SFD Report

Kolhabi Municipality
Nepal

Final Report

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

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SFD Report Kolhabi Municipality, Nepal, 2023

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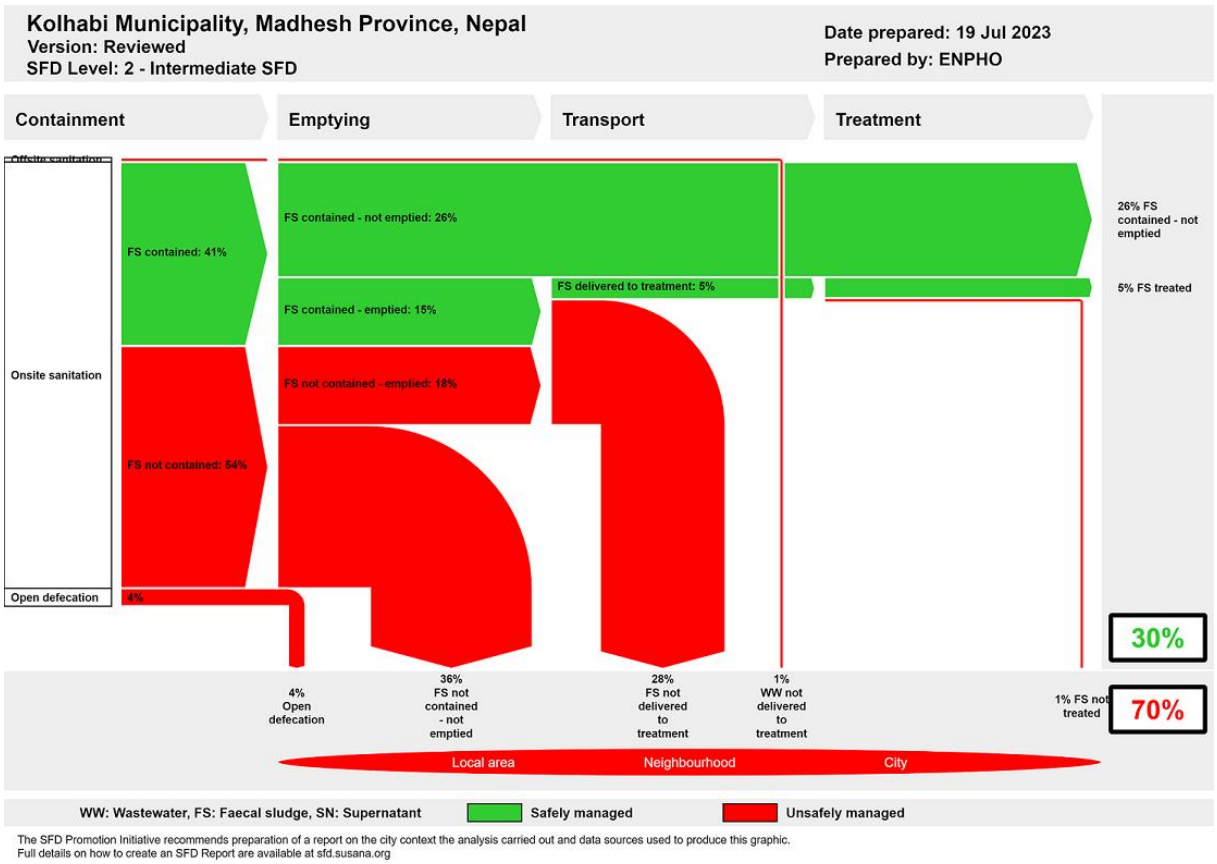
1. The SFD Graphic



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

2. Diagram information

SFD Level:

This SFD is level 2 - Intermediate report.

Produced by:

Environment and Public Health Organization (ENPHO).

Collaborating partners:

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

Status:

Final SFD report.

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3. General city information

Kolhabi Municipality is situated in Bara District of Madhesh Province in the southern region of Nepal. It is divided into 11 wards and covers an area of 157.40 sq. km. It was restructured by merging the already-existing Kolhabi, Sapahi, Prasauna, Kakadi, Amab, Bachhanpurwa, Rampurwa Village Development Committeees (VDCs) and some wards from VDCs Sinhasani (wards 1 and 2), Haraiya (ward 6), Karaiya (ward 8) and Sihorwa (ward 5). It spreads over 27° 0′ 9″ to 27° 10′ 47″ N latitude, 85° 4′ 26″ to 85° 12′ 30″ E longitude and the altitude of 131 m above sea level (masl).

A population of 51,182 is residing in 10,561 households in the municipality. It has an annual population growth rate of 1.6%. The municipality has a temperate climate with dry winters and hot summers. It has an average high temperature of 28.3 °C and average low temperature of 14.9°C and receives 1,423 mm rainfall per year (Climate-Data, 2021).

4. Service outcomes

The overview of different sanitation technologies across the sanitation value chain in the municipality is briefly explained in this section. All data in this section is from the household and institutional surveys conducted for this study (ENPHO, 2023). Kolhabi Municipality District was declared open defecation free (ODF) on June 25, 2018. However, 4% of households do not have toilets whereas 96% of households have the coverage of improved sanitation facility. The households without improved sanitation facility opt for open defecation.

Containment:

About 1% of households with improved sanitation facilities rely on offsite sanitation systems and 95% rely on onsite sanitation systems. The municipality does not have a sewer network and thus, the households with offsite sanitation system have their toilets connected to water bodies. Households with onsite sanitation systems have different sanitation technologies. About 20% of households have fully lined tanks, 7% have lined tanks with impermeable walls and open bottom, 67% have lined pits with semi-permeable walls and open bottom and 1% have an unlined pit.

Similarly, all the institutional buildings have toilets among which, 92% have fully lined tanks and 8% have lined pits with semi-permeable walls and open bottom.

Emptying and Transport:

Among the buildings with onsite sanitation systems, 44% of households and 16% of institutional buildings have emptied their containment. Mechanical emptying is prevalent in the municipality. The municipality provides emptying services. It has one desludging vehicle with a tank capacity of 5,000-litres (KII-2, 2022).

Treatment and Disposal/Reuse:

Mechanically emptied Faecal Sludge (FS) is disposed of untreated in farmlands or in a forest and manually emptied FS is composted, dug and dumped and applied to farmlands untreated, as well. Moreover, FS fed to biogas digesters is used for biogas production and treated sludge is applied to farmlands. Therefore, all the emptied FS is disposed of unsafely into an open environment except the FS fed in the biogas digesters.

The municipality has three public toilets located in ward no. 2, 3 and 5. All of them are constructed by the municipality. Among them, only a public toilet in ward 2 is functional. It serves 5 people at a time. The service recipients of this toilet are customers and public passing by the local marketplace.

Groundwater is the primary source of drinking water in Kolhabi Municipality. 967 households receive piped drinking water supply in the municipality. However, 94% of households still rely on handpumps for drinking water supply.

Water contamination at source is possible for aquifers. The vulnerability of an aquifer depends on lateral spacing between sanitation systems and the groundwater sources. Almost 92% of the population using lined tanks with impermeable walls and open bottom and 79% of population using lined pits with semi-permeable walls and open bottom, and unlined pits possesses a significant risk to groundwater pollution.

The SFD graphic shows that excreta generated from 30% of the population are safely managed while 70% are unsafely managed. The safely managed excreta generated from 26% of the population is temporary since the containments have not been emptied. Once the containments start to fill, the proportion of not emptied FS will be unsafely managed under the current practice of Faecal Sludge Management (FSM).

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 enforced the Water Supply and Sanitation Law 2022 which 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, NSHMP 2011 has proved to be an important strategic document for all stakeholders to develop uniform programs and implementation mechanisms at all levels. It strengthened institutional set up with the formation of Water and Sanitation Coordination Committee (WASH-CC) to actively engage in sanitation campaigns. The sanitation campaign was implemented throughout the country mainly focusing on achieving universal access to improved sanitation.

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).

6. Overview of stakeholders

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

Table 1: Overview of Stakeholders.

Key Stakeholders	Institutions / Organizations
Public Institutions at Federal Government	Ministry of Water Supply
Public Institutions at Provincial Government	Ministry of Water Supply and Energy Development
Public Institutions at Local Government	Kolhabi Municipality
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Development Partners, Donors	MuAN, BMGF, UCLG ASPAC

7. Process of SFD development

Data on sanitation situation were collected through household and institutional surveys (ENPHO, 2023). Enumerators from the municipality were mobilized after providing orientation on sanitation technologies, objectives of the survey and proper use of mobile application, KOBOCOLLECT for collection of data for survey. Along with this, Key Informant Interviews (KIIs) were conducted with officers and engineers of municipality, Water Supply and Sanitation Users Committee. Types of sanitation technologies used in various locations have been mapped using ARCGIS. For the Shit Flow Diagram (SFD) graphic production, initially, a relationship between sanitation technology used in questionnaire survey and Shit Flow Diagram Promotive Initiatives (SFD PI) methodology was made. Then, data were fed into SFD graphic generator to produce the SFD graphic.

8. Credibility of data

The major data were collected from random household sampling. Altogether, 372 households and 25 institutions were surveyed from eleven wards of Kolhabi Municipality. Primary data on emptying, transportation and current sanitation practices in the municipality were validated from KII with Mayor of the municipality and municipal sanitation workers. The overall data and findings were shared with the stakeholders of the municipality and validated through a sharing program.

9. List of data sources

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

- Chaudhary, D. K., 2022. FS Emptying, Disposal and Treatment Practice in Kolhabi Municipality [Interview] (1 January 2022).
- Climate-Data, 2021. Climate-Data. [Online] Available at: https://en.climate-data.org/asia/nepal/central-development-region/simara-799270/ [Accessed 19 July 2023].
- ENPHO, 2023. Sanitation Situation Assessment of Mirchaiya Municipality, s.l.: Unpublished
- Kolhabi Municipality, 2023. Kolhabi Municipality. [Online] Available at: https://Kolhabimun.gov.np/en/brief-Introduction [Accessed 7 July 2023].
- MoWS, 2020. Open Defecation Free Nepal: Narration of the Journey, Kathmandu: Secretariat of National Sanitation and Hygiene Coordination Committee, Nepal.
- National Statistics Office, 2023. National Population and Housing Census 2021 National Report, Kathmandu: National Statistics Office.

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Abbreviations

DWSSM	Department of Water Supply and Sewerage Management
DUDBC	Department of Urban Development and Building Construction
ENPHO	Environment and Public Health Organization
EPA	Environment Protection Act
FS	Faecal Sludge
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
GoN	Government of Nepal
HH	Household
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
KM	Kilometre
masl	meter above sea level
MDG	Millennium Development Goal
Mm	Millimetre
MoPIT	Ministry of Physical Infrastructure and Transport
MoWS	Ministry of Water Supply
MuAN	Municipal Association of Nepal
NPC	National Planning Commission
NSHMP	National Sanitation and Hygiene Master Plan
NWSSP	National Water Supply and Sanitation Policy
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
ODF	Open Defecation Free
PPP	Public Private Partnership
RWSSNP	Rural Water Supply and Sanitation National Policy
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD	Shit Flow Diagram
SFD PI	Shit Flow Diagram Promotion Initiative
SuSanA	Sustainable Sanitation Alliance
UCLG ASPAC	United Cities and Local Governments Asia Pacific
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WSSDO	Water supply and Sanitation Divisional Office
WSUC	Water Supply and User's Committee

1 City context

Kolhabi Municipality is situated in Bara District of Madhesh Province in the southern region of Nepal. It was restructured by merging the already-existing Village Development Committeees (VDCs): Kolhabi, Sapahi, Prasauna, Kakadi, Amab, Bachhanpurwa, Rampurwa and some wards from VDCs Sinhasani (wards 1 and 2), Haraiya (ward 6), Karaiya (ward 8) and Sihorwa (ward 5). It is divided into 11 wards. It shares its boundary with Rautahat District on the east, Jitpur Simara and Kalaiya sub-metropolitan city and Karaiyamai rural Municipality on the west, Nijgadh Municipality on the north and, Baragadhi and Karaiyamai rural municipalities on the south (Kolhabi Municipality, 2023). Figure 1 shows the ward boundary map of Kolhabi Municipality.

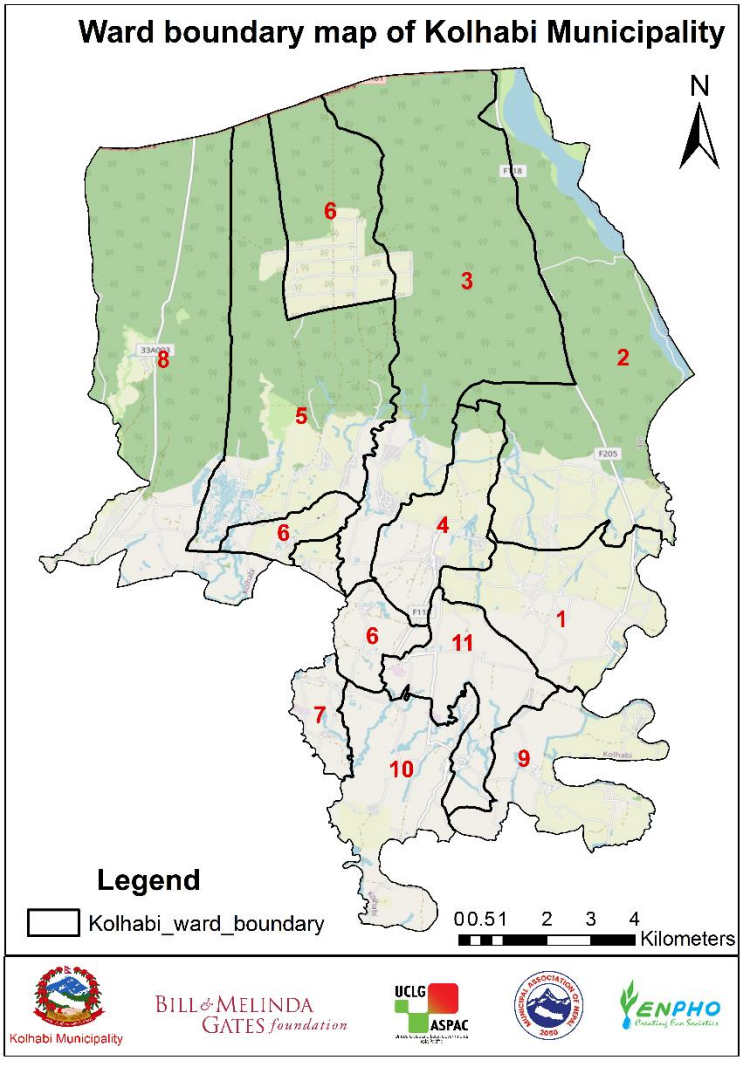

Figure 1: Ward boundary map of Kolhabi Municipality.

1.1 Population

As per the national population and housing census conducted in 2021, Kolhabi Municipality has a total population of 51,182 with 24,862 male and 26,320 female population. It has altogether 10,561 households. The annual population growth rate of Kolhabi Municipality is 1.6% (National Statistics Office, 2023).

1.2 Topography and Geography

Kolhabi Municipality spreads over 27° 0′ 9″ to 27° 10′ 47″ N latitude, 85° 4′ 26″ to 85° 12′ 30″ E longitude and the altitude of 131 m above sea level (masl). It covers the total area of 157.40 sq. km (Kolhabi Municipality, 2018). It lies in the Terai region of Nepal. The soil composition of the municipality consists of alluvial sediments i.e. sand, silt and clay along-with coarse gravels (Upreti, 1999).

1.3 Climate

Köppen–Geiger classification is one of the most used systems for climatic categorization. This classification is a widely used method for portraying climates worldwide based on monthly air temperature and precipitation. The climatic condition of Kolhabi Municipality falls on temperate climate based on Köppen–Geiger classification. This climatic condition has dry winters and hot summers (Karki, et al., 2015). In Kolhabi Municipality, the warmest month of the year is May with average high temperature of 28.3°C whereas coldest month is January with average low temperature of 14.9°C and the annual average temperature is 23.3°C. Additionally, it receives 1,423 mm rainfall annually with the most rainfall in July and the least in November (Climate-Data, 2021). Figure 2 shows the graph of the monthly average for precipitation and temperature of Kolhabi Municipality.

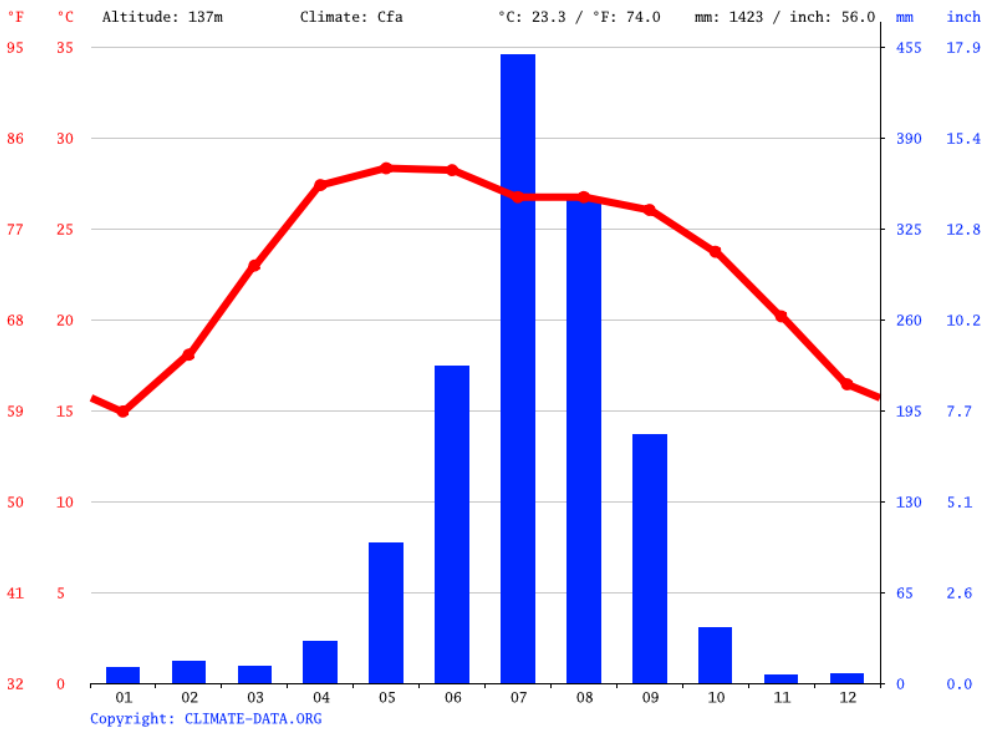

Figure 2: Monthly average for precipitation and temperature of Kolhabi Municipality.

2 Service Outcomes

2.1 Overview

Data on sanitation situation were collected through household and institutional surveys(ENPHO, 2023). A total of 372 households were sampled from 10,561 households distributed in twelve 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 secondary data, Key Informant Interviews (KIIs) and a validation workshop is presented in this section.

Sanitation is defined as infrastructures, facilities or services provided for safe management of human excreta emanating from toilet while handling, storage, and treatment onsite or offsite conveying it safely to the end use or disposal to protect human health and environment (Affam & Ezechi, 2021).

2.1.1 Sanitation System in Household Buildings

Kolhabi Municipality was declared Open Defecation Free (ODF) on June 25, 2018 (MoWS, 2020). The status of ODF indicates accessibility to basic sanitation on each household (HH). In Kolhabi Municipality, still 4% of the households do not have toilets and practice open defecation. The households practising open defecation goes to an open ground. Figure 3 shows the picture of open defecation in an open ground.

Figure 3: Open defecation in an open ground in Kolhabi Municipality.

The remaining 96% of the households have improved sanitation facility either with offsite or onsite sanitation systems. Offsite sanitation refers to a sanitation system in which excreta (referred to as wastewater) is collected and transported away from the plot where they are generated. An offsite sanitation system relies on sewer technology for transport. Onsite sanitation refers to a sanitation technology or sanitation system in which excreta (referred to as faecal sludge) is collected and stored and emptied from or treated on the plot where they are generated (SuSanA, 2018). In the municipality, 1% of the households have offsite sanitation systems whereas 95% have onsite sanitation systems. Figure 4 presents the location map of households with status of access to improved sanitation.

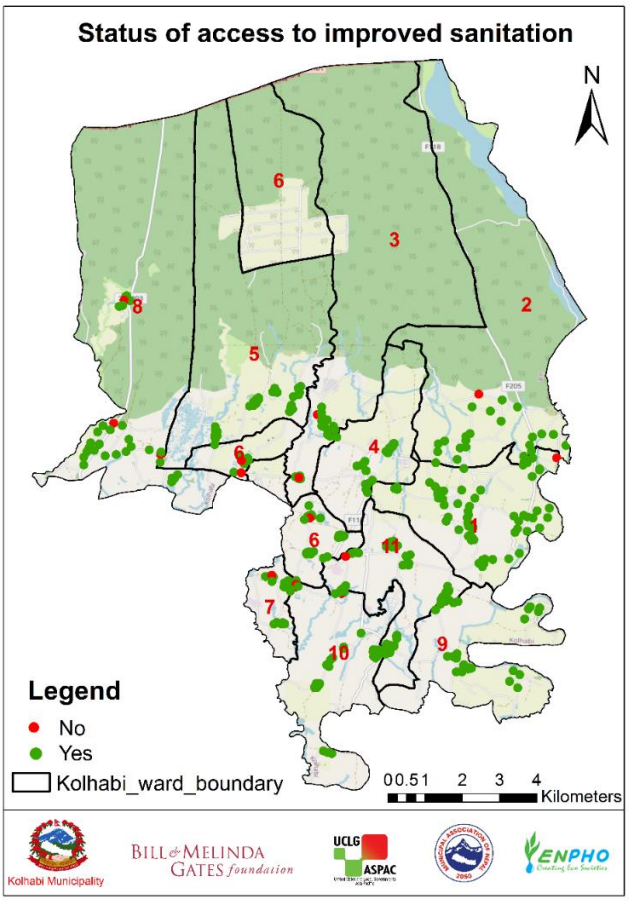

Figure 4: Location map of households with status of access to improved sanitation.

Types of Offsite Sanitation Systems

Kolhabi Municipality does not have sewerage network, but 1% of households have offsite sanitation systems. Here, the households that have their toilet connected to water body are considered as offsite sanitation systems. It is taken as toilet with no onsite container for the SFD graphic. The Faecal Sludge (FS) and wastewater from offsite sanitation systems is directly disposed of into water bodies. Figure 5 shows the outlet of a toilet discharging to a water body.

Figure 5: Toilet discharges directly to water body.

Types of Onsite Sanitation Systems

In the municipality, 95% of the households have onsite sanitation systems. Table 1 shows the types of onsite sanitation technologies and percentage of households using it at Kolhabi Municipality.

Table 1: Types of onsite sanitation system at households of Kolhabi Municipality

Containment	Wall construction materials	Bottom of containment	Chamber	Number	Connected to	%
Biogas digester	NA	NA	NA	NA	No outlet/overflow	6%
Fully lined tank	Concrete walls or Cemented brick/stone walls	PCC or plastered	One or Two	NA	Soak pit Sewer Open drain/open ground No outlet/overflow	14%
Lined tank with impermeable walls and open bottom	Concrete walls or Cemented brick/stone walls	Soiling or Nothing	one two More than two	NA	Soak pit Sewer Open drain/open ground No outlet/overflow	7%
Single pit	Concrete rings piled one after other	Soiling or Nothing	NA	One	NA	38%
Twin pit	Concrete rings piled one after other	Soiling or Nothing	NA	Two	NA	29%
Unlined pit	Mud mortar brick wall/Mud mortar cement wall/No lining/Dry stone wall	Nothing	NA	NA	NA	1%

Biogas Digester is a waste to energy conversion technology designed to treat household organic waste and FS to generate biogas. 6% of households have built a biogas digester in their houses. Alternative Energy Promotion Centre (AEPC) have promoted biogas technology at households in 75 districts of Nepal. The installation of biogas at households have supported in improving situation of health status and sanitation status in Nepal (AEPC, 2018). Figure 6 shows the types of biogas digesters in Kolhabi Municipality.

Figure 6: Types of biogas digesters in Kolhabi Municipality.

Fully lined tank is a rectangular tank with impermeable walls and base to safely store FS. It does not have outlet for the discharge of effluents (Strande, et al., 2014). 14% of the households have fully lined tanks.

Lined tank with impermeable walls and open bottom is a rectangular onsite technology where the walls of the tank are lined and sealed, and with a permeable base. The facility allows infiltration of effluents which could contaminate groundwater (Peal, et al., 2020). 7% of the households have these types of containments in the municipality.

Single Pit is a circular onsite technology made from concrete rings. There is no lining between rings, and it allows infiltration of effluents from walls and as well as bottom of the pit. No outlet or overflow for effluent is observed in this type of containment (SuSanA, 2018). 38% of the households have single pits in the municipality. Figure 7 shows pictures of single pist found in the municipality.

Figure 7: Single pits found in the Kolhabi Municipality.

Twin Pit is also a circular onsite sanitation technology with two sets of concrete rings. It has semi-permeable walls and a permeable base (SuSanA, 2018). Each pit is used alternatively after filled. This technology is ideally designed to safely store and treat FS. It effectively treats FS if there is no exfiltration of water (Saxena & Den, 2022) The facility consists of two sets of pits with the minimum horizontal distance of 1.2m. Both pits are connected from a diversion box. However, most twin pits installed by the households are not as per the design. 29% of the households have twin pits. Figure 8 shows the inappropriate design of twin pits in the municipality.

Figure 8: Inappropriate design of twin pits, the distance between two pits is less than 1.2m

Unlined Pit is a dug pit in the ground which has permeable walls and base. These containments are not sealed and thus water infiltrates into the ground (SuSanA, 2018). 1% of the households have unlined pits.

Table 2 shows the types of sanitation technologies recategorized according to SFD PI.

Table 2: Types of sanitation technologies recategorized according to Shit Flow Diagram Promotion Initiative (SFD PI).

Sanitation System	Percentage
No onsite container	1%
No toilet/Open defecation	4%
Onsite Sanitation System	
Fully lined tank	20%
Lined tank with impermeable walls and open bottom	7%
Lined pit with semi-permeable walls and open bottom	67%
Unlined pit	1%
Grand Total	**100%**

Figure 11 shows the location map of households with different types of containment at Kolhabi Municipality.

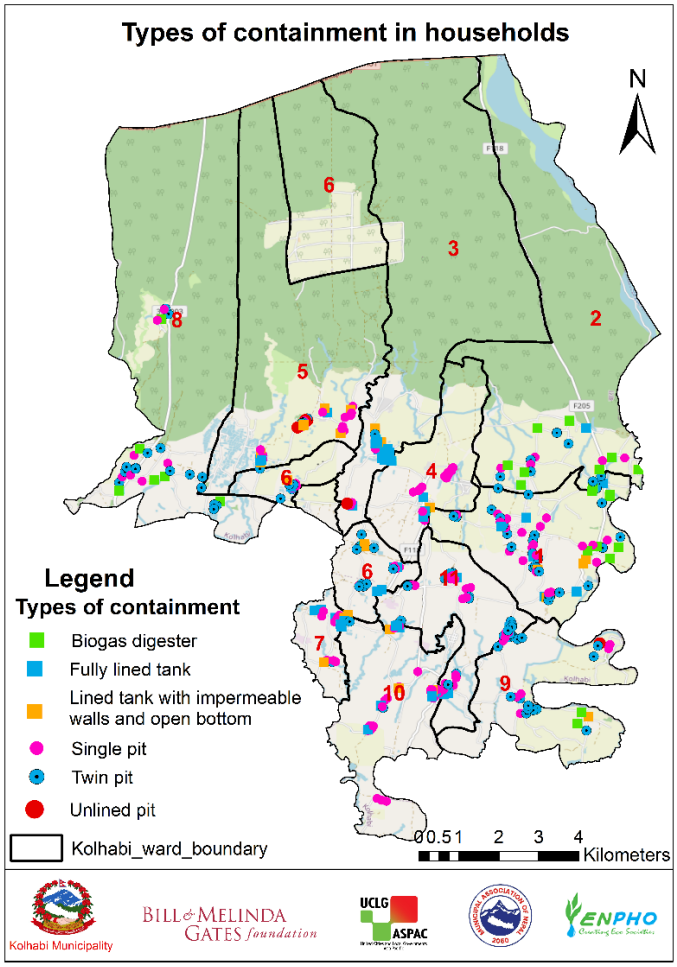

Figure 9: Location map of household with different types of containment.

2.1.2 Sanitation System in Institutional Buildings

Altogether 25 institutional buildings were surveyed. The sanitation data of institutional buildings were obtained from different types of institutions. Table 2 shows the types and number of surveyed institutions.

Table 3: Type and number of surveyed institutions.

Type of Institution	Number of Surveyed Institutions
Educational Institution	5
Government /Non-government Office	13
Health care centre	6
Hotel/ Home Stay	1
Grand Total	**25**

All the institutional buildings in the municipality have onsite sanitation systems. Among which, 92% have fully lined tanks and 8% have lined pits with semi-permeable walls and open bottom. Based on the data it is found that, most institutional buildings have safer practice of FS collection compared to the ratio of households. Figure 12 shows the location map of institutional buildings with different types of containments in Kolhabi Municipality.

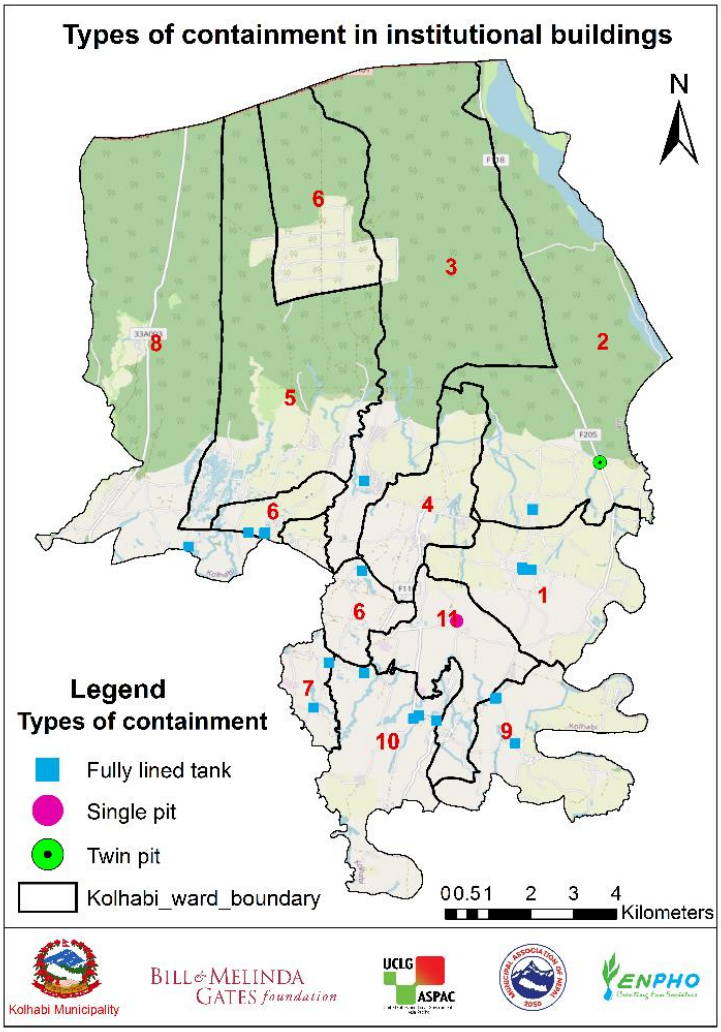

Figure 10: Different types of containment in institutional buildings of Kolhabi Municipality.

2.1.3 Public Toilets

Kolhabi Municipality has three public toilets which are in local marketplaces of ward no. 2, 3 and 5. The toilets are constructed by the municipality. The public toilets in ward no. 3 and 5 are not functional whereas only limited information could be gathered for the public toilets located at local marketplace in ward no. 2. The obtained information is thus fed in this report.

Public toilet at Ward no. 2

The public toilet located at the local marketplace of ward no. 2 is being managed by the municipality. It serves 5 people at a time with 2 pans and 3 urinals. It does not have separate male and female compartments. The public passing by and customers of the local marketplace are the service recipients of this toilet. It does not have a handwashing facility and lacks

cleanliness. Also, the toilet compartments do not have ventilation. Figures 11 and 12 show the structure and status of the public toilet in local marketplace at ward no. 2.

Figure 11: Structure of public toilet located at local marketplace of ward no. 2.

Figure 12: Status of pan (left) and urinals in female compartment (right) of public toilet at local marketplace of ward no.2.

2.1.4 Emptying and Transport

Emptying is one of the key elements of sanitation service chain. It basically assures the proper operation of containment. Regular emptying of the containment prevents sludge overflow and blockages (Strande, et al., 2014). Moreover, emptying of containment is determined by the number of users, duration of years and types and size of containment.

Among the households with onsite sanitation system, about 44% of the households have emptied their containment whereas 56% of the households have not emptied them. Similarly, about 16% of the institutional buildings have emptied their containment. The emptying practice proportion in institutional buildings was less than in households.

Mechanical emptying is prevalent in the municipality. Among the households and institutional buildings that have emptied their containments, almost 84% of the households and 100% of institutional buildings used mechanical emptying method compared to only 16% of households that used manual emptying method.

The municipality has only a municipal desludging service. It owns a desludging vehicle with a tank capacity of 5,000-litres. On average, it makes 2 trips per day and charges Nrs. 2,000 (USD 15.1) for a trip to empty faecal sludge from rectangular tanks, and charges NRs. 100 (USD 0.7) per ring from concrete ring containments. Altogether six sanitation workers are employed in the municipality. Among them, a driver and a support staff are mobilized during desludging for each trip (KII-2, 2022). Figure 13 shows a picture of the desludging vehicle of Kolhabi Municipality.

Figure 13: Desludging vehicle of Kolhabi Municipality.

2.1.5 Treatment and Disposal/Reuse

Kolhabi Municipality does not have Faecal Sludge Treatment Plant (FSTP). Therefore, mechanically emptied FS is disposed of untreated into farmlands or in a forest (KII-2, 2022). Manually emptied FS is composted, dug and dumped and applied to farmlands, all considered to be unsafely managed practices. However, FS supplied to biogas digesters is safely processed for the generation of biogas and treated sludge is applied to farms. Therefore, almost all emptied FS is disposed of unsafely in an open environment except the FS fed into the biogas digesters.

2.1.6 Risk Assessment of Groundwater Pollution

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

a. Sources of drinking water and water production

Groundwater is the primary source of drinking water in the municipality. As per the national population and housing census conducted in 2021, altogether 967 households had piped drinking water supply in their premises (National Statistics Office, 2023). However, 94% of households still rely on handpumps for drinking water supply.

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

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 (Foster, et al., 2013). Among other anthropogenic activities, improperly designed and constructed and unmanaged sanitation technologies also contribute to the groundwater contamination (EPA, 2015). In addition to it, the key factor to risk of groundwater pollution is the soil type and geological structure. According to WHO, 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. The size of pores in the soil determines the infiltration rate (Krishnan, 2011).

The soil composition of Kolhabi Municipality consists of alluvial sediments i.e. sand, silt and clay along-with coarse gravels (Upreti, 1999) also known as sandy loam soil. In the sandy loam soil, the permeability is approximately 2.5 cm per hour (INREM, 2011). Thus, between 25 and 50 days the pollutant could travel to the depth of approximately 30 metres (98.67 feet) in the soil type of Kolhabi Municipality and would possess a risk of groundwater pollution. Hence, the people using open bottom tanks and consuming water from the handpumps with the depth upto 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 14 shows the depth of handpumps and horizontal distance of it from source of pollutant by lined tanks with impermeable walls and open bottom. Almost 92% of the households (i.e.T2A4C10: 92% x 6.7% = 6.1% ≈ 6% of the overall population, where 6.7% is the percentage of population using lined tanks with impermeable walls and open bottom with no outlet or overflow and groundwater as drinking water source) using this type of containment possess significant risk to groundwater contamination.

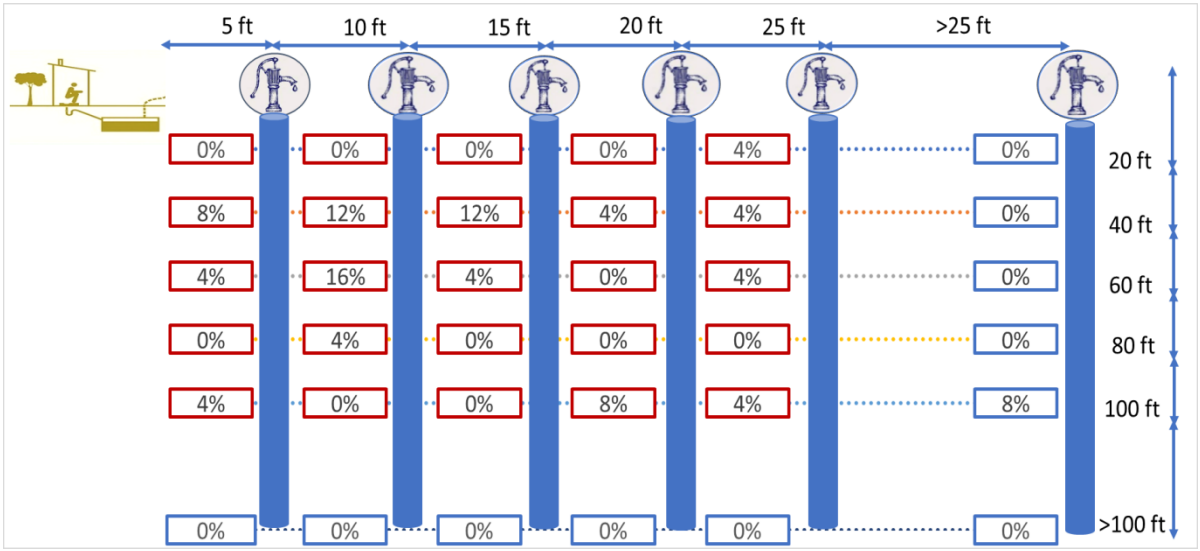

Figure 14: Depth of hand pumps and lateral spacing of it with containment type lined tank with impermeable walls and open bottom.

Figure 15 shows the depth of hand pumps and horizontal distance of it with the containment type lined pit with semi-permeable walls and open bottom and unlined pit. It shows that almost 79% of the households (i.e. T2A5C10: 79% x 58.9% = 46.5% ≈ 46% and T2A6C10: 79% x 1.0% = 0.7% ≈ 1% where 58.9% is the percentage of population using lined pits with semi-permeable walls and open bottom and 1.0% is the percentage of population using unlined pits both with no outlet or overflow and using groundwater as drinking water source) using these types of containment possess significant risk to groundwater contamination.

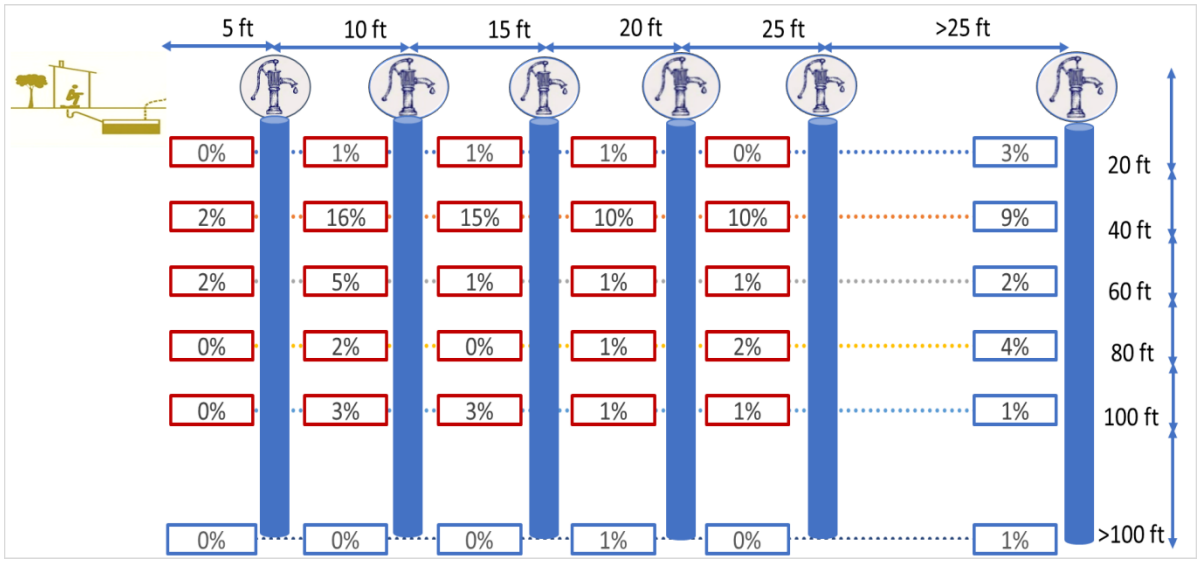

Figure 15: Depth of hand pumps and lateral spacing of it with containment type lined pit with semi-permeable walls and open bottom.

2.2 SFD Selection Grid

Figure 16 shows the types of sanitation technologies present in the Kolhabi Municipality selected in the Shit Flow Diagram (SFD) selection grid. The vertical column on the left side of grid represents sanitation technologies to which toilet is connected to, and horizontal row at top is connection of the technologies. The households with single pit and twin pits are selected as lined pit with semipermeable walls and open bottom in this selection grid.

Figure 16: SFD selection grid for Kolhabi Municipality.

The detail description of selected terms in the selection grid is provided in Table 4.

Table 4: Explanation of terms used to indicate different frame selected in the SFD selection grid in Figure 16.

T1A1C7	A fully functioning toilet discharging directly to a water body. The excreta is raw, untreated and hazardous and since it discharges directly to a water body, all the excreta in this system are considered NOT contained.
T1A3C8	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 (consequently the excreta is potentially more toxic than the excreta in a septic tank). Since the tank is fitted with a supernatant/effluent overflow connected to open ground the excreta in this system are considered NOT contained.
T1A3C10	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 (consequently the excreta is potentially more toxic than the excreta in a septic tank). However, since the tank is NOT fitted with a supernatant/effluent overflow this system is considered contained.

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. It includes all lined but open bottomed tanks and containers which are sometimes mistakenly referred to as septic tanks (e.g. cubluks in Indonesia). 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.
T1A4C10	A correctly designed, properly constructed and well maintained lined tank with sealed, impermeable walls and an open, permeable base, through which infiltration can occur. It includes all lined but open bottomed tanks and containers which are sometimes mistakenly referred to as septic tanks (e.g. cubluks in Indonesia). However, since the tank is NOT fitted with a supernatant/effluent overflow this system is considered contained.
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.
T1A5C10	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.
T2A6C10	A correctly designed, properly constructed and well maintained unlined pit with permeable walls and 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.
T1B11C7 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.

2.3 SFD Matrix

2.3.1 Proportion of Faecal Sludge from types of sanitation technologies

The second step in the process of developing the SFD graphic is the calculation of the proportion of contents of each type of onsite container which is faecal sludge. SFD matrix calculates the proportion of people using each type of system and the proportion of each system, from which FS and supernatant is emptied, transported, and treated. A detailed instruction on how to calculate SFD proportion in SFD PI was used as guide to calculate SFD proportion. As stated on SFD PI, the default "100%" value is used for onsite containers which are connected to soak pits, 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. The value for onsite containers that are connected to a sewer network or to open drains is used as "50%" which means half of the contents are modelled FS and 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 obtained from SFD PI used for FS proportion calculation is shown below:

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

The calculated FS proportion in each type of sanitation technologies are:

i. The proportion of FS in septic tanks is 0%, since there are no septic tanks.

ii. The proportion of FS in fully lined tanks is 100%, as none of the fully lined tanks are connected to an open drain.

iii. The proportion of FS from lined tanks with open bottom and all types of pit is 99%, as the proportion of lined tanks with impermeable walls and open bottom connected to open drain is only 1%.

Upon calculation of proportion of FS in each type of sanitation technologies, the population using the system selected in the SFD selection grid are fed in. The column Population (Pop) gives the proportion of population using type of sanitation system. Figure 17 shows the SFD matrix of Kolhabi Municipality.

Kolhabi Municipality, Madhesh Province, Nepal, 19 Jul 2023. SFD Level: 2 - Intermediate SFI
Population: 51182
Proportion of tanks: septic tanks: 0%, fully lined tanks: 100%, lined, open bottom tanks: 99%

Containment				
System type	Population	FS emptying	FS transport	FS treatment
	Pop	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C7 Toilet discharges directly to water body	1.0			
T1A3C10 Fully lined tank (sealed), no outlet or overflow	19.0	38.0	68.0	95.0
T1A3C8 Fully lined tank (sealed) connected to open ground	1.0	0.0	0.0	0.0
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	1.0	0.0	0.0	0.0
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	21.0	39.0	0.0	0.0
T1B11 C7 TO C9 Open defecation	4.0			
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	6.0	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	46.0	38.0	0.0	0.0
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	1.0	16.0	0.0	0.0

Figure 17: SFD Matrix of Kolhabi Municipality.

2.3.2 Proportion of Faecal Sludge Emptied (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-2, 2023). The information on FS emptied from containment is obtained from KII with desludging service providers. In an average 20% of the FS in the containment which is very thick and does not dissolve in water is not removed during emptying (KII-2, 2022). Hence, actual proportion of FS emptied from each containment is calculated as:

$$Actual\ Proportion\ of\ FS\ emptied\ (F3) = percentage\ of\ containment\ emptied \times proportion\ of\ FS\ removed\ during\ emptying$$

Table 5 shows the actual proportion of FS emptied from each containment.

Table 5: Sanitation technologies and proportion of emptied faecal sludge (ENPHO, 2023[1]; KII-2, 2023[2]).

Sanitation Technologies	SFD Reference Variable	Emptied Proportion of FS [1]	FS Emptied from Containment [2]	Actual Proportion of Emptied FS (F3)
Toilet discharges directly to water body	T1A1C7	0%	0%	0%
Fully lined tank (sealed) connected to open ground	T1A3C8	0%	80%	0%
Fully lined tank (sealed), no outlet or overflow	T1A3C10	48%	80%	38%
Lined tank with impermeable walls and open bottom, no outlet or overflow	T1A4C10	0%	80%	0%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow	T1A5C10	49%	80%	39%
Open defecation	T1B11 C7 TO C9	0%	0%	0%
Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A4C10	4%	80%	3%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A5C10	47%	80%	38%
Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	T2A6C10	20%	80%	16%

2.3.3 Proportion of FS emptied which is delivered to treatment plant and treated (F4 and F5)

The municipality does not have a treatment plant, however 5% of the FS is treated. The value for FS treated is obtained from the biogas digesters which is reclassified as fully lined tanks with no outlet or overflow. The emptying proportion of FS for the system is 68% (F4 = 68%) and the capacity of fully functioning biogas digester is taken to 95% (F5 = 95%). Apart from this technology, the rest of the FS extracted from the remaining onsite sanitation technologies is not treated. Also, the people using twin pits reclassified as lined pits with semi-permeable walls and open bottos are not using them properly. Hence, the portion of FS delivered to treatment plant for the remaining technologies (F4) and treated (F5) is 0%.

2.4 SFD Graphic

Figure 18 shows the SFD graphic of Kolhabi Municipality. The graphic shows that excreta generated from the proportion of population that are safely managed is shown in green coloured whereas unsafely managed excreta are shown in red coloured arrowhead. It shows that excreta from 30% of the population are safely managed and excreta from 70% of the population are unsafely managed. It also represents the sanitation value chain going from left to right.

Offsite Sanitation

Kolhabi Municipality does not have sewer network, however, 1% of households have an offsite sanitation system. The wastewater generated from these households is disposed of into an open environment. Therefore, wastewater from 1% of the population is not treated and is unsafely managed.

Onsite Sanitation

In the municipality, 95% of households rely on onsite sanitation systems. Of the total households having an onsite sanitation system, 41% of the population uses containment where FS is contained.

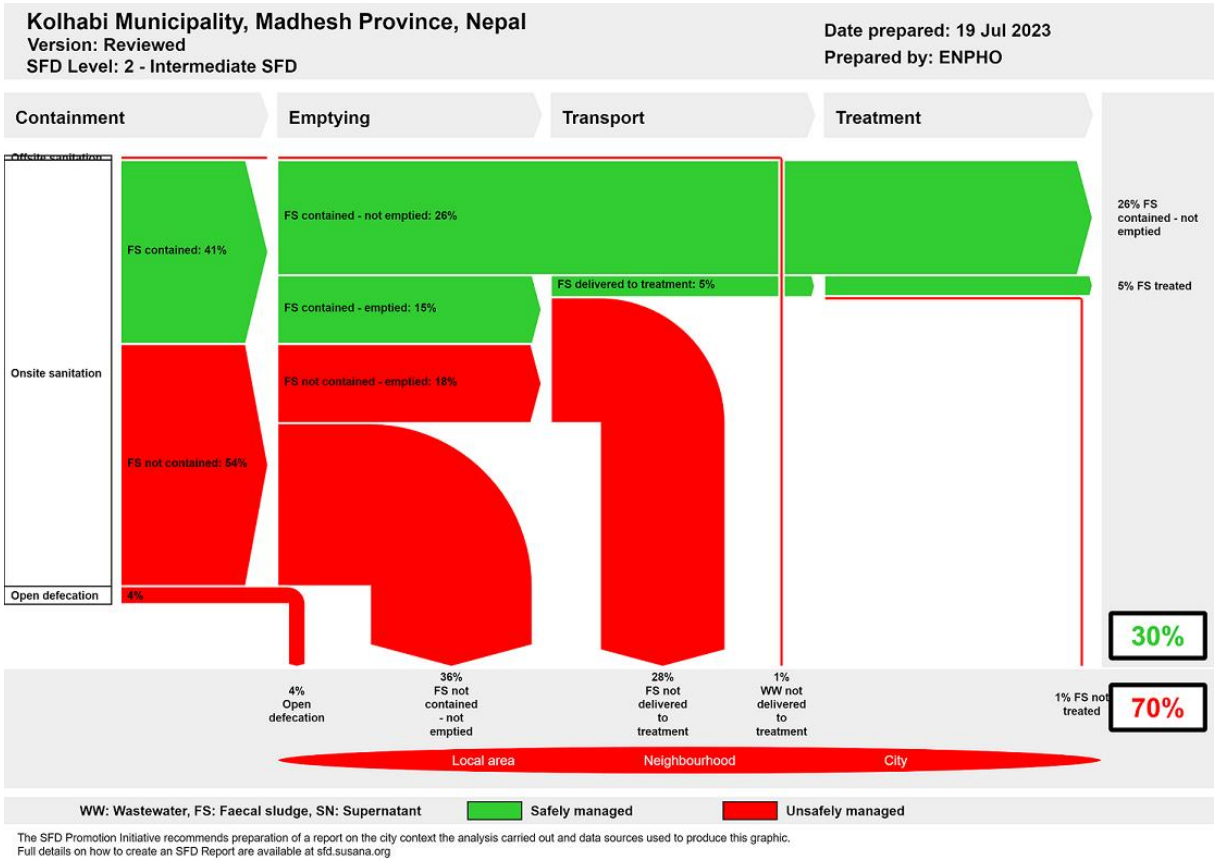

Figure 18: SFD Graphic of Kolhabi Municipality.

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 of FS contained i.e. 41% is obtained from the summation of population using fully lined tanks with no outlet or overflow (T1A3C10), lined tanks with impermeable walls and open bottom with no outlet or overflow (T1A4C10) and lined pits with semi-permeable walls and open bottom with no outlet or overflow (T1A5C10). Moreover, FS from 26% of the population that is contained, has not been emptied and considered to be safely managed. However, this FS eventually needs to be emptied as the containment gets filled. Hence, the current practice of FS emptying could lead to unsafe disposal of FS.

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 of FS not contained i.e. 54% is obtained from the summation of population using fully lined tanks connected to an open ground (T1A3C8), lined tanks with impermeable walls and open bottom with no outlet or overflow with 'significant risk' to groundwater (T2A4C10), lined pits with semi-permeable walls and open bottom with no outlet or overflow with 'significant risk' to groundwater (T2A5C10) and unlined pits with no outlet or overflow with 'significant risk' to groundwater (T2A6C10).

FS contained - not Emptied

The value of 26% is obtained from the proportion of the population using sanitation systems where the FS is contained and have not emptied their containment.

FS contained - Emptied

The value of 15% is obtained from the proportion of population using sanitation systems where the FS is contained and have emptied their containment.

FS not contained - Emptied

The value of 18% is obtained from the proportion of the population using sanitation systems where the FS is not contained and have emptied their containment.

FS not contained - not Emptied

The value of 36% is obtained from the proportion of the population using sanitation systems where the FS is not contained and have not emptied their containment.

FS not delivered to treatment

The proportion of FS not delivered to treatment, i.e. 28%, is the summation of FS contained - emptied and FS not contained - emptied. Since the municipality does not have a FS treatment plant, emptied FS is disposed of into farmlands, riverbanks, forest or in a FS dumping site. Therefore, this proportion of FS possesses risk to local area and neighbourhood.

FS treated

Almost 6% of households in the municipality have a biogas digester. The biogas digester here is considered as a fully lined tank with no outlet or overflow. Thus, the proportion of FS treated is obtained from the containment type fully lined tank with no outlet or overflow (T1A3C10).

Open Defecation

Despite Open Defecation Free (ODF) status, people residing in 4% of households still go for open defecation. Mostly, people living in poverty and who do not own land, do not have toilets and despite having toilets, lack in behaviour change has led to open defecation in the municipality.

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 promulgated 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 promulgated 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 promulgated 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.

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 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 and Sanitation Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

Total Sanitation Guideline, 2017

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.

3.2 Policies

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. However, it was unable to address the complex operational issue of urban water supply and sanitation service delivery. 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. Thus, the National Water Supply and Sanitation Policy (NWSSP) was formulated in 2014 by GON to address the emerging challenges and issues with the adoption of new approaches and resolve the inconsistency in RWSSNP and NUWSSSP.

The goal of the NWSSP was to reduce urban and rural poverty by ensuring equitable socio-economic development, improving health and the quality of life of the people and protection of

environment through the provision of sustainable water supply and sanitation services. It adopted innovative technologies and knowledge emerged in the sector. Remarkably, it was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted the surface water sources in urban areas.

Nepal is a signatory of the historical resolution of 2010 United Nations General Assembly on the Human Right to Water and Sanitation. 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. After the MDGs, United Nations General Assembly set 17 global goals as Sustainable Development Goals (SDGs). Sanitation is prioritized on SDG 6. The target 6.2 of SDG 6 majorly focuses on sanitation. It mentioned to achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations by 2030. In line with SDG 6.2, Nepal has targeted to provide improved sanitation to 95% households that are not shared and urban households with toilets connected to sewer system or proper FSM to 90% by 2030 (NPC, 2017). National Sanitation and Hygiene Master Plan, 2011 was developed for coordinated planning and implementation of National Sanitation Campaign. The campaign strengthened institutional setup tier of government in a participatory approach. In an alignment total sanitation campaign was initiated formally to sustain ODF. The guideline set various indicators to assess the sustainability of sanitation services. Remarkably, it extended sanitation definition as management of services and facilities to safely dispose of/reuse faecal sludge, collection and treatment of solid waste and wastewater to establish the hygienic environment and promote public health (NPC, 2017).

Similarly, Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) was formulated in 2016 for sector convergence, institutional and legal reforms, capacity development and establishing coordination and harmonization in the sector. The SDP classified service system and delineated roles and responsibilities for effective and sustainable service delivery. The SDP highlighted that majority of households rely on onsite sanitation system (70%) that requires effective treatment of faecal sludge. However, there is lack of concrete policies, guidelines, and indicators on Faecal Sludge Management in the sector for effective planning, implementation, and service delivery. Nepal was declared ODF nation on September 23, 2019 (MoWS, 2020) however, the target of 90% households with toilets connected to sewer system or proper FSM is yet to be achieved.

3.3 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 Government

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 19.

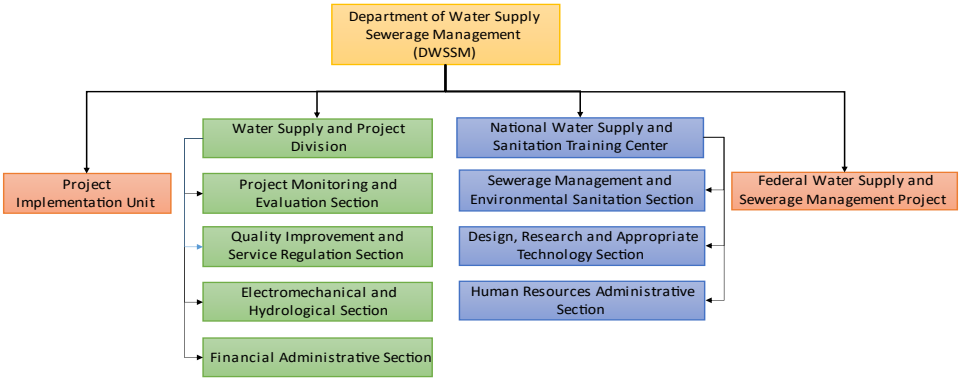

Figure 19: Organizational Structure Department of Water Supply and Sewerage Management (DWSSM).

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

At Provincial Level

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

i. Inter local government projects.

ii. 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 Level

The municipality has Social Development section to manage the activities related to water, sanitation and hygiene. The section has been providing desludging service along with door to door solid waste collection service in the municipality. This section also manages the public toilets in the municipality. Furthermore, staffs for sanitation work and desludging vehicle are also managed by this section.

3.4 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 socio-economic 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).

The municipality does not have a sewer network. Toilet system is either directly connected to open drain, water bodies or open ground. The toilets that are connected to containments are emptied mechanically by desludging vacuum truck from municipality or private service providers whereas manually emptied FS is carried out by traditional desludgers.

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

Table 6: Sanitation Service Level and its Components.

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

4 Stakeholder Engagement

4.1 Key Informant Interviews (KIIs)

The Key Informant Interviews (KIIs) and objective sharing of the study were conducted with major stakeholders of the sanitation sector in the municipality. Mayor of the municipality was interviewed on current sanitation services with respect to technical, institutional, and financial aspects. Also, KIIs were performed with the municipal sanitation workers to understand the emptying practice, disposal and treatment of FS (Table 7 and Figure 20).

Table 7: List of Key Informant Interviewed personnel.

S.N.	Name	Designation	Organization/Company	Purpose of KII	Date
1.	Ram Prasad Chaudhary (KII-1)	Mayor	Kolhabi Municipality	Sanitation status, municipality representatives	1 January, 2023
2.	Dev Kant Chaudhary (KII-2)	Sanitation Worker	Kolhbi Municipality	Emptying practices, finances, requirement, disposal and treatment	1 January, 2023
3.	Sitaram Hajara (KII-2)	Sanitation Worker	Kolhbi Municipality	Emptying practices, finances, requirement, disposal and treatment	1 January, 2023

Figure 20: KIIs with sanitation workers in the municipality.

4.2 Household Survey

A random household survey was conducted in all wards of the municipality. The municipality selected local enumerators who were oriented prior to the survey and were mobilized for data collection (Figure 21). A mobile application "KOBOCOLLECT" was used for the household survey. In the orientation, enumerators were clarified on survey objectives, technical terms concerning sanitation, use of the mobile application and procedure of random sampling survey based on the provided map.

Figure 21: SFD orientation to local enumerators at Kolhabi Municipality.

4.2.1 Determining Sample Size

The number of households to be sampled in the municipality was determined by using Cochran (1963:75) sample size formula $no = \frac{z2pq}{e2}$ and its finite population correction for the proportion $n = n_o/(1+ (n_o-1)/N)$.

Where,

Z^2	1.96	At the confidence level of 95%
p	0.5	Assuming that about 50% of the population should have some sanitation characteristics that need to be studied (this was set at 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 sites).
q	1-p	
e	+/-5%	Level of precision or sampling error.
N		A total number of population (households in the municipality).

This is followed by proportionate stratification random sampling such that each ward in the municipality is considered as one stratum. The sample sized required in each ward is calculated as

$n_h = (N_h/N)*n$, where N_h is a total population in each stratum.

A total of 372 households were sampled from 10,561 households distributed in eleven wards with proportionate stratification random sampling. The household samples surveyed in the municipality are shown in Figure 22.

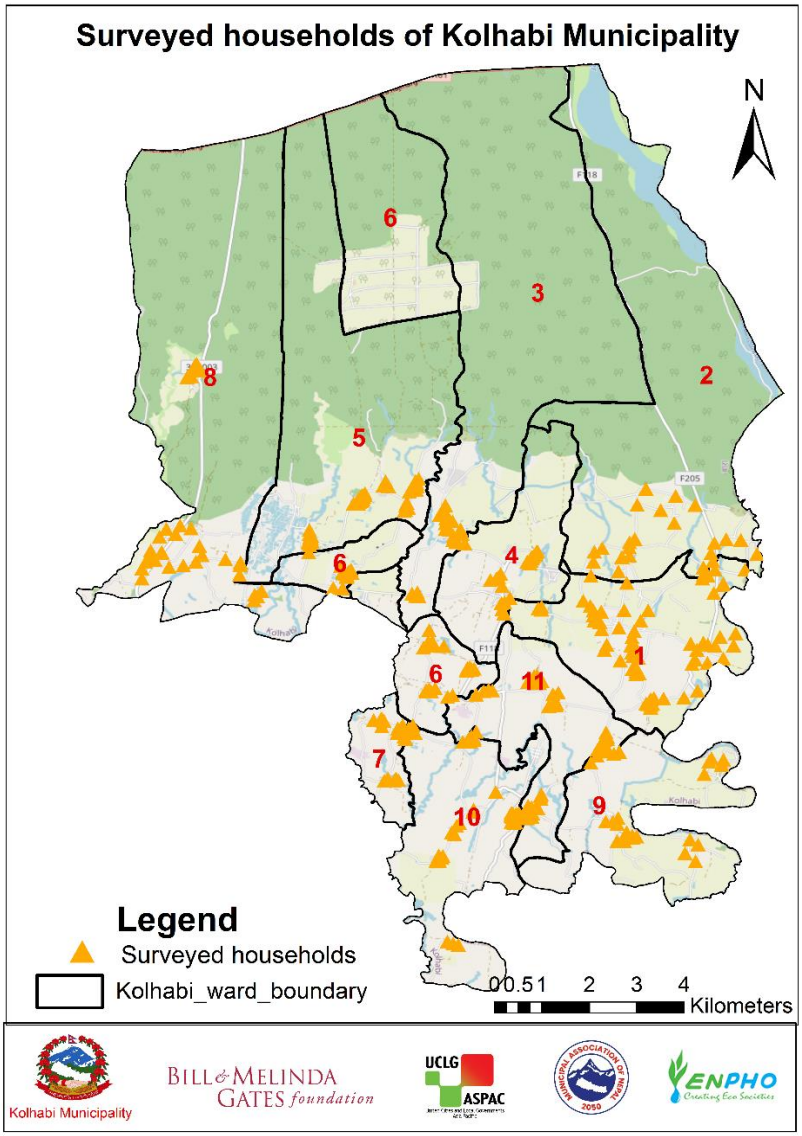

Figure 22: Location map of surveyed households.

4.3 Direct Observation

Various sanitation technologies in the households of the municipality were observed and visual references were kept. Also, observation of the public toilets and water collection overhed tanks were carried out. Figure 23 shows the picture of observation of public toilet at Kolhabi Municipality.

Figure 23: Observation of public toilet located at ward 2 of Kolhabi Municipality.

4.4 Sharing and Validation of Data

The Shit Flow Diagram Sharing and Validation Workshop was conducted on 1 March, 2023 at Kolhabi Municipality hall to share the findings on sanitation situation survey and receive the suggestions from the municipal stakeholders. Altogether, 26 participants including Mayor, Deputy mayor, ward chairpersons, municipal council members, sectoral staffs and other relevant stakeholders actively participated on the workshop and provided valuable suggestion. The Mayor was curious on safe disposal of FS and technologies for FSM. He expressed his deepest interest on FSM at local and policy level along with infrastructure development. Figure 24 shows the picture of SFD findings sharing to the participants and Figure 25 shows Mayor Ram Prasad Chaudhary sharing his remarks during SFD sharing and validation workshop. The list of participants with their designation is attached in Appendix 4.

Figure 24: Sharing of findings during validation workshop.

Figure 25: Mayor sharing his remarks during SFD sharing and validation workshop.

5 Acknowledgements

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7 Appendix

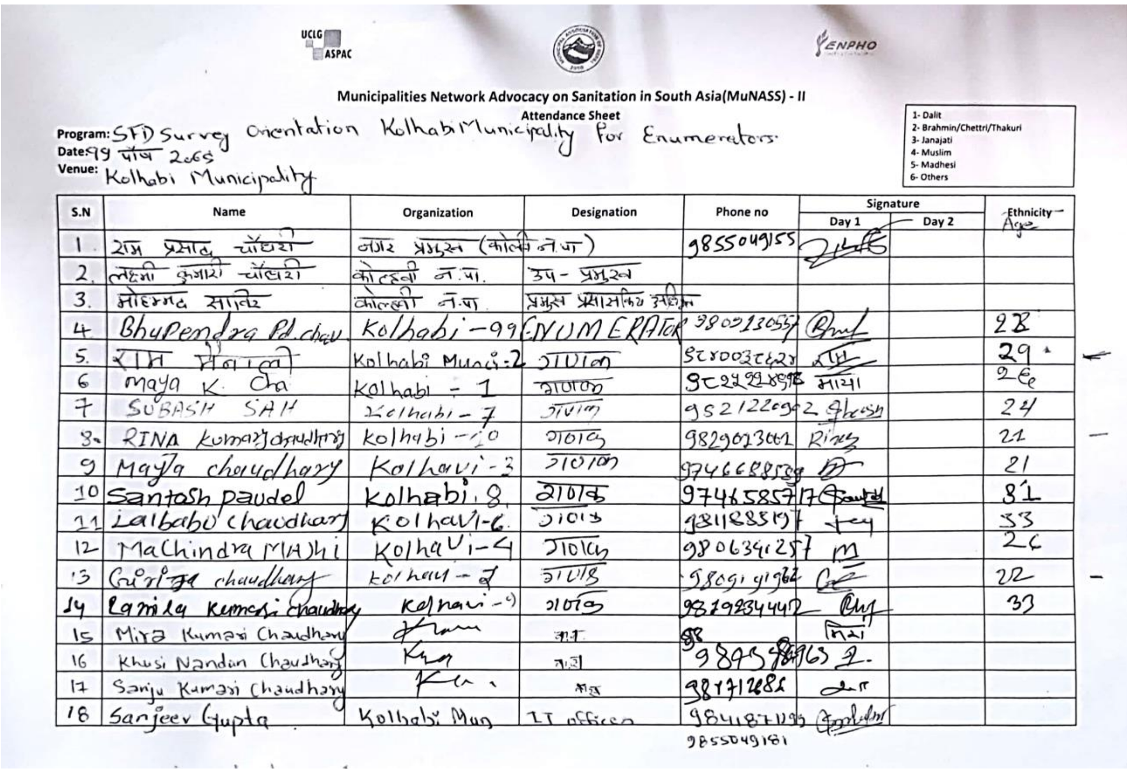
7.1 Appendix 1: Roles and Responsibility of Various Tiers of Governments Delineated in Drafted SDP 2016 – 2030

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

7.2 Appendix 2: Total Number of Population and Household in Each Ward and Number of Surveyed Households

Ward No.	Number of surveyed households
1	63
2	26
3	22
4	28
5	42
6	26
7	26
8	32
9	33
10	33
11	40
	372

7.3 Appendix 3: List of Participants on SFD Survey Orientation



UCLG ASPAC | ENPHO

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

Attendance Sheet

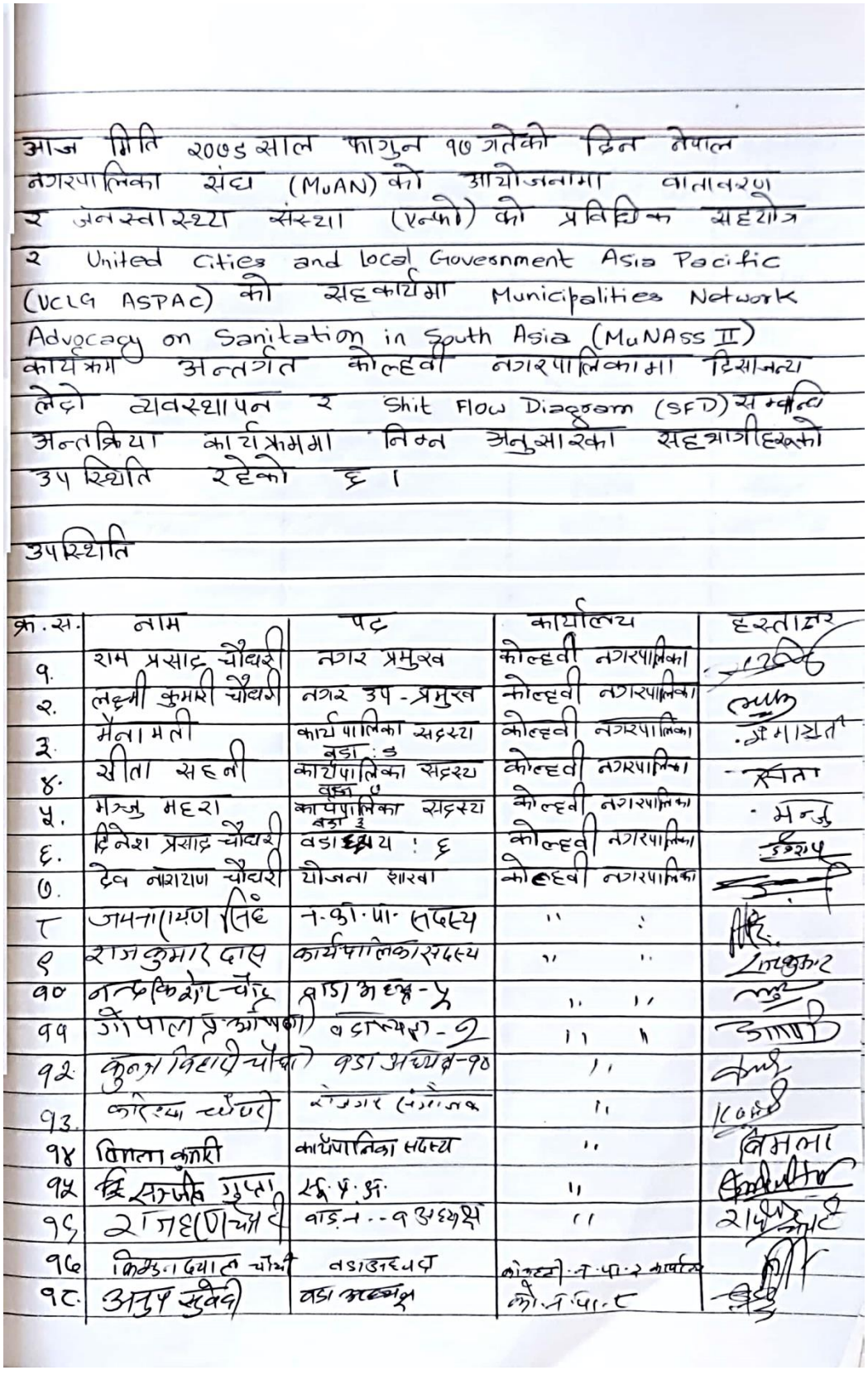
Program: SFD Survey Orientation Kolhabi Municipality for Enumerators.
Date: १९ पौष 2069
Venue: Kolhabi Municipality

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

S.N	Name	Organization	Designation	Phone no	Signature Day 1	Signature Day 2	Ethnicity Age
1	राम प्रसाद चौधरी	नगर प्रमुख (कोल्हवी न.पा)		9855049155	[illegible]		
2	लक्ष्मी कुमारी चौधरी	कोल्हवी न.पा.	उप-प्रमुख				
3	मोहम्मद साबिर	कोल्हवी न.पा.	प्रमुख प्रशासकिय अधिकृत				
4	Bhupendra Pd. chau	Kolhabi-9	ENUMERATOR	9809130557	[illegible]		28
5	राम मैनाली	Kolhabi Munci-2	गणक	९८४००३८६८४	राम		29
6	Maya K. Cha	Kolhabi - 1	गणक	९८४४४४८९१	माया		२६
7	SUBASH SAH	Kolhabi - 7	गणक	9521220962	Subash		24
8	RINA kumari chaudhary	kolhabi - 10	गणक	9829023061	Rina		21
9	Maya chaudhary	Kolhavi - 3	गणक	9746688539	[illegible]		21
10	Santosh paudel	kolhabi. 8	गणक	9746585717	[illegible]		31
11	Lalbabu chaudhary	Kolhavi-6	गणक	9811885197	[illegible]		33
12	MaChindra MAJhi	Kolhavi-4	गणक	9806341257	M		26
13	Girija chaudhary	Kolhavi - 2	गणक	9809191962	[illegible]		22
14	Ramila Kumari chaudhary	Kolhavi - 9	गणक	9819234442	[illegible]		33
15	Mira Kumari Chaudhary	[illegible]	गणक	98	मिरा		
16	Khusi Nandan Chaudhary	[illegible]	गणक	9845984963	[illegible]		
17	Sanju Kumari Chaudhary	[illegible]	गणक	9817126862	[illegible]		
18	Sanjeev Gupta	Kolhabi Mun	IT officer	9841871199	[illegible]		

9855049181

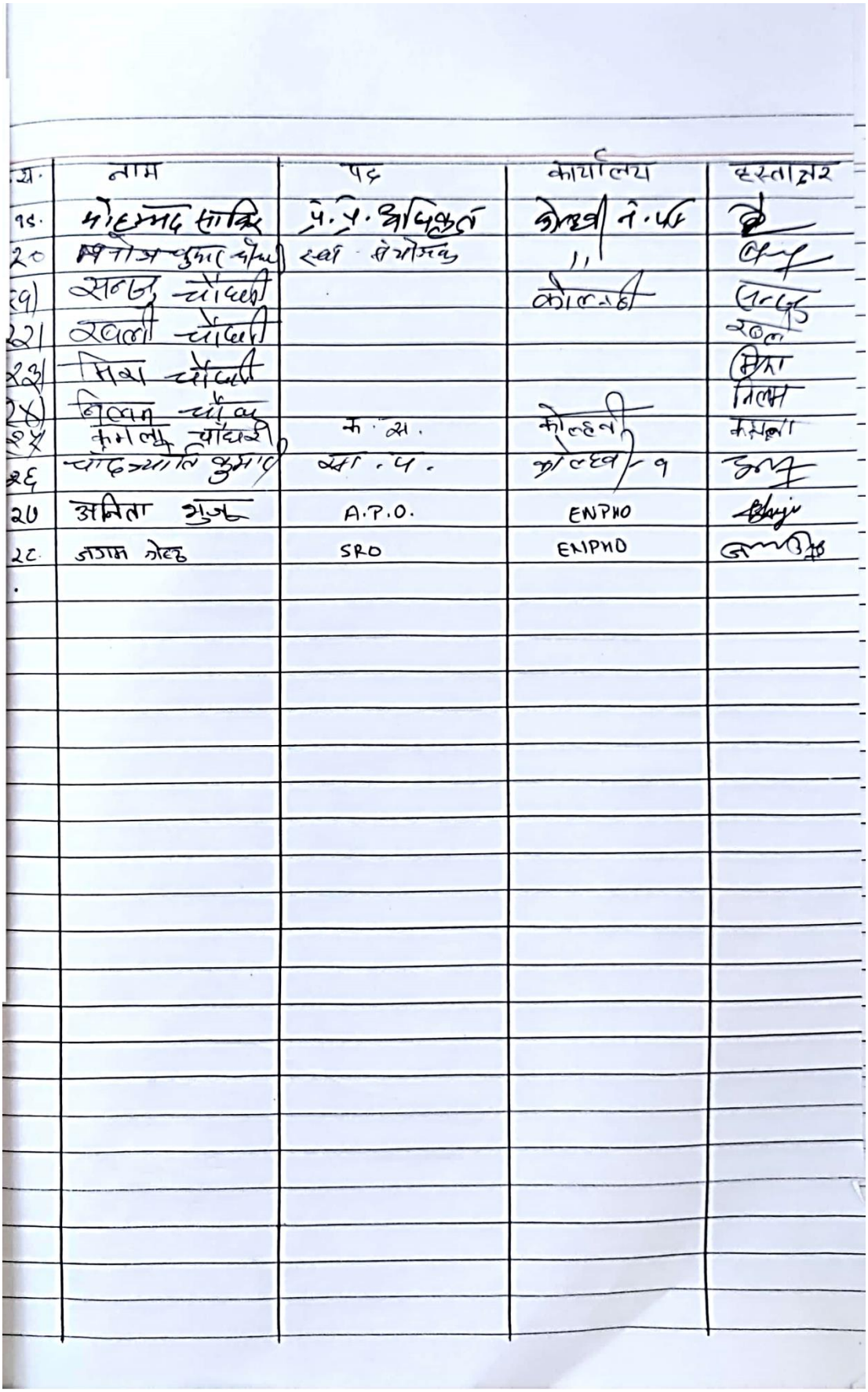
7.4 Appendix 4: List of Participants in Sharing and Validation Workshop



आज मिति २०७९ साल फागुन १७ गतेको दिन नेपाल नगरपालिका संघ (MuAN) को आयोजनामा वातावरण र जनस्वास्थ्य संस्था (ENPHO) को प्राविधिक सहयोग र United Cities and local Government Asia Pacific (UCLG ASPAC) को सहकार्यमा Municipalities Network Advocacy on Sanitation in South Asia (MuNASS II) कार्यक्रम अन्तर्गत कोल्हवी नगरपालिकामा दिसामन्त्र लेदो व्यवस्थापन र Shit Flow Diagram (SFD) सम्बन्धि अन्तक्रिया कार्यक्रममा निम्न अनुसारका सहभागीहरुको उपस्थिति रहेको छ ।

उपस्थिति

क्र.स.	नाम	पद	कार्यालय	हस्ताक्षर
१.	राम प्रसाद चौधरी	नगर प्रमुख	कोल्हवी नगरपालिका	
२.	लक्ष्मी कुमारी चौधरी	नगर उप-प्रमुख	कोल्हवी नगरपालिका	
३.	मैना मती	कार्य पालिका सदस्या वडा : ७	कोल्हवी नगरपालिका	
४.	सीता सहनी	कार्यपालिका सदस्य वडा : ८	कोल्हवी नगरपालिका	
५.	मन्जु मद्रा	कार्यपालिका सदस्य वडा ३	कोल्हवी नगरपालिका	
६.	दिनेश प्रसाद चौधरी	वडा अध्यक्ष : ६	कोल्हवी नगरपालिका	
७.	देव नारायण चौधरी	योजना शाखा	कोल्हवी नगरपालिका	
८	जयनारायण सिंह	न.कृ.पा. सदस्य	"	
९	राजकुमार दास	कार्यपालिका सदस्य	"	
१०	नन्दकिशोर चौधरी	वडा अध्यक्ष-५	"	
११	गोपाल प्रसाद यादव	वडा अध्यक्ष-७	"	
१२	कुन्ज बिहारी चौधरी	वडा अध्यक्ष-१०	"	
१३	कविता चौधरी	रोजगार संयोजक	"	
१४	विमला कुमारी	कार्यपालिका सदस्य	"	
१५	[illegible]	सह.प्र.अ.	"	
१६	[illegible]	वडा उपाध्यक्ष	"	
१७	किसुन दयाल चौधरी	वडा उपाध्यक्ष	कोल्ह.न.पा.२ कार्यालय	
१८	अनुप खुवेदी	वडा अध्यक्ष	को.न.पा.८	



ज.	नाम	पद	कार्यालय	हस्ताक्षर
१८.	मोहम्मद साबिर	प्रा.प्र. अधिकृत	कोल्हबी न.पा.	
२०	मनोज कुमार चौधरी	स्वा. संयोजक	,,	
२१	सन्जु चौधरी		कोल्हबी	
२२	रजली चौधरी			
२३	सिवा चौधरी			
२४	बिरम चौधरी			
२५	कमलु चौधरी	न.स.	कोल्हबी	
२६	चन्द्रमणि कुमाल	स्वा.प.	कोल्हबी-१	
२७	अनिता गुरु	A.P.O.	ENPHO	
२८	जगम शेरु	SRO	ENPHO	

SFD Kolhabi Municipality, Nepal, 2023

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SFD Promotion Initiative