SFD Promotion Initiative

Lahan
Nepal

Final Report

This SFD Report – Intermediate SFD level - was prepared by Environment and Public Health Organization

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SFD Report Lahan, Nepal, 2020

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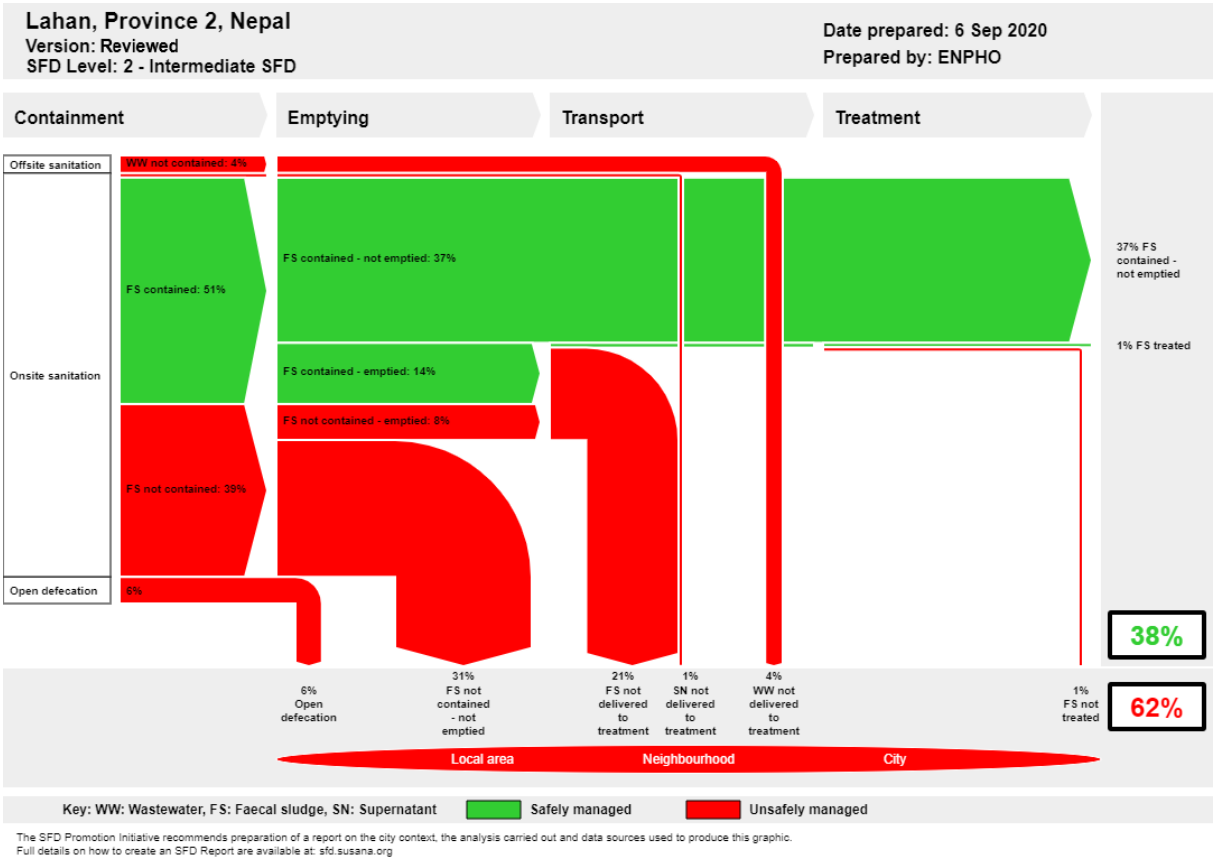
1. The Diagram



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

Desk or field-based:

Intermediate. Level 2 report.

Produced by:

Environment and Public Health Organization (ENPHO)

Collaborating partners:

Lahan Municipality,

Municipal Association Nepal (MuAN),

United Cities and Local Government- Asia Pacific (UCLG- ASPAC)

Status:

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3. General city information

Lahan municipality is located in Siraha district of province number 2, Nepal. The municipality is divided into 24 wards. The municipality is home to 91,766 people as per census 2011. The population growth rate was 1.16% per year from 2001 to 2011.

The municipality is located at the latitude of 26.717 and longitude of 86.483. It is at an elevation of 111 meters above sea level. The topography of the municipality increases flooding and inundation during the rainy season. The climate of Lahan is warm and temperate. The average annual temperature is 24.3°C. The warmest month of the year is June, with an average temperature of 29.2°C and January is the coldest month of the year with the average temperature of 15.9°C. The average annual rainfall is 1,511 mm. The precipitation reaches its peak in July with an average of 448 mm while the driest month is December with 5 mm of rainfall

4. Service delivery context

Access to drinking water and sanitation has been defined as fundamental rights of 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 billed the Water Supply and Sanitation Law 2018 which has emphasized in 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 placed to accomplish the sanitation need of people. Particularly, NSHMP 2011 has proved as an important strategic document for all stakeholders to develop uniform programs and implementation mechanism at all level. It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government to actively engage into sanitation campaign. The document adopted sanitation facilities as improved, basic and limited in line with WHO/UNICEF guideline. The sanitation campaign throughout the country was focused to achieve universal access to improved sanitation.

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 from sanitation campaign and way forward to post ODF. It mainly emphasized sector convergence, institutional and legal reforms, and capacity development of the service providers. Together, with a commitment to Sustainable Development Goal (SDG) and promulgation of Total Sanitation Guideline 2017, it assists the service provider with clear indicators and targets to be achieved. The latest outcome, specifically to manage Faecal Sludge Management (FSM) in the country is the Institutional and Regulatory Framework for Faecal Sludge Management. The framework envisaged featuring of FSM on national policies through the federal government and issuing policy directives at the local level along with enhancing the capacity of the service providers. The overall planning, implementation and regulating of FSM service chain have been authorized to local government. In this regard, the local government can develop a partnership with either private sector or water and sanitation user committee for effective service delivery. However, the local government has yet to develop rules and regulations, and standards to effectively deliver services across the sanitation value chain.

5. Service outcomes

The overview of different sanitation technologies across the sanitation value chain in the municipality is briefly explained in this section.

Containment: The municipality has been declared open defecation free zone. The municipality lacks sewer networks thus it depends on onsite sanitation system. At the household level, the majority of houses have installed either fully lined tank or lined tank with impermeable walls with open bottom while the household at rural areas has installed lined pits with semipermeable walls either twin pits or single pits made from concrete rings. Also, a significant number of the population use unlined pits.

It was observed that most of the institutions have been established and operated in the core urban area of the municipality except educational institutions. It was observed that 52.2% of the institutions consists of either fully lined tank or septic tank. While a significant number of institutions also have installed twin pits (21.8%), lined tank with impermeable walls and open bottoms (27%) and single pits mostly in rural areas (12.6%).

The urban ward numbers from 1 to 10 receive piped water supply operated and managed by Nepal Water Supply Corporation. Remaining wards rely on groundwater sources and almost every households have installed hand pumps to uplift swallow groundwater. The significant risk of groundwater contamination is observed based on soil characteristics, types of containment, depth of groundwater and lateral spacing of the groundwater source and containment.

Emptying and Transportation: Both traditional manual scavenging and mechanical emptying practices are observed. Unpredictably, while it was revealed that only 29.5% of households have emptied their containments at least once after the installation, others have never been emptied. Also, the emptying frequency for lined pits and unlined pits are higher. Emptying and transportation services have been provided by both the municipal sanitation section and private entrepreneur.

Treatment and Disposal/ End Use: The municipality dump collected FS in its landfill site without any forms of treatment. The private desludging entrepreneur has developed a

disposal mechanism in agricultural land or barren land around the Balan River.

6. Overview of stakeholders

Based on the regulatory framework for FSM, the major stakeholders for effective and sustaining service delivery are as presented in Table 1.

Table 1 Overview of Stakeholders

Key Stakeholders	Institutions / Organizations /
Public Institutions at Federal Government	National Planning Commission, Ministry of Water Supply and Sanitation, Ministry of Environment and Population, Ministry of Federal Affairs and General Administration, Department of Water Supply and Sewerage, Department of Environment, Local Government (Municipal Council)
Public Institutions at local Government	Municipality Nepal Water Supply Corporation, Lahan Branch Office
Non-governmental Organizations	Environment and Public Health Organization (ENPHO)
Private Sector	Sanjya Sanitation Services
Development Partners, Donors	MuAN, BMGF,UCLG ASPAC

7. Credibility of data

The major data were collected from random household sampling. Altogether, 376 households and 159 institutions were surveyed from all the wards of the municipality. The primary data on emptying and transportation were validated with KIIs from private entrepreneurs and sanitation section of the municipality. The overall data and findings were shared with the stakeholders of the municipality and validated through sharing program.

Major limitation during the collection of data is the types of containments: whether it is lined or unlined is based upon the responses from the respondent.

8. Process of SFD development

The data on the sanitation situation is collected through a household survey (ENPHO, 2019). The community mobilizers from the sub-metropolitan were mobilized after providing the orientation on sanitation technologies, objectives of the survey and using a mobile application for the survey. Also, KIIs were conducted with officers form the municipality, water supply system, town development committee and private emptying entrepreneurs to understand the situation across the service delivery chain. For the production of the SFD graphic, initially, a relationship between sanitation technology used in a questionnaire survey and SFD PI methodology was made. Then, data were fed in the graphic generator to produce the SFD graphic.

9. List of data sources

ENPHO. (2019). *Study on Sanitation Status of Lahan Municipality.* Environment and public Health Organization.

MoAC. (2011). *Disaster Risk Management Plan: Siraha District.* Kathmandu, Nepal: Ministry of Agriculture and Cooperatives, Government of Nepal.

MoPE. (2017). *National Population Report 2017.* Singha Dardar, Kathmandu: Ministry of Population and Environment.

MoWSS. (2016). *Water Service Providers: Capacity Assessment and Benchmarking Data year 2071-72 (2014-15).* Kathmandu, Nepal: Sector Efficiency Improvement Unit (SEIU), Ministry of Water Supply and Sanitation, Government of Nepal.

Lahan, Nepal, 2020

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Table of Content

List of tables

List of figures

Abbreviations

BGS	British Geological Survey
BMGF	Bill and Melinda Gates Foundation
CBS	Central Bureau of Statistics
DWSS	Department of Water Supply and Sewerage
ENPHO	Environment and Public Health Organization
FS	Faecal Sludge
FSM	Faecal Sludge Management
GON	Government of Nepal
IRF	Institutional and Regulatory Framework
KII	Key Informant Interview
MoAC	Ministry of Agricultural and Cooperatives
MOF	Ministry of Finance
MOFAGA	Ministry of Federal Affairs and General Administration
MOPPW	Ministry of Physical Planning and Works
MOWSS	Ministry of Water Supply and Sanitation
NPC	National Planning Commission
NRWSSSP	National Rural Water Supply and Sanitation Sector Policy
NSHMP	National Sanitation and Hygiene Master Plan
NUWSSSP	National Urban Water Supply and Sanitation Sector Policy
ODF	Open Defecation Free
PPE	Personal Protective Equipment
PPP	Public Private Partnership
SDG	Sustainable Development Goal
SDP	Sector Development Plan
SFD	Shit Flow Diagram
SFD PI	Shit Flow Diagram Promotion Initiative

UCLG ASPAC	United Cities of Local Government Asia Pacific
UNICEF	United Nations Children's Education Fund
USAID	United States
VDC	Village Development Committee
WASH	Water, Sanitation and Hygiene
WEDC	Water Engineering and Development Centre
WHO	World Health Organization

1 City context

Lahan municipality is located in Siraha District in the Province number 2 of south-eastern Nepal. The municipality was formed in 1976 by merging Lahan Bazar, Lahan Goth and Sigarahi Matiyarwa Village Development Committees (VDC). It was reformed into 22 wards from 10 wards in December 2014. Latest adjoining VDCs namely Gadha and Govindapur Malhaniya has merged to restructure the municipality into 24 wards. The political boundary map of the municipality is shown in figure 1.

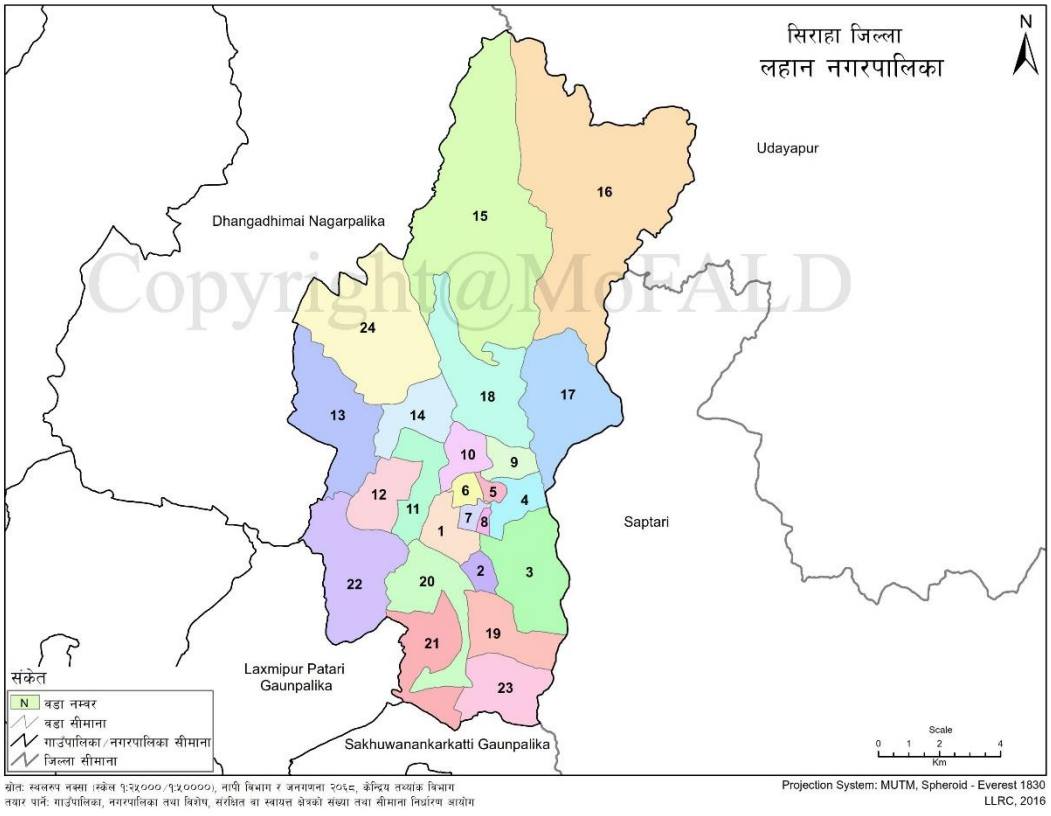

Figure 1: Location map of Lahan Municipality.

1.1 Population

In a total 91,766 population resides in the municipality as per census 2011. According to the census 2001, the total population was 81, 918. The population growth rate was 1.16% per year from 2001 to 2011. However, the urban population of Lahan municipality has increased to 33927 in 2011 from 27,645 in 2001 with an urban population growth rate of 2.04% (MoPE, 2017).

1.2 Geography

The municipality is located at the latitude of 26.717 and longitude of 86.483. It is at an elevation of 111 meters above sea level. The land towards the North is made up of the Chure hills with gradients greater than 20^{o} however it only covers a few areas and the majority are terai plan. This topography increases flooding and inundation during the rainy season (MoAC, 2011).

1.3 Climate

The climate of Lahan is warm and temperate. The average annual temperature is 24.3°C. The warmest month of the year is June, with an average temperature of 29.2°C and January is the coldest month of the year with the average temperature of 15.9°C. The average annual rainfall is 1,511 mm. The precipitation reaches its peak in July with an average of 448 mm while the driest month is December with 5 mm of rainfall (Climate-Data.org, n.d.).

2 Service delivery context description

2.1 Policy, legislation and regulation

2.1.1 Policy

The constitution of Nepal 2015 has envisioned access to drinking water and sanitation as fundamental rights of the citizens that would be delivered and managed by federal, provincial and local governments in mutual coordination (GON, 2015). GON through its Ministry of Water Supply (MoWS) has billed Water Supply and Sanitation Law 2018 in its federal parliament to respect, protect, promote, fulfil and implement the provisions in the constitution. It has envisioned every citizen a right to quality sanitation services and prohibited the direct discharge of wastewater and sewage into water bodies or public places directly against the prescribed standard in section 38. Also, it has a provision of imprisonment for a term ranging from three months to one year or a fine of up to NPR 5, 00,000 (US$ 4,390) or both to the offender (MoWS, 2018).

Beside current developments in laws and policies, earlier National Sanitation Policy (1994) was the first sanitation specific policy that provided guidelines for the planning and implementation of sanitation programs. An unofficial revised version was produced in 2002, however, it was not ratified by GON instead of National Rural Water Supply and Sanitation Sector Policy (NRWSSSP) was approved in 2004 (WEDC, 2005). The policy was formulated to provide a basic level of water supply to all people such that development of water supply and sanitation services supports the social and economic development of the nation and improves the health status. It mainly focused on the participatory approach and community leadership project development with emphasized given on optimization of local resources and installation of locally appropriate technology (DWSS, 2004). Similarly, the GON approved National Urban Water Supply and Sanitation Policy (NUWSSSP) in 2009. The policy uses Water and Sanitation Hygiene (WASH) services as a tool for poverty reduction. Output-Based Aid Approach was adopted for supporting the construction of household toilets along with cost recovery principles and decentralized waste management in urban areas (DWSS, 2009). A Unified National Water Supply and Sanitation Sector Policy (NWSSSP) was approved in 2014 by the GON to resolve existing inconsistent and incoherent in rural and urban sanitation policies. The NWSSSP aimed to grab many opportunities like new technologies and knowledge, and service delivery approaches emerged in the sector. Remarkably, NWSSSP was the first official document that recognized discharge of untreated wastewater and dumping of septic sludge heavily polluted into surface water sources in urban areas. Further, it

pinpointed that densely located onsite sanitation facilities in urban and rural localities have been posing a risk of groundwater pollution. The policy set strategy to develop and enforce wastewater quality standards for discharging all kinds of wastewater into natural water bodies and agricultural lands. Reuse options with appropriate treatment were highly prioritized and mandatory provisions were set for constructing onsite treatment facilities in hospitals, industries and commercial buildings (DWSS, 2014).

Based upon these policies, National Sanitation and Hygiene Master Plan (NSHMP) 2011 was formulated and implemented by the GON. Coordination among various stakeholders and local leadership was highly emphasized to develop participatory integrated sanitation programs. It focused on universal access to sanitation through the construction of household toilets and declaration of Open Defecation Free zones. It has set ODF as a basic indicator to universal access on improved sanitation with due consideration on sustainable changes in hygiene behaviours including proper use of toilet and waste management practices in the urban and rural areas. It provided strategic direction for all the concerned stakeholders to formulate an enabling environment for harmonizing the efforts of stakeholders, maintaining uniformity and standards and developing institutional arrangement at all levels of government (NPC, 2011). It strengthens institutional set up with the formation of water and sanitation coordination committee at every tier of government in a participatory approach. Also, it defined what sanitation facility should be promoted to achieve universal access to improved sanitation.

The national sanitation coverage after the implementation of NHSMP 2011 is 95.5% until March 2018 (MoWS, 2018). Thus upon achieving good progress towards the sanitation coverage, the GON has drafted Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (SDP 2016-2030) in 2016 emphasizing sector convergence, institutional and legal reforms, capacity development of the sector institutions and establishing coordination and harmonization. The draft SDP has classified service system and delineated roles and responsibilities accordingly for effective and sustainable service delivery as shown in Appendix 1.

Together, with a national commitment to pursuing and achieving the Sustainable Development Goals (SDGs) by 2030, National Planning Commission (NPC) formulated targets and indicators for coordinated efforts to achieve the goals in 2017. Similarly, Total Sanitation Guideline 2017 has envisioned sustaining ODF outcomes and initiating post-ODF activities through integrated water, sanitation and hygiene plan at every local level. It has set various indicators and remarkably 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 the hygienic environment and promote public health (NPC, 2017).

All these above-mentioned policies and guideline states Faecal Sludge Management (FSM) as a component of the sanitation system. Lack of concrete policies, guidelines and indicators on FSM was felt in the sector for effective planning, implementation and service delivery. Thus, through in-depth discourses on FSM, Ministry of Water Supply and Sanitation (MOWSS) through its Department of Water Supply and Sewerage (DWSS) articulated and endorsed Institutional and Regulatory Framework for Faecal Sludge Management in Urban Areas of Nepal in 2017.

The main objective of the FSM framework is to define the specific roles and responsibilities of key institutions for the effective management and regulation of FSM. It is framed upon existing

laws such as Environmental Protection Act and Rules 1997, Self-Local Governance Act and Rules 1999, Environmental Standards on Effluent Discharge 2000, Nepal National Building Code 2003, and Land Acquisition Act amendment 2010 (MOWS, 2017). The framework primarily envisioned featuring FSM in the national policy and issuing policy directives into local government to incorporate FSM in their urban planning along with strengthening and enhancing the capacity of the local government to deliver effective services. A local government has been endowed with overall responsibility to plan, implement and regulate the FSM services within its jurisdiction. The provision of the ability to engage the private sector and other relevant stakeholders such as Water and Sanitation Users Committee (WSUC) in the framework reflects a participatory approach that would help in sustaining the interventions.

2.1.2 Institutional roles

At the federal government, the National Planning Commission (NPC) is responsible for planning the national sanitation programs in coordination with the respective ministry. Department of Water Supply and Sewerage under Ministry of Water Supply and Sanitation (MOWS) is a leading authoritative agency for development and implementation of sanitation policy and programs. Earlier, the sanitation programs were implemented through its regional offices at the local level. The policies formulated had to be channelized through Ministry of Federal Affairs and General Administration (MOFAGA), a ministry at federal government accredited with the role of coordination, cooperation, facilitation and monitoring and evaluation of activities undertaken by local governments; regulation and management of the civil service in the country. The schematic diagram as shown in figure 2 illustrates roles and responsibilities for effective management of faecal sludge at the federal government.

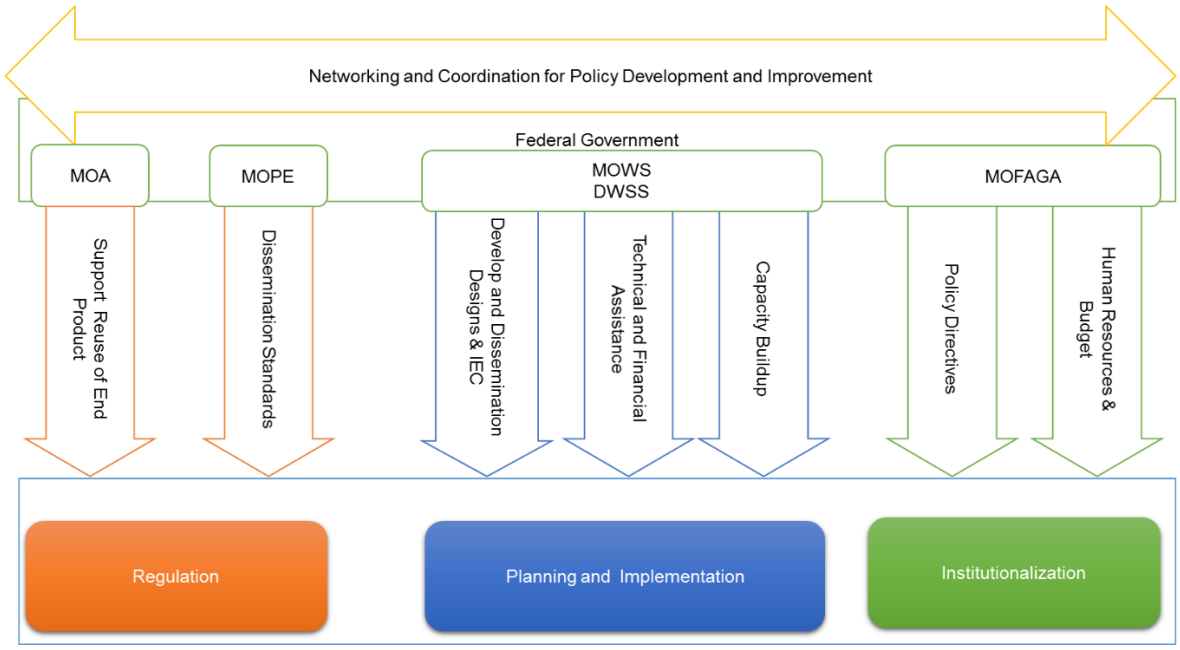

Figure 2: Institutional arrangements and their responsibility for FSM at the federal government.

Ministry of Physical Infrastructure and Development is entitled with authority for water supply and sanitation programs at the provincial government. The draft SDP has envisioned the role of the provincial government as roles of regulation and surveillance on small scale sanitation

systems implemented by the local government whereas it is responsible to undertake implementation program of medium to mega-scale sanitation interventions in coordination with federal and local government.

The Constitution of Nepal 2015 and Local Government Operation Act 2017 enabled the local government to implement sanitation interventions to enhance public health and living standards. Generally, local government in coordination and partnership with Water and Sanitation User Committee (WSUC) and developing agencies have been implementing water supply and sanitation programs. The IRF for FSM has delineated the roles and responsibility of local government across all sanitation values chain as presented in figure 3.

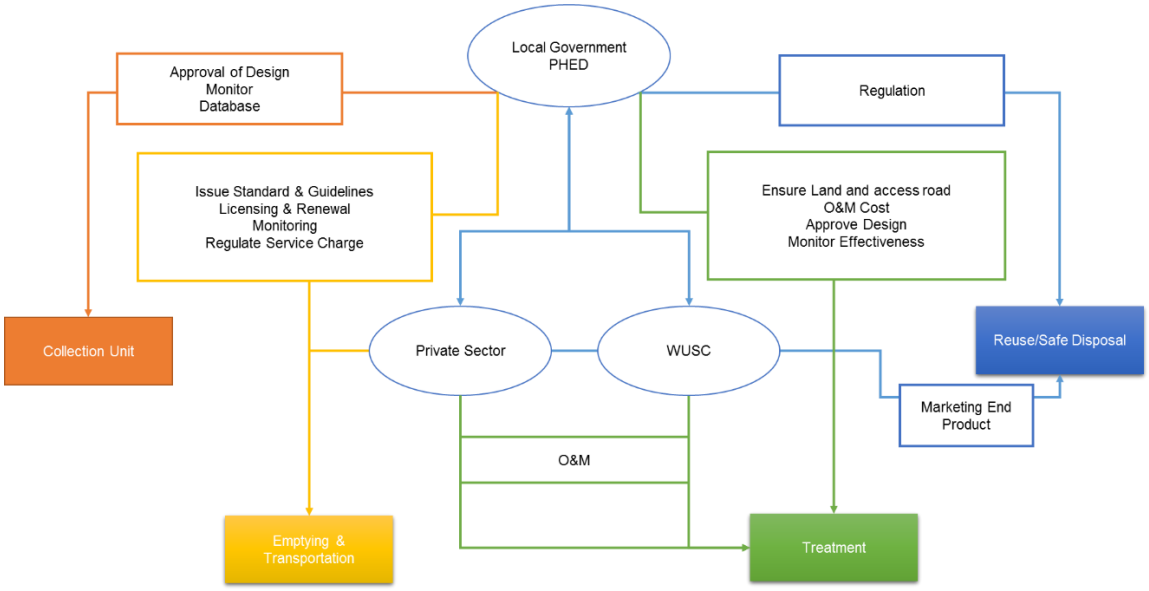

Figure 3: Roles and responsibility of local government (municipality) for FSM.

2.1.3 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 (MOPPW, 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).

Nepal Water Supply Corporation (NWSC) formed under the Nepal Water Supply Corporation Act, 1990 is the major water supply service provider in the municipality. NWSC has served 41% of the population in the municipality mainly in 10 wards out of total 24 wards through 2478 households' private taps and 56 public taps (MoWSS, 2016). While the municipality has been providing desludging services from its sanitation section since 2011. It owned the desludging vehicle with a capacity of 4000 litres. Currently, in an average 6 trips of faecal sludge is being emptied every day (KII2, 2019). Similarly, *Sanjay Safety Tank Sarsafi*, an unregistered private

desludging entrepreneur has initiated the service in 2018. In average, 10 households are served in a month (KII4, 2019).

2.1.4 Service standards

The sanitation service standards have been proposed in the draft Nepal Water Supply, Sanitation and Hygiene Sector Development Plan (2016-2030). It has classified sanitation services as high, medium and basic based on knowledge and facilities in place. The sanitation service levels with indicators are shown in table 2. However, FSM specific standards have yet to be developed and implemented.

Table 2: 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	✓	✓	✓

Source: MoWSS, 2017

3 Service Outcomes

3.1 Overview

Lahan municipality was declared Open Defecation Free (ODF) zone in 2018. However, the random sampling survey on household sanitation status during 2019 showed that 6.6% of households do not have toilets. Similar reports were published in the national daily paper in 2018 (MyRepublica, 2018). The majority of households have onsite sanitation while 4.3% have offsite sanitation such that toilets are connected to either open-drain or open land. Moreover, toilets in 1.6% of households have been damaged and not used.

3.1.1 Household Level Sanitation System

Household-level sanitation technologies vary in urban and rural areas of the municipality. In urban cluster fully lined tanks, lined tanks with impermeable walls and septic tanks are

common. While in rural areas of the municipality, the majority of households have installed single pits toilets with average 4 concrete rings. Also, remarkable numbers of twin pits have been installed though proper functioning of is a major concern for improvement. Distribution of various types of sanitation technologies installed in households is shown in figure 4.

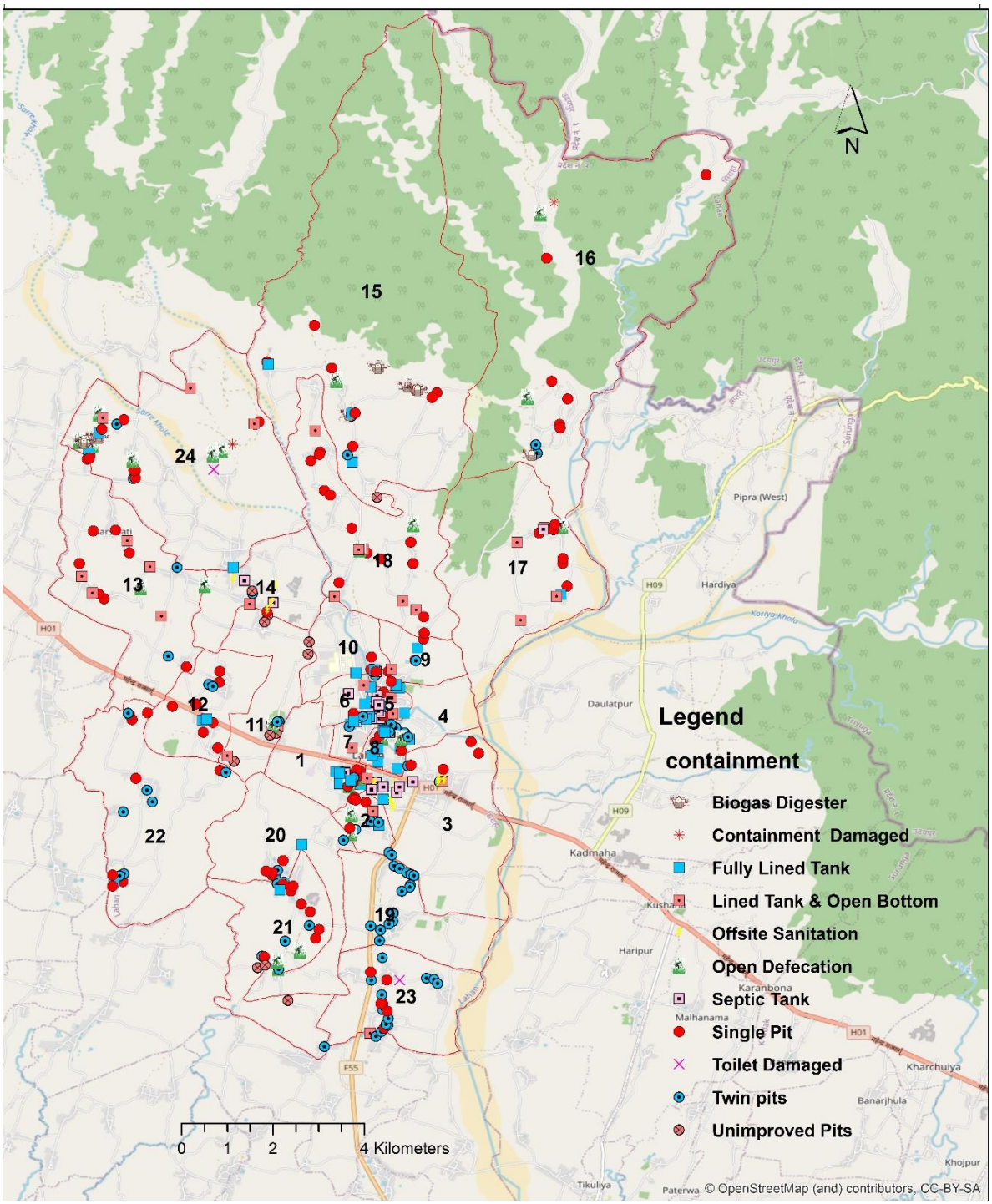

Figure 4: Distribution of various types of sanitation technologies in a household in Lahan Municipality

3.1.2 Institutional Level Sanitation System

It was observed that most of the institutions have been established and operated in the core urban area of the municipality except educational institutions. It was observed that 52.2% of the institutions consists of either fully lined tank or septic tank. While a significant number of institutions also have installed twin pits (21.8%), lined tank with impermeable walls and open bottoms (27%) and single pits mostly in rural areas (12.6%). Distribution of various types of sanitation technologies in institutional buildings in Lahan municipality is shown in figure 5.

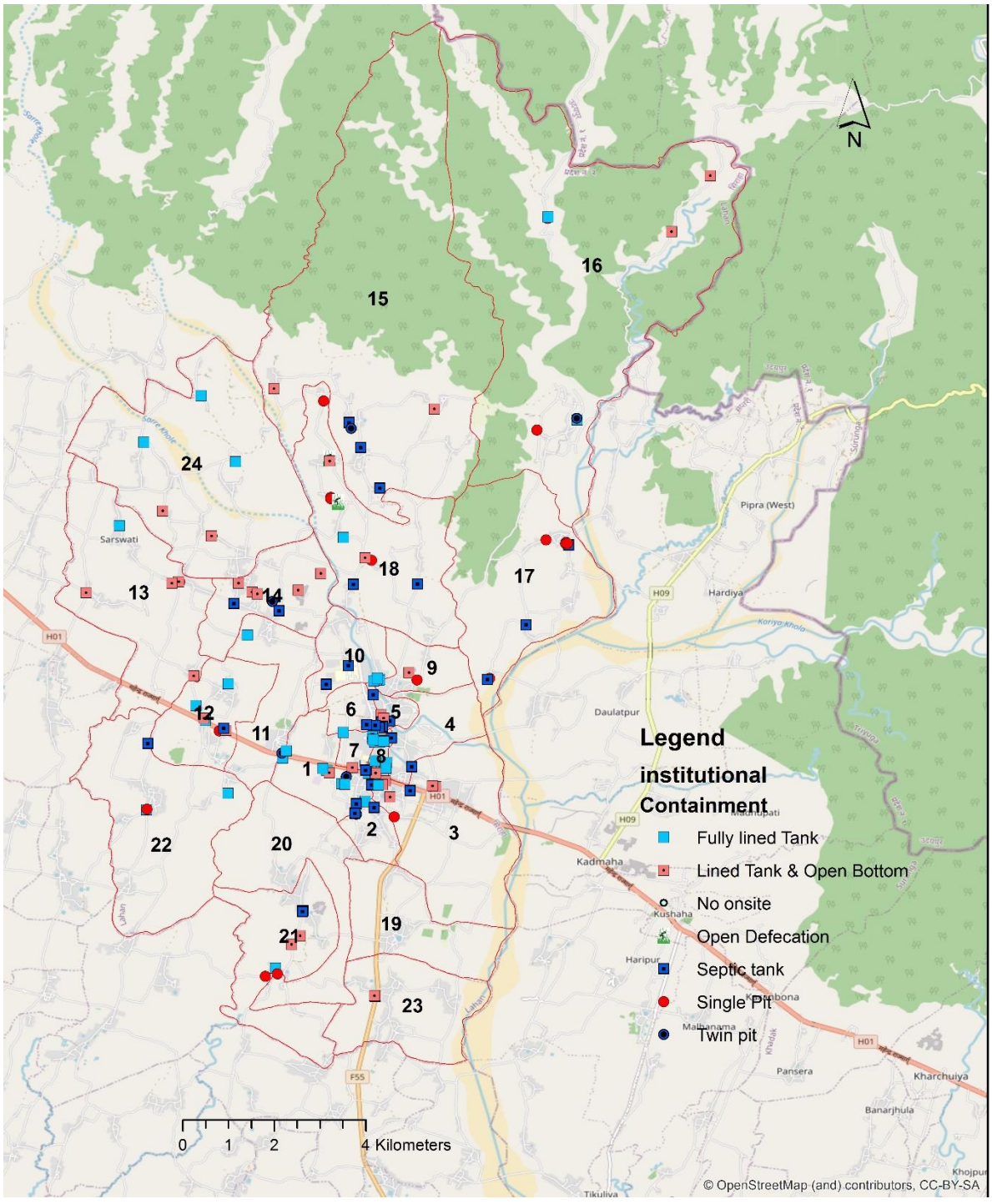

Figure 5: Distribution of various types of sanitation technologies in institutional buildings in Lahan Municipality

The various types of sanitation technologies selected for SFD graphic generator is shown in SFD selection grid in figure 6.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B					Significant risk of GW pollution Low risk of GW pollution	T1A1C6				Not Applicable
Septic tank					T2A2C5 T1A2C5	T1A2C6		T1A2C8	T1A2C9	
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					T1A3C10
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution					T2A4C10 T1A4C10
Lined pit with semi-permeable walls and open bottom	Not Applicable									T2A5C10 T1A5C10
Unlined pit										T2A6C10 T1A6C10
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										
User interface failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded									T1B10 C7 TO C9	
No toilet. Open defecation	Not Applicable								T1B11 C7 TO C9	Not Applicable

Figure 6: SFD selection grid for Lahan Municipality.

3.2 SFD Matrix

Figure 7 shows the SFD matrix of Lahan Municipality with a proportion of faecal sludge in a septic tank, fully lined tank and open bottom tanks. Also, it shows the proportion of the population using the different types of sanitation systems and information on the proportion of faecal sludge emptied, transported and treated. The proportions of FS in septic tanks, fully lined tanks and lined tanks/all types of pits (step two of the graphic generator) were set 92%, 100% and 100% respectively according to the relative proportions of the systems in the municipality as per SFD PI method.

Lahan, Province 2, Nepal, 6 Sep 2020. SFD Level: 2 - Intermediate SFD
Population: 86195
Proportion of tanks: septic tanks: 92%, fully lined tanks: 100%, lined, open bottom tanks: 100%

System label	Pop	W4c	W5c	F3	F4	F5	S4e	S5e
System description	Proportion of population using this type of system	Proportion of wastewater in open sewer or storm drain system, which is delivered to treatment plants	Proportion of wastewater delivered to 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 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
T1A1C6 Toilet discharges directly to open drain or storm sewer	4.0	0.0	0.0					
T1A2C5 Septic tank connected to soak pit	1.0			60.0	0.0	0.0		
T1A2C6 Septic tank connected to open drain or storm sewer	1.0			66.0	0.0	0.0	0.0	0.0
T1A2C8 Septic tank connected to open ground	1.0			80.0	0.0	0.0		
T1A2C9 Septic tank connected to 'don't know where'	2.0			0.0	0.0	0.0		
T1A3C10 Fully lined tank (sealed), no outlet or overflow	15.0			45.0	16.0	85.0		
T1A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow	4.0			9.0	0.0	0.0		
T1A5C10 Lined pit with semi-permeable walls and open bottom, no outlet or overflow	29.0			18.0	0.0	0.0		
T1A6C10 Unlined pit, no outlet or overflow	2.0			45.0	0.0	0.0		
T1B10 C7 TO C9 Containment (septic tanks, fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded - connected to water bodies, or open ground or 'don't know where'	1.0			0.0	0.0	0.0		
T1B11 C7 TO C9 Open defecation	6.0							
T2A2C5 Septic tank connected to soak pit, where there is a 'significant risk' of groundwater pollution	1.0			75.0	0.0	0.0		
T2A4C10 Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	5.0			4.0	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	26.0			20.0	0.0	0.0		
T2A6C10 Unlined pit, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	2.0			34.0	0.0	0.0		

Figure 7: SFD matrix of Lahan Municipality.

3.2.1 SFD Matrix Explanation

The sanitation technologies and the corresponding percentage of the population using those systems in the municipality are shown in table 3.

Table 3 Sanitation technologies with SFD reference variable and percentage of the population using each type

S.N.	Sanitation Technologies	SFD Reference Variable	Percentage of Population
	User interface discharges directly to open drain or storm sewer	T1A1C6	4%
1	Septic tank connected to soak pit	T1A2C5	1%
2	Septic tank connected to open drain or stormwater	T1A2C6	1%
3	Septic tank connected to open ground	T1A2C8	1%
4	Septic tank connected to don't know where	T1A2C9	2%
5	Fully lined tank (sealed)	T1A3C10	15%
6	Lined tank with impermeable walls and open bottom, no outlet or overflow,	T1A4C10	4%
7	Lined pit with semipermeable walls and open bottom, no outlet or overflow,	T1A5C10	29%
	Unlined pit, no outlet or overflow	T1A6C10	2%
8	Containment (septic tanks, fully lined tanks, partially lined tanks and pits, and unlined pits) failed, damaged, collapsed or flooded – connected to water bodies, or open ground or “don’t know where”	T1B10C7 to C9	1%
9	Open defecation	T1B11C7 To C9	6%
10	Septic tank connected to soak pit, where there is a significant risk of groundwater pollution	T2A2C5	1%
11	Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a significant risk of groundwater pollution	T2A4C10	5%
12	Lined pit with semipermeable walls and open bottom, no outlet or overflow, where there is a significant risk to groundwater pollution	T2A5C10	26%
13	Unlined pit, no outlet or overflow where there is a significant risk to groundwater pollution	T2A6C10	2%

Sanitation technologies referred as T1AxCy and T2AxCy, where Ax is types of sanitation system such as septic tank, fully lined tank and so on, and Cy represents the connection of effluents such as soak pit, sewer network, no outlet and so on. Here, sanitation technologies under T1 represent the technologies which have low risk towards potential groundwater

contamination. While T2 types of sanitation technologies have a high risk of groundwater contamination in the given geographical context and types of water sources used for drinking.

The technically appropriate installation of a septic tank is used by 5% of the population in the municipality. However, only 1% of these have connected effluent to soak pit. Similarly, 15% of the population use toilet connected to a fully lined tank which includes 2% of anaerobic biogas digester is considered as low risk to groundwater contamination. The anaerobic biogas digester is assumed to be fully lined tank which is emptied regularly and capable of self-treatment of the sludge.

Figure 8: Fully lined tank at household in Lahan Municipality

The people living in the newly constructed buildings in emerging urban areas used lined tank with impermeable walls and open bottoms without outlet and overflow as shown in figure 8. In an aggregate, 9% of the population used the lined tank and impermeable walls and open bottom among which only 55% has high risk towards potential groundwater contamination. Whereas, the majority of the population living in both urban and rural area used either twin pits or single pit constructed from concrete rings as shown in figure 9. These twin pits and single pits are considered as line pits with semi-permeable walls and open bottoms, it accounts for 55% of total sanitation technologies. Among these almost 50% of such technologies are inappropriate regards to the higher rate of seepage, regular flooding and inundation and source of drinking water. In the poor community, 4% of people still used unlined pits.

Figure 9: Twin pit and single pit installed at households in Lahan Municipality

3.2.2 Risk of Groundwater Pollution

The risk of groundwater pollution is assessed according to the following explained criteria.

i. Sources of Drinking Water and Water Production

Drinking water in the core urban area of Lahan Municipality has been supplied with piped drinking water supply schemes since the 1980s. The schemes have been upgraded and operated by Department of Water Supply and Sewerage (DWSS) till 1998. Currently, the scheme is being operated by Nepal Water Supply Corporation (NWSC) and served only 10 wards of the municipality (MoWSS, 2016).

The survey in 2019 showed approximately 30% of the households were benefitted from the water supply schemes and almost 70% rely on hand pumps or tube wells.

ii. The vulnerability of the aquifer and Lateral Spacing between sanitation systems and groundwater source

The municipality is located in the Terai region in between Chure range in north and Dundwa range of Siwalik in the south. The region consists of fluvial sedimentary rocks that are soft, loose and easily erodible. They are represented by sandstone, siltstone, mudstone and conglomerate. Further, at lower region towards the south, it comprises of fine-grained red, ash grey, grey and reddish-brown sandstone (Dhakal S, 2014). The fluvial deposits such as sandy sediments increase the higher permeability and thus risk of shallow groundwater contamination (BGS, 2001). Thus, depth of hand pumps installed at households with a lined tank with impermeable walls and open bottom and lined pits were assessed.

Data on water quality of groundwater is unavailable, however, the risk on water contamination could be estimated concerning lateral spacing and depth of the source of drinking water and containment. It was observed 8.68% and 66.42% of households consuming water from hand pumps have installed the lined tank and open bottom and lined pits with semipermeable walls and open bottoms (twin, single or unimproved) respectively.

It was observed that among 8.68% of households depending on hand pumps for drinking water and having containment type of lined tank with impermeable walls and open bottoms, 17% of hand pumps extract groundwater from the depth of fewer than 20 feet (6.09 m). Similarly, 66% of hand pumps extract groundwater from a depth of 80 feet (12.19 m) while remaining pumps out from depth greater than 80 feet (24.38 m) as shown in figure 10. Similarly, among 66.4% of households depending on hand pumps for drinking water and having lined pits with semi-permeable walls and open bottoms, 31%, 30% and 39% have extracted water from the depth of less or equal to 20 feet (6.09 m), 40 feet (12.19 m)and 60 feet (18.28 m), respectively as shown in figure 11.

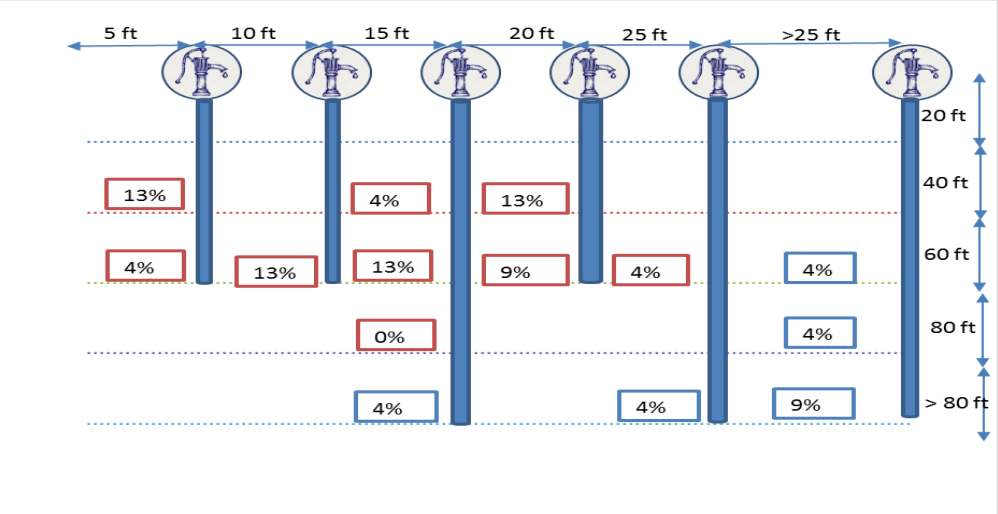

Figure 10: Depth of hand pumps and lateral spacing of it with containment type lined tank with impermeable wall and open bottom.

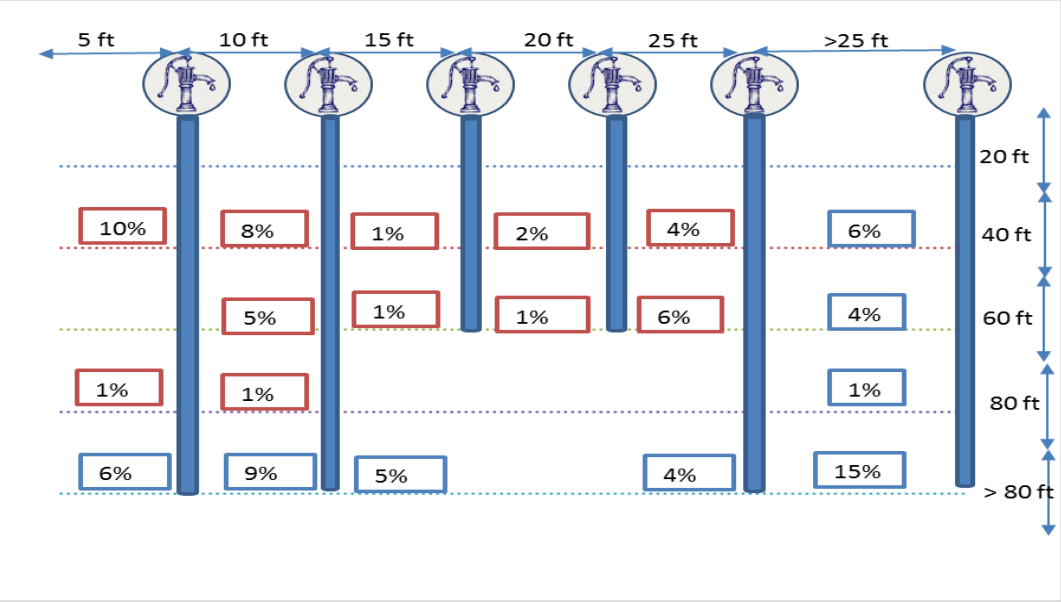

Figure 11: Depth of hand pumps and lateral spacing of it with containment type lined the pit with semi-permeable wall and open bottom

Also, the lateral spacing of hand pumps and containments of both lined tank and lined pits with the open bottom is as shown in table 4.

Table 4Lateral spacing of source of drinking water and containments

S.N.	Types of Containment	5 – 10 ft. (1.52-3.04m)	10 – 15 ft. (3.04-4.57m)	15 – 20 ft. (4.57-6.09m)	20 – 25 ft. (6.09-7.62m)	More than 25 ft. (7.62m)
1	Lined tanks with impermeable walls and open bottom	40%	17%	16%	10%	17%
2	Lined pits with semi-permeable walls and open bottom	38%	24%	9%	10%	19%

3.2.3 Emptying of Faecal Sludge

Emptying is one of the major components of the sanitation value chain. It ensures proper functioning of containment basically for a septic tank which functioned well until the volume of sludge is one-third of the total volume of the tank. Also, in other containments, regular emptying prevents overflow of the sludge and blockages. However, anaerobic biogas digester has been designed such that treated slurry is automatically overflowed from the outlet chamber which is used as manure. Thus, the toilet connected to anaerobic biogas digester has been assumed as regularly emptied.

Both traditional manual scavenging and mechanical emptying of the containments are practised in the municipality. Altogether 29.5% of the sanitation technologies have been emptied at least once after installation. The sanitation technology and its emptied portion are given in table 5.

Table 5 Sanitation technologies and an emptied portion of FS

S.N.	Sanitation Technology	Emptied Portion
1	**Septic tanks**	**3.46%**
2.	**Fully Lined Tan (sealed)**	**5.8%**
3.	**Lined tank with Impermeable walls and open bottoms**	**1.06%**
4.	**Lined pits with semipermeable walls and open bottoms**	**17.8%**
5.	**Unlined Pits**	**1.3%**
6.	**Total**	**29.5%**

The data shows lined pits with semipermeable walls and open bottoms are mostly empty as the average size of such containment is only 2.3 cubic meter and inflow of water during frequent inundation (ENPHO, 2019).

All septic tanks either connected to soak pit without significant risk to groundwater (T1A2C5) or with significant risk to groundwater pollution (T2A2C5), open-drain or storm sewer (T1A2A6)

and open ground (T1A2C8) are emptied at least once after installation. Among these proportion of FS emptied from T1A2C8, T1A2C6, T1A2C5 and T2A2C5 are 80%, 66%, 60% and 75% respectively. While septic tank where the connection is unknown has never been emptied.

Similarly, a portion of FS emptied from a fully lined tank (T1A3C10) is 45% has been emptied. Among these only 16% i.e. proportion of FS collected in anaerobic biogas digester considered as the fully lined tank is assumed to be transported and 85% of it is treated. Whereas, lined tank with impermeable walls and open bottom is least emptied, the data revealed on 9% and 4% of FS in T1A4C10 and T2A4C10 is emptied.

However, lined pits with semipermeable tanks without outlet or overflow is frequently emptied primarily due to average size of 2 cubic meter and inflow of stormwater during frequent inundation. The portion of FS emptied from T1A5C10 and T2A5C10 are 18% and 20% respectively. Also, unlined pits are emptied frequently.

3.2.4 Transportation, Treatment and Disposal/Reuse of Faecal Sludge

The FS emptied by either the sanitation section of the municipality or private desludging entrepreneur is transported to disposal site as shown in figure 12. While the manually emptied FS is dumped into a pit bored in nearby agricultural land. The municipality lacks proper treatment facility. It has bored a big pit located at the solid waste dumping site. The site is used by the sanitation section for disposing of faecal sludge. Whereas the private desludging entrepreneur disposed into the Balan River or agricultural land (KII1, 2019).

Figure 12 Disposal site at Solid Waste Landfill Site in Lahan Municipality

3.3 SFD Graphic

Figure 13, the SFD graphic for Lahan shows that 38% and 62% of faecal sludge is being safely and unsafely managed respectively. Among the safely managed FS, only 1% is being treated from household anaerobic biogas digester considered as a fully lined tank (sealed) while rest

is being stored safely in the containment which has low risk towards groundwater pollution. The portion of unmanaged FS (62%) accounts to:

i. Haphazard disposal of wastewater water,

ii. The emptied portion of FS from the containment with either low or high risk to groundwater pollution but not transported to the treatment plant

iii. FS poorly stored in the containment with the high risk towards groundwater pollution and

iv. The portion of FS from open defecation.

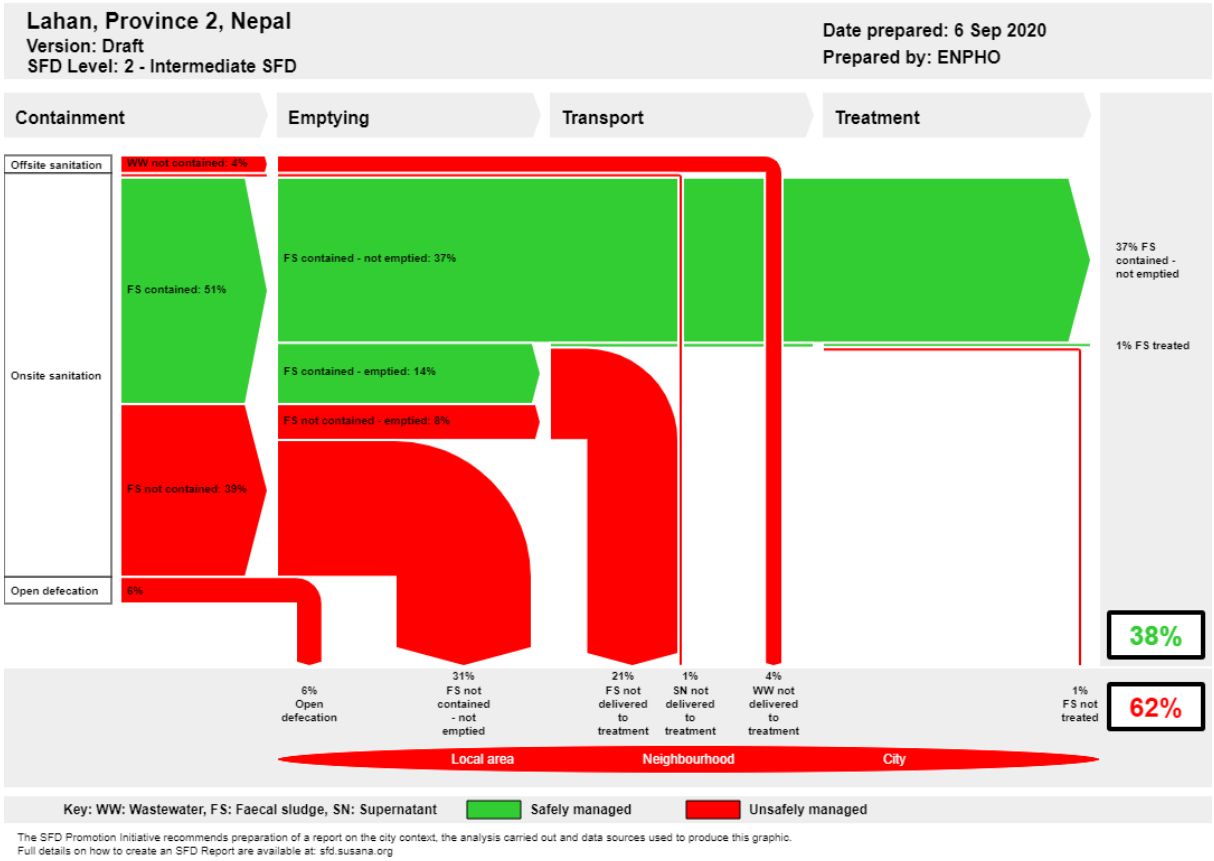

Figure 13: SFD graphic of Lahan Municipality.

Offsite and Onsite Sanitation System

A sanitation system in which excreta/wastewater is collected and transported away from the plot where they generate is defined as offsite sanitation system. It relies on sewer technology for transport. Nepal Demographic and Health Survey reported that 6.9% of the urban population in the country have offsite sanitation systems connected to piped sewer networks (MoH, Nepal, New ERA and ICF, 2017). However, no piped sewer networks have been developed in Lahan Municipality. Although, 4% of households have an illegal connection of their toilets directly discharged into an open drain or stormwater drainage. Thus, the portion of the wastewater not contained is 4% due to improper means of transport where transmission of the pathogen to the user or general public is high.

A sanitation technology or sanitation system in which excreta is collected, stored, emptied from or treated on the plot where they are generated is termed as onsite sanitation system. In Lahan municipality, 90% of the population rely on onsite sanitation system.

The proportion of FS Contained and FS contained emptied

FS contained is defined by SFD PI regarding WHO as faecal sludge stored in sanitation technology and or system which ensures a safe level of protection from excreta i.e. pathogen transfer to the user or general public is limited. Thus, faecal sludge stored in the septic tank connected to soak pit, fully lined tanked (sealed), lined tank with impermeable walls open bottoms without significant risk to groundwater pollution and lined/unlined pit without significant risk to groundwater pollution is considered FS contained. Thus, the proportion of FS contained in Lahan municipality is 51% as shown in table 6.

The proportion of FS emptied (F3) from these FS contained sanitation technologies are shown in table 5. Thus the sum of the resultant proportion of FS contained emptied is 14% whereas the sum of FS contained not emptied primarily due to never emptied sanitation technologies and remaining FS during the emptying process is 37%. The proportion of FS contained not emptied is considered to be safely stored in the SFD graphic represented by the green arrow.

Table 6 Sanitation technologies and proportion of FS contained and FS emptied

Sanitation technologies	SFD Reference Variable	The proportion of FS contained	The proportion of FS emptied (F3)	Proportion FS-contained emptied
Septic tank connected to soak pit	T1A2C5	1%	60%	0.6%
Fully lined tank	T1A3C10	15%	45%	6.75%
Lined tank with impermeable walls and open bottom, no outlet or overflow,	T1A4C10	4%	9%	.36%
Lined pit with semipermeable walls and open bottom, no outlet or overflow,	T1A5C10	29%	18%	5.22%
Unlined pit, no outlet or overflow	T1A6C10	2%	45%	0.9%
Total		**51%**		**14%**

Also, only 1% of the FS contained emptied is transported and treated as the anaerobic biogas digester assumed as fully lined tank (sealed) is capable of treating faecal sludge effectively and efficiently onsite.

The proportion of FS not contained and FS not contained emptied

FS stored in the inappropriate sanitation technologies where the transmission of the pathogen to the user and the general public is higher is considered as FS not contained. The portion of FS – not contained stored in the inappropriate sanitation technologies with a high risk to

groundwater pollution is 39% as shown in table 6. Also, the resultant proportion of FS not contained emptied is 8% as shown in table 8.

Table 7 Description of the percentages of the SFD graphic

Sanitation technologies	Variable	The proportion of FS not contained	The proportion of FS emptied (F3)	Proportion FS-not contained emptied
Septic tank connected to soak pit, where there is a significant risk of groundwater pollution	T2A2C5	1%	75 %	0.75%
Septic tank connected to open drain or stromwater	T1A2C6	1%	66%	0.66%
Septic tank connected to open ground	T1A2C8	1%	80%	0.80%
Septic tank connected to don't know where	T1A2C9	2%	0%	0.00%
Lined tank with impermeable walls and open bottom, no outlet or overflow, where there is a significant risk of groundwater pollution	T2A4C10	5%	4%	0.20%
Lined pit with semipermeable walls and open bottom, no outlet or overflow, where there is a significant risk to groundwater pollution	T2A5C10	26%	20%	5.2%
Unlined pit, no outlet or overflow where there is a significant risk to groundwater pollution	T2A6C10	2%	34%	0.68%
Damaged containment	T1B10C7 to C9	1%	0%	0.00%
Total		**39%**		**8%**

FS emptied not delivered to the treatment plant

Lahan municipality does not have a faecal sludge treatment plant. Thus the FS emptied from either FS contained or FS not contained sanitation technologies are disposed of without any treatment. The FS emptied and transported by the municipal sanitation service is disposed into open-pit located at solid waste treatment plant whereas the private desludging operator disposed directly into either river bank or barren land. In aggregate, 21% of FS emptied are

not delivered into the treatment plant and possess the high risk of transmission of the pathogen to the general public.

Open Defecation

Despite declaring Open Defecation Free zone, approximately 6% of the population practice open defecation in the nearby jungles, rivers and open spaces.

4 Stakeholder Engagement

4.1 Key Informant Interviews

The KIIs and sharing of the objective of the study were conducted with the major stakeholders in the sanitation sector in the municipality as shown in Figure 14. Staffs from sanitation section of the municipality were interviewed on current sanitation services. Also, an engineer from Lahan municipality was interviewed to understand current sanitation services provided by the municipality.

Figure 14: Interview with municipal officials from Lahan Municipality

Similarly, ward chairperson from ward number 15 was interviewed to understand sanitation status at the local level.

Also, the proprietor of *Sanjay Safety Tank Sarsafi* was interviewed on emptying services and disposal practices in the municipality as shown in figure 16. The interview was mainly focused on their current service area, several emptying vehicles, its registration, service charges and challenges they faced in the business.

Figure 15: Interview with ward chairperson

Figure 16: Interview with the proprietor of a private desludging entrepreneur in Lahan Municipality

4.2 Household Survey

A random household survey was conducted in all wards of the municipality through the mobilization of volunteers selected by the municipality. The household survey was conducted using a mobile application “KOBOCOLLECT” after orientation. Two days orientation training was conducted to make volunteer understand the objective of the survey, technical terms regarding sanitation, use of the mobile application and conducting random sample survey as shown in figure 17.

Figure 17: Local volunteer conducting a questionnaire survey.

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 $n_o = \frac{Z^2pq}{e^2}$ and its finite population correction for the proportion $n = \frac{n_0}{1+\frac{(n_0-1)}{N}}$.

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 since 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

$n_h = \frac{N_h}{N} \times n$, where, N_h is a total population in each stratum.

Thus, a total of 375 households were sampled from 17,239 households distributed in 24 wards with proportionate stratification random sampling as shown in Appendix 5.

4.2.2 Direct Observation

Various sanitation technologies in the households in all the wards were observed and visual references were kept. Also, observation of the emptying and transportation of the containments was carried out. The disposal site of both the municipality and private entrepreneur was observed during the usage.

4.2.3 Sharing and Validation of Data

The sharing and validation of findings on sanitation status were conducted in the municipality hall participated by the mayor, ward chairpersons, general members of the municipal council and other relevant stakeholders, shown in Figure 18. The participants responded that the findings of this study reflected the current sanitation situation of the municipality. The program was also participated by the executive director of a Municipal Association Nepal (MuAN) and suggested to develop FSM plan and effectively implement it to provide sustainable sanitation services in the municipality. The list of participants with their designation is attached in Appendix 7.

Figure 18: Sharing and validation of findings of a household survey in Lahan Municipality.

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

Table 8 Roles and responsibility of various tiers of governments delineated in draft 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: Number of Institutions in the survey

Table 9 Number of surveyed institutions

Ward	Financial Institutions	Hotel/ Home Stay	Commercial Buildings	Educational Institutions	Government /Non-government Office	Community Buildings	Health Care Center	Total
1		2		8	1			11
2				3	2			5
3	2			4	1		4	11
4				5				7
5				2	1		2	5
6				2				
7	2	4	4	2	5	2	1	20
8	1	1		5	1			8
9				1		1		2
10				3	1	1	2	7
11	2			1	1			
12	1			3	1	1	1	
13				4	2			
14				4	4		1	
15				5			1	
16				5	1		1	
17	1			5	2	1	1	
18				7		3	1	

19				4				
20				2				
21				4	2		2	
22				3	1			
23					1	1	1	
24				4	1		1	
Total	9	7	6	82	28	10	19	159

7.3 Appendix 3: Stakeholder identification

Table 10 Stakeholder identification

S.N.	Stakeholder group	In Lahan Municipality context
1	Municipal Council	Municipal Council, Lahan Municipality
2	Ministry in charge of water supply and sanitation	Department of Water Supply and Sewerage Management
3	Ministry in charge of environmental protection	Department of Environment
4	Service provider for drinking water	Nepal Water Supply Corporation
4	Service provider for solid waste management	Sanitation Section of Lahan Municipality
5	Service provider for construction of onsite sanitation	Local masons
6	Service providers for emptying and transportation	Sanitation section of Lahan Municipality, Private mechanized emptying service entrepreneurs
7	Service provider for operation and maintenance of treatment infrastructure	N/A
8	Market participants practising end-use of FS end products	N/A
9	Service provider for disposal of FS (sanitary landfill)	Sanitation section of Lahan Municipality, Private mechanized emptying service entrepreneurs
10	External agencies associated with FSM services	Municipal Association of Nepal, Environment and Public Health Organization

7.4 Appendix 4: Tracking of Engagement

Table 11 Tracking of stakeholder engagement

S.N.	Name of Organization	Person	Designation	Date of Engagement	Purpose of Engagement
1	Lahan Municipality	Munni Shah Suri	Mayor	24th February 2019	KII (1)
2	Lahan Municipality	Rajkumar Shah	Ward Chairperson, 11	24th February 2019	KII (2)
3	Sanitation Section, Lahan Municipality	Satrudhan Chaudary	Engineer Focal Person	24th February 2019	KII (3)
4	Sanjay Septic Tank Sarsafi	Shiv Kumar	Proprietor	2nd March 2019	KII (4)
5	Lahan Municipality		Local Volunteers	19 to 24 April 2019	Household survey

7.5 Appendix 5: Number of household in each ward and sampled number of household

Table 12 Number of total households in each ward and sampled households

Ward	Households	Sample	Wards	Households	Sample
1	**950**	**21**	**13**	**752**	**16**
2	**475**	**10**	**14**	**406**	**9**
3	**845**	**18**	**15**	**979**	**21**
4	**823**	**18**	**16**	**494**	**11**
5	**905**	**20**	**17**	**576**	**13**
6	**537**	**12**	**18**	**1017**	**22**
7	**456**	**10**	**19**	**745**	**16**
8	**540**	**12**	**20**	**676**	**15**
9	**398**	**9**	**21**	**740**	**16**
10	**550**	**12**	**22**	**993**	**22**
11	**616**	**13**	**23**	**870**	**19**
12	**531**	**12**	**24**	**1365**	**30**
Total					**376**