SFD Report

Hetauda Sub-Metropolitan City
Nepal

Final Report

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

Date of production: 01/11/2023

Last update: 21/03/2024

SFD Report Hetauda Sub-Metropolitan City, Nepal, 2024

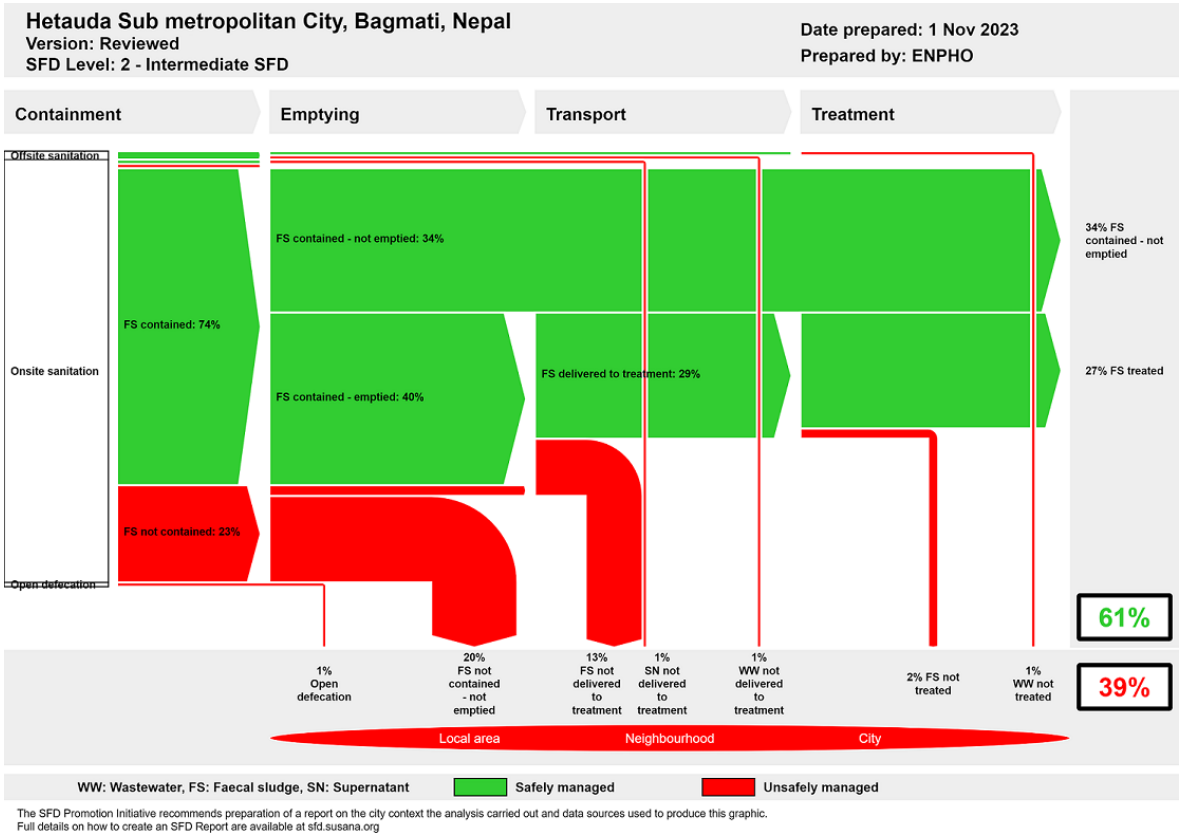
Produced by:

Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Buddha Bajracharya, ENPHO
Jagam Shrestha, ENPHO
Anita Bhuju, ENPHO
Asmita Shrestha, ENPHO

This Executive Summary and SFD Report are available from:

www.sfd.susana.org

1. The SFD Graphic



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

2. Diagram information

SFD Level:

This SFD is a level 2 - Intermediate report.

Produced by:

Environment and Public Health Organization (ENPHO).

Collaborating partners:

Hetauda Sub-Metropolitan City, Municipal Association of Nepal (MuAN), United Cities and Local Government- Asia Pacific (UCLG-ASPAC).

Status:

Final SFD report.

Date of production: 01/11/2023

3. General city information

Hetauda Sub-Metropolitan City (SMC) is situated in the confluence of the two prominent national highways viz. Tribhuvan highway and Mahendra highway. Hetauda Municipality was expanded as Sub-Metropolitan City in 2014. It has 19 wards and covers the area of 261.58 sq.km.

According to national population and housing census 2021, Hetauda Sub-Metropolitan City has a total population of 193,576 and 46,566 households (NSO, 2023).

The Hetauda SMC has warm and temperate climate (Climate Data, n.d.). The average temperature in Hetauda is 26.83°C. Hetauda typically receives about 231.78 millimetres of precipitation and has 166.84 rainy days (45.71% of the time) annually (Weather and Climate, n.d.). It is extended from 85° 53' 27" to and 85° 11' 24" E and 28° 32'31" to 27°19'58" N. The elevation of the SMC ranges between 300 metres to 390

metres above mean sea level (Hetauda SMC, 2017).

4. Service outcomes

The overview of different sanitation technologies across the sanitation value chain in the Hetauda Sub-Metropolitan City is briefly explained in this section. All data in this section are from the household and institutional surveys conducted for this study (ENPHO, 2023). 99% of the households in the SMC have toilet. The public toilets were constructed by the Hetauda SMC and operated by the private sector.

Sewer Network

A total of 2% of households are directly connected to the sewer network, whereas 1% of households have linked to the sewer network after connecting to a containment system.

Containment:

97% of the households rely on onsite sanitation technologies. 58% of the households have constructed fully lined tanks (34% corresponds to biogas digesters also modelled as fully lined tanks). 24% of the households have installed lined pits with semi-permeable walls and open bottom. 12% of the households have constructed lined tanks with impermeable walls and open bottom. Only 2% of the households have their toilet connected to a septic tank and 1% of the households in the SMC have constructed unlined pits.

Emptying and Transportation:

According to assessment of sanitation situation of the SMC by ENPHO in 2023, only 15% of the households have emptied their containments at least once after used. Among these households, 44%, have emptied them mechanically with municipal vehicle while 18% have emptied through the private service providers. 20% of the households rely on self-manual emptying and 18% emptied with support of traditional desludging workers. Although both the municipal vehicle and private sector are actively involved in the FS desludging service, manual emptying the containment also has been practised.

Treatment and Disposal:

The Hetauda SMC lacks a faecal sludge treatment facility. Most of the faecal sludge emptied is dumped in the disposal site situated at Sisaughari nearby Rapti River. Households having a biogas digester installed utilize its energy in cooking and other purposes.

According to the household survey conducted in SMC, 91% of households rely on private taps, only 2% depend on public or community taps and 7% depends on direct to groundwater sources such as dug wells and handpumps (ENPHO, 2023). Hetauda Water Supply Management Board (HWSMB) is major water supply service provider in the Hetauda SMC. The HWSMB has been providing drinking water for wards 2, 4, 5, 6, 7, 8, 9 and 10 completely and partially at wards 1, 3, 14, 15, 16, 17, 18 and 19. The HWSMB has provided 20.5 Million litre water daily through 23,991 taps maintaining a flow for 6-7 hours per day (HWSMB, 2023). The Padampokhari Water Supply User's Committee is also providing the water services at wards 12 and 13.

The SFD graphic shows that 61% of the excreta or faecal sludge generated are safely managed while 39% are unsafely managed. The safely managed Faecal Sludge (FS) generated by 34% of the population is temporary as this FS is only contained. So, once the containment gets filled and the FS from the containment is emptied, the percentage of unsafely managed FS would increase. The faecal sludge generated from 27% of the population is contained and safely treated in anaerobic biogas digesters.

Two percent of the wastewater remains untreated because the treatment plant is not receiving the wastewater and the wastewater treatment plants are non-operational.

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.

Hetauda municipal council has approved the Environment and Natural Resource Protection Act, 2020. This legislation prohibits individuals or organizations from causing pollution that deviates from established standards in a way that could have a significant negative impact on public life, human health, and the environment (Hetauda Sub-Metropolitan City, 2020).

Hetauda Sub-Metropolitan City has endorsed Sanitation Management Procedure, 2023 to ensure the right to live in clean and healthy environment. This involves the efficient coordination of local government, private sector, civil society, and Tole Development Organizations to establish a sustainable and institutionalized sanitation program, facilitating the successful execution of the *Clean Hetauda and Healthy Hetauda Campaign* (Hetauda Sub-Metropolitan City, 2023).

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 SMC 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, Energy, and Irrigation Water Supply and Sanitation Division Office (WSSDO)
Public Institutions at Local Government	Hetauda Sub-Metropolitan City Office Hetauda Water Supply Management Board (HWSMB)
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Green and Clean City Service Pvt Ltd. Desludging service providers Public toilet operators
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Credibility of data

The major data were collected from random household sampling. Altogether, 1,043 households and 55 institutions were surveyed from 19 wards of the SMC on 30-31 May, 2023. Primary data on current sanitation practices in the SMC were triangulated from Key Informant Interviews (KIIs) with municipal officials, public toilet operators, desludging service providers and water supply service providers, treatment plant operators. The overall data and findings were shared with the stakeholders of the Hetauda SMC and validated through a sharing program on 5 January, 2024.

8. Process of SFD development

Data on sanitation situation were collected through household and institutional survey (ENPHO, 2023). The local enumerators from each ward of the SMC 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 SMC, public toilet operators, desludging service providers and water supply service provider, treatment plant operator 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:

- Climate Data. (n.d.). Climate of Hetauda. Retrieved from climate data.org: https://en.climate-data.org/asia/nepal
- 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.
- Hetauda SMC. (2017). City Profile of Hetauda Sub-Metropolitan City
- Hetauda Sub-Metropolitan City. (2020). Environment and Natural Resource Protection Act.
- Hetauda Sub-Metropolitan City. (2023). Sanitation Management Procedure. Hetauda Sub-Metropolitan City.

SFD Hetauda Sub-Metropolitan City, Nepal, 2024

Produced by:

Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Buddha Bajracharya, ENPHO
Jagam Shrestha, ENPHO
Anita Bhuju, ENPHO
Asmita Shrestha, ENPHO

This Executive Summary and the SFD Report are available from:

www.sfd.susana.org

Table of Contents

List of Tables

List of Figures

Abbreviations

ADB	Asian Development Bank
AEPC	Alternative Energy Promotion Centre
BOD	Biochemical Oxygen Demand
CAO	Chief Administrative Officer
CFU	Colony Forming Unit
COD	Chemical Oxygen Demand,
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
FSTP	Faecal Sludge Treatment Plant
FWSSM	Federal Water Supply and Sewerage Management
HH	Household
HWSMB	Hetauda Water Supply Management Board
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometers
MoUD	Ministry of Urban Development
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NDWQS	National Drinking Quality Standard
NGO	Non-Governmental Organization
NPC	National Planning Commission
NSO	Nepal Statistical Office
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
NWSSP	National Water Supply and Sanitation Policy
ODF	Open Defecation Free
PCC	Plain Cement Concrete
RCC	Reinforced Cement Concrete
RVT	Reservoir Tank
RWSSNP	Rural Water Supply and Sanitation National Policy
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD PI	Shit Flow Diagram Promotion Initiative
SFD	Shit Flow Diagram
SMC	Sub-Metropolitan City
SN	Supernatant
STIUEIP	Secondary Town Integrated Urban Environmental Improvement Project
SuSANA	Sustainable Sanitation Alliance
TDS	Total Dissolve Solid
TSS	Total Suspended Solid
UCLG ASPAC	United Cities and Local Governments Asia Pacific
UNICEF	United Nations Children's Education Fund

WASH	Water, Sanitation and Hygiene
WSUC	Water Supply Users' Committee
WW	Wastewater

1 City context

Hetauda Sub-Metropolitan City (SMC) is situated in the confluence of the two prominent national highways viz. Tribhuvan highway and Mahendra highway. Hetauda was declared municipality in 1969 and announced headquarters of the Makwanpur District in 1982. Hetauda Municipality was expanded as Sub-Metropolitan City in 2014. It has 19 wards and covers the area of 261.58 sq.km. It is surrounded by Makawanpurgadhi Rural Municipality, Bhimphedi Rural Municipality and Kailash Rural Municipality in the north, Raksirang Rural Municipality and Manahari Rural Municipality in the west, Bakaiya Rural Municipality in the east, Parsa and Bara Districts in the south (Figure 1).

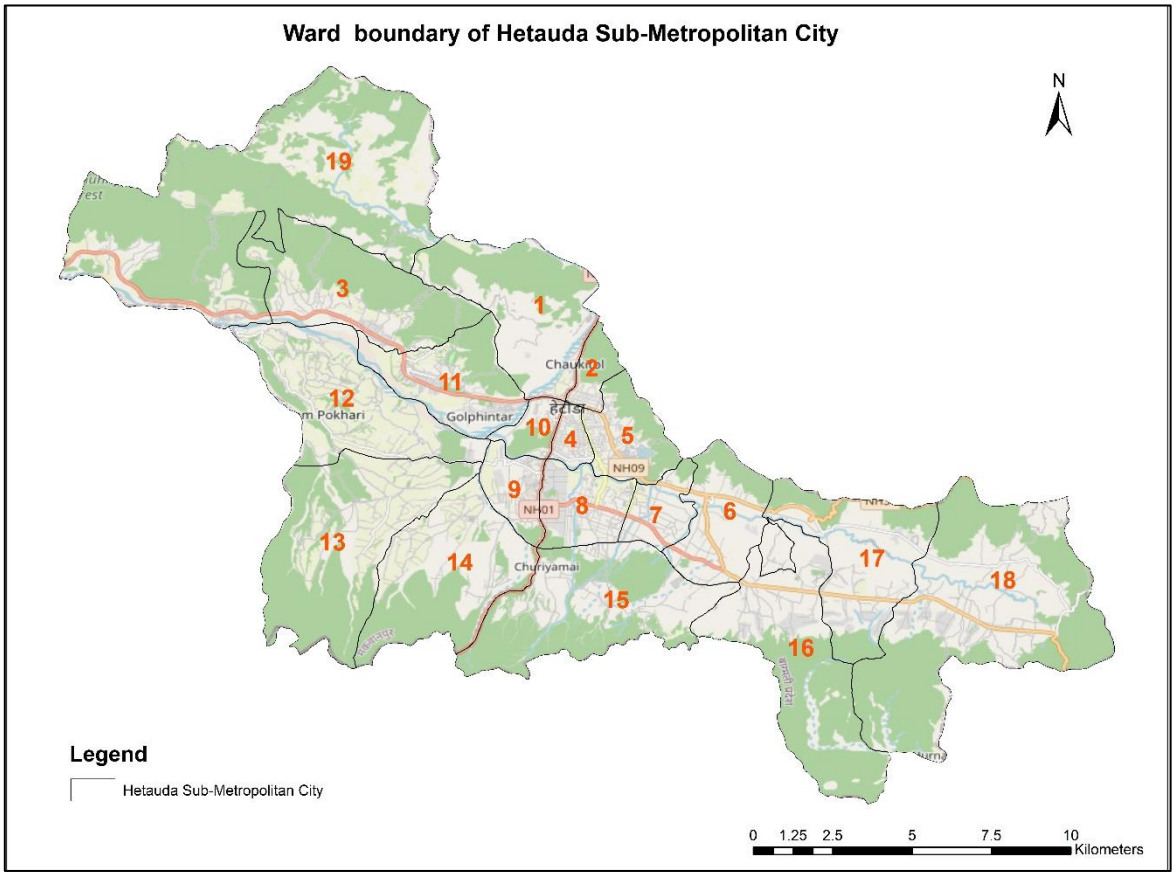


Figure 1: Map of Hetauda SMC with ward boundaries.

1.1. Population

According to national population and housing census 2021, Hetauda Sub-Metropolitan City has total population of 193,576 and 46,566 households. The total male and total female are 95,678 and 97,898 respectively. The population density of the SMC is 740 people per square kilometre. Ward number 4 has the highest population of 18,035 (9,047 male and 8,988 female), while ward number 7 has the least population with 6,032 (2,930 male and 3,102 female).

Similarly, ward 4 has the highest number of households (4,630), while ward 7 has the least number of households (1,438) (NSO, 2023).

1.2. Climate

The Hetauda Sub-Metropolitan City has warm and temperate climate with much less rainfall in winter than in summer. This location is classified as Cwa by Köppen and Geiger(Climate Data, n.d.). The average temperature in Hetauda is 26.83°C. Hetauda typically receives about 231.78 millimetres of precipitation and has 166.84 rainy days (45.71% of the time) annually. Figure 2 shows the average temperature and precipitation of the Hetauda. The maximum warmth month in a year is May while January has the lowest average temperature of the whole year (Weather and Climate, n.d.).

The month with the highest relative humidity is July (89.70 %). The month with the lowest relative humidity is April (45.77 %). The month with the highest number of rainy days is August (28.97 days). The month with the lowest number of rainy days is December (1.50 days) (Climate Data, n.d.).

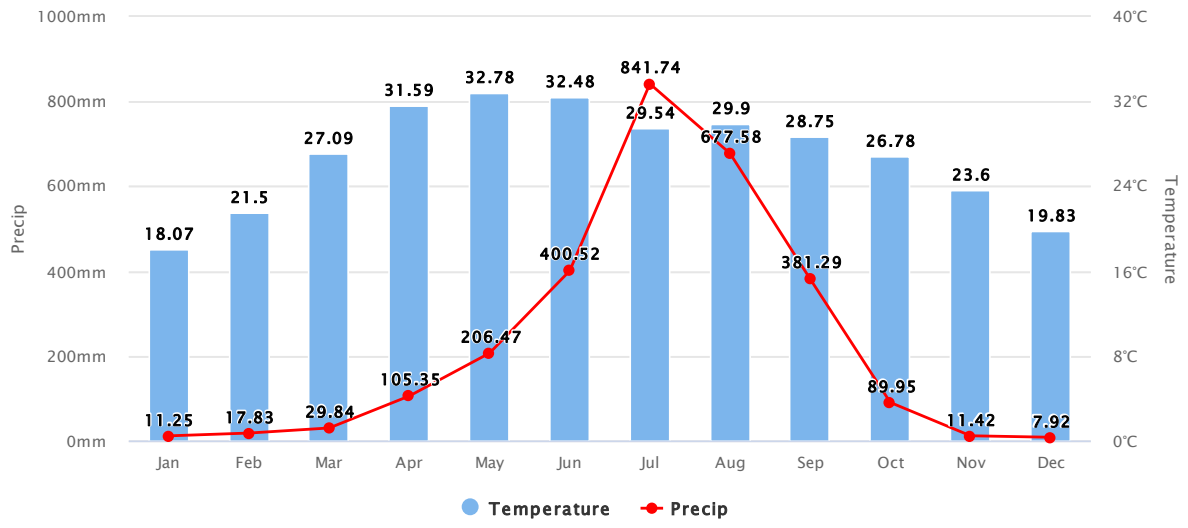


Figure 2: Monthly Average Temperature from January to December.

1.3. Topography

Hetauda is surrounded by hills, the Mahabharata range in the north, the Siwalik (Churiya range) in the south. Ward 1 and 19 lies in the hilly region while other wards have plain area. It is extended from 85° 53' 27" to and 85° 11' 24" E and 28° 32'31" to 27°19'58" N. The elevation of the SMC ranges between 300 metres to 390 metres above mean sea level (Hetauda SMC, 2017).

Three rivers flow through the city that meet to one of the largest in the country, the Narayani River. Rapti River, Samari River and Karra River are major rivers in the Sub-Metropolitan City. Chakari Khola and Kukhreni Khola originates from Chure region and flows towards northern side. Shakti Khola originates from Chure region and flows towards southern side.

2 Service Outcomes

2.1. Overview

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). A total of 1,043 households were sampled from 46,566 households distributed in fourteen wards (further details are presented in section 4). The results obtained after the triangulation and validation of the data with all the data sources including literature reviews, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

Particularly over the past 20 years, sanitation has been promoted in Nepal, which led to the nation as Open Defecation Free (ODF) nation on September 30, 2019, with the combine effort of the 3 tiers of the government (MoWS, 2020). Hetauda was declared an Open Defecation Free Zone in 2013 (KII_1, 2023) (KII_2, 2023). However, it was revealed that 1% of the households still lack access to improved sanitation facilities.

2.1.1 Sanitation System in Households Building

Offsite Sanitation System

2% of the households have been connected to sewer networks directly.

The sewer networks in the core urban areas of the Hetauda SMC were upgraded and improved under Secondary Town Integrated Urban Environmental Improvement Project (STIUEIP) by Department of Urban Development and Building Construction (DUDBC) under the Ministry of Physical Planning and Works (MoPPW) from the Asian Development Bank (ADB) in 2007. The project included three combined sewerage systems. There are three schemes named as Rapti-1, Rapti-2 and Karra system of 14.6 km length. Reinforced Cement Concrete (RCC) hume pipe with wastewater (reed bed) treatment plants each on the banks or Rapti and Karra rivers serves wards 1, 2, 4, 5 and 10 of Hetauda SMC (KII_1, 2023) (KII_2, 2023).

Onsite Sanitation System

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

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

Table 1: Types of containment in households building in Hetauda Sub-Metropolitan City (ENPHO, 2023).

Containment	Wall construction materials	Bottom of containment	Number	Chamber	Connected to	%	Recategorized as SFD	%
Septic Tank	Cemented walls or cemented brick/ stone wall	PCC or plastered	NA	Two or more than two	Open drain	2%	Septic Tank	2%
					Soak pit			
Biogas Digester	NA	NA	NA	NA	NA	34%	Fully lined tank	58%
Fully lined tank	Cemented walls or cemented brick / stone wall	PCC or plastered	NA	One	No outlet	24%		
					Sewer Network			
					Open ground			
				Two, more than two	No outlet			
					Open ground			
Lined tank with impermeable walls and open bottom	Cemented walls or cemented brick / stone wall	Soiling / nothing	NA	One, Two, more than Two	Open ground, no outlet/ overflow, open drain	12%	Lined tank with impermeable walls and open bottom	12%
Single pit	Concrete rings piled one	Soiling/ nothing	1	NA	NA	20%	Lined pit with semi-permeable walls and open bottom	24%
Twin pit	Concrete rings piled one	Soiling / nothing	2	NA	NA	4%		
Unlined Pit	Mud mortar stone/ brick wall/ dry stone wall/ no lining	Soiling / nothing	NA	One	No outlet/ overflow	1%	Unlined pit	1%
Open defecation	NA	NA	NA	NA	NA	1%	Open defecation	1%
Flushed toilet	NA	NA	NA	NA	Sewer network	2%	Toilet discharges directly to a decentralised foul/separate sewer	2%
TOTAL								100%

A septic tank is installed in 2% 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 the 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.

An anaerobic biogas digester has been installed in 34% of households to treat the household organic waste and generate energy (Figure 3). Under the Biogas Support Program, 9387 households in the former Village Development Committee (Churiyamai-1475 HHs, Barsamadi-732 HHs, Harnamadi -832 HHs, Hetauda -2690 HHs, Padampokhari -2077 HHs, Hatiya-1581 HHs) of Hetauda SMC have installed a biogas plant (AEPC, 2011). Nepal Biogas Support Programme is a nation-wide programme for the dissemination of household biogas digesters, managed by Alternative Energy Promotion Center (AEPC). 5 Major private sector were involved in biogas installation in Hetauda SMC in fiscal year 2075/76 (AEPC, 2019). Approximately, 200 biogas digesters are installed each year. However, the demand for the biogas digester installation at household level is on decreasing trend (KII-9, 2023) (KII_10, 2023).

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

Figure 3: Biogas digester in households.

Lined tanks with impermeable walls and open bottom are also a popular system in the SMC and have been constructed by 12% 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.

20% 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).

4% 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.

Moreover, 1% of the households in the SMC have constructed unlined pits. Unlined pits are constructed with mud mortar brick / stone wall or dry-stone wall and soling or nothing at bottom.

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

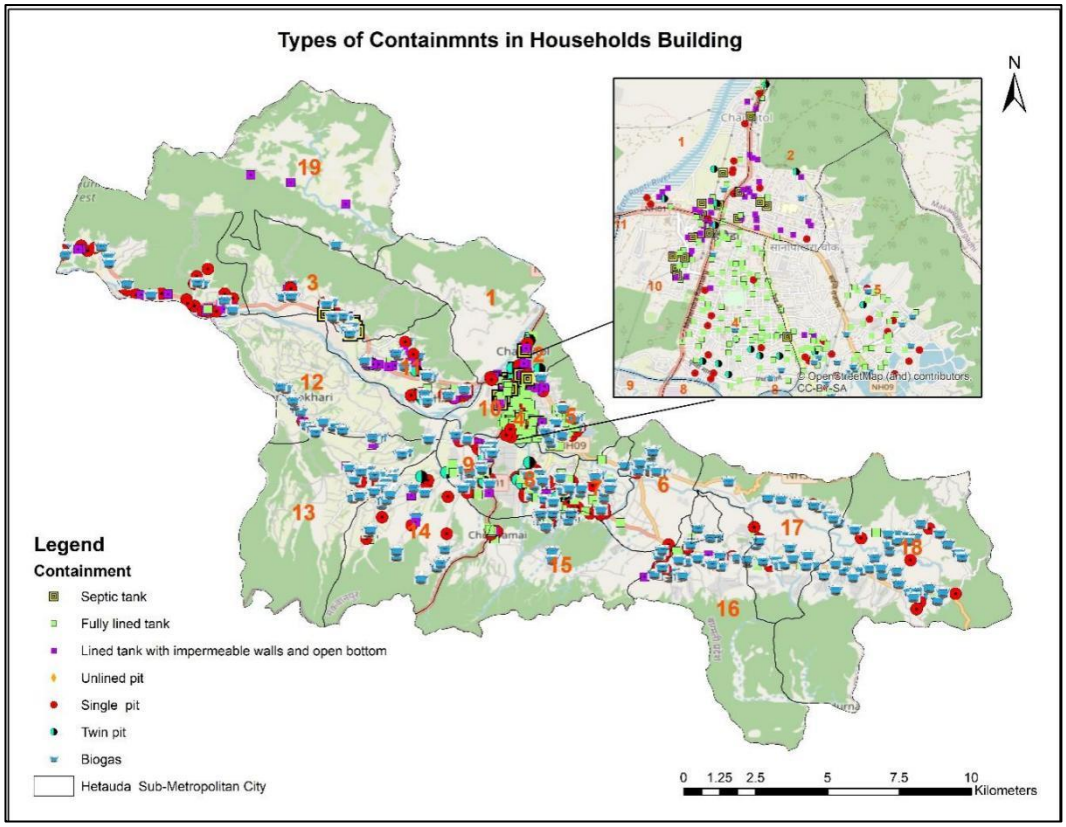


Figure 5: Map showing the households with the types of containments in Hetauda Sub-Metropolitan City.

2.1.2. Sanitation Systems in Institutional building

All institutional buildings (55 institutions such as schools, hospital / health post, ward offices, hotels) surveyed have been connected waste from toilet into onsite sanitation technologies. The fully lined tank is popular onsite sanitation technology in institutions of Hetauda Sub-Metropolitan City. Figure 6 shows the different sanitation technologies available in the institutions of Hetauda Sub-Metropolitan City.

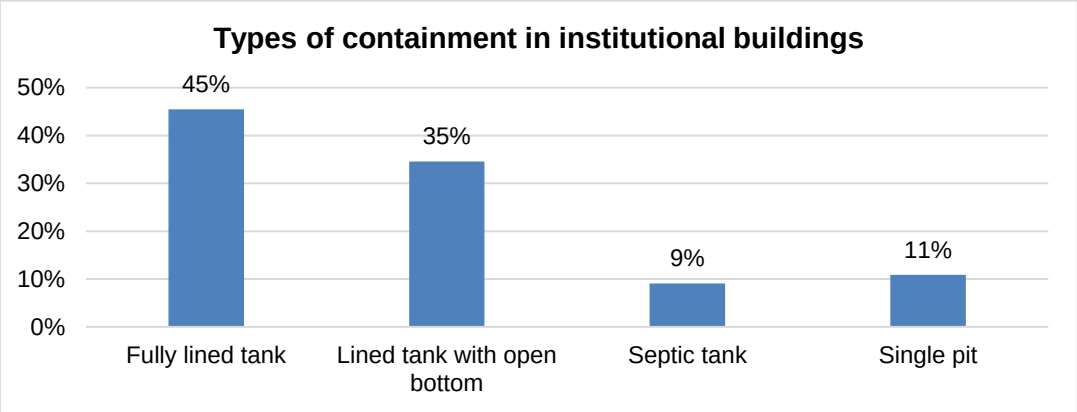


Figure 6: Types of containment in the institutional building of Hetauda Sub-Metropolitan City.

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

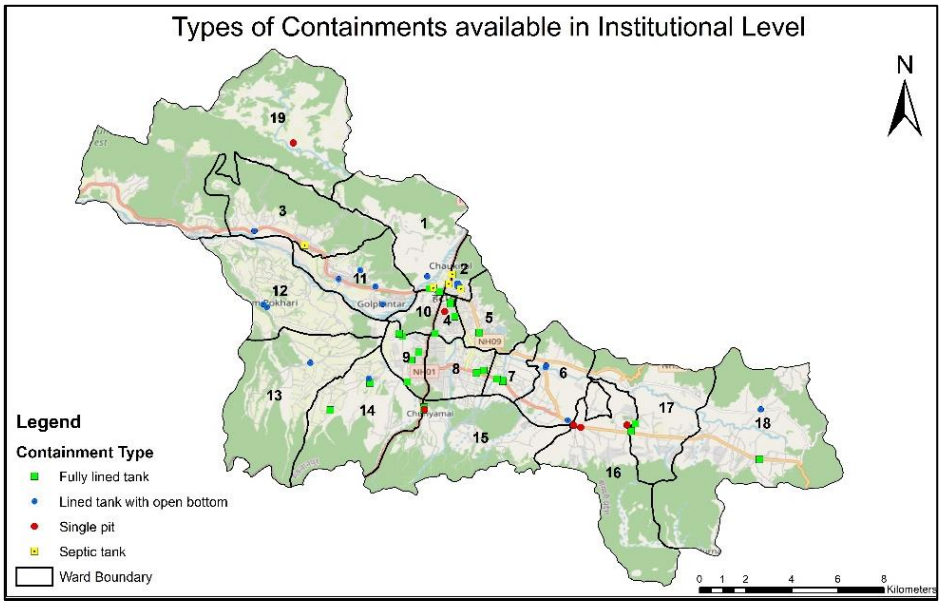


Figure 7: Map locating institutional building with types of sanitation technologies.

2.1.3. Public Toilets

There are two public toilets operated in the bus park area of Hetauda SMC (Figure 8). It was constructed by Hetauda SMC. The operation and maintenance of the toilet is leased to private sector (KII_1, 2023) (KII-7, 2023). A toilet located at market area (near Buspark) has 20 pans and 8 urinals. The toilet was used regularly by the shopkeeper, visitors, and passengers. It has a fully lined tank installed. It is emptied the thrice every year. The water required for cleaning

the toilet is fulfilled from a tap connected to pipeline distributed by Hetauda Water Supply Management Board. There is storage tank of 2,000L. Approximately, 350 people are using the toilet in daily basis (KII-8, 2023).

Figure 8: Components of the public toilet at Buspark area in Hetauda Sub-Metropolitan City.

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 15% of the households have emptied their containments at least once since it was used. Among these households, 44 % have emptied them mechanically with municipal vehicle while 18% have emptied through the private service providers. 20% of the households rely on self-manual emptying and 18% emptied it with support of traditional desludging workers. As pointed out, although both the municipal vehicle and private sector are actively involved in the FS desludging service, manual emptying the containment is also practised. However, poor emptying practices can lead to direct exposure of the person involved in emptying activities to pathogens (WHO, 2018).

Hetauda SMC has been providing services for about 20 years. The desludging vehicle has a capacity of 3,500 L (Figure 9) and approximately carries out 30 trips per month. The people submit an application to SMC office to get services. It charges on average NPR 3,500 (USD 26.6) per trip. Usually, 2 staffs are involved for the desludging service who are also involved in the other sanitation works within SMC (KII_3, 2023).

Figure 9: Municipal vehicle for providing desludging services.

Green and Clean City Services Pvt Ltd has been providing faecal sludge desludging services since 2017. The desludging vehicle has a capacity of 3,000 L (Figure 10) and approximately carries out 50 trips per month. It charges on average NPR 3,500 (USD 26) per trip (KII_4, 2023).

Figure 10: Private desludging service provider of Hetauda Sub-Metropolitan City.

2.1.5. Treatment and Disposal

FS emptied manually is either mixed with organic solid waste at household level without following any procedure to produce quality compost manure or directly applied into farmlands or discharged into water bodies. The direct use of faecal sludge has the highest level of risk for human health, therefore not recommended to practice it (Strande et. al., 2014). Thus, the handling of the manually emptied FS in the SMC in unhygienic and possess risk to human health.

The SMC does not have a faecal sludge treatment plant (KII_1, 2023) (KII_2, 2023). The mechanically emptied faecal sludge is disposed of at Sisaughari, nearby a solid waste landfill site (KII_3, 2023) (KII_4, 2023). The FS disposal site is situated at the bank of Rapti River (Figure 11).

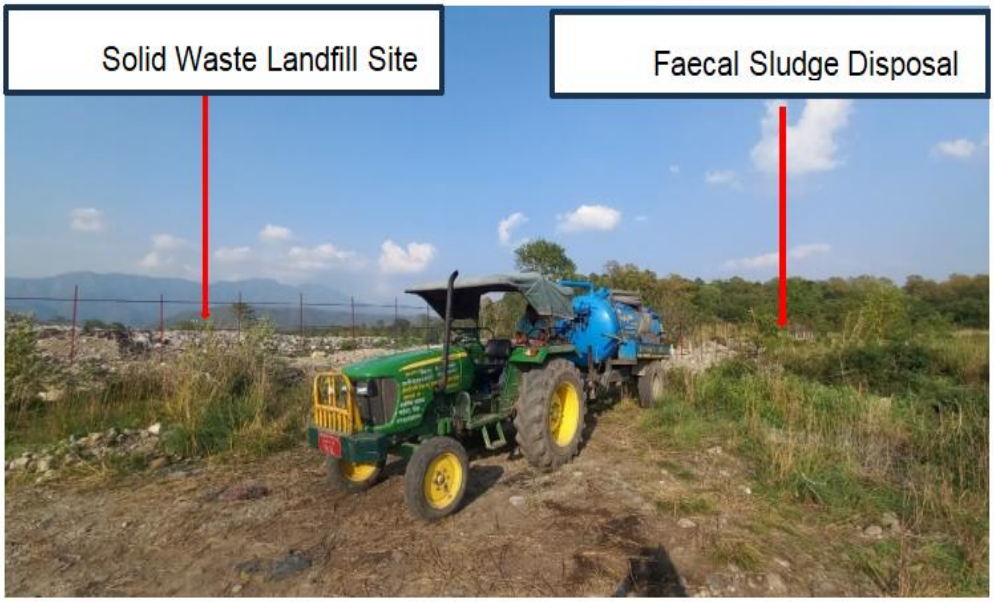


Figure 11: Desludging service provider disposing the faecal sludge to the disposal site at Sisaughari (bank of Rapti River).

Under STIUEIP, the reed bed wastewater treatment plant was constructed on the banks or Rapti and Karra rivers serves wards 1, 2, 4, 5 and 10 of Hetauda SMC (KII_1, 2023) (KII_2, 2023).

A first wastewater treatment facility is located in Ward 5, designed to handle wastewater primarily from ward 4 and 5. Unfortunately, the plant is currently non-operational, and the infrastructure has been damaged. Figure 12 provides a visual representation of the current status of the treatment plant.

Figure 12: Status of wastewater treatment plant at bank of Karra River (Ward 5).

Domestic Wastewater Treatment Plant- 2

A second wastewater treatment facility is located in Ward 10, designed to handle wastewater primarily from its own ward. Unfortunately, the plant is currently non-operational, and the infrastructure has suffered damage. Figure 13 provides a visual representation of the current status of the treatment plant.

Figure 13: Status of wastewater treatment plant at Ward 10.

Domestic Wastewater Treatment Plant- 3

A third domestic wastewater treatment facility is located in Sisaughari of Ward 10, designed to handle wastewater primarily from wards 1, 2, and 10. Unfortunately, it is currently non-operational, and the infrastructure has become overgrown with grass, as depicted in Figure 14 illustrating the current state of the treatment plant.

Figure 14: Status of wastewater treatment plant at Ward 10.

Industrial Wastewater Treatment Plant at Hetauda Industrial District (HID)

The natural stabilization wastewater treatment plant at HID was built in 2002-2003 under the financial and technical assistance of Government of Denmark. The industrial and sanitary wastewater from HID industries and building are treated in the constructed wastewater treatment plant before it is discharged to Karra River. The treatment plant is partially functional and required major maintenance for fully operation (KII-6, 2023).

This research, conducted on the wastewater treatment plant at HID, indicated that the average concentrations of Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolve Solids (TDS), oil and grease, and ammonical nitrogen in the effluent were 252, 1,226, 595, 384, 6.2, and 36.16 mg/l, respectively. These values fell short of the effluent standards for BOD_5, COD, and TSS. The pretreatment processes at the brewery, dairy, vegetable ghee, and soap factories were insufficient to meet the established criteria. To address the inefficiencies in treatment, it is recommended to connect more factory sewerage systems to the treatment plant, thereby addressing the issue of under BOD_5 loading in the anaerobic pond. Additionally, wastewater should undergo adequate treatment to meet pretreatment criteria before being discharged into the wastewater treatment plant (Shah Teli, 2017).

Figure 15: Current status of different components of the wastewater treatment plant at Hetauda Industrial District.

Figure 16 represents the map locating the wastewater treatment plant sites within the SMC.

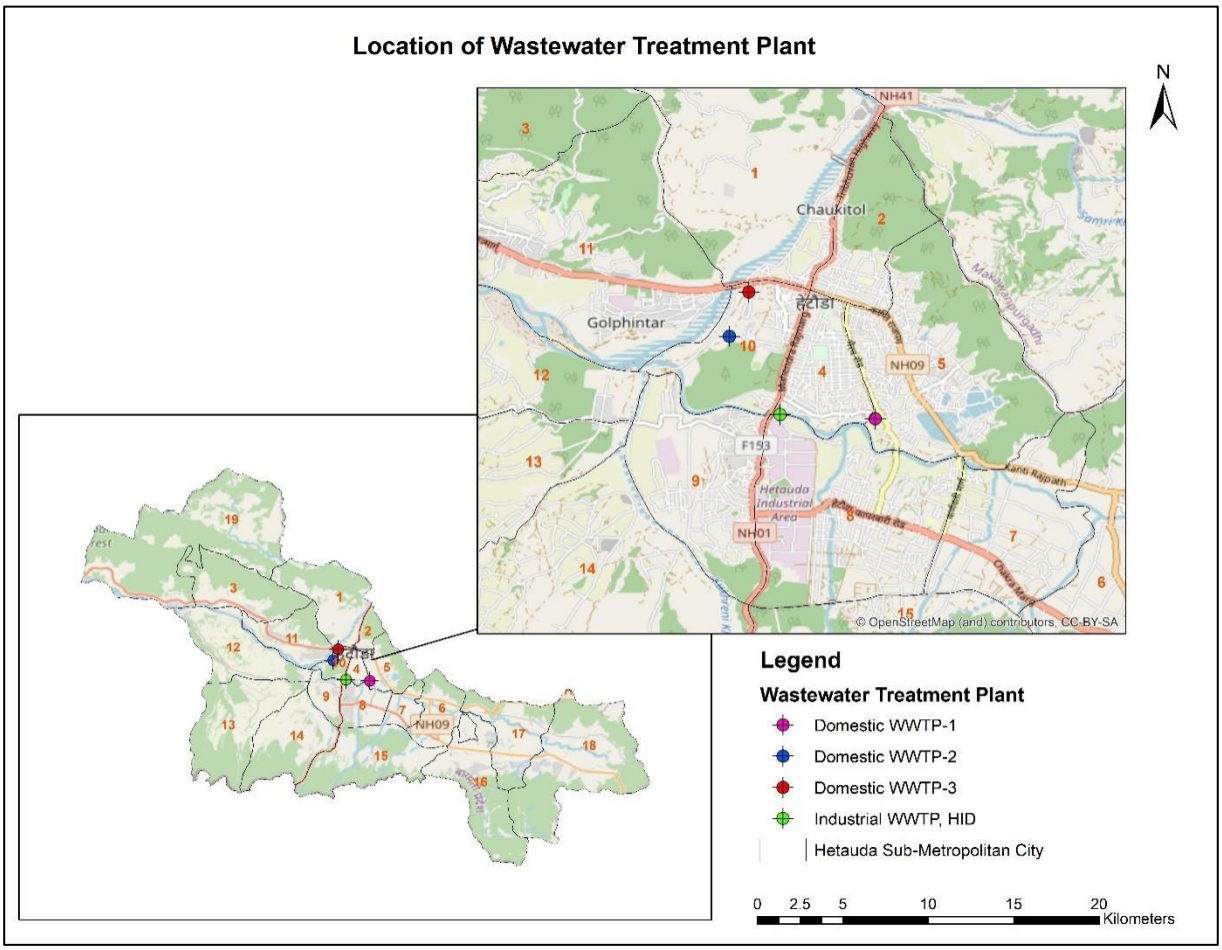


Figure 16: Location map of the Domestic and Industrial Wastewater treatment plants.

2.1.6. Risk Assessment of Groundwater Pollution

a. Sources of Drinking Water

According to the assessment, 91% of households in the SMC rely on private tap while 2% of households rely on public tap for drinking purpose. Moreover, 7% of households rely on groundwater sources such as dugwells and hand pumps (ENPHO, 2023). Hetauda Water Supply Management Board (HWSMB) is major water supply service provider in the Hetauda SMC. The Padampokhari, Duibasti, Sadak, Tarsaling Water Supply User's Committee (WSUC) are also providing the water services at wards 11,12 and 13 (Figure 17 and Figure 18).

HWSMB was established in 2007 under Water Supply Management Act 2006. Nepal Water Supply Corporation (NWSC) Hetauda Branch was also formally handed over to HWSMB on 22 May, 2013. The HWSMB has been providing drinking water for wards 2, 4, 5, 6, 7, 8, 9 and 10 completely and partially at wards 1, 3, 14, 15, 16, 17, 18 and 19. The HWSMB has provided

20.5 Million litres water daily through 23,991 taps maintaining a flow for 6-7 hours per day (HWSMB, 2023) (KII-5, 2023).

The description of the components and location of water supply stem under HWSMB are mentioned in the Table 2.

Table 2: Main components and location of water supply system (HWSMB, 2023).

Components	Location	Units
Water Sources- Groundwater Deep boring -28	Kamane, Chaukitole and TCN	3 each
	Karra, Huprachaur, Nagswoti	2 each
	Nayabasti, Gauritar, Smrititole, Gardoi, Raitole, Baneldhap, Hatiya, Kamane Garibi Niwaran, Kiran Chowk, Thulodamar, Kalyantar, Milan Tole and Chitrepaani	1 each
Water sources-Sump well -8	Samari	3 each
	Kukhreni	2 each
	Nayabasti, Mayurdhap, Bastipur	1 each
Water Sources- Surface Water-1	Bungadole	1 each
Water Storage Capacity		6,435 m^3
Water Treatment – Pressure Filter	Harikunja and Gauritar	1 each
Chlorine Dosing Pump		regular

Figure 17: Overhead water tank at Huprachaur.

Figure 18: Overhead water tank along with automatic chlorination unit.

To ensure the quality of the water supplied, a dedicated laboratory for water quality testing has been established and water quality is tested regularly (KII-5, 2023). The water quality report obtained from the lab shows the source water contaminated with fecal coliform as mentioned in Table 3. The water quality reports obtained from HWSMB have been attached to Appendix 2.

Table 3: Microbial contamination of drinking water in different sources in Hetauda SMC (HWSMB, 2023).

S.N	Source Location	Faecal Coliform *E.coli* (CFU/100 ml)	National Drinking Water Quality Standard, 2022-Value	Total Coliform (CFU/100 ml)	National Drinking Water Quality Standard, 2022-Value
1	Gardol	10	0	16	0 in 95 % sample
2	Rai Tole	8	0	15	0 in 95 % sample
3	Samari	12	0	16	0 in 95 % sample
4	Lamsure	10	0	20	0 in 95 % sample
5	Chaukitole	8	0	16	0 in 95 % sample
6	Huprachaur	12	0	20	0 in 95 % sample
7	Karra-1	10	0	16	0 in 95 % sample
8	Karra 2	10	0	24	0 in 95 % sample
9	Gauritar	10	0	16	0 in 95 % sample
10	Nagswoti	8	0	20	0 in 95 % sample
11	Baneldhap	10	0	16	0 in 95 % sample
12	Kamane 7	8	0	15	0 in 95 % sample
13	Nayabasti	10	0	20	0 in 95 % sample
14	Mayurdhap	12	0	16	0 in 95 % sample

15	Kamane 8 (1)	8	0	15	0 in 95 % sample
16	Kamane 8 (2)	12	0	20	0 in 95 % sample
17	Kiran Chowk	10	0	20	0 in 95 % sample

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.

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 19 demonstrates the depth of dug wells, hand pumps and tubewells and horizontal distance of it with the containment type lined pit with semi-permeable walls and open bottom. Altogether 24% of the households used lined pits with semi-permeable walls and open bottom. Among these, 15% 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 100% of these have higher potential on consuming contaminated groundwater. Thus, the population with lined pits with semipermeable walls and open bottom with significant risk to groundwater pollution is calculated as (24% x 15% x 100% = 4%).

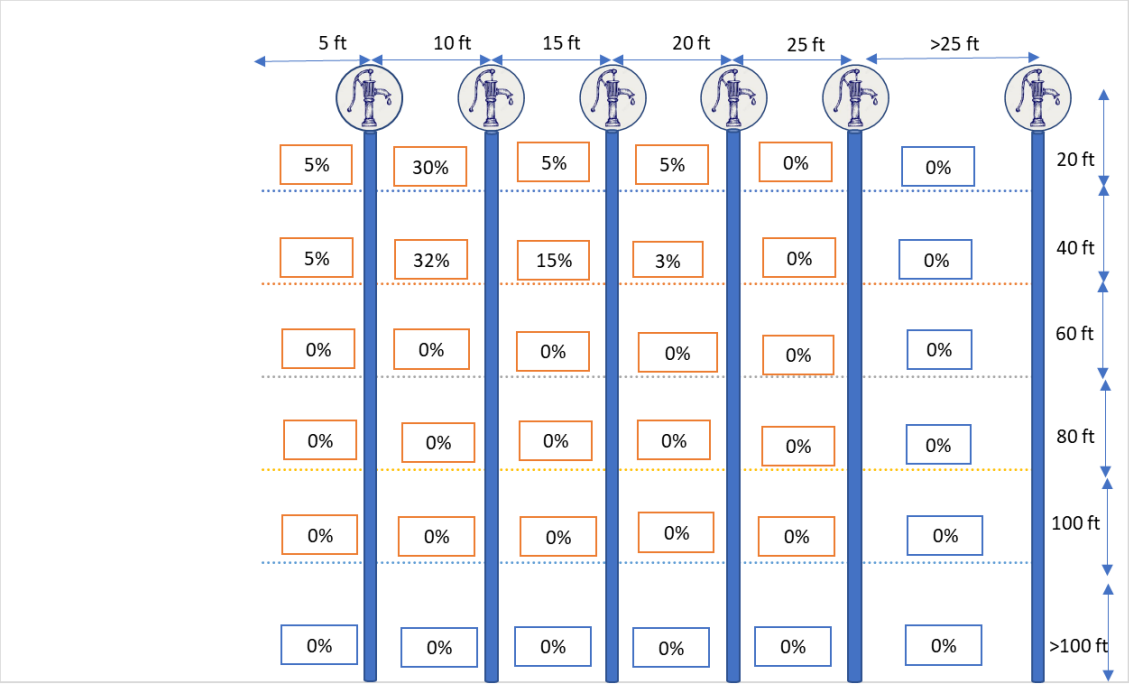


Figure 19: Depth of hand pumps and tube wells and lateral spacing of it with containment types lined pit with semi-permeable walls and open bottom.

Based on the literature review on water resources and water quality testing reports, information obtained from stakeholders and observation, the risk of the water contamination has been assumed as pointed out in Table 4.

Table 4: Containment type and potential risk for water contamination.

Containment Type	Drinking Water sources	High Risk	Low Risk
Lined pits with semipermeable wall and open bottom (No outflow/outlet)	Groundwater sources	4%	0%
	Private/Yard Tap	6%	13%
	Public/Community Tap	1%	0%
	Total	**11% (T2A5C10)**	**13% (T1A5C10)**
Lined tank with impermeable wall and open bottom (No outflow/outlet)	Groundwater sources	1%	0%
	Private/Yard Tap	4%	3%
	Total	**5% (T2A4C10)**	**3% (T1A4C10)**

2.2. SFD Matrix

2.2.1. SFD Selection Grid

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

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

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 5.

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				T1A1C4	Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					Significant risk of GW pollution T1A2C5	T1A2C6				
Fully lined tank (sealed)				T1A3C4	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	T1A4C6		T1A4C8		T2A4C10 T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										T2A6C10 Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable								T1B11 C7 TO C9	Not Applicable

Figure 20: SFD selection grid of Hetauda Sub-Metropolitan City.

Table 5: Explanation of different variables and containment technologies selected in SFD selection grid (SuSanA, 2018).

SN	Variables	Explanation
1	T1A1C4	This is a fully functioning toilet discharging directly to a correctly designed, properly constructed, fully functioning decentralised foul/separate sewer. All the excreta in this system is considered contained.
2	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.
3	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.

4	T1A3C4	This is a correctly designed, properly constructed and well maintained fully lined tank with impermeable walls and base. It includes poorly designed and/or constructed and/or maintained septic tanks that, because of these faults or deficiencies, are NOT performing as septic tanks, instead they are acting as sealed vaults. All the excreta in this system is considered contained.
5	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.
6	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.
7	T1A4C6	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 an open drain or storm sewer, the excreta in this system is considered not contained.
8	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.
9	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.
10	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.
11	T1B11 C7 TO C9	With no toilet, users defecate in water bodies, on open ground and to don't know where; consequently, the excreta is not contained.
12	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.
13	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.
14	T2A6C10	This is a correctly designed, properly constructed and well maintained unlined pit with permeable walls and base, through which infiltration can occur. Since there is a 'significant risk' of groundwater pollution, the excreta of this system are considered not contained.

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

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

This will model the contents as 100% faecal sludge and a proportion of this may be emptied periodically. The remaining not emptied fraction is made up of one or more of the following: faecal sludge which remains in the container, supernatant (when discharging to water bodies

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

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

The proportion of FS in septic tanks was set to 75%, the proportion of fully lined tanks was set 99% and lined tanks with impermeable walls and open bottom and all types of pits was set to 97% according to the relative proportions of the systems in the SMC, as per the guidance provided by SuSanA.

2.2.3. SFD matrix

The 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 Hetauda SMC.

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_3, 2023) (KII_4, 2023).

Hetauda Sub metropolitan City, Bagmati, Nepal, 1 Nov 2023. SFD Level: 2 - Intermediate SFD
Population: 193576
Proportion of tanks: septic tanks: 75%, fully lined tanks: 99%, lined, open bottom tanks: 97%

Containment										
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment	SN transport	SN treatment	SN transport	SN treatment
	Pop	W4b	W5b	F3	F4	F5	S4d	S5d	S4e	S5e
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to decentralised treatment plants	Proportion of wastewater delivered to decentralised treatment plants, which is treated	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 sewer system, which is delivered to treatment plants	Proportion of supernatant in sewer system that is 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
T1A1C4 Toilet discharges directly to a decentralised foul/separate sewer	2.0	50.0	0.0							
T1A2C5 Septic tank connected to soak pit	1.0			26.0	0.0	0.0				
T1A2C6 Septic tank connected to open drain or storm sewer	1.0			29.0	25.0	0.0			0.0	0.0
T1A3C10 Fully lined tank (sealed), no outlet or overflow	56.0			59.0	89.0	92.0				
T1A3C4 Fully lined tank (sealed) connected to a decentralised foul/separate sewer	1.0			22.0	0.0	0.0	0.0	0.0		
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	3.0			36.0	0.0	0.0				
T1A4C6 Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	2.0			25.0	0.0	0.0			0.0	0.0
T1A4C8 Lined tank with impermeable walls and open bottom, connected to open ground	2.0			23.0	0.0	0.0				
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	13.0			46.0	0.0	0.0				
T1B11 C7 TO C9 Open defecation	1.0									
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	5.0			3.0	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	11.0			10.0	0.0	0.0				
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	1.0			15.0	0.0	0.0				

Figure 21: SFD matrix of Hetauda Sub-Metropolitan City.

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

The proportion of faecal sludge emptied (F3) is calculated based on percentage containment emptied (ENPHO, 2023) and amount of FS emptied during the process (KII_3, 2023) (KII_4, 2023). In average, 87% 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 87% of the emptied containment. Hence, the proportion of FS emptied from the sanitation technology is calculated as 87% 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 percentage of biogas digester emptied. The emptied percentage of the fully lined tank no outlet or overflow mentioned in Table 6 is the sum of the emptied proportion of biogas digesters and fully lined tanks.

Table 6: Actual emptying proportion for existing containment technologies (ENPHO, 2023[(1)]; KII_3, 2023[(2)] ,KII_4, 2023[(2)]).

SN	Reference Variables	Containment technologies	Percentage of emptied containment [(1)]	Emptied proportion of FS [(2)]	Actual proportion of emptied FS (F3)
1	T1A1C4	Toilet discharges directly to a decentralised foul/separate sewer	NA	NA	NA
2	T1A2C5	Septic tank connected to soak pit	29.41%	87%	26%
3	T1A2C6	Septic tank connected to open drain or storm sewer	33.33%	87%	29%
4	T1A3C4	Fully lined tank (sealed) connected to a decentralised foul/separate sewer	25.00%	87%	22%
5	T1A3C8	Fully lined tank (sealed) connected to open ground	0.00%	87%	0%
6	T1A3C10	Fully lined tank (sealed), no outlet or overflow	67.91%	87%	59%
7	T1A4C6	Lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer	29.17%	87%	25%
8	T1A4C8	Lined tank with impermeable walls and open bottom, connected to open ground	26.23%	87%	23%
9	T1A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow	41.94%	87%	36%
10	T1A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow	53.03%	87%	46%
11	T1B11 C7 TO C9	Open defecation	NA	NA	NA
12	T2A4C10	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	4.00%	87%	3%
13	T2A5C10	Lined pit with semi-permeable walls and open bottom, no outlet or overflow,	12.00%	87%	10%

		where there is a 'significant risk' of groundwater pollution			
14	T2A6C10	Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	17.00%	87%	15%

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

34% of households in the SMC have been using the biogas digesters which have been included as a fully lined tanks (sealed) containment while preparing the SFD graphic. The cow dung has been fed into a 4 m^3, 6 m^3, and 8 m^3 capacities of digesters to mix with faecal sludge for biogas production.

The actual percentage of emptied fully lined tanks with no outlet or overflow and biogas digesters is 59% (T13C10, F3 = 59%). All the households using biogas digesters have been considered as transported to treatment plant. Among them, 89% are biogas digesters that have been used by households. Thus, it has been considered as transported to treatment plant (F4 = 89%). Thus, 92% of the households which have been using biogas digesters has been considered as treated (F5 = 92%).

25% of the emptied FS from septic tanks connected to open drains is disposed of untreated in the environment (F4 = 25% and F5 = 0%).

For the rest of the systems, all values for variables F4 and F5, have been set to 0% since all the emptied FS is disposed of untreated in the environment. Moreover, values for Supernatant (SN) from systems T1A2C6 and T1A3C4 (variables S4d, S4e, S5d and S5e) have also been all set to 0%.

2.2.5. Calculation of wastewater (WW) delivered to treatment plant and treated (Variables W4b and W5b)

2% of the households have been connected to sewer network directly. Based on the key informant interview and observation, the wastewater delivered to treatment plant has been assumed as 50% (W4b = 50%). Despite there are domestic wastewater treatment plants in 3 places, all of them are non-operational, as mentioned in section 2.1.5. Thus, the wastewater treated has been assumed as 0% (W5b = 0%).

2.3. Summary of Assumptions

Offsite sanitation Systems:

- ✓ 3% of the households depends on offsite sanitation systems as they have connected toilets directly with sewer network. Some of the households have their septic tank and fully lined tank connected to the sewer network, open drain or storm sewer (considered as an offsite sanitation system).

- ✓ Based on the key informant interview and observation, the wastewater delivered to treatment plant has been assumed as 50% (W4b = 50%). The domestic wastewater treatment plants are not functional. Thus, the wastewater treated has been assumed as 0% (W5b = 0%).

Onsite Sanitation Systems:

- ✓ The proportion of FS in septic tanks was set to 75%, the proportion of FS in fully lined tanks was set to 99% and the proportion of FS in lined tanks with impermeable walls and open bottom and all types of pits was set to 97% according to the relative proportions of the systems in the SMC, as per the guidance provided by SuSanA.
- ✓ Variables F3, F4 and F5 for all onsite sanitation systems were derived from the household survey and cross-checked with KIIs conducted.
- ✓ The SMC 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 and disposal site at Sisaughari by desludging service providers and thus, variables S4e, S5e, S5d, S5e, F4 and F5 were properly set to 0% in the SFD matrix for all sanitation systems except T1A2C6, and T1A3C10.
- ✓ FS from anaerobic biogas digesters, classified as fully lined tanks (system T1A3C10), is considered as transported and treated with a treatment efficiency estimated at 92% 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 92% (F5 = 92% for both systems).

2.4. SFD Graphic

Figure 22 represents the fate and flow of wastewater, faecal sludge and supernatant through each sanitation service chain. It shows that FS generated from 61% of the population is safely managed represented by “Green” colour arrowhead where 39% resembles the FS stored in the containment without significant risk to groundwater pollution. However, the safely managed percentage of FS generated by this 34% of the population is temporary until the FS from the containment is emptied. Therefore, these containments will require emptying services in the short and medium term as they fill up. 27% of the population have treated the FS using biogas digesters.

The FS from 39% of the population is unsafely managed, represented by “Red” arrow heads. The percentage of unsafely managed is generated from FS emptied but not delivered to treatment plant (13%), FS from containments where FS is not contained - not emptied (20%),

SN not delivered to treatment (1%), WW not delivered to treatment (1%), WW not treated (1%), FS not treated (2%) and people practising open defecation (1%).

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 23% of the population uses systems where the FS is considered not contained.

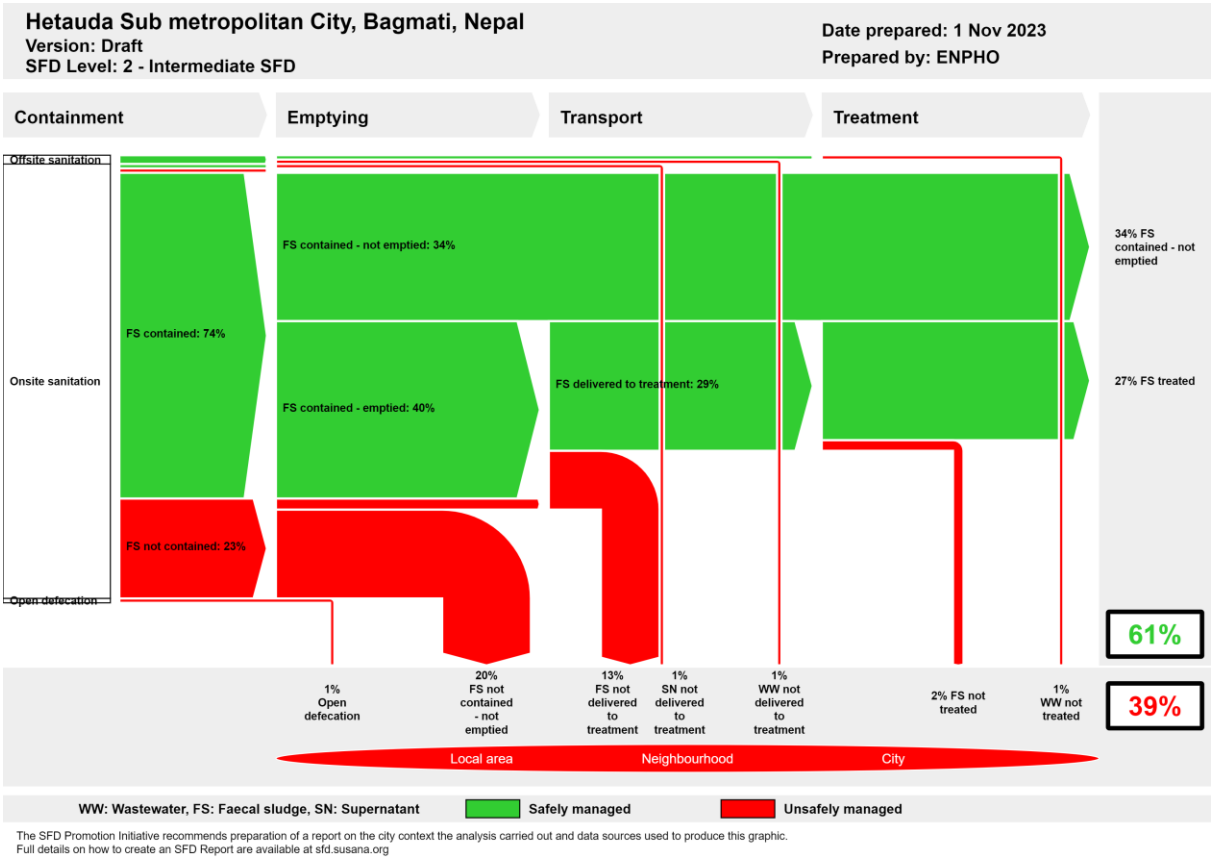


Figure 22: SFD graphic of Hetauda Sub-Metropolitan City.

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 soak pit (T1A2C5), fully lined tanks (sealed) connected to a decentralised foul/separate sewer (T1A3C4), 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 tanks connected to open drain or storm sewer (T1A2C6), fully lined tanks (sealed) connected to open ground (T1A3C8), lined tank with impermeable walls and open bottom, connected to an open drain or storm sewer (T1A4C6), 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), lined pits with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A5C10) and unlined pits, no outlet or overflow, where there is a 'significant risk' of groundwater pollution (T2A6C10). Thus, the FS generated by 23% of the population is considered not contained.

FS contained - emptied

The proportion of FS contained - emptied (40%) is FS that is contained in onsite sanitation technologies and emptied either mechanically or manually. The proportion of FS contained - emptied is the summation of the proportion of FS emptied from septic tanks connected to soak pit (T1A2C5), fully lined tanks (sealed) connected to a decentralised foul/separate sewer (T1A3C4), 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).

FS not contained - emptied

The proportion of FS not contained - emptied (2%) is FS that is not contained in onsite sanitation technologies and emptied either mechanically or manually.

FS not delivered to treatment

The SMC does not have treatment facility to treat faecal sludge. So, all the FS emptied from contained and not contained containments is disposed of into farmlands and disposal site. The proportion of FS not delivered to treatment (13%) is the summation of FS contained - emptied and FS not contained - emptied and not treated.

SN not delivered to treatment

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

FS treated

The proportion of FS obtained from containment which has been transported to treatment and treated is 27%. It is the FS treated using the biogas digesters.

Open Defecation

Hetauda was declared as an open defecation free municipality in 2011. However, the household survey reveals that 1% of the households have no toilet and practise open defecation and using the toilet of the neighbours.

3. Service Delivery Context

3.1. Policy, Legislation and Regulation

The constitution of Nepal 2015 has established right to access to clean drinking water and citizen as fundamental right. In Article 35 (4) related to right to health recognizes citizen's rights to access to clean drinking water and sanitation. In addition, Right to Clean Environment, Article 30 (1) recognizes that every person shall have the right to live in a healthy and clean environment (GoN, 2015). To respect and promote the right of citizens to wards accessing clean drinking water and sanitation services, the government has promulgated and amended necessary laws. The most relevant legislation for promotion of safe sanitation services is discussed here.

Local Government Operation Act, 2017

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

Environment Protection Act, 2019

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

Water Supply and Sanitation Act, 2022

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

Environment Friendly Local Governance Framework 2013

The environment-friendly local governance framework 2013 has been issued to add value to environment-friendly local development concept encouraging environmental protection through local bodies. The framework has set basic and advanced indicators for households, settlement, ward, village, municipality, and district levels for declaration of environment friendly.

The use of water sealed toilets in households as basic indicators for sanitation and health. Provision of toilet with safety tank and use as advanced indicators for sanitation. Provision of gender, children and disabled friendly public toilets in parks, petrol pumps and main market as basic indicator for municipal level. Advance indicators such as drainage discharged only after being processed through biological or engineering technique. While it has failed to identify the necessity of faecal sludge treatment plants as it has assumed safety tank in the households is sufficient for treating faecal sludge.

Institutional and Regulatory Framework for Faecal Sludge Management, 2017

Ministry of Water Supply through its Department of Water Supply and Sewerage Management (DWSSM) articulated and endorsed Institutional and Regulatory Framework (IRF) for Faecal Sludge Management in Urban Areas of Nepal in 2017. The main objective of the IRF is to define the specific roles and responsibilities of key institutions for the effective management and regulation of Faecal Sludge Management (FSM). The framework primarily envisioned featuring FSM in the national policy and issuing policy directives into local government to incorporate FSM in their urban planning along with strengthening and enhancing the capacity of the local government to deliver effective services. A local government has been endowed with overall responsibility to plan, implement, and regulate the FSM services within its jurisdiction. The provision of the ability to engage the private sector and other relevant stakeholders such as the Water Users and Sanitation Committee (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.

Hetauda municipal council has approved the Environment and Natural Resource Protection Act, 2020. This legislation prohibits individuals or organizations from causing pollution that deviates from established standards in a way that could have a significant negative impact on public life, human health, and the environment (Hetauda Sub-Metropolitan City, 2020).

Hetauda Sub-Metropolitan City has endorsed Sanitation Management Procedure, 2023 to ensure the right to live in clean and healthy environment. This involves the efficient coordination of local government, private sector, civil society, and Tole Development Organizations to establish a sustainable and institutionalized sanitation program, facilitating the successful execution of the *Clean Hetauda and Healthy Hetauda Campaign*(Hetauda Sub-Metropolitan City, 2023). The procedure has included following provision:

a. Every residence in SMC is obligated to build a septic tank, with toilets required to be linked to these tanks. The construction of septic tanks must be guaranteed when issuing building permit certificates.

b. Household greywater originating from kitchens and laundry facilities is to be controlled on-site by constructing a holding tank, and after appropriate treatment, it should be connected to the public drainage system.

c. The sorting of waste into biodegradable and non-biodegradable categories is mandated.

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 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.

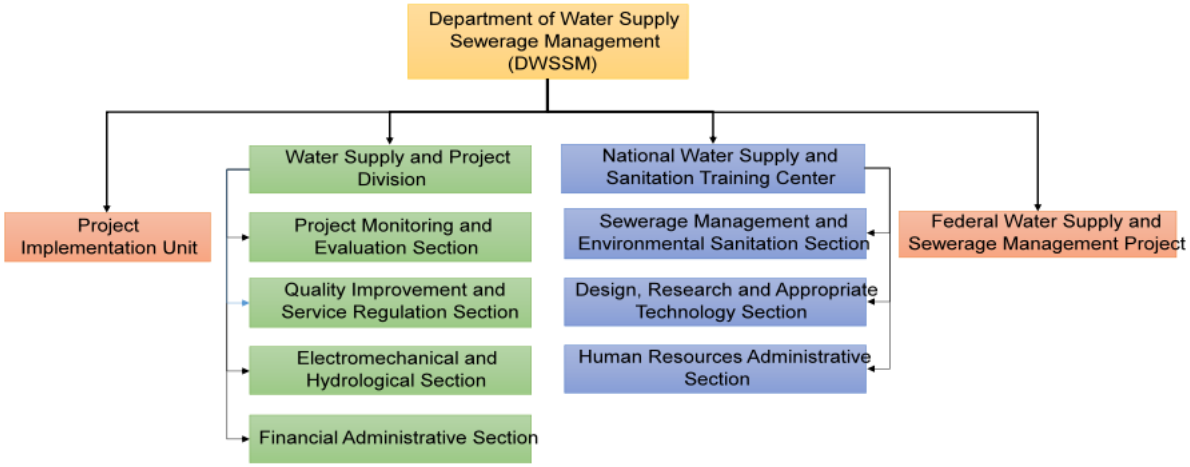


Figure 23: Organizational Structure Department of Water Supply and Sewerage Management.

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

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

At Local Government

Municipal council: The SMC consists of 8 major divisions such as General Administration, Urban Infrastructure Development, Social Development, Economic Development, Planning, Budget, Information and Statistics, Economic Administration Division, Education Development, Women and Child Development Division. The Disaster Response, Waste Management and Environment Section under Social Development Division oversee the overall sanitation related activities including FS desludging. Figure 24 shows the organizational structure of the Hetauda SMC.

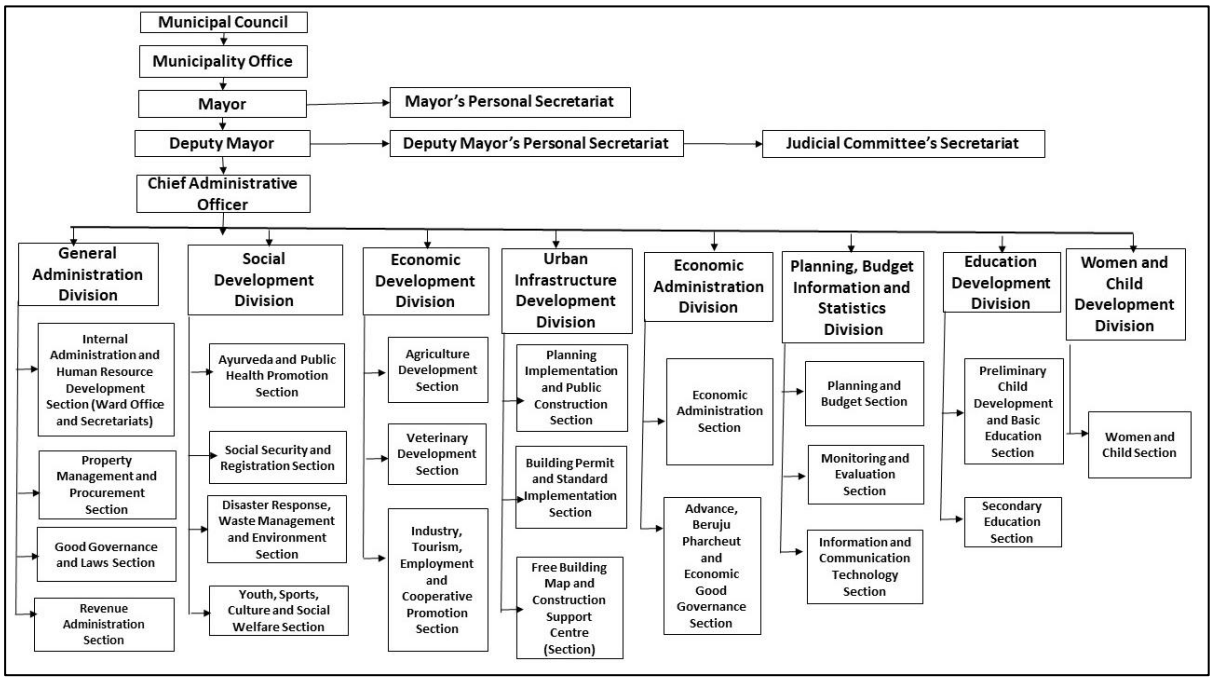


Figure 24: Organizational Structure of Hetauda Sub-Metropolitan City.

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 SMC has entered into contracts with private sector Green and Clean City Services Pvt Ltd and also involved in FS desludging services. Besides, SMC is also providing the FS emptying and transport services.

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 7. However, FSM specific standards have yet to be developed and implemented.

Table 7: Sanitation Service Level and its Components.

S.N.	Service Components	Service Level		
		High	Medium	Basic
1	Health and Hygiene Education	✓	✓	✓
2	Household Latrine	✓	✓	✓
3	Public and School Toilets	✓	✓	✓
4	Septic tank sludge collection, transport, treatment, and disposal	✓	✓	✓
5	Surface drains for collection, transmission, and disposal of grey water	✓	✓	✓
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. The purpose of key informant interviews is to collect information from a wide range of people who have first-hand knowledge about the concerned topic. KIIs were conducted with environment and sanitation related stakeholders. The KIIs were conducted with municipal officials, local elected bodies, water supply service provider, and public toilet service provider. The face-to-face interview was conducted and called after the interview to get more required information. The information was collected with key stakeholders about the status of sanitation services and water supply schemes. List of key informant stakeholders from the municipalities along with their organization and purpose are as shown in Table 8 and Figure 25.

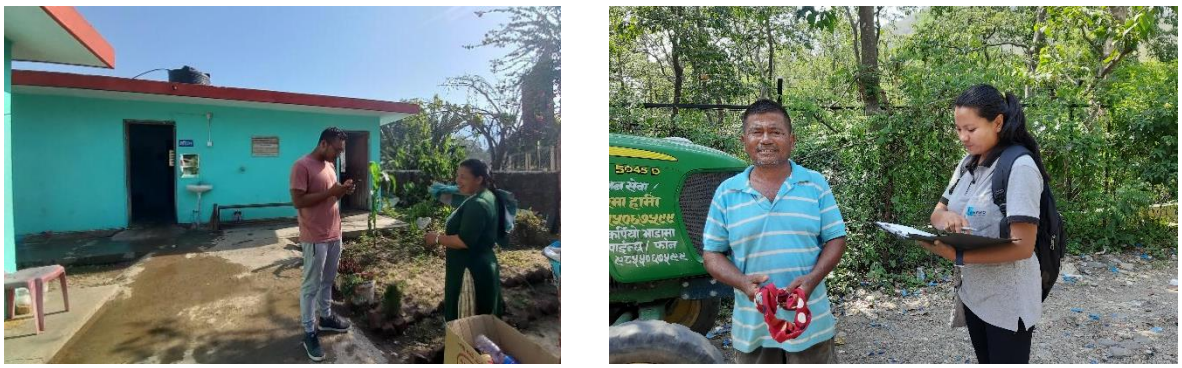


Figure 25: Key informant interview with public toilets operator and desludging service providers.

Table 8: List of Key Informant Interviewed personnel.

KII code	Name	Designation	Organization	Purpose	Date
KII-1	Jaganath Sapkota	Section Officer	Hetauda Sub-Metropolitan City	Sanitation Status and wastewater treatment plant of Hetauda Sub-Metropolitan City	29 May,2023
KII-2	Chanda Khadka	Environment Engineer	Hetauda Sub-Metropolitan City	Sanitation Status of Hetauda Sub-Metropolitan City	31 May,2023
KII-3	Gokarna BK	Desludging service provider	Hetauda Sub-Metropolitan City	Faecal sludge desluding service	29 May,2023
KII-4	Gopal Lama	Desludging service provider	Private Sector Green and Clean City Services Pvt Ltd	Faecal sludge desluding service	29 May,2023
KII-5	Sanjaya Kumar Neupane	Information Officer	Hetauda Water Supply Management Board	Water supply, coverage, treatment, water quality	31 May,2023
KII-6	Ashok Kumar Yadav	Engineer	Hetauda Industrial District Wastewater Treatment Plant	Industrial Wastewater treatment plant	29 May,2023
KII-7	Sandesh Lama	Public Toilet Operator	Public Toilet Operator	Status of public toilet	1 June ,2023
KII-8	Debaki Pariyar	Public Toilet Operator	Public Toilet Operator	Status of public toilet	1 June ,2023
KII-9	Mohan Prasad Parajuli	Biogas service provider	PS Energy Power Pvt. Ltd.	Status of Biogas digester	1 June ,2023
KII-10	Subodh Rimal	Biogas service provider	Hetauda Gobargas Company Pvt Ltd.	Status of Biogas digester	1 June ,2023

4.2. Household Survey

In each ward of the Hetauda SMC, a random household survey was conducted. The two-day orientation workshop was provided to local enumerators chosen by SMC 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 3. The data were collected using the *KoboCollect* application.

Determining Sample Size

The sample size for the household survey in Hetauda Sub-Metropolitan City 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 SMC)

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

Thus 1,043 households were sampled from 46,566 households distributed in 19 wards were sampled using proportionate stratification random sampling. The number of ward wise sample size has been attached in Appendix 4. The distribution of sampling points in the SMC is shown in Figure 26.

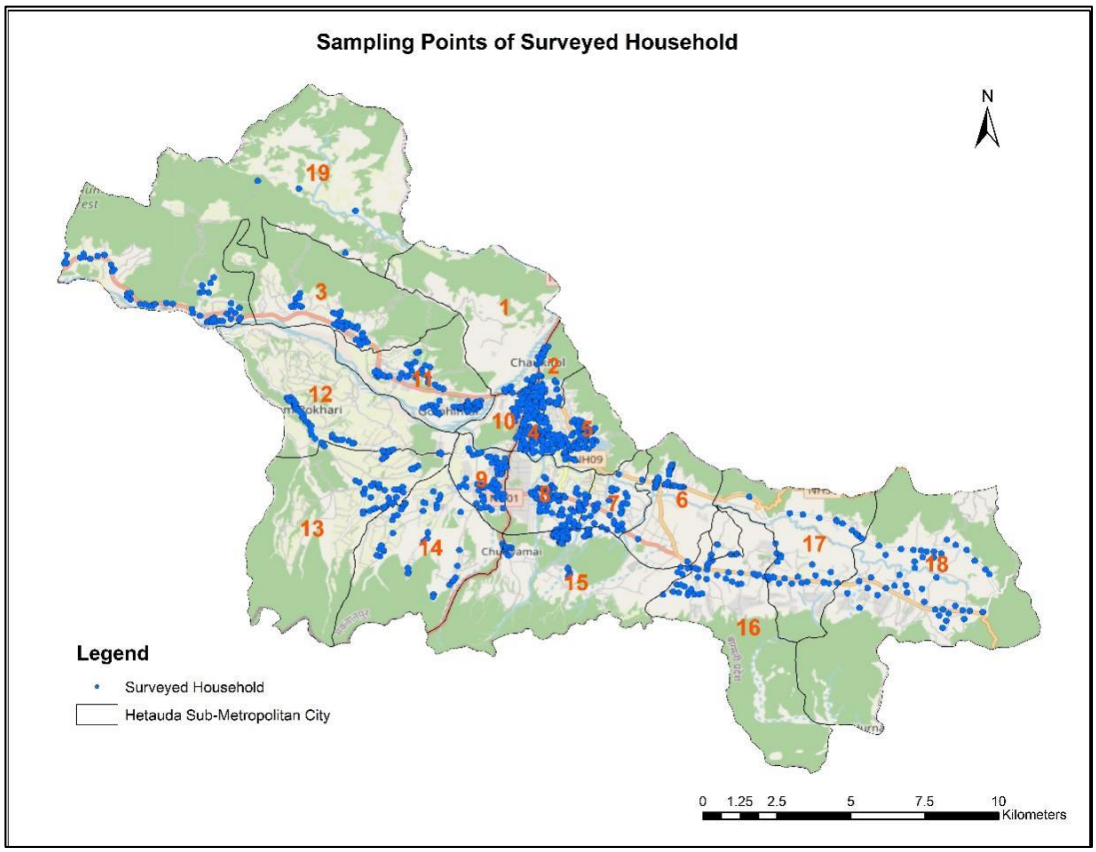


Figure 26: Distribution of sampling points in all wards of Hetauda Sub-Metropolitan City.

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

Figure 27: Field observation and monitoring the households survey.

4.4. Sharing and Validation of Data

On 5 January, 2024, a SFD Sharing and validation workshop was organized at Hetauda SMC hall. The results of SFD survey in SMC were presented to Mayor, Deputy Mayor, Chief Administrative Officer (CAO), ward chairpersons, section officers and other relevant stakeholders. In the workshop, the results including sanitation status, containment types, emptying, transport, treatment and re-use or disposal practice of faecal sludge in the SMC were presented and discussed. Altogether, 49 participants including the Deputy Mayor, CAO, ward chairpersons, other members from municipal executive council, sectoral staffs etc. actively participated on the workshop and provided the valuable suggestions. Ms. Mina Kumari Lama, Mayor expressed the appreciation for conducting the study and concurred with the presented findings. She underscored the importance of prioritizing sanitation issues within the SMC.The meeting minute of the validation workshop is attached in Appendix 5.

Figure 28: Sharing and validating the SFD of Hetauda Sub-Metropolitan City.

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 Hetauda Sub-Metropolitan City.

We offer our sincere gratitude to Ms. Mina Kumari Lama, Mayor, Mr. Rajesh Baniya, Deputy Mayor, Shibraj Chaulagain, Chief Administrative Officer, Mr. Bhanubhakta Thapaliya, Information and Communication Officer, Mr. Jaganath Sapkota, Section Officer, Ms. Chanda Khadka, Environment Engineer, Mr. Gokarna B.K, desludging service provider and entire staffs of Hetauda Sub-Metropolitan City for their remarkable support during the study.

We are very much grateful to Mr. Sanjaya Kumar Neupane and Mr. Atul Bhandari, Hetauda Water Supply Management Board, Mr. Gopal Lama, desludging service provider, Green and Clean City Services Pvt. Ltd., and public toilet operator for providing valuable information.

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

We are very much grateful to Ms. Bhawana Sharma, Executive Director 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.

We are grateful towards the enumerators Ms. Arati Thing, Ms. Bimala Lamichhane, Ms. Binita Dhakal, Ms. Goma Sapkota, Ms. Jharana Sharma Bidari, Ms. Kalpana Lamichhane, Ms. Kalpana Thapa, Ms. Manju Acharya, Ms. Rachana Manandhar, Ms. Radhika Timalsina, Ms. Smita Dahal, Ms. Sunita Adhikari, Ms. Sunita Gautam for their support during the survey.

6. References

AEPC. (2011). *District Climate and Energy plan, Coordination Committee, Makawanpur.* Alternative Energy Promotion Centre.

AEPC. (2019). *List of Competent Domestic Biogas Construction/Installer Companies for the FY 2075/76*. Retrieved from https://www.aepc.gov.np/public/uploads/files/List%20of%20Competent%20Domestic%20Biogas.pdf

Andreo, S. F. (2013). The aquifer pollution vulnerability concept: aid or impediment in promoting groundwater protection? *Hydrogeology Journal*.

Climate Data. (n.d.). *Climate of Hetauda*. Retrieved from climate data.org: https://en.climate-data.org/asia/nepal

DWSSM. (2004). *National Rural Water Supply and Sanitation Sector Policy. Kathamndu, Nepal.* Department of Water Supply and Sewarage Management, Ministry of Water Supply, Goverment of Nepal.

DWSSM. (2009). *National Urban Water Supply and Sanitation Sector Policy.* Kathmandu, Nepal: Department of Water Supply and Sewerage Management, Ministry of Water Supply, Government of Nepal.

Elizabeth Tilley, L. U. (2014). *Compendium of Sanitation Systems and Technology.* (Vol. 2nd Revised Edition). Dübendorf, Switzerland.: Swiss Federal Institute of Aquatic Science and Technology (Eawag).

ENPHO. (2023). *Assessment of Sanitation Status of Hetauda Sub-Metropolitan City.*

FAO. (n.d.). Retrieved from Soil permeablity: https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e09.htm

GoN. (2015, September 30). *Constitution of Nepal: Goverment of Nepal*. Retrieved from https://lawcommission.gov.np/en/wp-content/uploads/2021/01/Constitution-of-Nepal.pdf

Hetauda SMC. (2017). *City Profile of Hetauda Sub-Metropolitan City,.*

Hetauda Sub-Metropolitan City. (2020). *Environment and Natural Resource Protection Act.*

Hetauda Sub-Metropolitan City. (2023). *Sanitation Management Procedure.* Hetauda Sub-Metropolitan City.

HWSMB. (2023). *Introduction and Present Situation of Hetauda Water Supply Management Board*. Retrieved from https://hwsmboard.org.np/

HWSMB. (2023). *Water Quality Testing Report, Hetauda Water Supply Management Board; unpublised data.*

KII_1. (2023). Sanitation Status in Hetauda Sub-Metropolitan City.

KII_10. (2023). Status of Biogas Digester in Hetauda Sub-Metropolitan City .

KII_2. (2023). Status of Sanitation in Hetauda Sub-Metropolitan City.

KII_3. (2023). Status of Faecal Sludge Emptying and Transport Services in Hetauda Sub-Metropolitan City.

KII_4. (2023). Status of Faecal Sludge Emptying and Transport Services in Hetauda Sub-Metropolitan City.

KII-5. (2023). Status of Water Supply Coverage, Treatment and Quality in Hetauda Sub-Metropolitan City.

KII-6. (2023). Status of Hetauda Industrial District Wastewater Treatment Plant .

KII-7. (2023). Status of Public Toilets in Hetauda Sub-Metropolitan City.

KII-8. (2023). Status of Public Toilets in Hetauda Sub-Metropolitan City.

KII-9. (2023). Status of Biogas Digester in Hetauda Sub-Metropolitan City .

Krishnan, S. (2011). *On-site Sanitation and Groundwater Contamination: A Policy and Technical Review.* Anand: INREM Foundation.

Linda Strande, M. R. (2014). *Faecal Sludge Management Systems Approach for Implementation and Operation.* London: IWA Publishing.

MoF. (2015). *Public-Private Partnership Policy.* Kathmandu: Ministry of Finance, Goverment of Nepal.

MoPIT. (2009). *National Urban Water Supply and Sanitation Sector Policy. In: s.l.:Ministry of Physical Infrastructure and Transport.*

MoWS. (2017a). *Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal.* Kathmandu,Nepal: Ministry of Water Supply.

MoWS. (2020). *Open Defecation Free Nepal; Narration of the Journey.* Department of Water Supply and Sewerage Management, Ministry of Water Supply.

MoWS. (2022a). *Drinking Water and Sanitation Act.* Ministry of Water Supply; Goverment of Nepal.

MoWS. (2022b). *National Drinking Water Quality Standard.* Ministry of Water Supply, Goverment of Nepal.

MoWS. (2023). *National Water, Sanitation and Hygiene Policy.* Ministry of Water Supply.

NPC. (2017). *Nepal Sustainable Development Goals, Status and Roadmap: 2016-2030.* National Planning Commission.

NSO. (2023). *National Population and Housing Census 2021.* National Statistics Office.

Patricia J. Vittum. (2009). *Encyclopedia of Insects (Second Edition), Soil Habitats.*

Shah Teli, S. K. (2017). Performance Evaluation of Central Wastewater Treatment Plant: a Case Study of Hetauda Industrial District, Nepal. . *Environment and Natural Resources Journal, 6(2). Retrieved from https://ph02.tci-thaijo.org/index.php/ennrj/article/view/83832*.

Strande et. al. (2014). Faecal Sludge Management Systems Approach for Implementation and Operation. In M. R. Linda Strande. London: IWA Publishing.

SuSanA. (2018). *Shit Flow Diagram Manual; Volume 1 and 2;SFD promotion initiatives.* www.susana.org.

UNGA. (2010). *Human Right to Water and Sanitation*. Retrieved from United Nations General Assembly.

Water Online. (2015). Retrieved from https://www.wateronline.com/doc/introducing-home-biogas-reactors-0001

Weather and Climate. (n.d.). *Weather and Climate data of Hetauda*. Retrieved from https://weatherandclimate.com/nepal

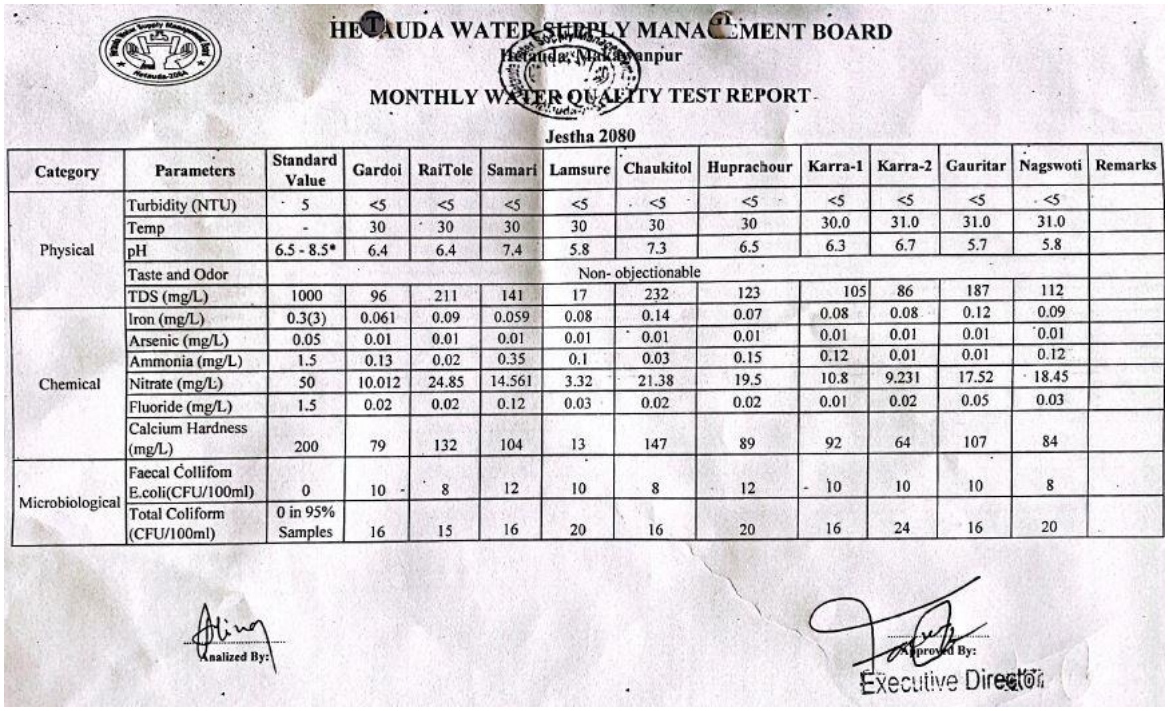
WHO. (2018). *Guidelines on Sanitation and Health, Geneva, Licence: CC BY-NC-SA 3.0 IGO.* Geneva.

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

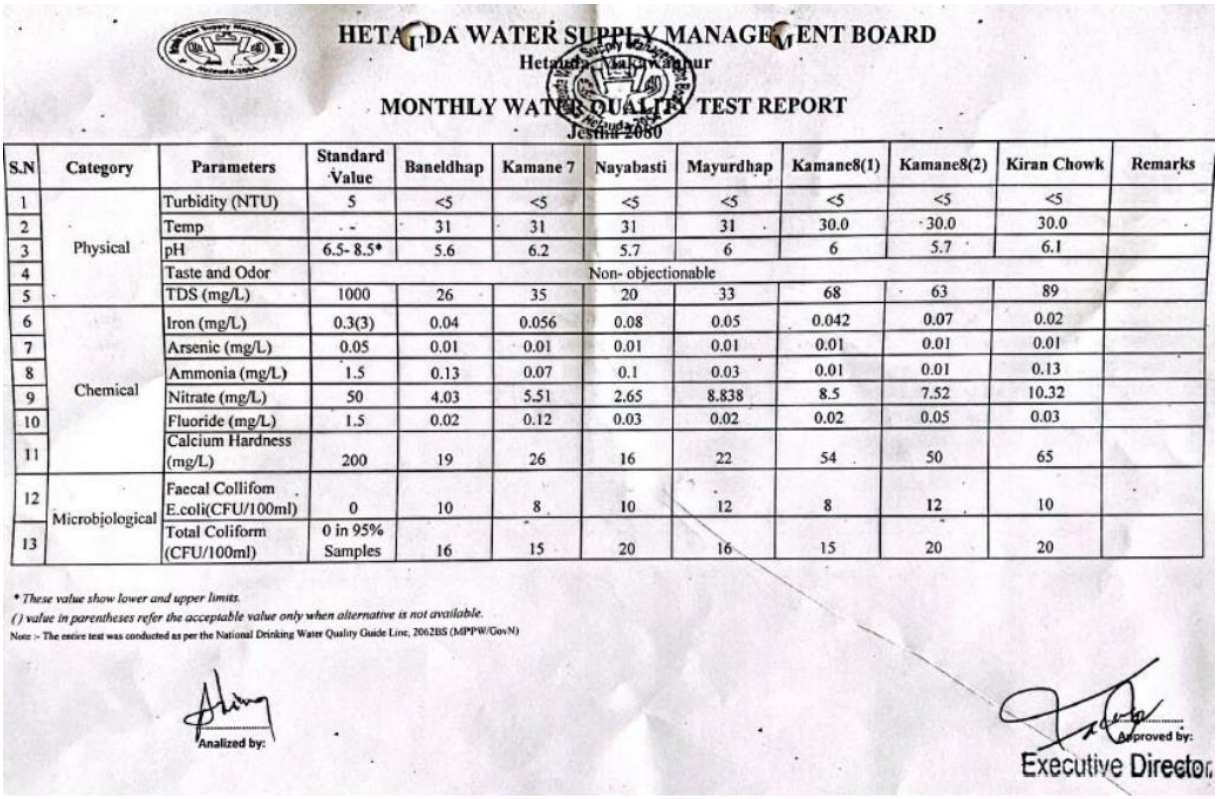
7.2. Appendix 2. Water quality testing report



HETAUDA WATER SUPPLY MANAGEMENT BOARD
Hetauda, Makwanpur
MONTHLY WATER QUALITY TEST REPORT
Jestha 2080

Category	Parameters	Standard Value	Gardoi	RaiTole	Samari	Lamsure	Chaukitol	Huprachour	Karra-1	Karra-2	Gauritar	Nagswoti	Remarks
Physical	Turbidity (NTU)	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
	Temp	-	30	30	30	30	30	30	30.0	31.0	31.0	31.0	
	pH	6.5 - 8.5*	6.4	6.4	7.4	5.8	7.3	6.5	6.3	6.7	5.7	5.8	
	Taste and Odor	Non- objectionable											
	TDS (mg/L)	1000	96	211	141	17	232	123	105	86	187	112	
Chemical	Iron (mg/L)	0.3(3)	0.061	0.09	0.059	0.08	0.14	0.07	0.08	0.08	0.12	0.09	
	Arsenic (mg/L)	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
	Ammonia (mg/L)	1.5	0.13	0.02	0.35	0.1	0.03	0.15	0.12	0.01	0.01	0.12	
	Nitrate (mg/L)	50	10.012	24.85	14.561	3.32	21.38	19.5	10.8	9.231	17.52	18.45	
	Fluoride (mg/L)	1.5	0.02	0.02	0.12	0.03	0.02	0.02	0.01	0.02	0.05	0.03	
	Calcium Hardness (mg/L)	200	79	132	104	13	147	89	92	64	107	84	
Microbiological	Faecal Collifom E.coli(CFU/100ml)	0	10	8	12	10	8	12	10	10	10	8	
	Total Coliform (CFU/100ml)	0 in 95% Samples	16	15	16	20	16	20	16	24	16	20	

Analized By:
Approved By:
Executive Director



HETAUDA WATER SUPPLY MANAGEMENT BOARD

Hetauda Lalitpur

MONTHLY WATER QUALITY TEST REPORT

Jestha 2080

S.N	Category	Parameters	Standard Value	Baneldhap	Kamane 7	Nayabasti	Mayurdhap	Kamane8(1)	Kamane8(2)	Kiran Chowk	Remarks
1	Physical	Turbidity (NTU)	5	<5	<5	<5	<5	<5	<5	<5	
2		Temp	- -	31	31	31	31	30.0	30.0	30.0	
3		pH	6.5- 8.5*	5.6	6.2	5.7	6	6	5.7	6.1	
4		Taste and Odor	Non- objectionable								
5		TDS (mg/L)	1000	26	35	20	33	68	63	89	
6	Chemical	Iron (mg/L)	0.3(3)	0.04	0.056	0.08	0.05	0.042	0.07	0.02	
7		Arsenic (mg/L)	0.05	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
8		Ammonia (mg/L)	1.5	0.13	0.07	0.1	0.03	0.01	0.01	0.13	
9		Nitrate (mg/L)	50	4.03	5.51	2.65	8.838	8.5	7.52	10.32	
10		Fluoride (mg/L)	1.5	0.02	0.12	0.03	0.02	0.02	0.05	0.03	
11		Calcium Hardness (mg/L)	200	19	26	16	22	54	50	65	
12	Microbiological	Faecal Collifom E.coli(CFU/100ml)	0	10	8	10	12	8	12	10	
13		Total Coliform (CFU/100ml)	0 in 95% Samples	16	15	20	16	15	20	20	

** These value show lower and upper limits.*

( ) value in parentheses refer the acceptable value only when alternative is not available.

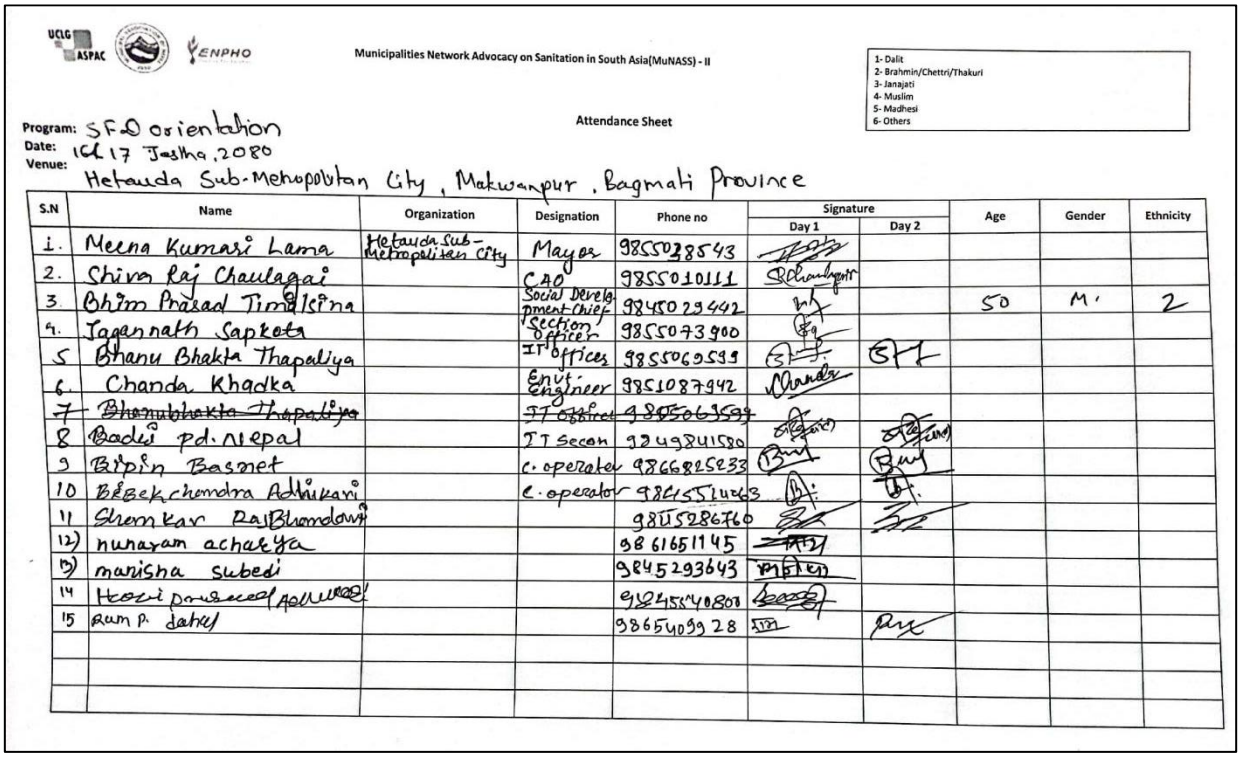
Note :- The entire test was conducted as per the National Drinking Water Quality Guide Line, 2062BS (MPPW/GovN)

Analized by:

Approved by:

Executive Director

7.3. Appendix 3: List of participants of SFD orientation



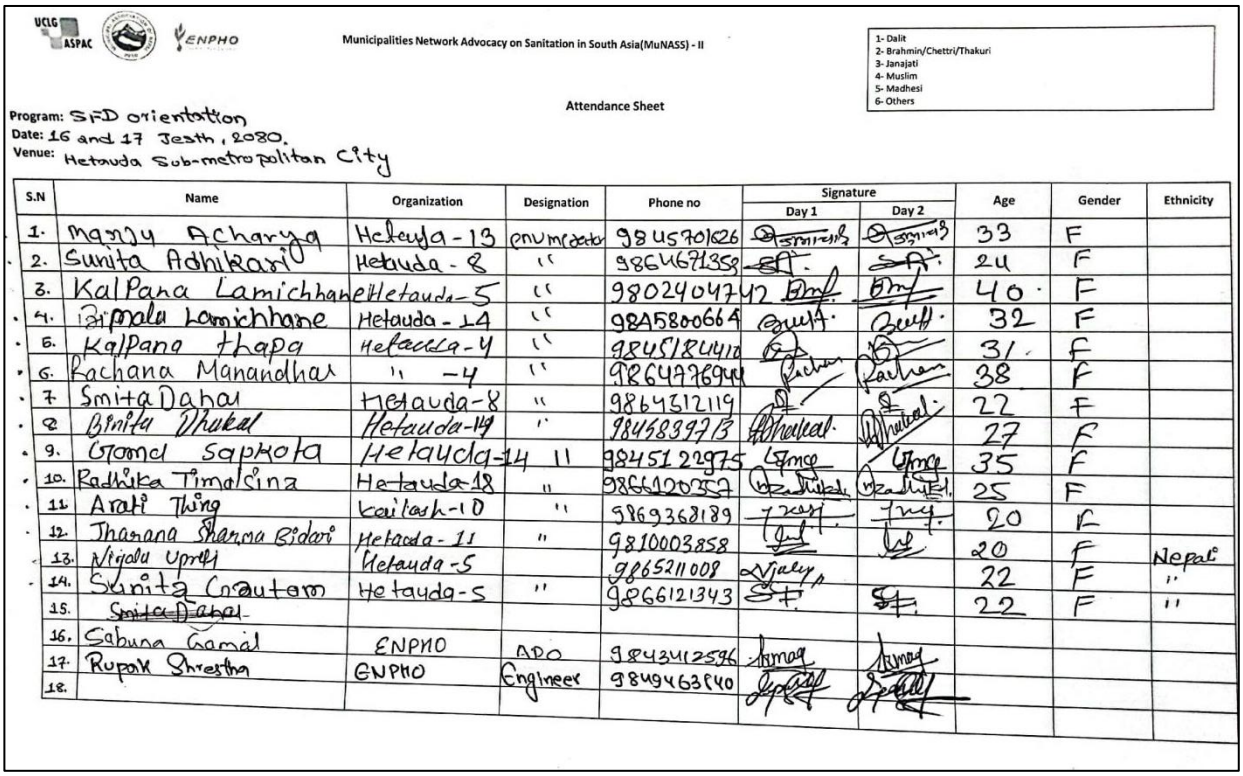
Municipalities Network Advocacy on Sanitation in South Asia(MuNASS) - II

Attendance Sheet

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

Program: SFD orientation
Date: 16 17 Jestha, 2080
Venue: Hetauda Sub-Metropolitan City, Makwanpur, Bagmati Province

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Age	Gender	Ethnicity
1.	Meena Kumari Lama	Hetauda Sub-Metropolitan City	Mayor	9855038543					
2.	Shiva Raj Chaulagai		CAO	9855010111					
3	Bhim Prasad Timilsina		Social Development Chief	9845029442			50	M.	2
4.	Jagannath Sapkota		Section Officer	9855073900					
5	Bhanu Bhakta Thapaliya		IT Officer	9855069599					
6.	Chanda Khadka		Envt. Engineer	9851087942					
7	~~Bhanubhakta Thapaliya~~		~~IT Officer~~	~~9855069599~~					
8	Badri pd. Nepal		IT Secon	9849841580					
9	Bipin Basnet		C. operator	9866825833					
10	Bibek Chandra Adhikari		C. operator	9841552463					
11	Shreekar RajBhandari			9855286760					
12)	nuraram acharya			9861651145					
13)	manisha subedi			9845293643					
14	Hari poudel (ADWASH)			9845540801					
15	Ram P. Dahal			9865409928					



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

Attendance Sheet

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

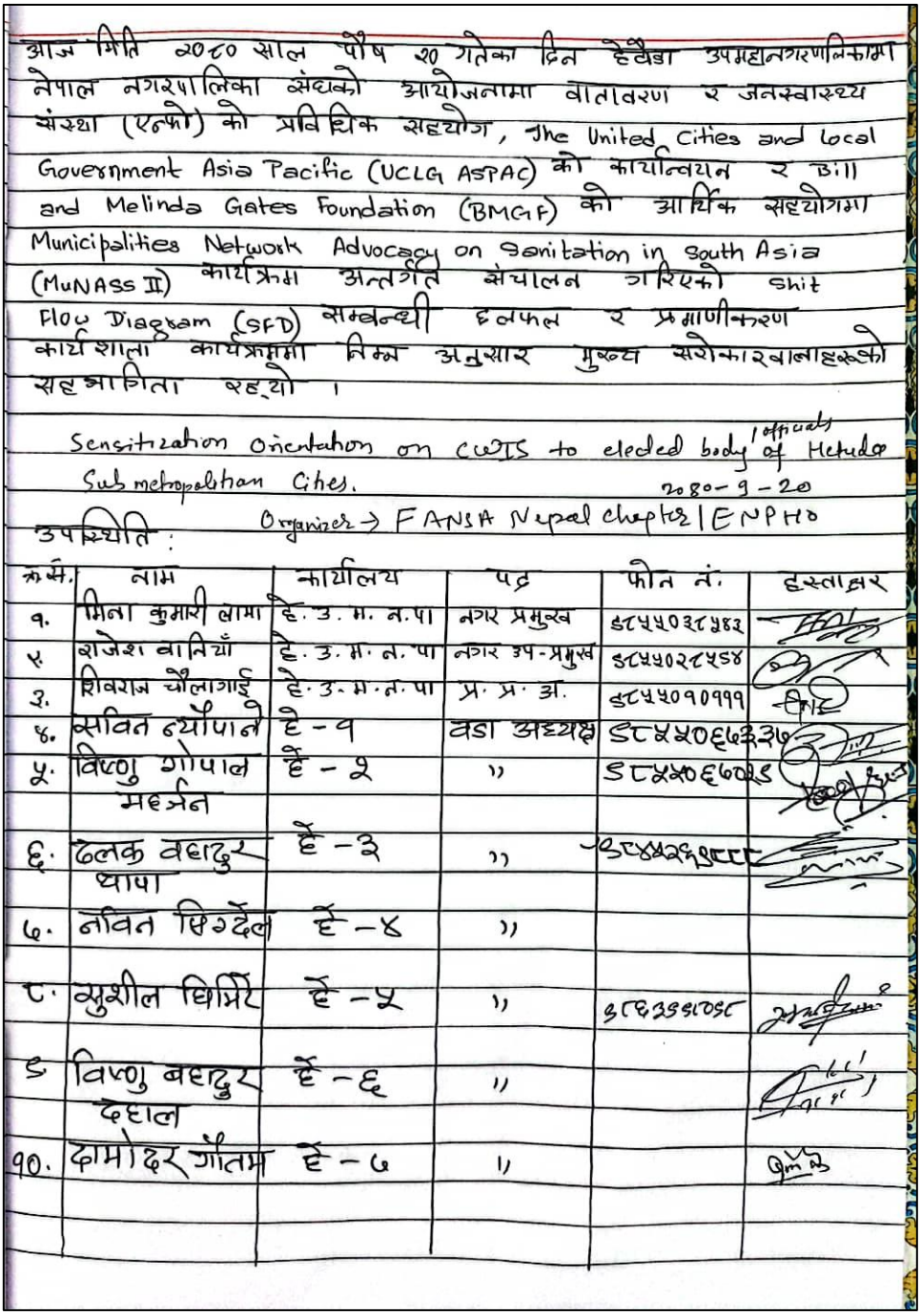
Program: SFD orientation
Date: 16 and 17 Jestha, 2080.
Venue: Hetauda Sub-metropolitan City

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Age	Gender	Ethnicity
1.	Manju Acharya	Hetauda-13	ENUMerator	9845701626			33	F	
2.	Sunita Adhikari	Hetauda-8	"	9864671358			24	F	
3.	Kalpana Lamichhane	Hetauda-5	"	9802404742			40	F	
4.	Bipana Lamichhane	Hetauda-14	"	9845800664			32	F	
5.	Kalpana Thapa	Hetauda-4	"	9845184410			31	F	
6.	Rachana Manandhar	" -4	"	9864976941			38	F	
7.	Smita Dahal	Hetauda-8	"	9864312119			22	F	
8	Binita Dhakal	Hetauda-14	"	9845839713			27	F	
9.	Uma Sapkota	Hetauda-14	"	9845122975			35	F	
10.	Radhika Timilsina	Hetauda-13	"	9866120357			25	F	
11	Arati Thing	Kailash-10	"	9869368189			20	F	
12.	Thanana Sharma Bidari	Hetauda-11	"	9810003858			20	F	Nepali
13.	Nijala Upreti	Hetauda-5		9865211008			22	F	"
14.	Sunita Gautam	Hetauda-5	"	9866121343			22	F	"
15.	~~Smita Dahal~~								
16.	Sabina Kamal	ENPHO	ADO	9843412596					
17.	Rupak Shrestha	ENPHO	Engineer	9849463840					
18.									

7.4. Appendix 4: Ward wise sample size distribution in Hetauda Sub-Metropolitan City

Wards	Population	Households	Proportion (%)	Required Sample
1	8,266	1,839	4	41
2	8,925	2,291	5	51
3	8,367	1,951	4	44
4	18,035	4,630	10	103
5	17,349	4,202	9	94
6	7,034	1,685	4	38
7	6,032	1,438	3	32
8	13,008	3,289	7	74
9	11,346	2,892	6	65
10	6,997	1,799	4	40
11	14,094	3,423	7	77
12	13,028	2,950	6	66
13	7,949	1,854	4	42
14	7,956	1,790	4	40
15	10,623	2,483	5	56
16	7,145	1,666	4	37
17	8,386	1,882	4	42
18	7,836	1,921	4	43
19	11,200	2,581	6	58
	193,576	**46,566**		**1,043**

7.5. Appendix 5: List of participants present in sharing and validation meeting



आज मिति २०८० साल पौष ३० गतेका दिन हेटौंडा उपमहानगरपालिकामा नेपाल नगरपालिका संघको आयोजनामा वातावरण र जनस्वास्थ्य संस्था (एन्फो) को प्राविधिक सहयोग, The United Cities and Local Government Asia Pacific (UCLG ASPAC) को कार्यान्वयन र Bill and Melinda Gates Foundation (BMGF) को आर्थिक सहयोगमा Municipalities Network Advocacy on Sanitation in South Asia (MuNASS II) कार्यक्रम अन्तर्गत संचालन गरिएको Shit Flow Diagram (SFD) सम्बन्धी दलफल र प्रमाणीकरण कार्यशाला कार्यक्रममा निम्न अनुसार मुख्य सरोकारवालाहरुको सहभागिता रहेको ।

Sensitization Orientation on CWIS to elected body/officials of Hetauda Sub metropolitan Cities.

2080-9-20

Organizer → FANSA Nepal Chapter | ENPHO

उपस्थिति :

क्र.सं.	नाम	कार्यालय	पद	फोन नं.	हस्ताक्षर
१.	मिना कुमारी लामा	हे.उ.म.न.पा	नगर प्रमुख	९८५५०३८५४२	
२.	राजेश वानियाँ	हे.उ.म.न.पा	नगर उप-प्रमुख	९८५५०२८५९४	
३.	शिवराज चौलागाई	हे.उ.म.न.पा	प्र.प्र.अ.	९८५५०१०१११	
४.	सविन थापा	हे-१	वडा अध्यक्ष	९८५५०६७३३७	
५.	विष्णु गोपाल मल्ल	हे-२	"	९८५५०६७०२९	
६.	दिलक बहादुर थापा	हे-३	"	९८४५२६१८८८	
७.	नविन सिग्देल	हे-४	"		
८.	सुशील घिमिरे	हे-५	"	९८६३५९०७८	
९	विष्णु बहादुर दहाल	हे-६	"		
१०.	दामोदर गौतम	हे-७	"		

क्र.सं.	नाम	कार्यालय	पद	फोन नं.	हस्ताक्षर
१९)	अनिल बानिया	हे०उ०म०न०पा	वडा-१८	९८५२५० ६८०९४	
१२)	राम कृष्ण थापा	हे०उ०म०न०पा-८	वडा अध्य		
१३)	सुकराम केवी	।। — ९	।।		
१४)	फूर्वा दोर्जे लामा	।। — १०	।।		
१५)	जुना दाहाल	।। — ११	।।		
१६)	ज्ञान ब० श्रेष्ठ	वडा १२	।।		
१७)	पैम्वा लामा	वडा — १३	।।		
१८)	दिपक खड्का	वडा — १४	।।		
१९)	सुनिल मुक्तान	वडा — १५	।।		
२०)	रामकृष्ण कोइराला	वडा १६	।।		
२१)	उद्धव सत्पाल	वडा — १७	।।		
२२)	अर्जुन ब० राई	कार्यपालिका सदस्य			
२३)	वीर बहादुर थिक	।।			
२४)	शंकर राई	।।			
२५)	पातलीमाया गोइवा	।।			
२६)	रुक्मिणी गोइम्बा	।।			
२७)	साधना श्रेष्ठ	।।			

			सम्पर्क नं.	सही
२८)	ईश्वरी विक्र	कार्यपालिका सदस्य	९८६४४५१९६०	ईश्वरी
२९)	प्रताप [illegible]	[illegible]		[illegible]
३०)	गोपाल प्रसाद पोखरेल	(प्रमुख प्रशासकीय अधिकृत)		[illegible]
३१)	[illegible] थपलिया	ITO		
३२)	तेज राज पाण्डे	(लेखापाल)		[illegible]
३३)	[illegible]	([illegible])		[illegible]
३४)	केशव [illegible]	वातावरण शाखा		[illegible]
३५	सत्यवती अधिकारी	उपाध्यक्ष [illegible]		[illegible]
३६	अतिश नेपाल	"		[illegible]
३७.	भीष्मप्रसाद [illegible]	[illegible] प्रमुख		[illegible]
३८.	लक्ष्मण [illegible]	[illegible] प्रमुख	९८४५०[illegible]	[illegible]
३९.	चन्दा खड्का	वातावरण इन्जिनियर	9851087942	Chandra
४०	[illegible]	"	९८४५०२६६६७	[illegible]
४१	श्याम कुमार श्रेष्ठ	राजस्व प्रशासन शाखा	९८४५०१११६६	[illegible]
४२	बिना [illegible]	मानव संसाधन विकास शाखा	९८४५०३९६०४	[illegible]
४३	ई. [illegible]	नगर [illegible] योजना	9856038813	[illegible]
४३	[illegible]	[illegible]	९८४५०६९२३६	
४४.	रुपा [illegible]	हे.उ.म.न.पा	९८४५६४००००	Rupa
४५.	ममिता थापा	हे.उ.म.न.पा		Mamita
४६.	सुमन प्रजा	"		[illegible]
४७.	शंकर राज मण्डरी	"		[illegible]
४८.	मनिषा दुवेदी	"		[illegible]
४९.	राधिका क्षेत्री	"		Radika
५०.	समिर लामा	"		Samir
५१	तुलराम आचार्य	"		[illegible]
५२	बलराम दुमागाई	(नगर प्रहरी)		[illegible]
५३	मानब. राई	(" ")		[illegible]

SFD Hetauda Sub-Metropolitan City, Nepal, 2024

Produced by:

Sabuna Gamal, ENPHO
Rupak Shrestha, ENPHO
Buddha Bajracharya, ENPHO
Jagam Shrestha, ENPHO
Anita Bhuju, ENPHO
Asmita Shrestha, ENPHO

This Executive Summary and the SFD Report are available from:

www.sfd.susana.org

SFD Promotion Initiative