S5e, F4 and F5 were properly set to 0% in the SFD matrix for most sanitation systems.
- ✓ However, one service provider operates a private Faecal Sludge Treatment Plan (FSTP) where the emptied FS from lined tanks (T1A4C10) and part of fully lined tanks (T1A3C10) is disposed of and treated at Ramnagar Community Forest. Values for variable F4 for these sanitation systems (F4 = 52% for T1A3C10 and F4 = 35% for T1A4C10) are calculated based on the household survey and KIIs.
- ✓ FS from anaerobic biogas digesters, classified as fully lined tanks (system T1A3C10), is considered as transported and treated with a treatment efficiency estimated at 95% and FS from fully lined tanks and lined tanks with impermeable walls and open bottom is treated in the privately operated treatment plant was also considered as 95% (F5 = 95% for both systems).

2.4. SFD Graphic

Figure 22 represents the fate and flow of wastewater (WW), faecal sludge and supernatant through each sanitation service chain. It shows that excreta generated from 64% of the population is safely managed represented by “Green” colour arrow head. However, 61% resembles as FS stored in the containment without significant risk to groundwater pollution. However, the safely managed percentage of FS generated by this 61% of the population is temporary until the FS from the containment is emptied. Therefore, these systems will require emptying services in the short and medium term as they fill up. Only 3% of the population have treated the FS using biogas digesters as well as the treatment plant at Ramnagar community forest.

The FS and supernatant from 36% of the population is unsafely managed, represented by “Red” arrow heads. The percentage of these unsafely managed excreta is generated from FS emptied but not delivered to treatment plant (16%), FS from containments where FS is not contained - not emptied (19%), FS not treated (1%) and supernatant not delivered to treatment (1%)[1].

[1] Please note that individual numbers do not add up to 36% but to 37% due to rounding.

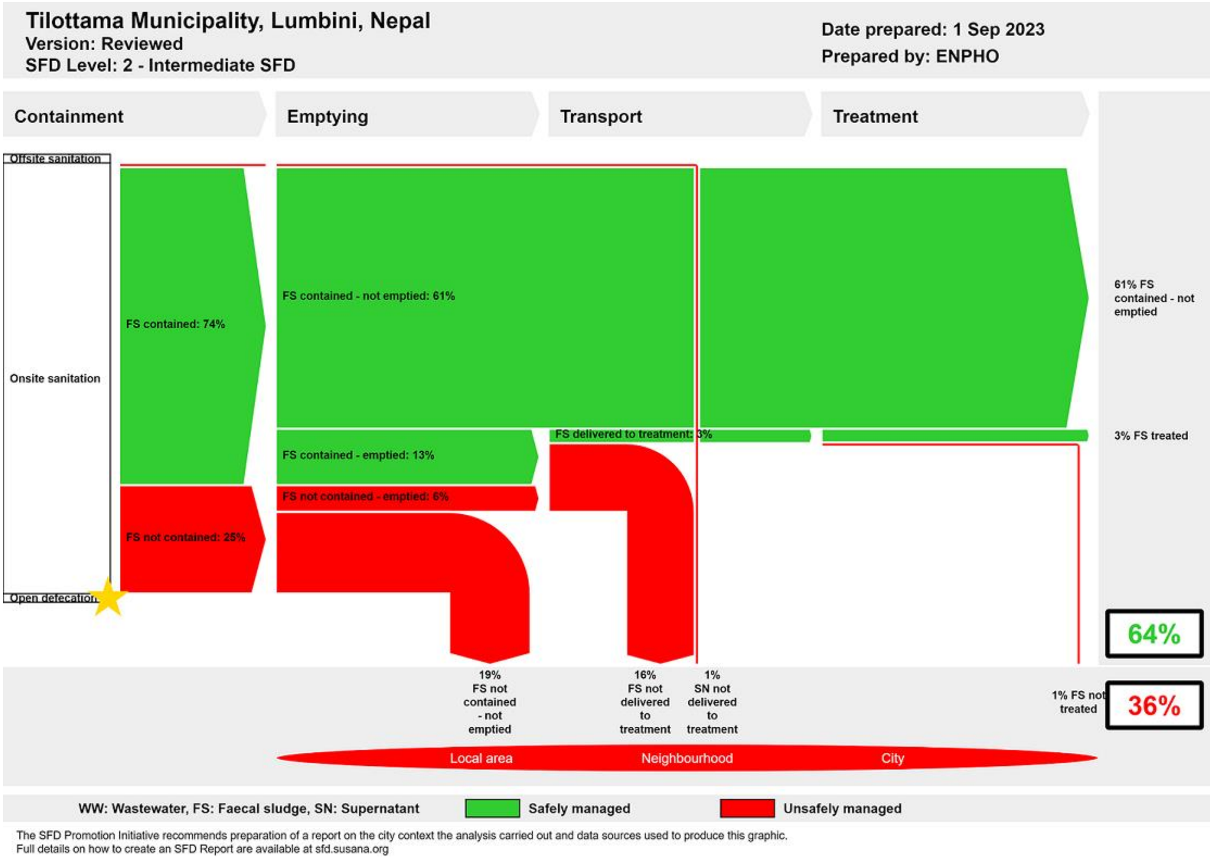


Figure 22: SFD graphic of Tilottama Municipality.

All of the population have access to toilets and relies on onsite sanitation systems. As shown on the SFD graphic (Figure 22), it is estimated that 74% of the population uses systems where the FS is considered contained, while 25% of the population uses systems where the FS is considered not contained.

FS contained

The definition of 'FS contained' is faecal sludge contained within an onsite sanitation technology which ensures safe level of protection from excreta i.e. pathogen transmission to the user or general public is limited. These are tanks or pits that are correctly designed, properly constructed, fully functioning, and/or are causing no risk or only a 'low' risk of polluting groundwater used for drinking (SuSanA, 2018).

The value is the summation of the percentage of population using septic tanks connected to a soak pit (T1A2C5), fully lined tanks (sealed), no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom, no outlet or overflow (T1A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow (T1A5C10). Thus, the FS generated by 74% 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 septic tansk connected to open drain or storm sewer (T1A2C6), fully lined tanks (sealed) connected to open ground (T1A3C8), lined tanks with impermeable walls and open bottom, connected to open ground (T1A4C8), lined tanks with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A4C10) and lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10). Thus, the FS generated by 25% of the population is considered not contained.

FS contained - emptied

The value of 13% is obtained from the proportion of the population using sanitation systems where the FS is contained and have emptied their containment.

FS not contained - emptied

The proportion of FS not contained emptied is the summation of the proportion of FS emptied from either technically appropriate or inappropriate containment with potential risk on direct contact with human or contamination of groundwater. Thus, the proportion of FS not contained and emptied is 6%.

FS not delivered to treatment.

A portion of the emptied faecal sludge is treated in a FSTP operated by the private sector. However, FS emptied from contained and not contained containment systems by most of the mechanical desludging service providers, manual scavenger and household members is disposed of into farmlands and forest. The proportion of FS not delivered to treatment (16%), is the summation of FS contained - emptied and FS not contained - emptied.

SN not delivered to treatment.

1% of the supernatant obtained from the containment connected to open drain or stormwater drain is not delivered to treatment.

FS treated

The proportion of FS obtained from containments which has been transported to treatment and treated is 3%.

3. Service Outcomes

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 (WUSC) 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 (WASH) 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

The constitution of Nepal has provided the right for local government to form acts, rules and regulation based on the national policies and laws. Local Governance Operation Act 2017 has been formed to implement the right of local government and promote co-operation, co-existence, and co-ordination among federal, provincial, and local government. The act has mentioned the right, roles and responsibility of municipalities along with provision and procedure for approving laws and regulations at local level.

Tilottama Municipality has endorsed the Environment and Natural Resources Conservation Act of 2020, aiming to safeguard fundamental human rights related to residing in a healthy and clean environment, ensuring proper utilization, and promoting sustainable management of natural resources. The Act places significant emphasis on various aspects, including environmental protection, conducting environmental impact studies, pollution control and mitigation, solid waste collection, transport, treatment, and engagement with the private sector. Notably, there is a noticeable gap in attention towards faecal sludge management (Tilottama Municipality, 2020).

The Building Code Permit Standards 2017 (revised in 2019) establish guidelines specifying that households must incorporate a septic tank, water tank, and rainwater harvesting plan when developing their maps. Nevertheless, there is a lack of an effective monitoring system to verify whether households have indeed constructed septic tanks according to these standards (KII_3, 2023).

Furthermore, Tilottama Municipality has released the Waste Management, Zero Polyethene, and Total Sanitation Municipality Campaign Implementation Procedure of 2019. This initiative aims to institutionalize, sustain, and effectively implement cleanup campaigns in open spaces, historical and public places, fostering a clean and prosperous municipal identity. The strategy underscores the active involvement of the public, civil society, and the private sector, with a particular emphasis on formulating a WASH Plan for the municipality. The mobilization of Tole Development Organizations is instrumental in campaign implementation, facilitating and promoting activities as needed. Notably, the document highlights that punitive measures will be taken against households connecting toilets to drains without constructing septic tanks / collection tank, with corresponding notifications to ward offices (Tilottama Municipality, 2019).

In adherence to the Campaign Implementation Procedure 2019, Tilottama Municipality launched the 'Green Tilottama, Clean Tilottama' initiative in March 2020, which continues to date (KII_2, 2023). Bi-monthly activities aimed at cleaning public spaces and promoting greenery are consistently carried out, with robust participation from the community. These efforts are further bolstered by the collaborative engagement of diverse stakeholders, including various organizations and institutions.

3.1.2. Institutional Roles

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

At Federal Level

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

Ministry of Water Supply: Ministry of Water Supply is the lead ministry responsible for planning, implementation, regulation, and monitoring and evaluation of sanitation programs in the country (GoN, 2015). Under the MoWS, Department of Water Supply and Sewerage Management (DWSSM) plan and implement water and sanitation projects funded by foreign donors or inter provincial projects or serves at least 15,000, 5,000 and 1,000 people in terai, hilly and mountain region respectively (GoN, 2015). The organizational structure of DWSSM is shown in Figure 23.

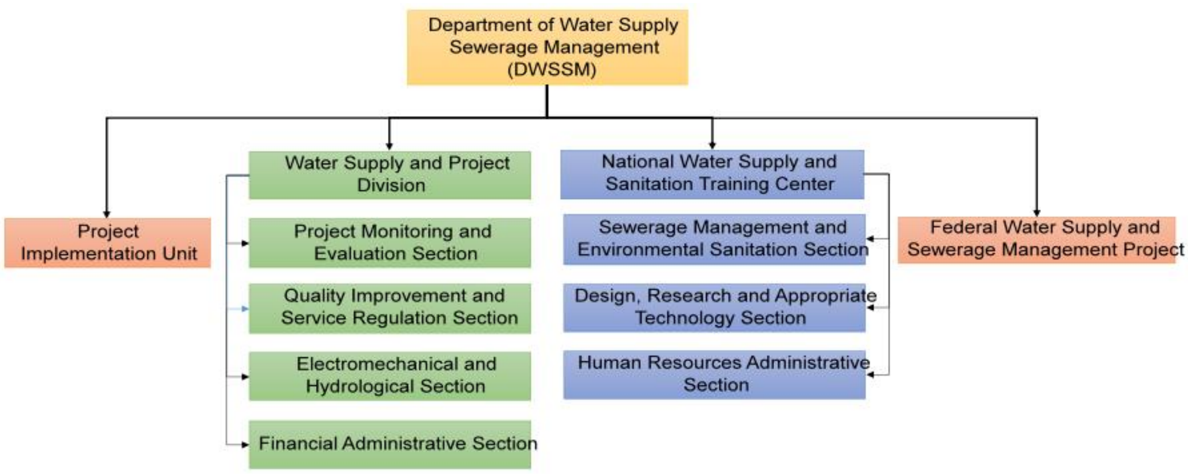


Figure 23: Organizational Structure Department of Water Supply and Sewerage Management.

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 Supply, Rural and Urban Development: Ministry of Water Supply, Rural and Urban Development of provincial government in Lumbini is major executing body in the province for planning, developing, and implementing water supply and sanitation programs. 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, which include the Environment and Disaster Management and Sanitation Unit. This unit oversees a range of activities related to the environment, disaster risk reduction, solid waste management, and clean-up campaigns. Figure 24 illustrates the organizational structure of the municipality.

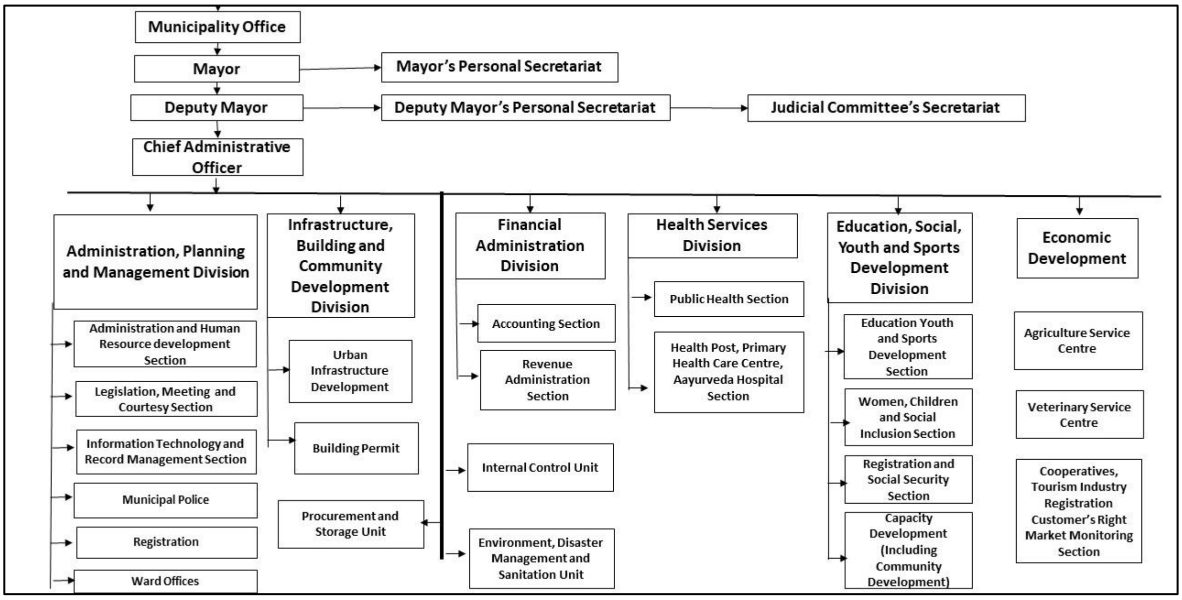


Figure 24: Organizational Structure of Tilottama Municipality.

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 improve solid waste management services, the municipality has entered into contracts with private sectors. Moreover, cooperatives play an active role in solid waste management endeavours within the municipality. While some private sectors are diligently engaged in the desludging and treatment of fecal sludge, others resort to open disposal in water bodies, forests, and open environments. However, private sector entities involved in mechanical desludging services are not officially registered with the 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 4. However, FSM specific standards have yet to be developed and implemented.

Table 4: Sanitation Service Level and its Components.

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

7	Sanitary sewers for wastewater collection, transmission, non-conventional treatment, and disposal	✓		
8	Sanitary sewers for wastewater collection, the transmission of conventional treatment and disposal	✓		
9	Limited solid waste collection and safe disposal	✓	✓	✓

4. Stakeholder Engagement

4.1. Key Informant Interviews (KIIs)

Key Informant Interviews (KIIs) are qualitative in-depth interviews with people who know what is going on in the community (Figure 25). 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 provider and public toilet service provider. The face-to-face interview was conducted and called after the interview to get more required information. The information was collected with key stakeholders about the status of sanitation services and water supply schemes. List of key informant stakeholders from the municipalities along with their organization and purpose are as shown in Table 5.

Table 5: List of key stakeholders for KIIs.

KII code	Name	Designation	Organization	Purpose	Date
KII-1	Yubaraj Panthi	Engineer Environment Disaster Management and Sanitation Unit Head	Tilottama Municipality	Sanitation status of Tilottama Municipality	10 May, 2023
KII-2	Gorakhnath Khanal	Officer	Tilottama Municipality	Sanitation status of Tilottama Municipality	10 May, 2023
KII_3	Manish Khanal	Sr. Engineer Building Permit Section	Tilottama Municipality	Sanitation status of Tilottama Municipality	10 May, 2023
KII-4	Rohit Chaudhary	Desludging service providers	Bhairav Sanitary Pvt Ltd	Status of faecal sludge desluding service	10 May, 2023
KII-5	Yam Bdr Thapa	Chairperson	Butwal Sanitary Private Ltd.	Status of faecal sludge desludging services and status of faecal sludge treatment plant	12 May, 2023
KII-6	Dipak Pandey	Manager	Shankhanagar Water Supply and Sanitation organization	Water supply, coverage, treatment, water quality, status of public toilet	12 May, 2023
KII-7	Keshab Raj Neupane	Chairperson	Aanandaban Shankhanagar Water Supply and Sanitation organization	Water supply, coverage, treatment, water quality	10 May, 2023
KII-8	Gokul Paudel	Manager	Karahiya Water Supply and Sanitation organization	Water supply, coverage, treatment, water quality	10 May, 2023

Figure 25: Key informant interview with water supply service provider and municipal official.

4.2. Household Survey

In each ward of the municipality, a random household survey was conducted. The two-day orientation workshop was provided to local enumerators chosen by municipality representing each ward. They were oriented on each component of the sanitation service chain, starting from user interface to reuse / safe disposal along with the use of mobile application for data collection. They were mobilized in the community level to gather data from households and institutional level. The list of the enumerator has been attached in Appendix 5. The data were collected using the *KoboCollect* application (Figure 26).

Figure 26: Photos of enumerators during their orientation on effective data collection techniques.

Determining Sample Size

The sample size for the household survey in Tilottama 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	± 3 %	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, 1,036 households out of 35,991 households distributed in 17 wards were sampled using proportionate stratification random sampling. The number of ward wise sample size has been attached in Appendix 6. The distribution of sampling points in the municipality are shown in Figure 27.

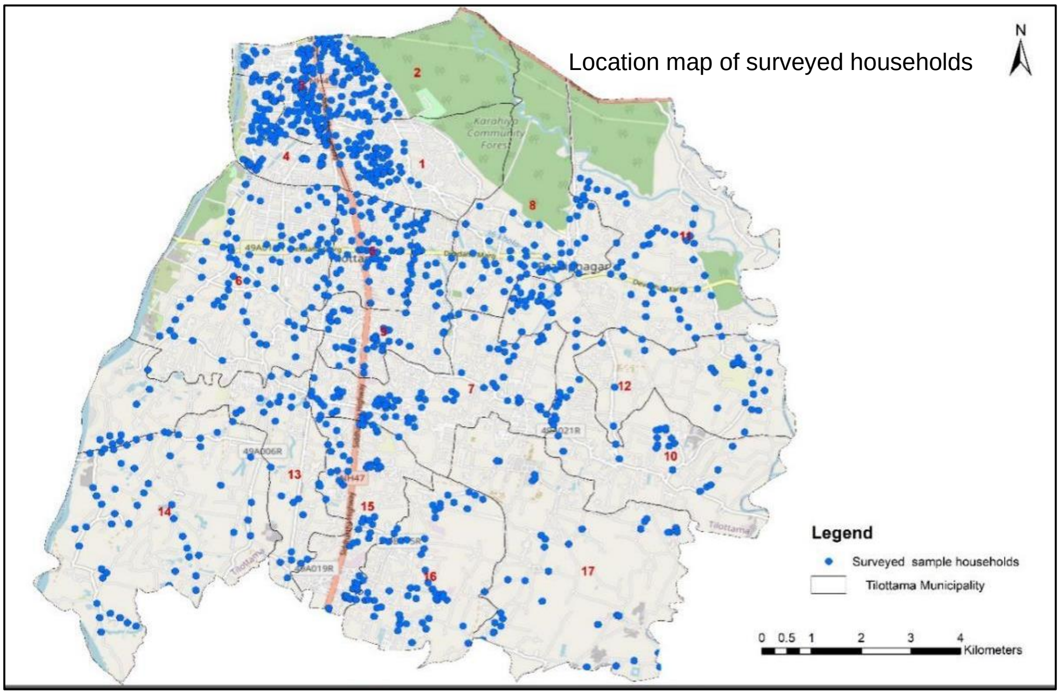


Figure 27: Distribution of sampling points in all wards of Tilottama Municipality.

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 28 illustrates the observation and monitoring of a household survey conducted.

Figure 28: Field observation and monitoring the households survey.

4.4. Sharing and Validation of Data

On 15 August 2023, an SFD validation workshop was organized at municipality hall of Tilottama Municipality, Rupandehi (Figure 29). The results of the SFD survey in Tilottama Municipality were presented to Deputy Mayor, elected officials, and relevant stakeholders. In the workshop, the results including sanitation status of the municipality, containment types in the municipality, emptying, transport, treatment and re-use or disposal practice of faecal sludge in the municipality were presented and discussed Altogether, 58 participants including the Deputy Mayor, ward chairpersons, other members from municipal executive council, sectoral staffs, representatives of water supply user's organizations etc. actively participated on the workshop and provided the valuable suggestions.

Jageshwar Devi Chaudhary, Deputy Mayor of Tilottama Municipality, emphasized that the improper disposal of faecal sludge had emerged as a significant issue within the municipality. She stressed the importance of taking action for faecal sludge treatment and safe disposal. According to her, their current focus is on the management of fecal sludge, recognizing it as a pivotal action that needs to be addressed. The list of participants with their designation is attached in Appendix 7.

Figure 29: SFD sharing and validation workshop in Tilottama Municipality.

5. Acknowledgements

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

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We are very much grateful to Mr. Keshab Raj Neupane, Chairperson, Aanandaban Shankhanagar Water Supply and Sanitation organization, Mr. Dipak Pandey, Manager, Shankhanagar Water Supply and Sanitation organization, Mr. Gokul Paudel, Manager, Karahiya Water Supply and Sanitation organization, Mr. Yam Bdr Thapa, Chairperson, desludging service providers and Mr. Rohit Chaudhary, desludging service providers for providing valuable information.

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We are very much grateful to Ms. Bhawana Sharma, Executive Director and Mr. Rajendra Shrestha, Program Director of Environment and Public Health Organization (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.

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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 of Shankarnagar WSCSA

Regd. No. 237/2066/067 PAN No. 303780164

Shankarnagar Water Experiment Laboratory

Shankarnagar-3, Rupandehi

Tel.: 071-437986
Mob.: 9847304541

Water Analysis Report

(Physical, Chemistry Microbiological)

Date 2079/3/2

Name and address : Shankarnagar Ban Batika gate-1

Batch No.

Water Source: Surface/Deep Boarding/Hand Pump/Well/Other

Lab No. :

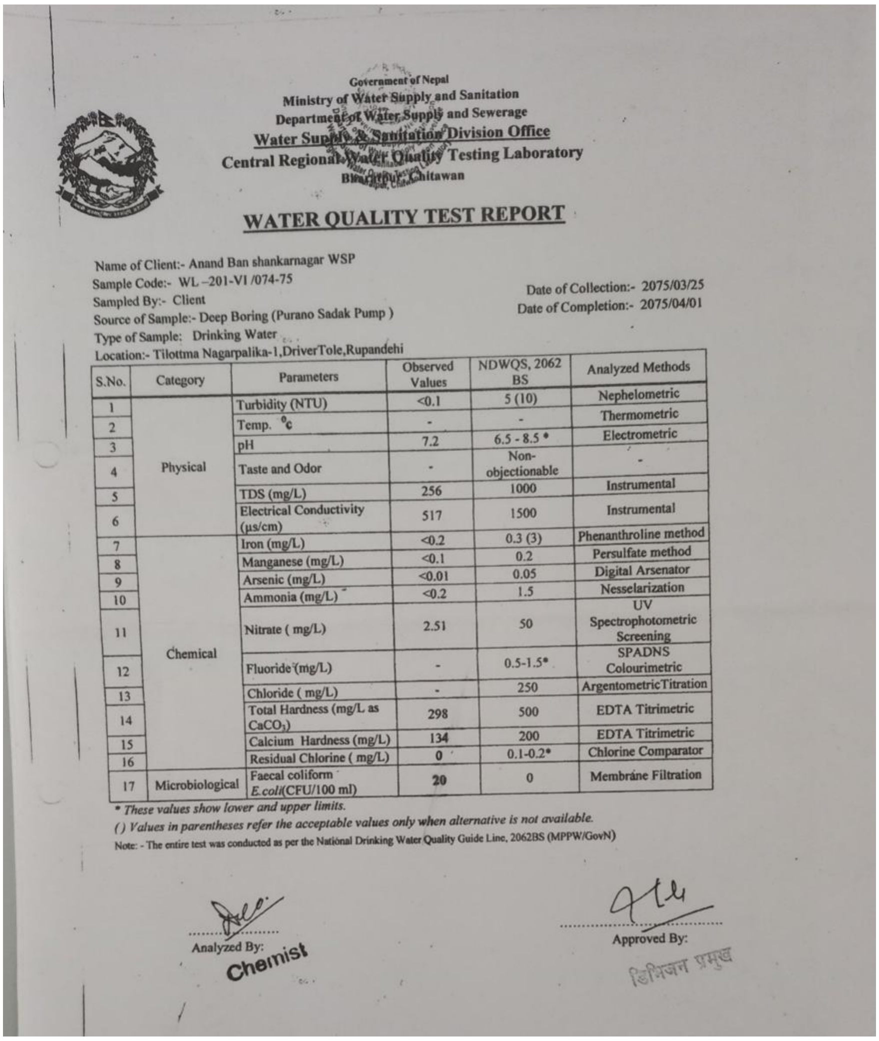
Depth :

Class	S.N.	Parameter	Unit	Maximum Concentration Limit	Observed Value
Physical	1.	Color	TCU	5 (15)	[illegible]
	2.	Odour			[illegible]
	3.	pH		6.5 - 8.5	7.6
	4	Temperature			20° C
	5	Turbidity	NTU	5 (10)	<5
	6.	T.D.S.	mg/l	1000	330 ml
	7.	Electrical Condutivity	mc/cm	1500	170 ml
Chemical	8	Iron	mg/l	0.3	0.15 ml
	9	Fluoride	mg/l	0.5-1.5	0.62 ml
	10	Phosphorus	mg/l		1 ml
	11	Total Hardness	mg/l	500	170 ml
	12	Ammonia NH_3+	mg/l	1.5	0.50 ml
	13	Chloride	mg/l	250	50 ml
	14	Nitrate NO_3+	mg/l	50	20 ml
	15	Arsenic	mg/l	0.05	nil
	16	Sulphate	mg/l	250	50 ml
	17	Calcium	mg/l	200	50 ml
	18	FRC	mg/l	_ 0.1-0.2	0.15 ml
Micro-Biological	19	Total Coliform	CFU/100ml	0	nil
	20	E Coli	CFU/100ml	0	nil

Comments : No, any comment. Potable and safe for drinking.

Lab Incharge

7.3. Appendix 3: Water Quality Testing Report of Anandaban Shankarnagar WSCSA



Government of Nepal
Ministry of Water Supply and Sanitation
Department of Water Supply and Sewerage
Water Supply & Sanitation Division Office
Central Regional Water Quality Testing Laboratory
Bharatpur, Chitawan

WATER QUALITY TEST REPORT

Name of Client:- Anand Ban shankarnagar WSP
Sample Code:- WL –201-VI /074-75
Sampled By:- Client
Source of Sample:- Deep Boring (Purano Sadak Pump)
Type of Sample: Drinking Water
Location:- Tilottma Nagarpalika-1,DriverTole,Rupandehi

Date of Collection:- 2075/03/25
Date of Completion:- 2075/04/01

S.No.	Category	Parameters	Observed Values	NDWQS, 2062 BS	Analyzed Methods
1	Physical	Turbidity (NTU)	<0.1	5 (10)	Nephelometric
2		Temp. °c	-	-	Thermometric
3		pH	7.2	6.5 - 8.5 *	Electrometric
4		Taste and Odor	-	Non-objectionable	-
5		TDS (mg/L)	256	1000	Instrumental
6		Electrical Conductivity (µs/cm)	517	1500	Instrumental
7	Chemical	Iron (mg/L)	<0.2	0.3 (3)	Phenanthroline method
8		Manganese (mg/L)	<0.1	0.2	Persulfate method
9		Arsenic (mg/L)	<0.01	0.05	Digital Arsenator
10		Ammonia (mg/L)	<0.2	1.5	Nesselarization
11		Nitrate (mg/L)	2.51	50	UV Spectrophotometric Screening
12		Fluoride (mg/L)	-	0.5-1.5*	SPADNS Colourimetric
13		Chloride (mg/L)	-	250	ArgentometricTitration
14		Total Hardness (mg/L as $CaCO_3$)	298	500	EDTA Titrimetric
15		Calcium Hardness (mg/L)	134	200	EDTA Titrimetric
16		Residual Chlorine (mg/L)	0	0.1-0.2*	Chlorine Comparator
17	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	20	0	Membrane Filtration

** These values show lower and upper limits.*
( ) Values in parentheses refer the acceptable values only when alternative is not available.
Note: - The entire test was conducted as per the National Drinking Water Quality Guide Line, 2062BS (MPPW/GovN)

Analyzed By:
Chemist

Approved By:
डिभिजन प्रमुख

7.4. Appendix 4: Water Quality Testing Report of Karahiya WSCSA

Government of Nepal
Ministry of Water Supply
Department of Water Supply and Sewerage Management
Federal water Supply and Sewerage Management Project
Water Quality Testing Laboratory
Bharatpur, Chitawan

WATER QUALITY TEST REPORT

Name of Client:-**Karahiya Water Supply and Sanitation Users Association**
Sample Code:- WL-133-II/079-80
Sampled By:- Client
Date of Collection:- 2079/12/14
Source of Sample:- Deep Boring(Tap:Rajan Shrestha,Bhadbaliya)
Date of Completion:-2079/12/ 20
Type of Sample:Drinking Water
Location:- Tilottma,Rupandehi

S.No.	Category	Parameters	Observed Values	NDWQS, 2079 BS	Analyzed Methods
1	Physical	Turbidity (NTU)	-	5	Nephelometric
2		Temp. ^{0}c	-	-	Thermometric
3		pH	-	6.5 - 8.5 *	Electrometric
4		Taste and Odor	-	Non-objectionable	-
5		TDS (mg/L)	-	1000	Instrumental
6		Electrical Conductivity (µs/cm)	-	1500	Instrumental
7	Chemical	Iron (mg/L)	-	0.3 (3)	Phenanthroline method
8		Manganese (mg/L)	-	0.2	Persulfate method
9		Arsenic (mg/L)	-	0.05	Digital Arsenator
10		Ammonia (mg/L)	-	1.5	Nesselarization
11		Nitrate (mg/L)	-	50	UV Spectrophotometric Screening
12		Fluoride (mg/L)	-	0.5-1.5*	SPADNS Colourimetric
13		Chloride (mg/L)	-	250	ArgentometricTitration
14		Total Hardness (mg/L as $CaCO_3$)	-	500	EDTA Titrimetric
15		Calcium Hardness (mg/L)	-	200	EDTA Titrimetric
16		Residual Chlorine (mg/L)	0.07	0.1-0.5*	Chlorine Comparator
17	Microbiological	Faecal coliform *E.coli*(CFU/100 ml)	0	0	Membrane Filtration

* *These values show lower and upper limits.*
( ) Values in parentheses refer the acceptable values only when alternative is not available.
Note: - The entire test was conducted as per the National Drinking Water Quality Guide Line, 2079BS
TNTC:Too Numerous to Count. ,ND:Not Detected
The Result Valid for submitted sample only

....
Analyzed By:
Chemist

7.5. Appendix 5: List of participants of SFD orientation

UCLG ASPAC ENPHO

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

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

Attendance Sheet

Program: Orientation on SFD
Date: 28-29 Baishakh, 2080
Venue: Tilottama Municipality, Rupandehi, Lumbini Province

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity	Age
1								
2	Narayan Aryal.	Tilottama Mun	Chief. add. officer	985708[illegible]		[illegible]		
3	Gorakh Nath Khanal	Tilottama MCP	officer	9847021499	[illegible]	[illegible]		
4	Krishna Prasad Pandey	Tilottama	[illegible] officer	9847020806	[illegible]			
5	Yubaraj Panthee	Tilottama	Engineer	985707[illegible]	[illegible]	[illegible]		
6	Sita Ghimire	"	Section officer	9857075567	[illegible]	[illegible]		
7	Manish Khanal	"	Sr. Engineer	9857010767	[illegible]	[illegible]		
8	Bhagawati Neupane	6 word	Enumerator	9844782872	[illegible]	[illegible]		32
9	Bishnu Pathak	Tilottama -9	"	9805418520	[illegible]	[illegible]		19
10	Maya Poudel	" 11	"	9817516779	Maya	Maya		31
11	Chandrakala chaudhary	" 98	"	[illegible]	[illegible]	[illegible]		30
12	Meena Thapa Uchai	16	"	9816497116	[illegible]	[illegible]		34
13	Mina chaudhary	17	"	9811596610	[illegible]	[illegible]		22
14	Ganga Tharu	Ward 13	"	9816418236	Ganga	Ganga		23
15	Kopila Roka	" "	"	9805811358	Kopila	Kopila		21
16	Durga Chaudhary	ward 12	"	9825822869	Durga	Durga		20
17	Pratima Lamichhane Rana	ward 3	"	9812998727	Pratima	Pratima		19
18	~~Maya Pandey~~	~~ward 3~~	-	~~9847098457~~	~~[illegible]~~			~~38~~

UCLG ASPAC ENPHO

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

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

Attendance Sheet

Program: Orientation on Shit Flow Diagram (SFD)
Date: 28-29 Baishakh, 2080
Venue: Tilottama Municipality, Rupandehi Lumbini Province

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity	Age
19	~~Hira Bastakoti~~	~~Tilottama~~		~~9864669151~~	[illegible]			
20	Suraj Dhakal	Tilottama, 8	Enumerator	9824458110	[illegible]	[illegible]		20
21	Rahul Sapkota	" -15	Enumerator	9814439255	[illegible]	[illegible]		28
22	Rahul Gurung	Tilottama - 10	Enumerator	9800700098	[illegible]	[illegible]		21
23	Prakash Nepal	" -02	"	9861071988	[illegible]	[illegible]		33
24	Prabesh Bhandari	Tilottama- 05	"	9865549283	[illegible]	[illegible]		23
25	Hira Bastakoti	Tilottama- 4	"	9864669151	[illegible]	[illegible]		39
26	Maya Pandey	Tilottama -1	"	9847098457	[illegible]	[illegible]		38
~~27~~	~~Pratima Lamichhane Rana~~	~~Tilottama -3~~	~~"~~	~~9812998727~~	~~Pratima~~			19
~~28~~	~~Mina chaudhary~~	Ti						
29	Mohan Neupane	Tilottama-6	It Branch	9857072858		[illegible]		
30	Shobha Godar	" -9	Sanitation staff	9865203167	शोभा	शोभा		
31	Janaki Paudel	" -9	"	9821241226	Janaki	Janaki		
0	Shobha Khanal	Tilottama		[illegible]	[illegible]	[illegible]		
	Kamala Neupane	" "		[illegible]	[illegible]	[illegible]		
	Raghunath Gaud	" "		9805411805	[illegible]	[illegible]		
	Radhika Pandey	"		9840[illegible]	[illegible]	[illegible]		
	Mukti Aryal	"	Account		[illegible]	[illegible]		
	Sanjeev Basyal	"	Mayor-Secretariats		[illegible]	[illegible]		
	Indira Subedi	"	"			[illegible]		

7.6. Appendix 6: Ward wise Sample size distribution in Tilottama Municipality

Wards	Population	Households	Proportion (%)	Sample size	Interval
1	10,149	2,473	6.9	71	35
2	10,227	2,689	7.5	77	35
3	12,180	3,202	8.9	92	35
4	10,302	2,586	7.2	74	35
5	8,665	2,282	6.3	66	35
6	12,104	2,861	7.9	82	35
7	11,599	2,801	7.8	81	35
8	6,520	1,589	4.4	46	35
9	8,537	2,126	5.9	61	35
10	5,136	1,156	3.2	34	35
11	11,749	2,853	7.9	82	35
12	5,039	1,184	3.3	34	35
13	5,799	1,320	3.7	38	35
14	9,402	1,906	5.3	55	35
15	7,442	1,770	4.9	51	35
16	6,409	1,516	4.2	44	35
17	8,220	1,677	4.7	48	35
Total	**149,479**	**35,991**		**1,036**	

7.7. Appendix 7: List of participants present in SFD sharing and validation workshop

आज मिति २०८०।४।३० गतेका दिन नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग तथा The United Cities and Local Government Asia Pacific (UCLG- ASPAC) को सहकार्यमा Municipalities Network Advocacy on Sanitation in South Asia (MuNASS II) कार्यक्रम अन्तर्गत तिलोत्तमा नगरपालिकामा संचालन गरिएको Shit Flow Diagram (SFD) सम्बन्धी अन्तरक्रिया र प्रमाणीकरण गोष्ठीमा निम्न अनुसार मुख्य सरोकारवालाहरूको सहभागीता रहयो ।

उपस्थिति

क्र.सं.	नाम	पद	फोन नं.	हस्ताक्षर
१.	राम कृष्ण खाण	नगर प्रमुख	९८५७०३०१११	
२.	जगेश्वर देवी चौधरी	नगर उप-प्रमुख	९८५७०४२७३०	
३.	नारायण अर्याल	प्रमुख प्रशासकिय अधिकृत	९८५७०८२१११	
४	नर बहादुर [illegible]	कार्यपालिका सदस्य	9847034471	
५.	प्रेम [illegible]	वडा अध्यक्ष १५	९८४६०२१९३५	
६	शोभा कान्त ढकाल	वडा सदस्य ६	9847594269-	
७.	प्रमिला सुनार	वडा सदस्य ५	9800745588	
८.	धर्मा न्यौपाने	वडा सदस्य ५	9847405558	धर्मा न्यौपाने
९	लक्ष्मी घिले	कार्यपालिका स. २	9823770413	
१०	तारा सुनार	कार्यपालिका स. ९	9817430375	
११	शोभा कुमारी राना	वा. ९ अध्यक्ष १६	९८४६५४२१२९	
११	राधा शाही	कार्यपालिका सदस्य	९८४६२५१३०३	
१२	अरविन पौडेल	वडाध्यक्ष १४	९८५६०८७८३०	
१३	नारायण ढकाल	वडा अध्यक्ष १३	९८५६०२१३९६	
१४	कृष्णप्रसाद पौडेल	वडा अध्यक्ष ३	९८५६०२६३६८	
१५	डिल बहादुर गैह्रागाई	वडा अध्यक्ष - २	९८४६०३३०६९	
१६	दीप लाल खनाल	नगर सेल निकास [illegible] सं. संयोजक	९८५७०१५४३४	
१७	हेमराज पौडेल	.. .. संयोजक	९८५७०३५५८८	

क्र.सं.	नाम	पद	फोन नं.	हस्ताक्षर
१८	तिलक थापा राना	करहिया खानेपानी उपाध्यक्ष	९८५६०४२८२१	
१९	गोरख नाथ [illegible]	अधिकृत	९८४६०११४५९	
२०	[illegible] कुसाल	[illegible]	[illegible]	
२१	युवराज पन्थी	इन्जिनियर	९८५७००७२०२७	
२२	पवन कु. पाठक	लेखापाल	९८८७६३९४२४	
२३	वन बहादुर पुरी	[illegible]	९८५६०२१५५४	
२४	तीरथनाथ पाण्डेय	मधवलिया खानेपानी अध्यक्ष	९८४६०३१५१२	
२५	इन्द्रकान्त अर्याल	ति.न.पा. २ अध्यक्ष उपभोक्ता	९८४४६३३१३४	
२६	किशोर कुमार श्रेष्ठ	आ.स. स्वा.नपा. उपाध्यक्ष	९८५६०२०५५८	
२७	करुणा थापा कार्की	अध्यक्ष वातावरणीय सुधार नेपाल	९८५६०३०३२०	
२८	शोभा खनाल	[illegible]	९८०४६३३१२३५	
२९	सम्पदा भण्डारी	अधिकृत छैठौं	९८४८२६६०४८	
३०	[illegible] भट्टराई	अध्यक्ष ति.न.पा.	९८०६३१८३००	
३१	प्रवेश पौडेल	[illegible]	९८४५१०५४१६	
३२	रम्भा देवी घिमिरे	नगर सदस्य तिनपा	9842264704	
३३	उमेश चन्द्र [illegible]	ति.न.पा. ११ वडा [illegible]	९८४७००६९४८	
३४	कमला न्यौपाने	ति.न.पा.	९८४६२०११९८	
३५	[illegible] कुँवर	नायब पशु सेवा प्राविधिक	९८६९८८४११२	
३६	[illegible]	[illegible]	९८४७१२६६५६	
३७	शकुन्तला ढकाल तिवारी	मनोसामाजिक परामर्शकर्ता	९८४४३१२०३५	
३८	इ. प्रदीप पन्त	इन्जिनियर ति.न.पा.	९८५७०३८४५८	
३९	[illegible]	[illegible]	९८५६०४४५३६	
४०	सुरज पाण्डे	प्राविधिक	9849608755	
४१	मोहन न्यौपाने	सूचना प्रविधि शाखा	9857072858	
४२	[illegible]	करहिया [illegible] खानेपानी	९८५६०३५५४०	
४३	[illegible] भण्डारी	शंकरनगर खानेपानी	९८५६०२४३३२	
४४	कमल [illegible]	वडा सदस्य ६	९८४८०३५०८३	
४५	रवि सेन [illegible]	कार्यपालिका सदस्य	९८४६०३३३२	
४६	[illegible]	[illegible]	९८४६११६८८०	
४७	गोपाल घिमिरे	वडा अध्यक्ष ४	९८०४५१६०८२	
४८	[illegible]	कार्यपालिका सदस्य		

क्र.सं.	नाम	पद	फोन नं.	हस्ताक्षर
४९	विनोद ज्ञवाली	अधिकृत पाँचौं	९८४६०३८६२४	
५०	सुजना आचार्य	रोजगार सहायक	9847089004	
५१	अल्पना घिमिरे	प.प्रा.प.	९८४६०२०६४८	
५२	राधा पाण्डे	सा. का.	९८०९२९५७६४	
५३	निर्मला थापा	का.स.		निर्मला
५४	मुक्ती प्रसाद अर्याल	का.स.		मुक्ती
५५.	गंगाराम आचार्य	(उपसचिव)	ति.न.पा.	
५६	कृष्ण प्रसाद पाण्डे	(अधिकृत)	ति.न.पा.	
५७	अनिल वलिया	ना.प.		Anil.
५८	प्रकाश चौधरी	न.प.		प्रकाश
५९.	नरेन्द्रप्रसाद श्रेष्ठ	[illegible] इन्चार्ज		
६०	देवेन्द्र ज्ञवाली	रोजगार संयोजक		
६१	सबुना गमाल	स्वा.प.अ.	९८४८३४९२३६	
६२	अनिता भुजु	〃	९८४६३५९९५७	

SFD Tilottama Municipality, Nepal, 2024

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