CWIS BASED ASSESSMENT OF SANITATION INTERVENTION & IMIS INVESTMENT PLAN, BIRENDRANAGAR MUNICIPLAITY

SUBMITTED | 8 FEBRUARY 2022

TA SUPPORT TO WORLD BANK FUNDED DESIGN AND IMPLEMENTATION OF SANITATION COMPONENT FOR NEPAL WATER GOVERNANCE & INFRASTRUCTURE SUPPORT PROJECT (NWGIP)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Background and Scope
The current study is part of the Nepal Water Governance & Infrastructure Support Project (World Bank-supported) and in continuation of phase-1 findings report of 'rapid assessment of sanitation situation assessment with respect to CWIS for Birendranagar Municipality'. The scope includes an understanding of settlement level sanitation interventions followed by broad technological recommendations with financial estimates for both sewer and non-sewer areas and mechanisms of improved service delivery through the Integrated Municipal Information System (IMIS).

Approach, Process and Output
Based on collected data from various sources (literature review, data, and information from secondary sources, GIS analysis, KII with various stakeholders, primary data collection from field surveys), the data framework for CWIS planning for Birendranagar municipality has been established. The data framework helps to understand the CWIS situation of the town, and it is the basic source of information for overall analysis and planning for this assignment.

Geo-spatial information has been analyzed for undertaking three stages of suitability analysis to arrive at the final settlement categorized for sewer and non-sewer interventions. Flood risk, water sensitive settlements, and similarly high-rise buildings (>G+2), institutions, and commercial complexes within non-sewer interventions are further prioritized for greywater management and this entire category is called 'FS+ Greywater management. Settlement excluding 'FS+ Greywater' management category within NSS zone are relevant for FSM and would continue to rely on emptying of tank containment (as prioritizing black water handling). These three-stage settlement level output of sewer, FS+ Greywater management, and FSM are forming the base of final sanitation interventions of Birendranagar municipality. The output indicates the suitability of building with 37% as sewerage, 7% for FS+ Greywater management, and 56% for FSM interventions. Suitability analysis has laid the foundation for developing technological recommendations for both sewer and non-sewer systems.

Summary of key highlights and output map is presented in the infographics below.

Based on newly discovered GIS datasets, data gap assessments (in terms of data availability) has been performed. The analysis indicates that many datasets required for IMIS implementation are readily available. An improved service delivery approach best suited for the municipality has been proposed so that municipality could effectively monitor the entire sanitation value chain using an IT-enabled real-time monitoring system. The approach envisaged a unified help desk that forward lodged applications to a service provider with an auto-forwarding module integrated within IMIS. Data are collected in real-time through web/mobile applications from relevant stakeholders and securely stored in IMIS during service delivery. Once the approach is endorsed by the municipality, IMIS needs to be customized to incorporate the improved service delivery approach in IMIS. The revised estimated cost of implementing IMIS is USD 156K. Based on consultations with NWASH development team, a conceptual model that facilitates a data-sharing mechanism between IMIS and NWASH for illustrating the CWIS status of municipalities through a dashboard has been proposed.

Technological Interventions and Cost Estimates
Understanding the cumulative wastewater generation volume of 6 MLD from core settlement area (sewerage area) and factoring slope terrain, two wastewater treatment plants of 3.6 MLD and 2.4 MLD of activated sludge process-based technology are proposed to efficiently handle the effluent loads. The wastewater treatment plant based on activated sludge process (ASP) has been recommended for both the location considering the land requirement, ambient climate compatibility, and the technology adopted by other cities in Nepal.

Similarly, three categories (i.e., urban poor households, institutional premises, and co-treatment/co-handling at WTP) are prioritized for NSS level interventions. NSS interventions includes recommendation of drafting new sanitation regulations of Birendranagar and factoring user paying capacity for mainstreaming entire user populations with safe sanitation access.

Based on KII and during field visits, it was observed that most of the urban poor households have pit-latrine. This was also observed in a recent study undertaken by SNV Nepal and during the Phase I Rapid assessment report by TA-Hub. Urban poor of various ground conditions including flood risk area (102 HHs), water-sensitive area (213 HHs), in-accessible regions (1844) and other poor households (2884) are suggested to have modules of interventions like elevated and lined containment, twin-pit toilets with soak/magic pit/kitchen garden set-up to take-care of both grey and black water management.

Further, a total of 102 institutions residing outside the delineated sewerage area consisting of schools, colleges, hospitals, offices, etc. are recommended for the installation of DEWATS. This set-up will take care of high waste-water volume treatment and with the reduced desludging frequency, operation costs are likely to substantially go down and save significant costs for emptying operations in long run. It was also observed during proximity analysis from existing FSTP, some of the settlements are remotely located (more than 45-60 mins travel distance) and to accommodate the need for additional treatment capacity (as highlighted in the study undertaken by SNV Nepal) and smooth sludge disposal in proximity, it is also suggested to have a co-treatment facility at both WTP.

It was also observed during proximity analysis from existing FSTP, some of the settlements are far located (more than 45-60 mins travel distance) and to accommodate the need for additional treatment capacity (as highlighted in the study undertaken by SNV Nepal) and smooth sludge disposal in proximity, it is also suggested to have a co-treatment at both WTP to supplement the drive of safe access and disposal facility for all tank emptying.

Summary of overall sanitation intervention cost: NSS & SS

DESCRIPTION	AMOUNT (IN MILLION NPR)	AMOUNT (IN MILLION USD)
NSS Interventions		
Urban Poor Households	266	2.25
Institutions	414	3.51
Co- Treatment/Co-handling Facility	7	0.06
Total Cost	**687**	**5.82**
SS Interventions		
Wastewater Treatment Plant	288	2.44
Sewer Network	1843	15.62
Land for wastewater treatment plant	93	0.79
Total Cost	**2225**	**18.85**
Grant Total cost	**2912**	**24.67**
Grant Total cost with VAT @13%	**3291**	**24.67 ~ 25 million USD**

Towards CWIS Planning

Some of the core objectives of CWIS planning have been addressed and visualised through series of spatial assessment i.e. inclusion of urban poor through rational tariff scheme, understanding of the inaccessible region in the municipality for the required need of customized desludging operations with a focus of extending services to all users, sanitation containment improvement schemes with safe sanitation options outreach to all users, sanitation service coverage for ease of emptying and safe disposal at proposed WTP and potential hotspots of wastewater re-use across land-uses. Some of the key statistical assessment includes 5498 economic vulnerable populations in need of financial subsidy for system improvements, 2515 buildings with the need of customized desludging operations, 678 households with the need of elevated toilet containment, 484 institutional needs with on-site wastewater management requirement (preferably with DEWATS) and 58 industrial units (and large agricultural land) for high potential of treated wastewater. Some of these assessments have also been part of an outline of sanitation regulations which can be detailed out in other relevant studies.

Enabling environments required for successful implementation of IMIS to catalyze CWIS planning and achieve the goal of providing safe, equitable, and inclusive sanitation to all have been framed. The municipality must adopt these recommendations to ensure the successful implementation and institutionalization of IMIS.

Implementation strategy

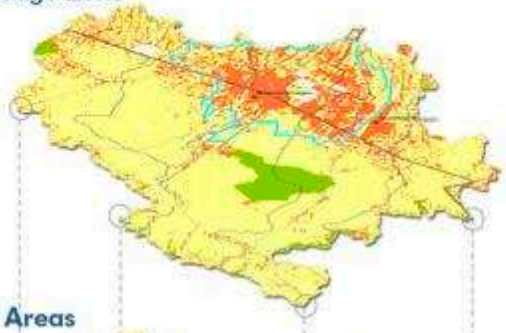
The implementation schedule of the four-year timeline has been worked out while accounting for all proposed interventions across sewer, non-sewer, and IMIS and expecting complete CWIS alliance operations in Birendranagar Municipality.

Proposed Implementation Schedule - Sanitation Interventions (NSS and SS) and IMIS

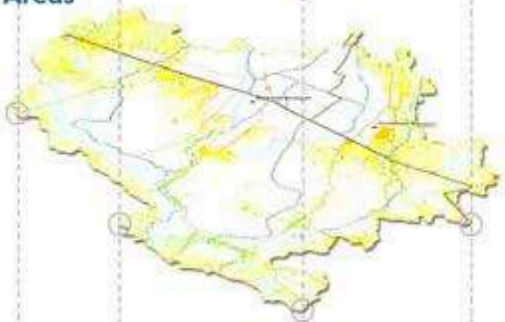
SL. No.	Activities	Year 1 (4 quarter)				Year 2 (4 quarter)				Year 3 (4 quarter)				Year 4 (4 quarter)			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
A.	Non-sewerage																
1.0	Preparatory																
2.0	Enabling Capacity																
3.0	Launch Construction																
4.0	Cohesive operations of SS and NSS																
B.	Sewerage																
1.0	Preparatory																
2.0	Phase I Construction																
3.0	Phase II Construction																
4.0	Testing and commissioning																
C.	IMIS																
1.0	Preparatory																
2.0	Survey and data update																
3.0	IMIS customization and deployment																
4.0	Implementation and maintenance support																

Sanitation Intervention and Key Statistics: Birendranagar Municipality

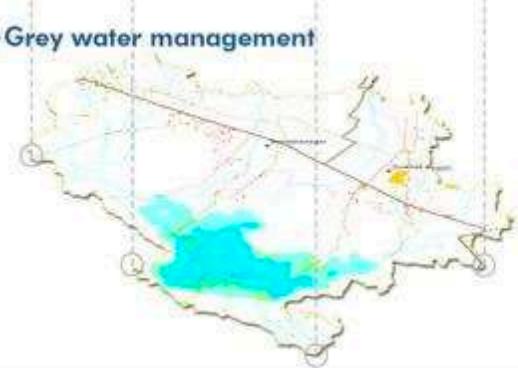
Sewerage Zone

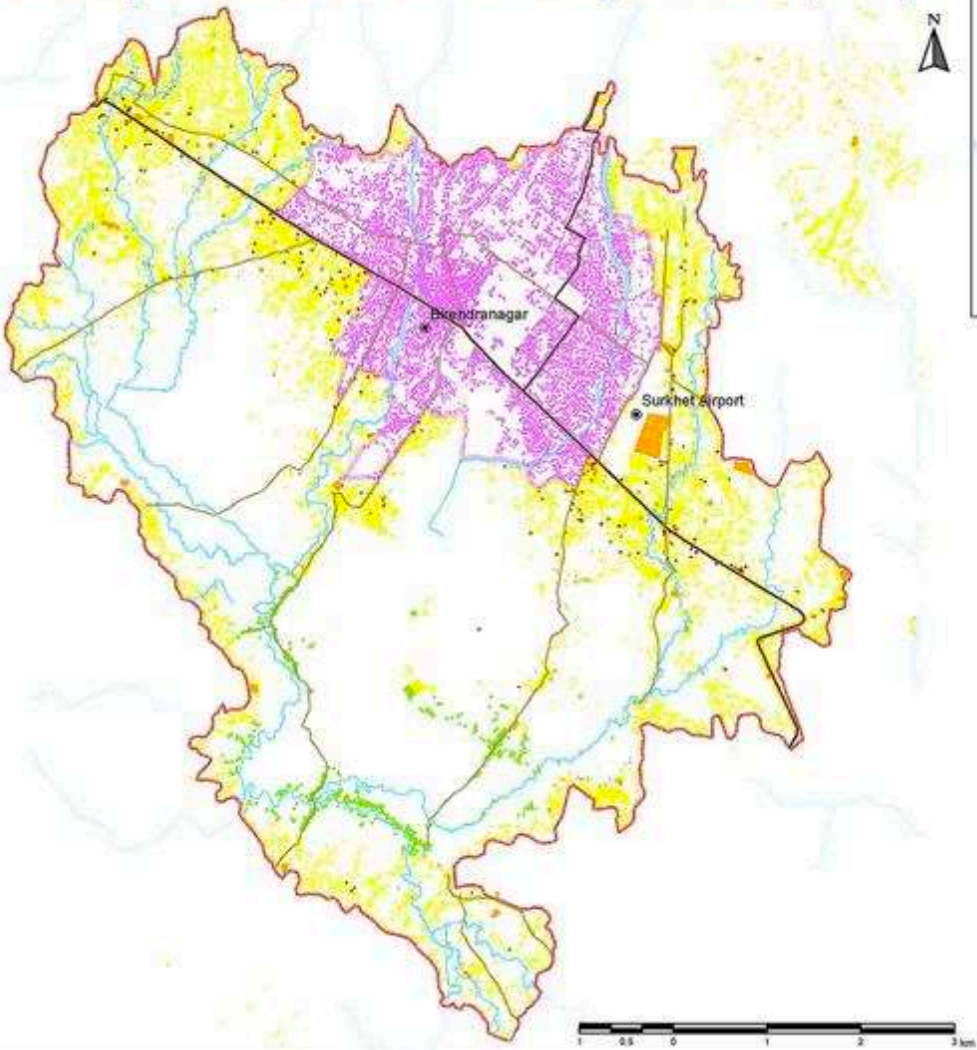


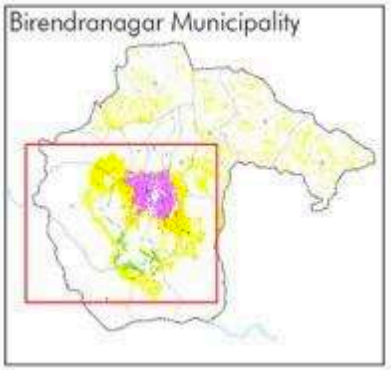
FSM Areas



FS+Grey water management



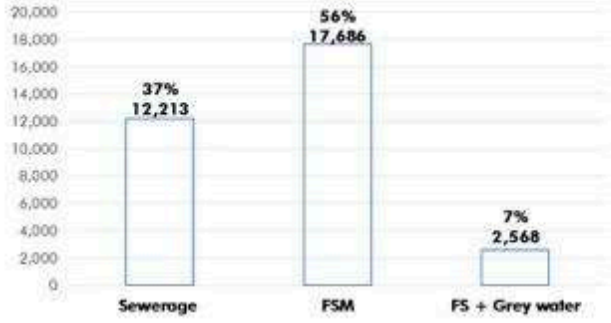




LEGEND

- Sewerage
- FSM
- Flood Prone
- Near Waterbody
- High-rise Building
- Institutions

FS+Grey-water



Sewerage Solutions

12,213 (37%)
Number of Buildings

456
Urban poor

Non-Sewerage Solutions

20,254 (63%)
Number of Buildings

17,686 (56%)
FSM Buildings

2568 (7%)
FS + Grey water Buildings

5,045
Urban poor

678
Flood Affected Buildings

1,385
Water Sensitive Buildings

221
Institutions

CHAPTER I

1. INTRODUCTION

1.1 BACKGROUND

One of the core objectives of Nepal Water Governance & Infrastructure Support Project (NWGIP) is to increase access to improved and climate resilient sanitation in participating local governments. The project has selected Birendranagar Municipality of Surkhet valley to pilot and demonstrate the "municipality wide" model for local WASH service delivery.

As part of phase I, rapid assessment of non-sewered sanitation situation with respect to CWIS has been undertaken to recommend appropriate project approach and recommendations with broad investment sizing. Detail recommendations in total ten thematic area were provided, and it has been able to develop a strong foundation and know-how towards sanitation improvement framework of Birendranagar municipality. Study was completed in July'21. This has been considered as Scenario I for sanitation interventions.

Moving forward, the need for a more comprehensive approach (for identification of possible sanitation interventions in Birendranagar, in-terms of both SS and NSS interventions, and taking urban and per-urban area into considerations) was realized and accordingly phase II of assessment has been launched. This has been considered as Scenario II and has been extensively detailed in this Phase. However, analysis between these two scenarios as which is more beneficial than the other has not been part of this scope and report. For improvement on sanitation service delivery part, the integration needs of NWASH and IMIS was also felt and included as a part of phase II scope of work.

1.2 SCOPE OF WORK – PHASE 2 TECHNICAL ASSISTANCE

As a part of support to the next phase of the NWGIP-WB project in Birendranagar, the scope of work is summarized in terms of two significant task:

A. Towards CWIS Planning of Birendranagar municipality:

- Comprehensive data-base development in line with CWIS framework
- Identification of suitable sanitation interventions through application of multitude of variables such as environmental, socio-economic, climatic vulnerabilities and settlement morphology of project town.
- Broad identification of technologies for identified sanitation interventions
- Tentative implementation and investment plan for identified sanitation and technology interventions

B. Groundwork for IMIS Implementation & Integration with NWASH

- Exploration IMIS Data Availability
- Business Model for integrating IMIS in Sanitation Service Chain
- Investment Plan for IMIS
- Strategy for integrating CWIS data and IMIS with NWASH

1.3 LIMITATIONS

- The spatial analysis was conducted based on the 2019 datasets provided by the Municipality hence, and findings are largely dependent on accuracy of provided database. Any further changes on ground in last two years are not included as part of this analysis. However, small sample validations of key geo-spatial output were cross validated during the filed visit and KIIs.
- The working of cost estimates is based on standard district rate and broad cost estimations has been attempted to arrive the tentative investment figure. Any detailed costing in terms of bill of quantity would be part of detailed engineering report.
- The technological interventions and system volume estimations are driven from suitability analysis and limited to suggestive recommendation which are likely to change post more comprehensive data availability during DPR stage preparations.
- The approach for service delivery is conceptualized based on a rapid assessment of an existing business process based on KIIs with both municipal officials and private entrepreneurs. The proposed approach must be consulted in detail with all relevant stakeholders and necessary modifications/refinements must be incorporated based on stakeholder's feedback.
- For system integration of IMIS with NWASH, a strategy has been proposed. From the initial discussions, it was identified that more extensive discussions with NWASH team is required to finalize intricate details and execution plan for implementing the suggested approach which was not possible within the timeline of this phase.

1.4 REPORT STRUCTURE

Chapter 1 provides the background of the scope under Phase 1 of the technical assistance package, along with the justification for a comprehensive study under Phase 2 and limitations of the assessment.

Chapter 2 highlights the overall approach and methodology for entire study, broken down into three main sections - database collection framework for CWIS driven planning, broad process understanding for zonification of sanitation intervention and IMIS based improved service delivery mechanism vis-à-vis. system integrations with NWASH.

Chapter 3 provides glimpse of all relevant analysis and key results in terms of three key sections:

- delineations of range of sanitation interventions at settlement level and arriving to pan town sanitation interventions output (in terms of sewerage, FS+ greywater handling and FSM) supported by relevant statistics.
- output here is indicative technological interventions across sanitation value chain with proposed system design and broad investment estimations for sanitation interventions for both SS and NSS.
- output is towards IMIS, while capturing highlights of data gap analysis, suggesting improved business process for sanitation system delivery and further recommendations for integrations with NWASH (followed by IMIS investment estimates).

Chapter 4 highlights key enablers across all six principles of CWIS based planning approach and build-upon the key findings of spatial assessments. Some of analysis and key recommendation of chapter includes inclusive service tariff scheme framework, gist of all containment improvement scheme for all NSS settlements, service coverage assessment from existing FSTP and recommendation for efficiency enhancement, IMIS led recommendations for robust service delivery framework and summary of suggested regulatory reform for both SS and NSS system improvements.

Chapter 5 provides an overall implementation scheduling/phasing for all three domain of SS, NSS and IMIS launch.

BIRENDRANAGAR CITY PROFILE

DISTRICT/ PROVINCE: Surkhet District; Karnali Province

1,00,458
Population *(Census 2011)*

1,26,082
(2022)

253.4 km²
Administrative Area

PHYSICAL

3003
Commercial Buildings

64
Industry Buildings

5518
Kutcha Houses

18 KLD FSTP Capacity

03 Desludging operators

CLIMATIC

8.8-37.2⁰C
Avg. Annual Temprature

1630mm;
Annual Rainfall

470mm
Peak Rainfall (July)

LAND COVER

180.7 km²
Forest Cover

54.2 km²
Agriculture Area

375-1672 m
Elevation Range
Above Mean Sea Level

180 km Stream Length

CHAPTER 2

2. APPROACH & METHDOLOGY

2.1 DATA FRAMEWORK FOR CWIS PLANNING

A **data framework for CWIS planning** was developed for Birendranagar Municipality, which provides insights into the CWIS situation of the town, and was also used as the basic source of information for overall analysis and planning for this assignment.

The data framework includes a total of **112 data points** categorized under the following themes:

TABLE 1: THEMES FOR DATA FRAMEWORK FOR CWIS PLANNING

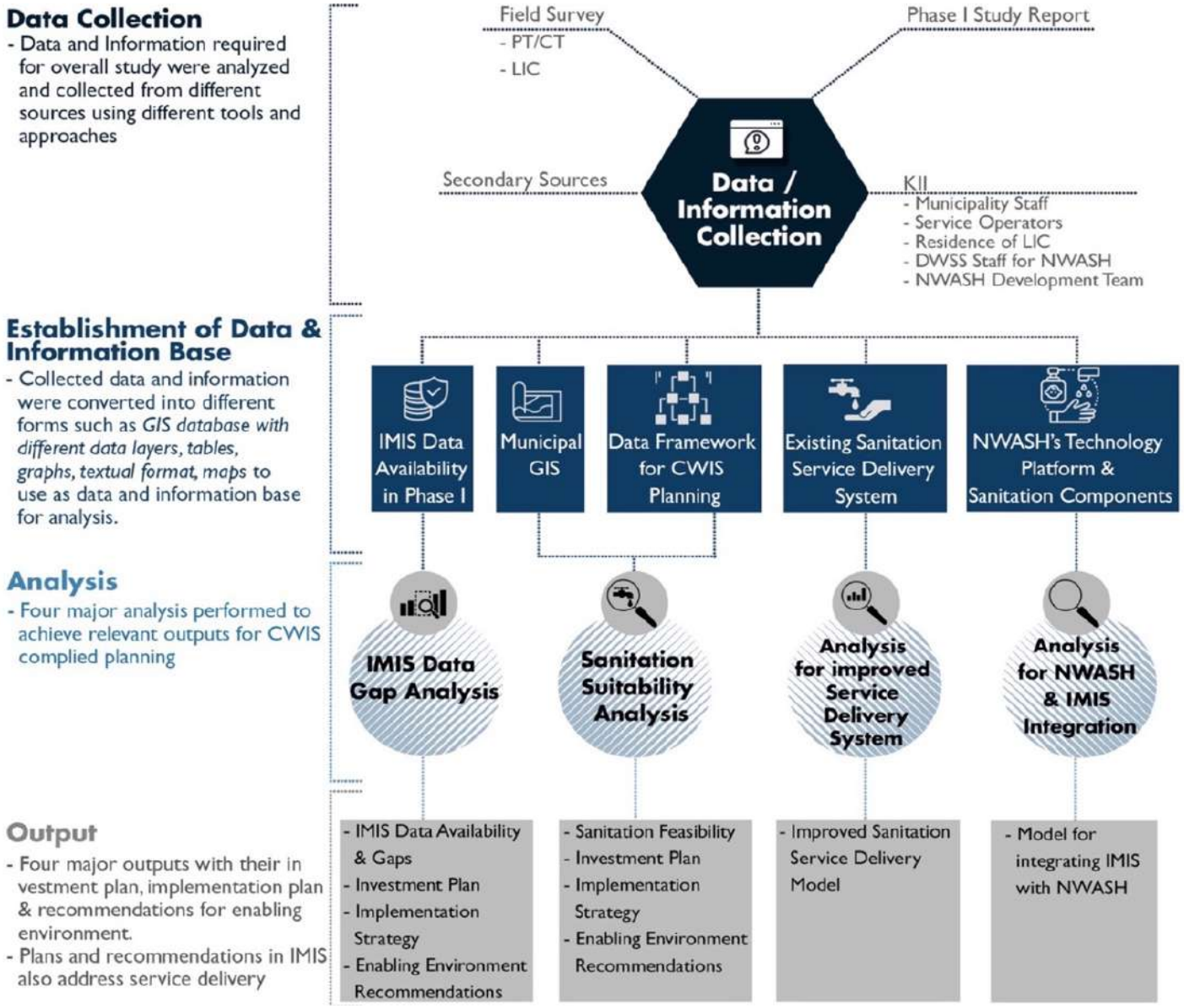
GENERAL CHARACTERISTICS OF THE MUNICIPALITY	• Population • Settlement typology • Topography • Health and hygiene • Brand development • Tourism • Savings
SANITATION PROFILE OF THE MUNICIPALITY	• Existing sanitation facilities at the household level • Existing shared sanitation facilities • Connection of household toilets to sewer and non-sewer systems • Existing or future sanitation plans • Groundwater vulnerability
TRANSPORT AND ACCESSIBILITY	• Accessibility to households and OSS • Road shape and width; Road surface • Distance from treatment facility
WATER SUPPLY	• Water supply coverage
SOCIO-ECONOMIC PROFILE	• Economic vulnerability • Social vulnerability
READINESS & SUSTAINABILITY	• Organizational mandate • Operations framework • Local governance and enabling policy framework • Political will • Public finance • Feasibility of private sector participation • Market environment
DESLUDGING DETAILS	• Planning for desludging / categorization of OSS
OPERATORS	• Economic vulnerability • Social acceptance
WORKER SAFETY	• Certification and training
DISPOSAL, TREATMENT & REUSE	• Safety of CTs, • Safety of PTs • Disposal and Treatment

The various methods were adopted to gather necessary data for establishing the data framework (e.g., literature review, data and information from secondary sources, GIS analysis, KII with various stakeholders, primary data collection from field surveys).

KIIs were conducted with Municipality Staffs, Sanitation Service Operators and residents in Low-Income Community (LIC). An extensive field survey was conducted to gather a detail information (e.g. legal status, population, households, water supply situation, sanitation situation etc.) about all LICs in the Municipality. Similarly, an extensive field survey was also conducted to gather detail information about all Public Toilet (PT) and Community Toilet (CT) in the Municipality. GIS data layers of LIC and PT/CT with their attribute information were created with the help these survey data.

Data framework approach including process and four key thrust area of CWIS planning is presented in the figure below.

FIGURE 1: DATA FRAMEWORK APPROACH FOR CWIS PLANNING



Information related to some of the data points for the Municipality could not be generated due to unavailability of information (e.g., average number of permanent works in the town, percentage of rise in recorded cases of illness related to unsafe / inadequate sanitation in the last 2 years, percent of sanitation facility located >10m from groundwater sources etc.). Data sources used for reporting all data points in the framework are mentioned in annexure 5.

This data framework also helps to understand the town's readiness for implementing CWIS approach for managing and delivering sanitation system and services in the Municipality. This data framework can be a valuable source of information for governmental agencies, development partners or any organizations working in the sanitation sector in the Municipality for preparing sustainable investment projects adopting the CWIS principles and its approaches.

2.2 SPATIAL ANALYSIS FRAMEWORK

Three stages of spatial analysis have been undertaken to understand the sanitation intervention at settlement level of Birendranagar Municipality.

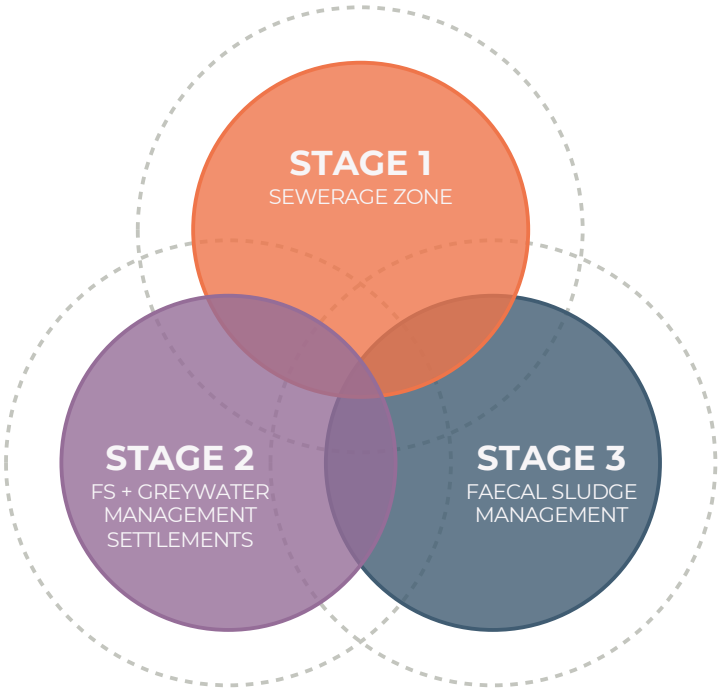


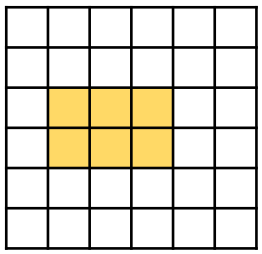
Figure 2 summaries the expected outputs and applicable parameters across the three stages, followed by Table 2 highlighting the detailed sub-parameters, implications, and key data sources.

The first level analysis mainly helps to delineate the sewerage zone based on parameters like population and non-residential built-up density, accessibility, and water-supply coverage. This help to delineate NSS and SS area in the town and further suitability of FS and greywater has been analyzed for left-over settlements. Parameters like flood affected settlements, settlement with proximity of water body, large commercial building, institutional area etc. have been considered for understanding the management need of both grey and black water generations. Area which are left-out from sewerage zone and FS + Greywater interventions would need to be facilitated by FSM intervention (i.e., with regular desludging services).

FIGURE 2: SUMMARY OF SANITATION INTERVENTIONS, SUB-PARAMETERS FOR ALL THREE STAGES OF SUITABILITY ANALYSIS

STAGE 1

SEWERAGE ZONE



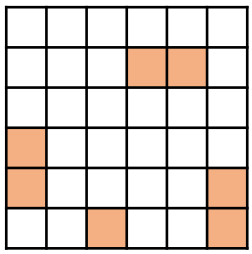
Identify the sewerage suitable settlements

Sub-parameters

- High population density
- High non-residential built-up density
- Piped water supply coverage
- Having adequate road width

STAGE 2

FS + GREYWATER MANAGEMENT SETTLEMENTS



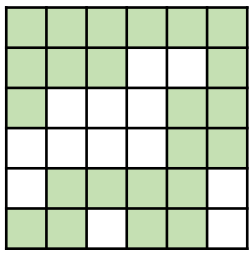
Identify the settlement which needs both grey and black water treatment after excluding sewerage zone

Sub-parameters

- Flood risk settlements
- Settlements close to water body
- High rise building (more than G+2)
- Institutional building
- Commercial cluster/complex including hotels

STAGE 3

FAECAL SLUDGE MANAGEMENT



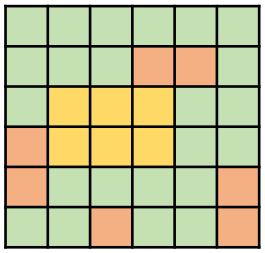
Excluding both sewerage and FS +Greywater management zone, remaining settlements suitable for FS management

Sub-parameters

- All remaining settlements from sewerage and FS+ Greywater management
- For tank emptying /desludging operations

STAGE 4

FINAL SANITATION INTERVENTIONS



Stage I + Stage II + Stage III

Sub-parameters

- All three stages overlay would arrive to final sanitation interventions

TABLE 2: KEY PARAMETERS, IMPLICATIONS, AND DATA SOURCES

PARAMETERS	SUB - PARAMETERS	IMPLICATIONS/UNDERSTANDING	DATA SOURCE
Settlement Typology	High population density	User demands for populations	Census
	High non-residential built-up density	Other non-residential user demands for safe sanitation	GIS database provided by Municipality, 2019
	High rise building (more than G+2)	Expecting more residing populations	
	Institutional buildings	High user influx expected	
Service Affordability	Employment and Income - Critical	Katcha housing settlements	GIS database provided by Municipality, 2019
	Employment and Income - Non critical	Pucca housing settlements	
Ground Water Vulnerability	High risk	Ground water database is not available with municipality	Data not available
	Moderate risk		
	Low risk		
Accessibility	Abutting road width more than 3.5 m	Desludging truck accessing settlements comfortably	GIS database provided by Municipality, 2019
	less than 2 m road width and beyond the 250 feet accessibility buffer *	Settlement understanding where desludging would be difficult and need customised operations	
Water Sensitive Settlements	Settlements close to water-body/streams	Settlement where high-water table are expected and containment needs to be designed accordingly. Settlement without having drainage infrastructure (which implies relatively weak set-up for handling grey-water generations) has also been identified as water-sensitive	GIS database provided by Municipality, 2019
Flood Prone	Settlements under flood risk (from nearby water body, rainfall flooding)	Toilet tank backflow issue , tank overflowing are some of prevalent issues in high flood risk settlements	GIS based analysis and DEM analysis using open source data
	Depression area/Low lying area		
Reuse Potential	Industrial zone classification based on potential re-use	Municipality has large number of industrial, forest and agricultural area spread across and this would be put on immediate uses for safe management of plant safe discharge	GIS database provided by Municipality, 2019, GIS based analysis using open source data
	Presence of agriculture and forest land uses		
Water Supply Coverage	Piped water supply coverage to HH	Populations/user with piped water supply coverage and /or dependency on other sources like borewell, dug well etc.	GIS database by Municipality, 2019, KII
Topography	Flat terrain	Designing of network based solutions including suitable locations of treatment plant	GIS based analysis using open source data, SRTM
	Depression area		
	Slope terrain		

2.3 IMIS DRIVEN IMPROVED SERVICE DELIVERY & INTEGRATIONS WITH NWASH

2.3.1 IMIS DRIVEN IMPROVED SERVICE DELIVERY

KIIs were conducted with Municipal Officials and existing private entrepreneurs involved in delivering sanitation services to reinforce the understanding about existing business processes at the Municipality – and access their readiness to adopt IMIS. KIIs were conducted individually with each service providers to understand their working mechanism and challenges they are facing (annexure 4).

An introductory presentation was also provided to the municipal officials to augment their understanding of IMIS and introduce how IMIS would assist the municipality in efficient data-driven planning, decision making, service delivery and real time monitoring of sanitation services.

Based on insights provided by the Municipal Officials and private entrepreneurs, there is an immediate need for an overhaul of the current service delivery mechanisms to increase the efficiency of service delivery and accountability of service providers.

2.3.2 INTEGRATION OF IMIS WITH NWASH PLATFORM

Discussions were planned with NWASH platform developers to better understand the features of the platform, roll-out strategies, roadblocks and data structures of the platform. Viewpoints on the potential integration of IMIS and NWASH platforms were also gathered from the NWASH Lead.

Based on the readily available information, a conceptual model for integration has been proposed and the recommendation made for further in-depth study for integration.

CHAPTER 3

3. ANALYSIS & RESULTS

3.1 SPATIAL ANALYSIS OUTCOMES AND INFERENCES

Some of key expected outcome from this section includes settlement level understanding of suitable sanitation interventions in terms of sewer and non-sewer interventions. In terms of non-sewered options, this will also help to understand which of the settlement needed additional consideration of greywater handling and further which would continue to priorities blackwater management through tank emptying operations. Only core town area is considered for sewerage zone delineations whereas other sanitation interventions suitability has been assessed at pan municipal boundary level.

3.1.1 STAGE 1: ZONIFICATION OF SS AND NSS ZONES

This section helps establish an understanding of the delineations of the sewerage suitable areas across the Municipality.

Key considerations for delineations of sewerage and non-sewerage zones

- High population density and/or non-residential built-up density are the base layers to start the process.
- The identified area of high density will be filtered with the pre-requisite of adequate accessibility and water supply availability. Here settlement which do not have either adequate accessibility or water supply availability, will need to be removed from sewerage suitable settlements.

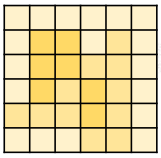
Katcha houses in left images and water deficit settlement with dependency on dug wells in right images. These are not suitable for sewer interventions

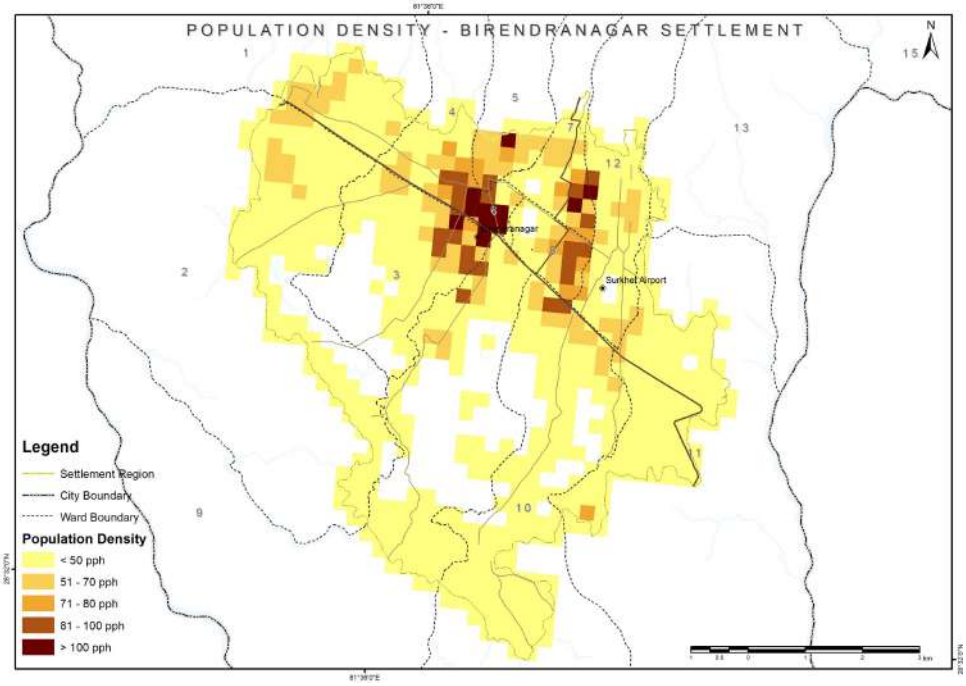
- Any adequate sizing of depression settlements and polluting industrial settlements should also be further removed from sewerage suitable settlements.
- Area identified after all above filtering is final sewerage interventions suitable area and following the nearby road boundary, delineations of sewerage zone will need to be undertaken.
- Parameters like water sensitive, high-rise buildings, institutional building need not to have separate considerations here as sewerage zone would anyway take-care of combined grey and black water treatment needs from all such settlement area.

STAGE I PARAMETERS, INFERENCES AND OUTPUT ILLUSTRATION

HIGH POPULATION DENSITY

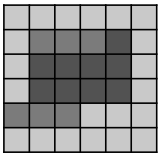
- High population density indicates the situation of more potential beneficiaries of improved sanitation(sewerage) interventions. Shades in illustrative image/maps indicates the intensity of population density.
- Northern region of city is more densely populated (ward 6,3,412,8).
- Higher population density varies from 100-125 pph and ranges from 70-100 in most of higher concentrated settlements area. (250*250-meter size grid space)

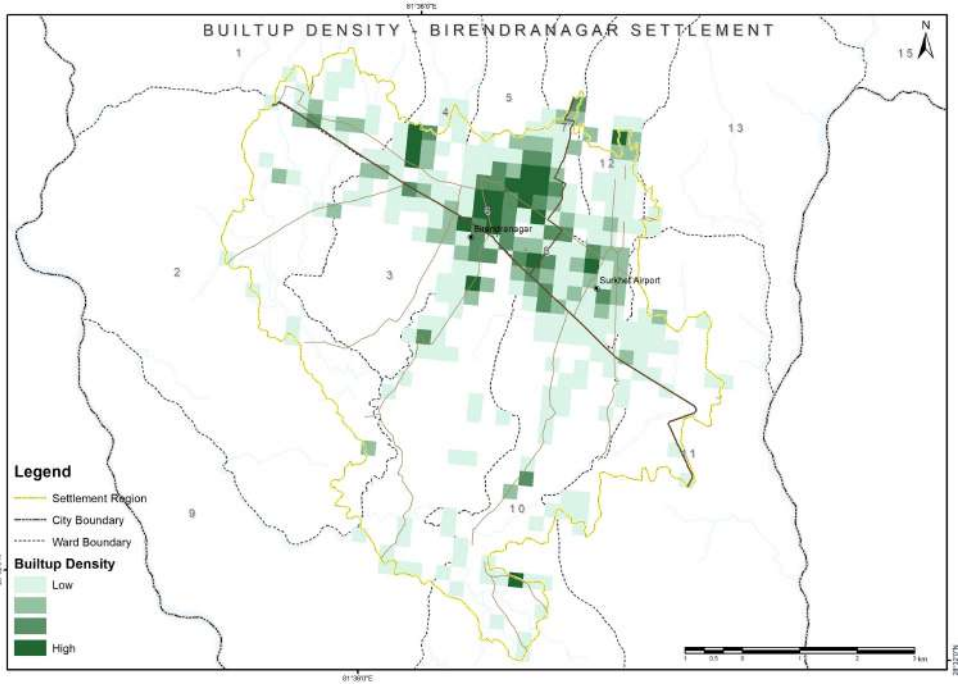




NON-RESIDENTIAL HIGH POPULATION DENSITY

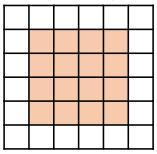
- High built-up density indicates cumulative intensity of various land uses other than residential. Shades in illustrative image/map indicates the intensity of built-up area.
- Separately identifying & analyzing non-residential land uses concentrations (Wards 6,8,5 & 7) would help to understand overall user demand for improved sanitation services.
- The outskirts of the town area have mostly scattered and sparse building units. (250*250-meter size grid space)

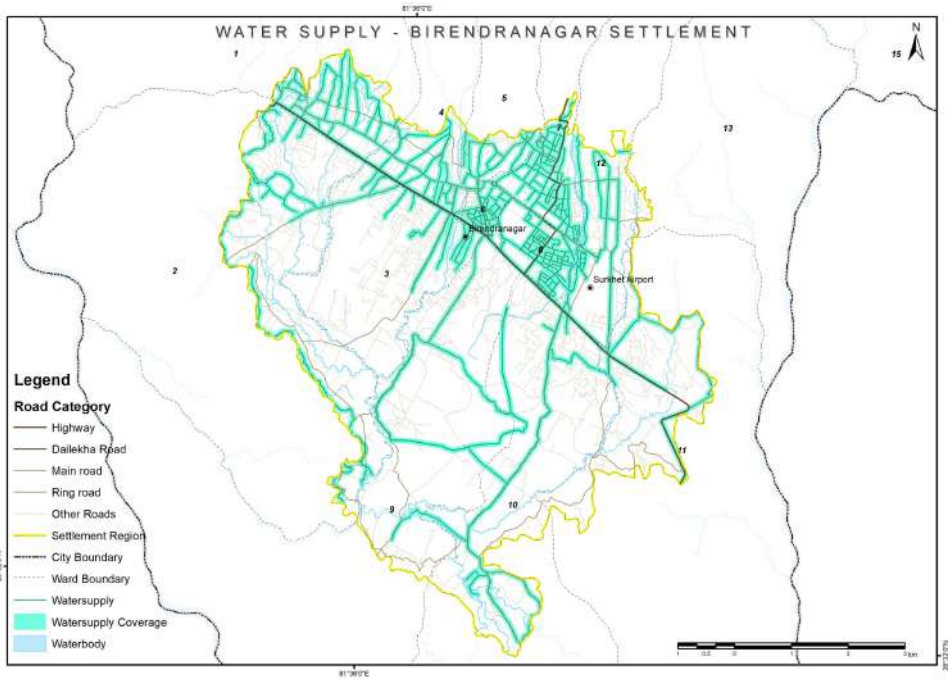




WATER SUPPLY COVERAGE

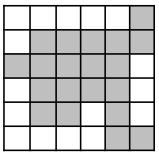
- Adequate water supply coverage and supply/availability are pre-requisite for having sewerage system in place.
- Core area covered with significant piped water supply coverage and overall, 80% of city populations is served with water connections (from KII).
- Supply hours are limited to only 1-2 hours in a day.
- During summer there were also situations of dry days which gets stretched even for a week's duration.
- Dug-wells and in some cases bore-well are also some of other supplementary sources.

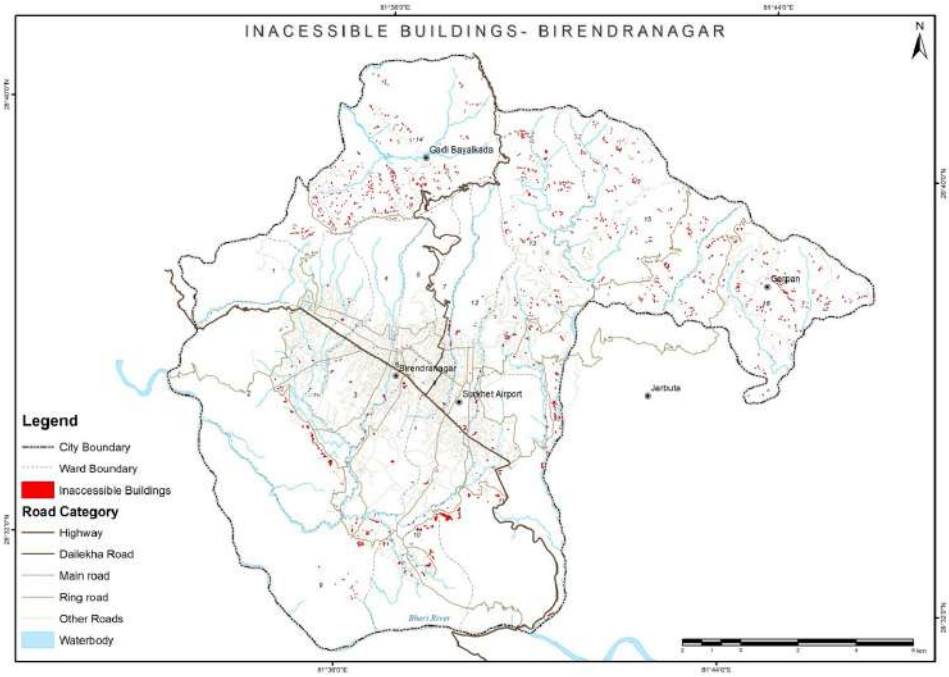




ACCESSIBLE BUILDING

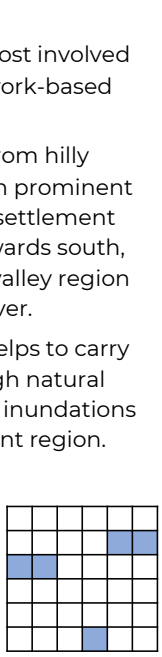
- All buildings having frontage of less than 2 meter are considered not feasible for laying down the sewerage network.
- Additional 250 feet buffers of desludging truck pipe have also been earmarked as inaccessible settlements
- Total of 2,515 residential buildings are identified as inaccessible. All such identified settlements are not suitable for sewerage network coverage & were excluded from SS zone.

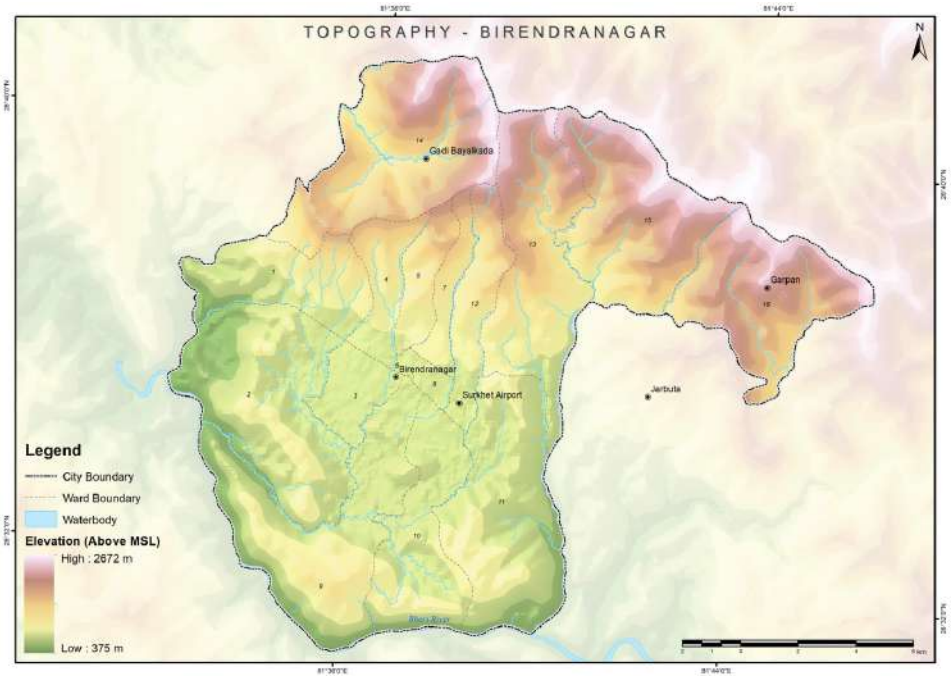




DEPRESSION AREA

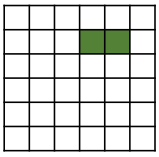
- Area with high pumping cost involved may be avoided with network-based solutions.
- Three varying slope level from hilly terrain of north region with prominent forest cover to almost flat settlement area and further down towards south, the lowest elevation with valley region and merging with Bheri river.
- The adequate slope also helps to carry the rain-fall volume through natural streams & avoid any water inundations situations in core settlement region.

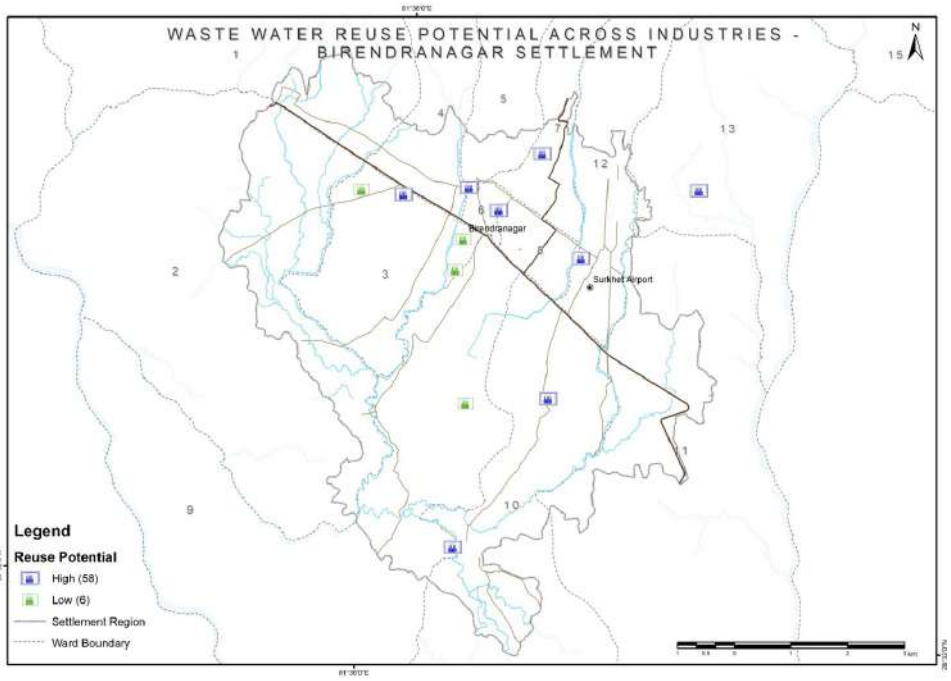




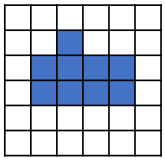
INDUSTRIAL SETTLEMENTS

- Area with high pumping cost involved may be avoided with network-based solutions.
- Three varying slope level from hilly terrain of north region with prominent forest cover to almost flat settlement area and further down towards south, the lowest elevation with valley region and merging with the Bheri river.
- The adequate slope also helps to carry the rain-fall volume through natural streams & avoid any water inundations situations in core settlement region.





SEWERAGE ZONE



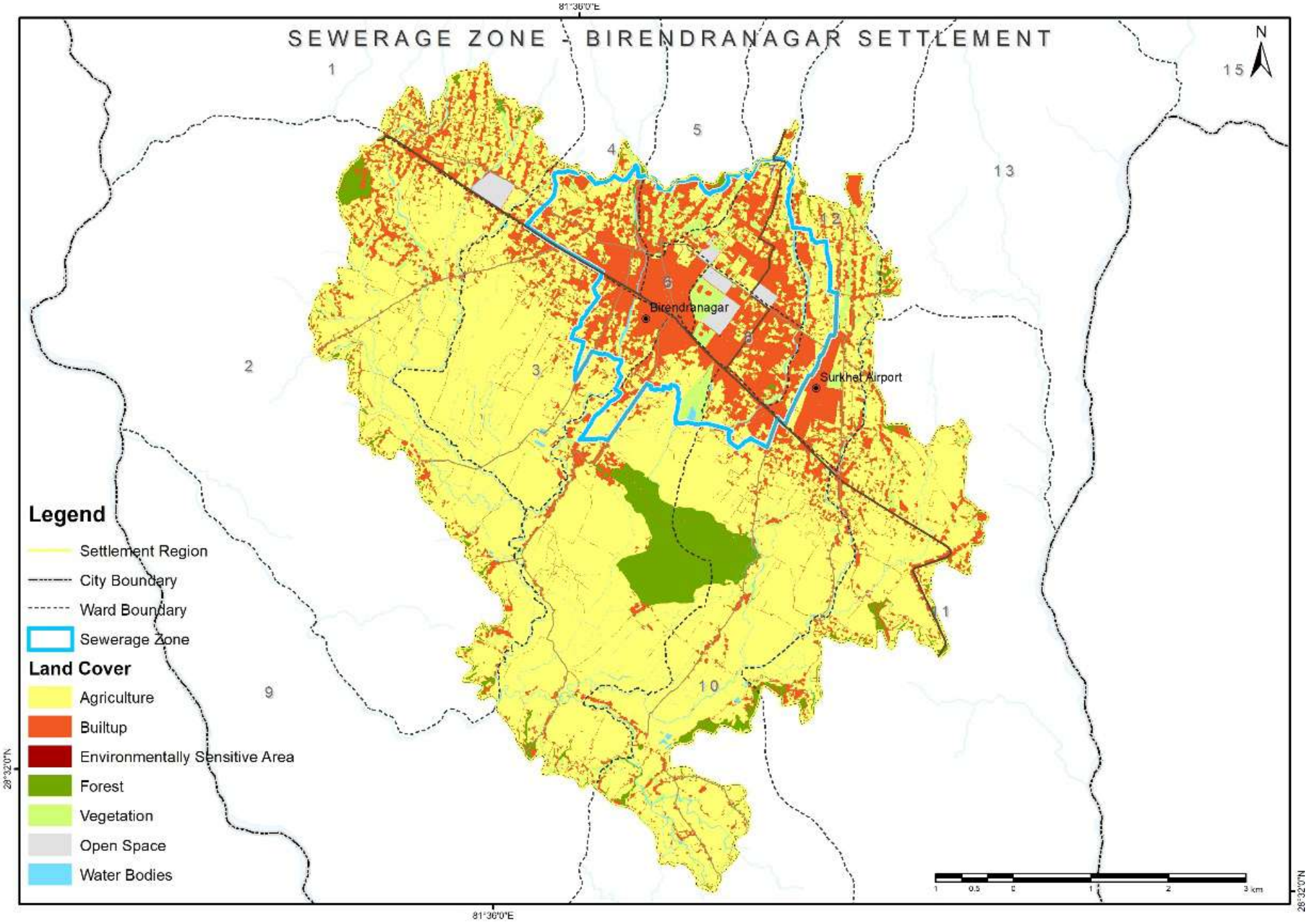
= (High population ∪ high built-up density) ∩ (water supply coverage) ∩ (accessible buildings) - (depression zone ∪ industrial settlements)

TABLE 3: KEY STATISTICAL INFERENCES FROM SEWERAGE ZONE

ATTRIBUTES WITHIN SS ZONE	NUMBER	%	REMARKS
No. of household	11349	37	Sewerage households of town
No. of urban poor household	456	8	Need to explore subsidy for same level of services
No. of buildings	12213	40	Included building from all land uses
No. of institutions	221	19	Both private and public institutions
No. of commercial units	2190		All commercial units of any scale
No. of industrial buildings	51	80	Polluting unit should have separate treatment system
Total water sensitive buildings	737	39	SS works as combined WWT solution
Flood risk buildings	None		There aren't any flood risk areas with SS zone

The output and findings from all the parameters in Table 3 have been overlayed and arrived at the final sewerage interventions zone or settlements of Birendranagar Municipality. Spatial analysis for sewerage zoning has been undertaken for core settlement area as other leftover settlements area are sparsely located and have very low population density for attaining any feasibility for such system/interventions.

FIGURE 3: SEWERAGE ZONE - BIRENDRANAGAR MUNICIPALITY



3.1.2 STAGE 2: IDENTIFYING SETTLEMENTS FOR 'FS & GREYWATER MANAGEMENT' INTERVENTIONS (WITHIN THE NSS ZONES)

Stage II analysis has been undertaken at the NSS zones identified from the earlier Stage 1 outcomes. Areas or settlements within NSS zone which needs priority of wastewater management (both grey and black water) would be identified as part of this stage. Settlements identified under this category can also be treated as areas suitable for 'FS + Greywater management'.

Key considerations of 'FS+ Greywater management' settlements

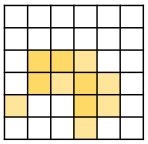
- All spatial output of parameters are overlaid, and all together would form suitable settlements of FS+ Greywater management.
- The identification is done at settlement level for recommending various ways of improvement in containment system and additional infrastructure components for grey-water management
- FS + Greywater management would only need to be assessed for NSS zone as sewerage system also does take care of combined grey and black water treatment needs.
- Based on ground conditions of different parameters (refer to parameters for Stage 2 below) findings, the suggested solutions of FS+ Greywater handling would be different. Summary of suitable technological interventions against ground condition of each parameter is presented in table 6.

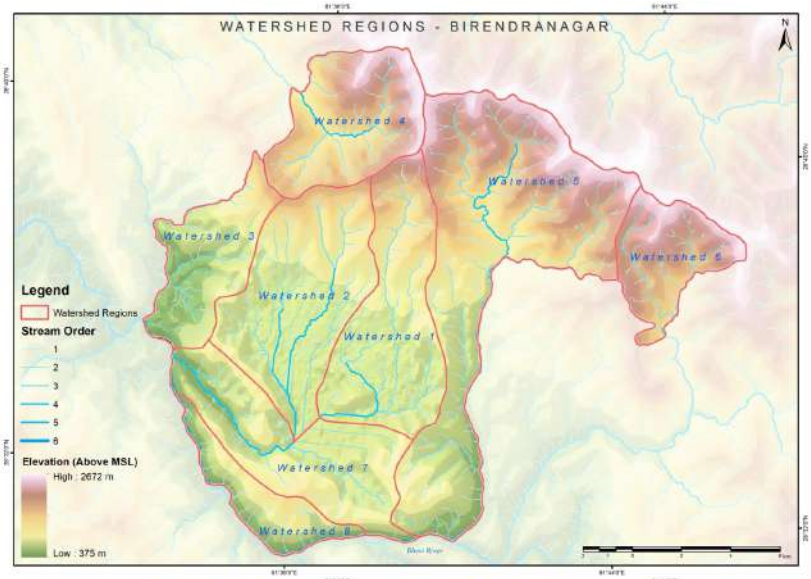
Water sensitive settlements along seasonal water streams (left) Schools located in flood prone area (right)

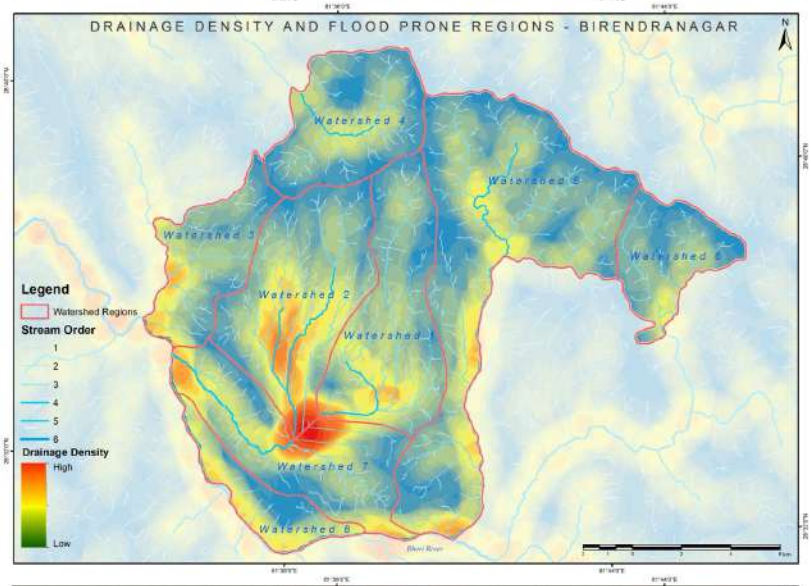
STAGE 2 RELEVANT PARAMETERS, SIGNIFICANCE, ILLUSTRATION FOR DELINEATING SETTLEMENT FOR FS & GREYWATER MANAGEMENT

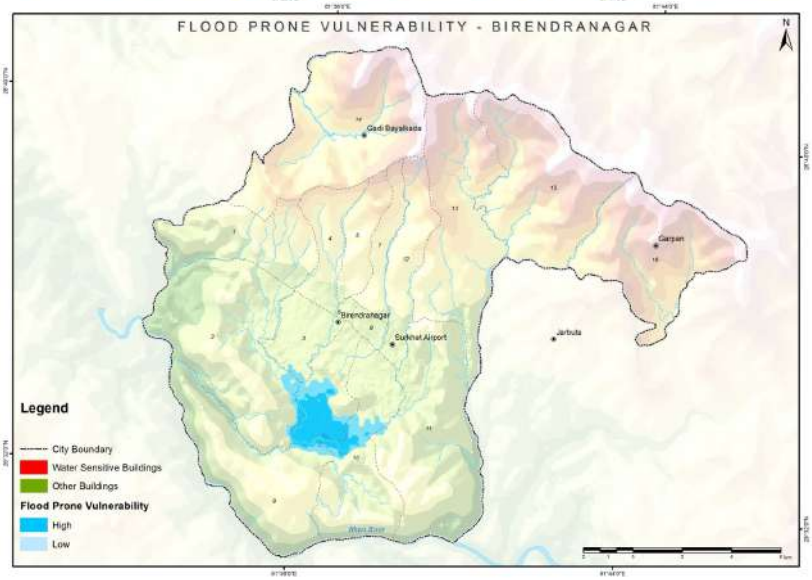
FLOOD RISK SETTLEMENTS INCLUDING WATER PONDING

- Area with high risk of flooding because of rainfall (including extreme rain fall event) when gets analyzed with drainage density and elevations profile, affected settlement can be identified with low and high flood risk intensity.
- Watershed boundary have been delineated using GIS and further stream modelling assessments was undertaken to understand the high drainage intensity area.
- Streams adjoining the hilly area are expected to carry more water volume during rainy season and further likely to go further down towards town settlements and then finally merging with Bheri river at lowest elevation point.
- Run-off of last 8 years including the highest recorded daily precipitation during August'2014 of 423 mm rain-fall was factored for the analysis. Considering an event of extreme rainfall was factored to arrive at high and low risk of flood area delineations.
- 7.6 sq.km. area of town under risk of flood including 3.9 sq.km of high prone area. and currently around 666 family and 678 buildings are falling under flood risk category.



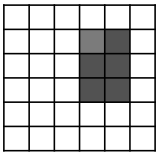


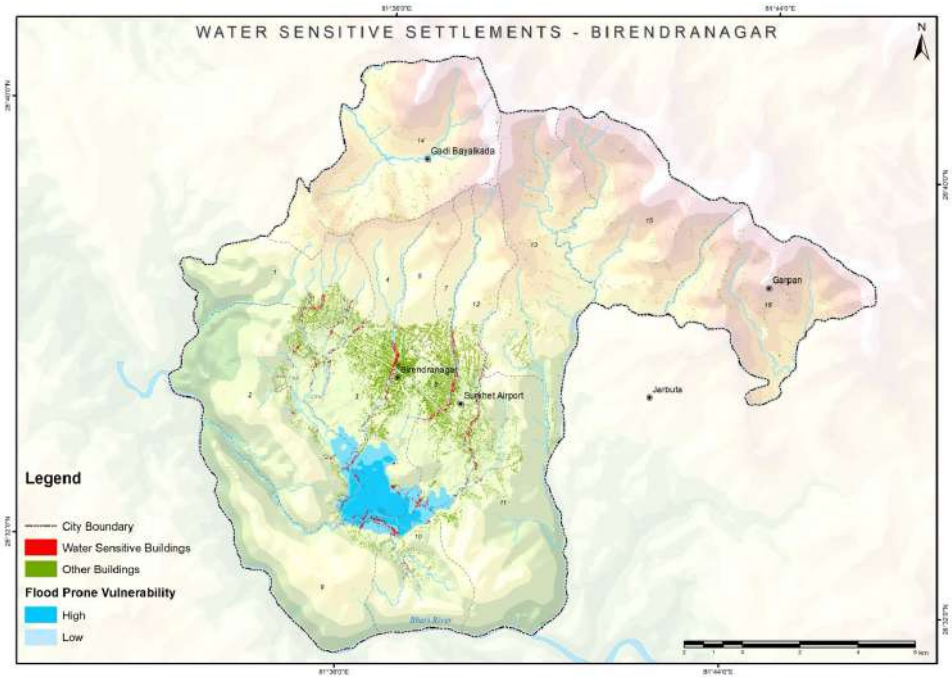




WATER SENSITIVE SETTLEMENTS

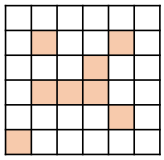
- Total 180 km length of seasonal water streams and adjoining settlements with 25-meter buffer area considered as water sensitive.
- These settlements are likely to have higher water table, particularly during rainy season & there is high scope of water source contaminations in the case where wastewater generations is not handled well.
- 1,913 buildings have been identified as water sensitive, and 1,176 (61%) buildings in NSS zone.

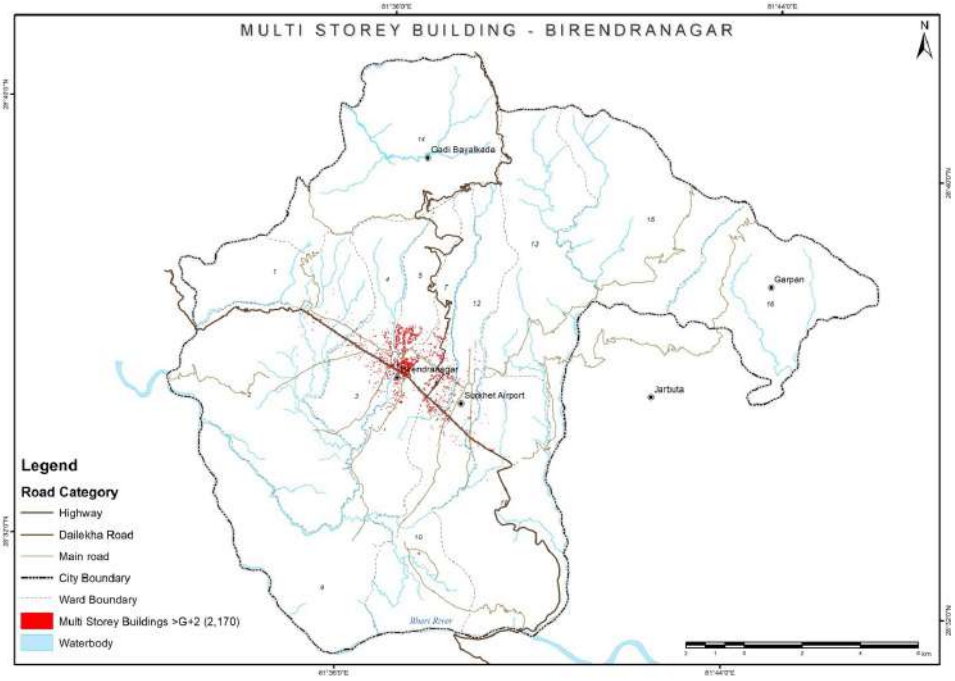




HIGH RISE BUILDING UNITS (MORE THAN G+2)

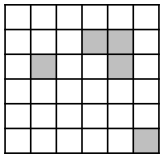
- High rise building of NSS zone indicated more residing dwellers within premises and potential hotspot of higher wastewater volume generation.
- Such building should be encouraged to take care of on-site greywater management where black water/toilet emptying can also be done periodically.
- 2,170 total such building in city.
  In NSS zone: 317

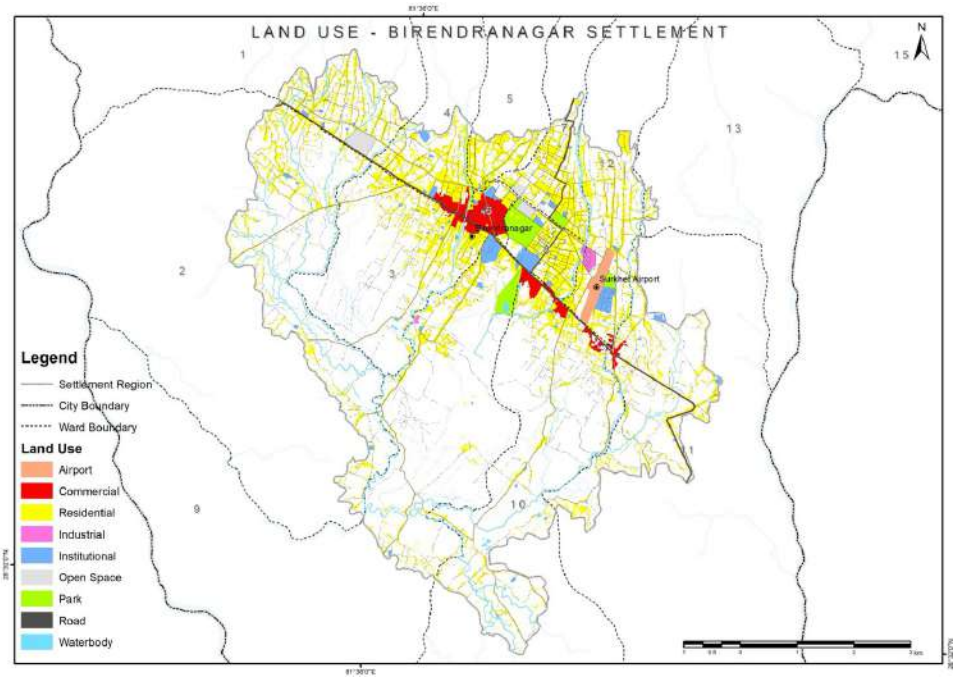




ALL INSTITUTIONAL AND LARGE COMMERCIAL UNITS

- Institutional units like education center, hospitals, offices, hotel, large commercial cluster etc. are likely to have more footfalls which preferably needs to have on-site greywater handling for improved sanitation services and system can be installed within premises.
- Total institutions in city: 864.
  In NSS Zone: 278,
- Commercial clusters are largely falling part of sewerage zone.

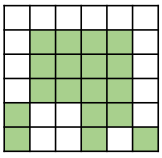




COLONY/GATED COMMUNITY

- Laying down network-based solution and centralized treatment are recommended in case of such controlled/relatively better managed environment of basic community services.
- No data available for gated/planned colony within Birendranagar municipality.

SETTLEMENTS FOR 'FS + GREYWATER MANAGEMENT'



- All parameters' findings have been added in overlay analysis and final settlement identification have been undertaken for additional handling of grey water measure (on/off site).
- There can be multiple infrastructure solutions of grey water management and section 3.2 and annexure 3 detail-out some of potential options.

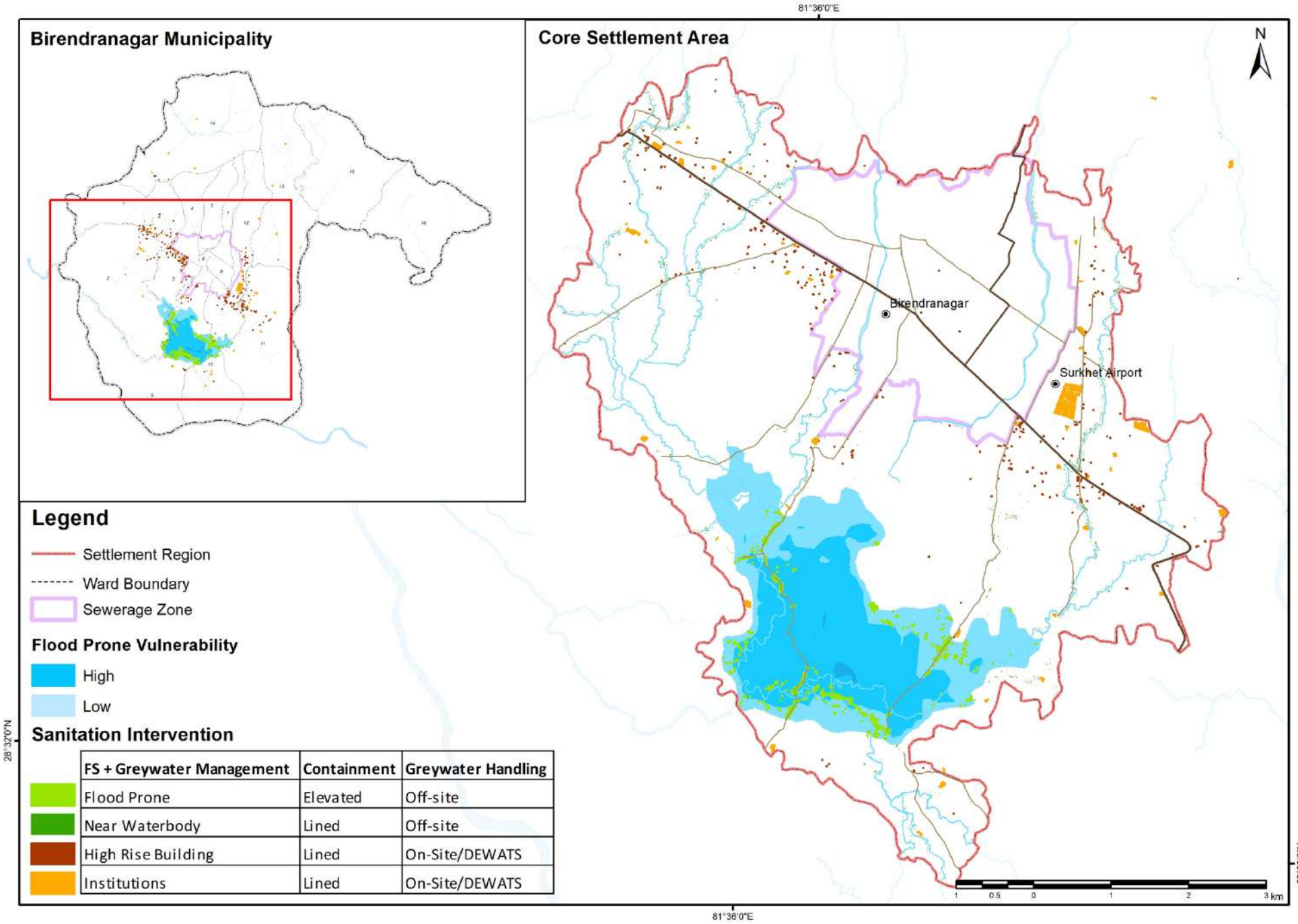
= (Flood risk settlements) ∪ (Water sensitive settlements) ∪ (High rise building > G +2) ∪ (Institutions) ∪ (Large commercial cluster) ∪ (Gates community/Colony)

TABLE 4: KEY STATISTICAL INFERENCES FROM SETTLEMENTS SUITABLE FOR 'FS+ GREYWATER MANAGEMENT' WITHIN NSS ZONE

ATTRIBUTES WITHIN NSS ZONE	NUMBER	%	REMARKS
No. of households	2304	7	HHs which needs additional greywater handling
Flood risk households	666	2	Need elevated toilet containment
Water sensitive households	1362	4	Need lined toilet containment
Households of high-rise units	276	1	Need lined containment, on-site greywater setup
No. of buildings	2568	9	Building is from all land uses including residential
Flood risk buildings	678	2	Need elevated toilet containment
Water sensitive buildings	1385	4	Need lined toilet containment
Institutional buildings	221	19	4 in flood risk and 3 in water sensitive
Multi-story buildings (>G+2)	317	15	Need lined containment, on-site greywater setup
Commercial building as large cluster	None		Closely placed units, Community level treatment
No. of Industrial buildings	3		Polluting units, need separate handling

Note: Percentage (%) here is in terms of comparison of respective parameters with pan municipal area.

FIGURE 4: SETTLEMENTS SUITABLE FOR 'FS + GREYWATER MANAGEMENT' WITHIN NSS ZONE



3.1.3 STAGE III: IDENTIFYING SETTLEMENTS SUITABLE FOR FSM (WITHIN NSS ZONE)

Settlements other than those from the Stage 2 outputs (Figure 4) i.e., combined need of 'FS +Greywater management' from NSS zone, will form the settlement suitable for FSM intervention. This implies here that settlement falling under stage III category will continue with tank emptying operations and greywater management is not mandatory in this case. In the long run, it is recommended to have a lined containment system with soak-pit units for all settlements of stage III, as to take care of both grey & black water generations.

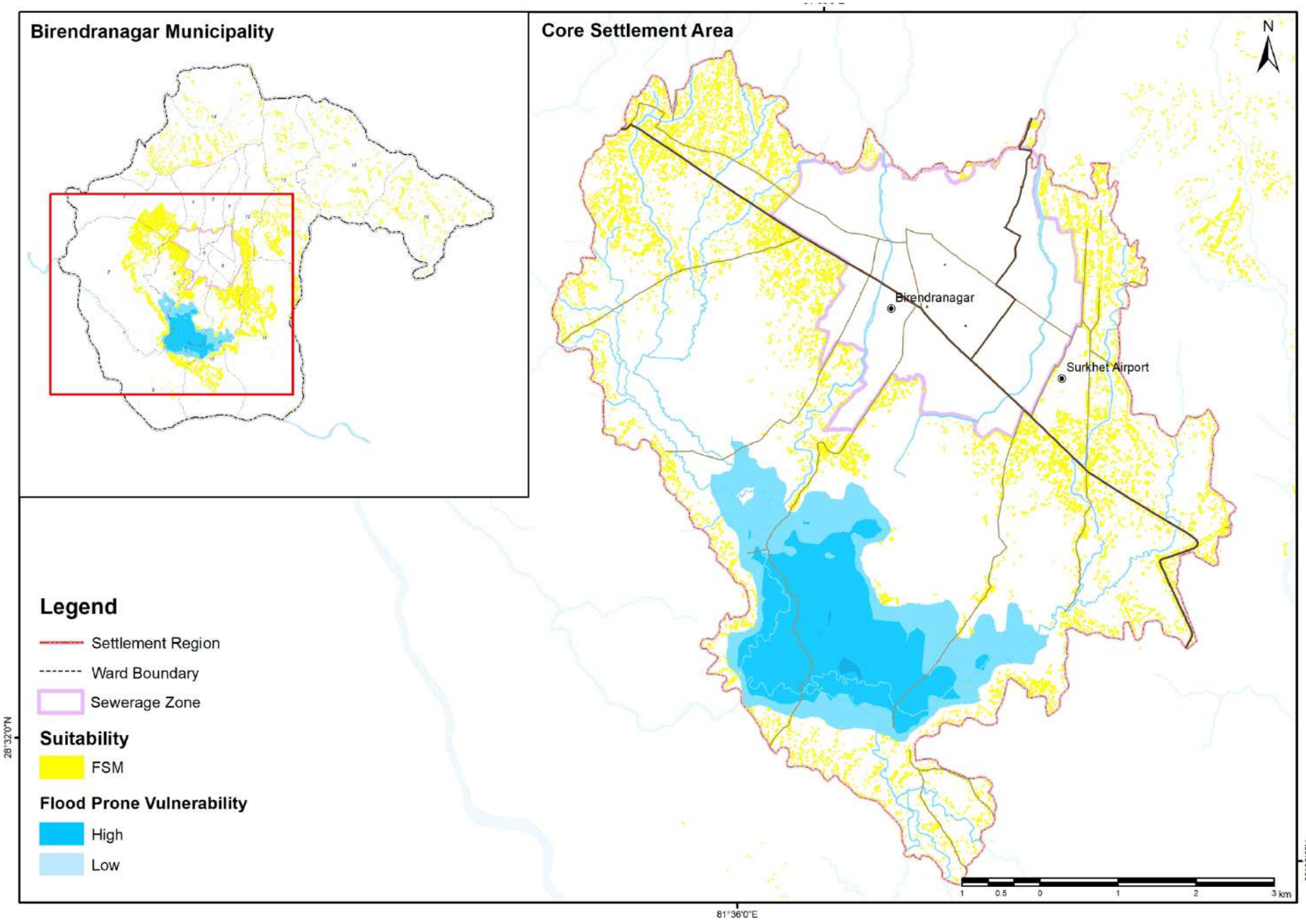
TABLE 5: KEY STATISTICAL INFERENCES FROM SETTLEMENTS SUITABLE FOR FSM WITHIN NSS ZONE

ATTRIBUTES WITHIN NSS ZONE	NUMBER	%	REMARKS
No. of households	17270	56	Dependent on tank emptying.
No. of buildings	17686	54	Dependent on tank emptying.
No. of industrial buildings	10	16	Polluting units and may need separate handling.
Water table in significant part town area are relatively higher and thus from regulatory enforcement, in long term it is advisable to have lined toilet containment for all settlements identified for tank emptying operations.			

Note: Percentage (%) here is in terms of comparison of respective parameters with pan municipal area.

The output of stage III is presented in the map below:

FIGURE 5: SETTLEMENTS SUITABLE FOR FSM IN BIRENDRANAGAR MUNICIPALITY



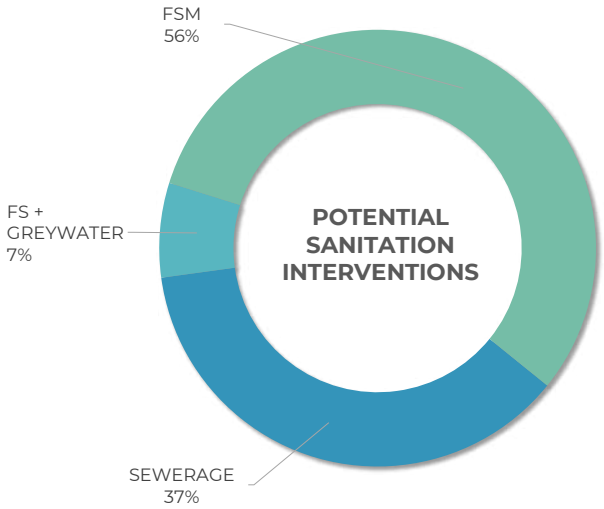
3.1.4 SANITATION INTERVENTIONS AND KEY INFERENCES FOR BIRENDRANAGAR MUNICIPALITY

All outputs derived from three stages have been overlaid and final sanitation interventions (i.e., clear demarcation of sewerage zone, settlement with current need of only desludging services and further settlement with priority of additional greywater handling) of have been finalized. Spatial interventions of all three stages are presented in the map below.

In final output map below, all settlements beyond sewerage zone and non-FSM (yellow color patches) are all suitable for interventions 'FS + Greywater management'.

KEY INFERENCES

- 37% of municipal populations are proposed to be covered by sewerage interventions, whereas 56% for FSM and 7% for both FS + Greywater management
- Core settlement areas are largely suitable for sewerage interventions whereas the rest can be covered by a mix of FSM and FS+ greywater management interventions
- Around 6% of town buildings are identified as water sensitive
- Flood prone areas have significant area spread (7.6 sq.km) and have 2% (666) households residing into such risk zone. This output also guides to restrict/regulate any future growth in such areas.



- Ward 4 to 8 have almost entire ward population suggested to be covered with sewerage interventions whereas wards 3, 9, 10 and 12 have part of settlement for sewerage coverage. Rest of the wards have mixed of NSS interventions of both FSM and additional need of grey water handling.
- Total number of households that would need desludging services are combined from both stage II and stage III output i.e., 19574. However, household from stage II output i.e., 2304 would need to adopt (individual or community level) suitable greywater management system. *More details on suitable technology are presented in section 3.2*

FIGURE 6: SANITATION INTERVENTION RECOMMENDATIONS FOR BIRENDRANAGAR MUNICIPALITY

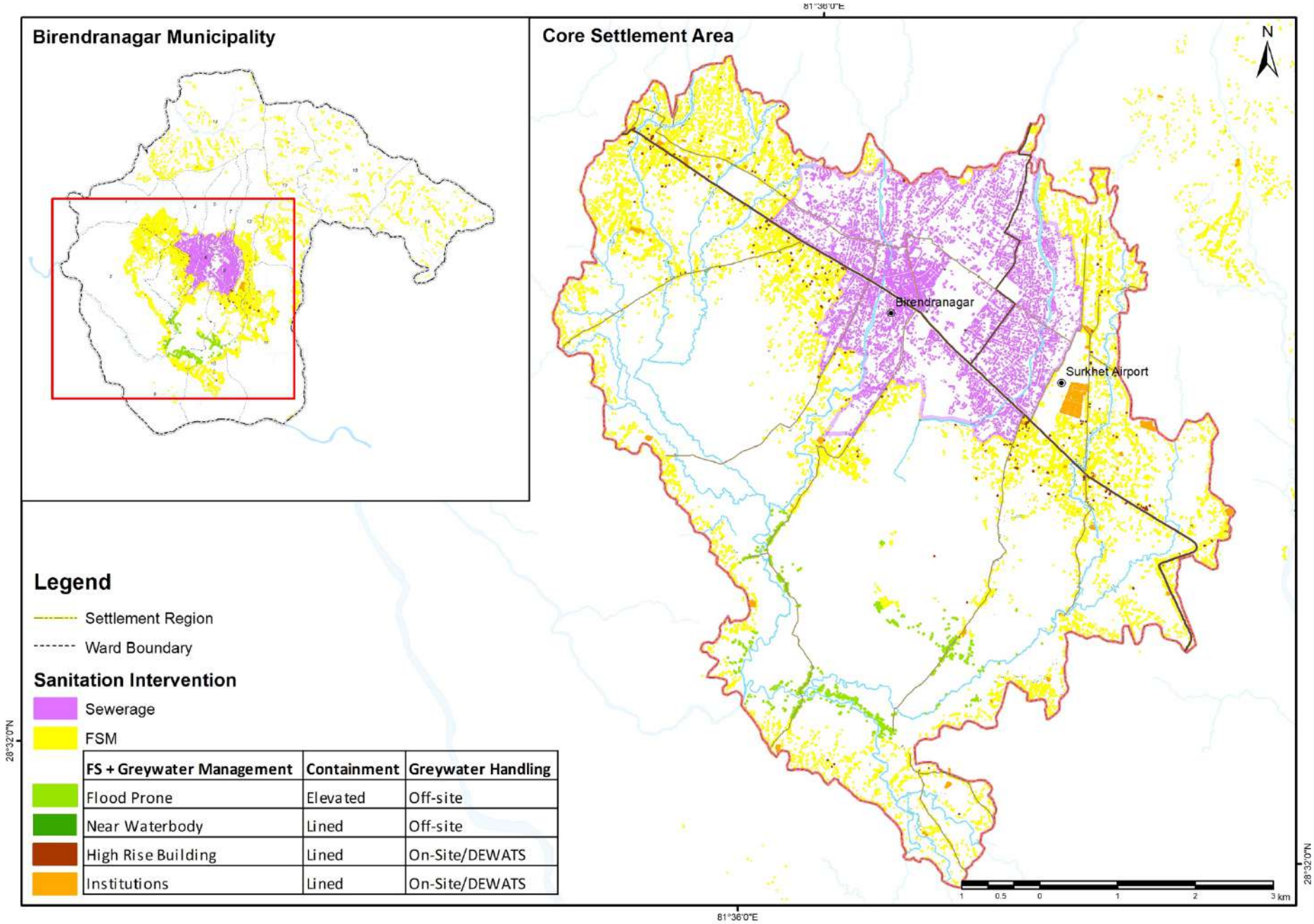
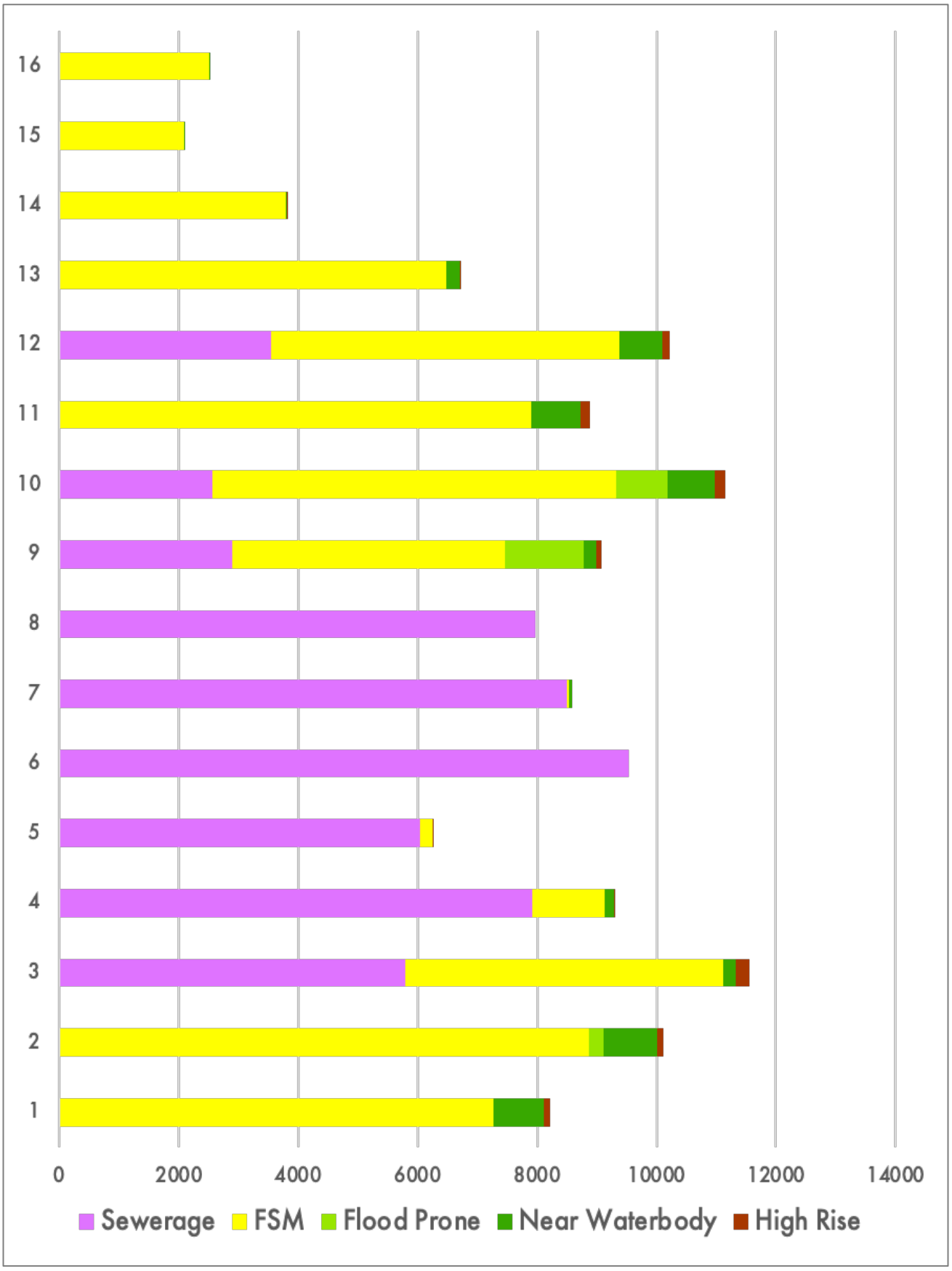


FIGURE 7: SUGGESTED SANITATION INTERVENTION AT WARD LEVEL POPULATION, BIRENDRANAGAR MUNICIPALITY



3.2 SYSTEM DESIGN & TECHNOLOGICAL INTERVENTIONS ACROSS SANITATION VALUE CHAIN

Based on the GIS analysis, findings from the site visits and relevant KIIs, **nine broad categories** have been defined to showcase the ground conditions and challenges within Birendranagar Municipality. Along with these ground conditions, a set of recommendations have also been suggested including technology and intervention level with a detailed rationale.

Each of the technological recommendations are briefed in detailed as part of annexure 3
.

TABLE 6: RECOMMENDED TECHNOLOGICAL INTERVENTIONS IN LINE WITH GROUND CONDITIONS

S.N	GROUND CONDITIONS	TECHNOLOGY RECOMMENDATIONS	INTERVENTION LEVEL	INTERVENTION RATIONALE
I.	Toilet in potential flood risk settlements	Elevated toilet containment and soak pit with tank edge above ground level/flood level	Individual HH level	To avoid tank flooding and to make sure continue uses of toilets during flood/water logging, toilet tank should be lined and above water-level.
II.	Toilet along water sensitive settlements	Unlined toilet needs to be upgraded as lined toilet tank, preferably septic tank, Common septic tank at community level	Individual HH and Community level	Water sensitive area gets seasonal situations (in rainy season) of high-water table and in some case cause soil erosion to nearby adjoining settlements of water streams. Lined containment will avoid water percolations and limit any effects of contaminations.
III.	Greywater handling along water sensitive settlements/ flood risk area	Filter media + Trap and/or Kitchen Garden	Individual level	Greywater produced can be partially treated with natural filter media and then connected with kitchen garden (in-case space available) or directly discharged to nearby drain (in-case no space available)
IV.	Greywater handling along water sensitive settlements/ flood risk area	Trap + DEWATS / Phytorid	Community level	Greywater handling at community level can be well managed with DEWATS (or Phytorid) system and this can also be connected to take-care the spill over of septic tanks.
V.	Toilet containment in inaccessible regions (town outskirts of hilly and forest region)	Twin Pit Toilet Containment + Soak pit	Individual HH level	Twin pit toilet are safe for manual emptying and can be used as an organic soil conditioner/manure. These regions can't be accesses by trucks and has significantly higher travel time, thus more appropriate for on-site handling of both grey and black water.
VI.	Institutional Building	• Trap + DEWATS / • Phytorid / • Packaged DEWATS /Mechanical	Individual level	All institutions need to have in-premises wastewater handling units. Septic tank outlet can also be connected and reduce the desludging interval. Based on affordability both natural DEWATS or packaged solutions (or Phytorid in case space available) can be installed.
VII.	Large commercial cluster/complex	• Trap + Magic Pit (low GW) / • Trap + DEWATS (high GW) /	Individual/ Community level	Commercial complex and/ or concentrated units should have

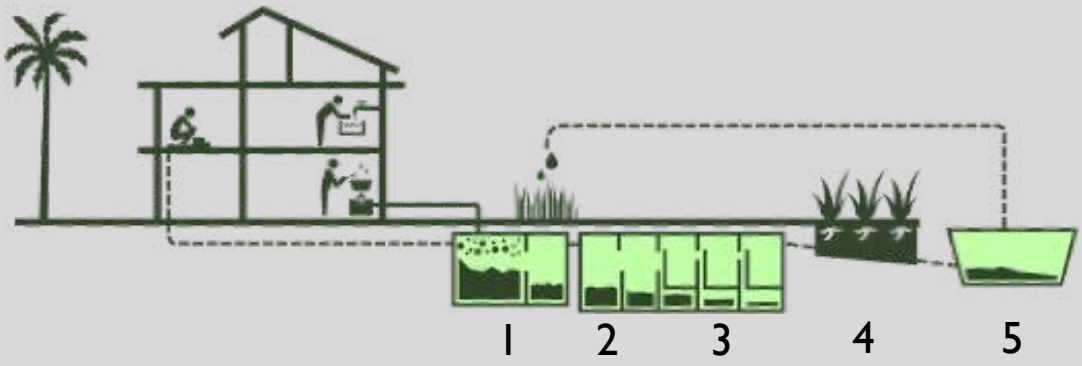
S.N	GROUND CONDITIONS	TECHNOLOGY RECOMMENDATIONS	INTERVENTION LEVEL	INTERVENTION RATIONALE
		• Packaged DEWATS /Mechanical (High GW)		on-site wastewater handling units like DEWATS or packaged mechanical set-up. In-case of individual toilet containment of commercial units, soak pit can be installed (provided low ground water table).
VIII.	High-rise buildings	• Trap + Magic Pit (low GW) / • Trap + DEWATS (high GW) / • Packaged DWT/Mechanical (high GW)	Individual level	Expected wastewater generations are considerably high because of more dwelling/family residing into multi-story buildings. Multiple options like magic pit (in case of low ground table), DEWATS (natural or packaged) can be explored.
IX.	Wastewater Treatment Plant	Activate Sludge Process (ASP)	Town Level	Activated sludge process (ASP) has been chosen for both the location considering the land requirement, ambient climate compatibility, and the technology adopted by other cities in Nepal.
X.	Reducing Travel Time to Operators	Co-Treatment or Sludge Transfer Stations	Co-Treatment /Sludge Transfer Station at Proposed WTP	From service coverage analysis, long travel route of desludging operations for some ward populations were observed. This was also validated during KII and thus treatment plant proximity will need to be investigated for smooth and safe disposal of collected sludge. Proposed STP units can be explored to serve as co-treatment or co-handling units and additional load can be factored during design stage of WTP.

Suggestive interventions for grey water management at the individual or community level

Kitchen Garden (Individual, Community)
Within building natural sand and gravel filter media (or magic pit) can be used to partially treat and divert the used grey water to natural plant with or outside building. PVC small diameter piping system needs to be lay-down to have larger reach within garden area with pumping sets for water sprinkling in case required. Plants that repel mosquitos may be adopted in the kitchen garden.

Kitchen garden is suitable for building having adequate plot size area (in case of area constrain, community garden concept can also be explored)

DEWAT (Natural treatment)
DEWAT is based on biological treatment mechanism such as sedimentations, floatation, aerobic and anaerobic treatment to treat wastewater. Accumulated and digested sludge gets periodically cleaned whereas system does constant treatment of liquid volume and produce treated wastewater applicable for large re-use purpose. This generally has both low CAPEX and OPEX involved and preferable to set-up in environment with relatively high footfall (at community level). This can be even set-up at individual level in case of space availability.



1)Settler: Removable of easily settlement solids
2)Anaerobic filter: Removal of easily degradable organic solids
3) Anaerobic Baffled Reactor: Removable of easily degradable organic solids
4)Planted Gravel Filter: Removal of easily and more difficult degradable organic solids
5) Polishing Pond: Removal of suspended digested solids and active bacteria mass

3.2.1 NON-SEWERED SANITAITON SYSTEM DESIGN AND INTERVENTIONS

Three target groups (i.e., urban poor households, institutional premises, and co-treatment/co-handling at WTP) have been prioritized for NSS level interventions. The identified beneficiaries of each category and recommended technical interventions are summarized in the table below.

Some of other NSS interventions can be guided by introducing new sanitation regulations in the Municipality. For example – in the case of high-rise buildings and commercial land-use, new sanitation regulation should mandate to have suitable amendment or improvement in existing containment systems. It is understood here that high-rise buildings/apartment and commercials building will have more paying capacity and 100% cost of construction should be borne at user end level. Similarly, for household which are not in urban poor/economic vulnerable category, should adhere to new sanitation regulations and needs to suitably amend/upgrade their tank including grey-water handling setup. All technical support can be extended from municipality in case requested by household/user.

TABLE 7: TARGET GROUPS, PROPOSED INTERVENTIONS AND BENEFICIARY UNDER. NSS REFORMS

SN	TARGET GROUP	PROPOSED TECHNOLOGY INTERVENTIONS	BENEFICIARY[1]
1.	**Urban Poor household:** *Based on KII and field visits, it was observed that most of urban poor households have pit-latrines. Similar inferences were also observed in recent study undertaken by SNV and during the Phase I rapid assessment report. It is assumed here that all cost of constructions needs to be extended by municipality and there can be user cost contribution model explored through willingness to pay survey and accordingly incorporated during the stage of detailed project report.*		
1.1	Residing in flood prone area	To be provided with **elevated toilet containment** and if possible, with **individual/community kitchen garden** for grey-water handling.	102
1.2	Residing in water-sensitive settlements	To be provided with **lined toilet containment**, and if possible, with individual/community kitchen garden for grey-water handling.	213
1.3	Residing in inaccessible region	To be provided with twin pit toilet containment with soak pit/magic pit for grey water handling.	1844
1.4	Other urban poor households	To be provided with **lined toilet containment and magic pit/soak pit** solutions.	2884
2	**Institutional premises:** *There are a total of 102 institutions residing outside the delineated sewerage area. This may consist of schools, colleges, hospitals, offices etc. It is also observed that some of the institutions have holding tanks and require frequent desludging once in six-month which is causing high expenditure on emptying operations. With the installation of DEWATS, the desludging frequency is expected to substantially go down and save significant costs for emptying operations in long run. Assessment of using existing holding tank (and/or similar infrastructure) as part of DEWATS and other installations is also encouraged during DPR stage. Since the functional ownership of premises was not known, it was assumed that all individual institutions are of Government property and full construction support will be extended by municipality. However, a survey of each such premise may help to get a more accurate picture of functional ownerships, and this can be done during the detailing stage of project.*		
2.1	Residing in flood prone area	To be provided with **DEWATs facility with planted gravel filter media** as to take-care of on-site greywater handling. The level of construction should factor the high flood level of past 10 years.	8
2.2	Residing in water-sensitive settlements	To be provided with **DEWATs facility with planted gravel filter media** as to take-care of on-site greywater handling. Outlet can be connected with nearby waterbody and/or in re-use for in-premises landscaping/gardening.	6

[1] The number of beneficiaries against each head of table10 are sourced from table 4,5 and 6.

SN	TARGET GROUP	PROPOSED TECHNOLOGY INTERVENTIONS	BENEFICIARY[1]
2.3	Other institutions	To be provided with **DEWATs facility with planted gravel filter media** as to take-care of on-site greywater handling.	484
3	**Co-treatment/co handling:** *As per study undertaken by SNV, it is suggested to have three phases of FSTP capacity augmentations where 1st phase is already operational and 2nd and 3rd stage phasing/expansion to be undertaken in the near future. From service coverage analysis, it is also observed that part of town's building (around 3073) is falling beyond 15km travel distance from existing FSTP and co-treatment at proposed WTP unit can help to significantly reduce the travel time. Thus, co-treatment units are suggested to be integrated with proposed WTP units to serve this beyond FSTP catchment (in terms of smooth service coverage) and ensure 100% town populations with easy access of desludging services.*		
3.1	At the wastewater treatment plant	To be provided with sludge thickening tank and additional capacity of screw capacity/available drying mechanism at WTP.	2 Nos of 7.2 KLD and 10.8 KLD capacity

3.2.2 SEWERED SANITAITON SYSTEM DESIGN AND INTERVENTIONS

DESIGN APPROACH OF SEWER NETWORK

The design of sewer network requires the maximum amount of wastewater discharge by the buildings to keep the sludge flowing downstream. The maximum production of blackwater and greywater based on water consumption is considered as wastewater in the design.

There are multiple water sources observed in the city like pipe supply, shallow tube well, water tanker, spring source etc. Assuming that by the end of sewer network commissioning, the city will have water consumption at the rate of 100 lpcd. The wastewater generating rate is taken as 80 lpcd. It was estimated that each building with 4 to 5 number of members will discharge 340 liters of wastewater every day. At the saturation condition of building density, around seventeen thousand buildings in sewerage zone can discharge up to 6 MLD of wastewater every day.

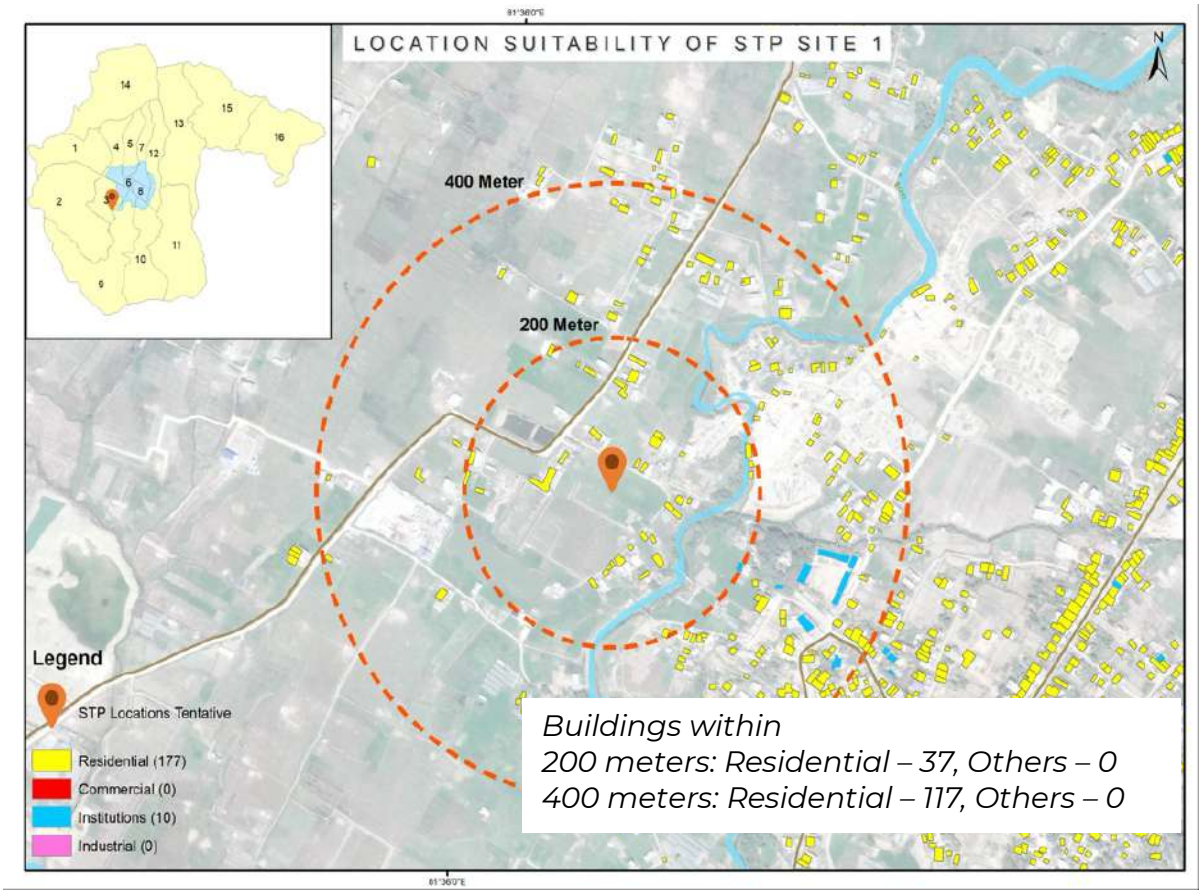
The design refers to the sanitary sewer that carries only the blackwater and the greywater. The storm water from the building compound can be drained through the existing storm drain network.

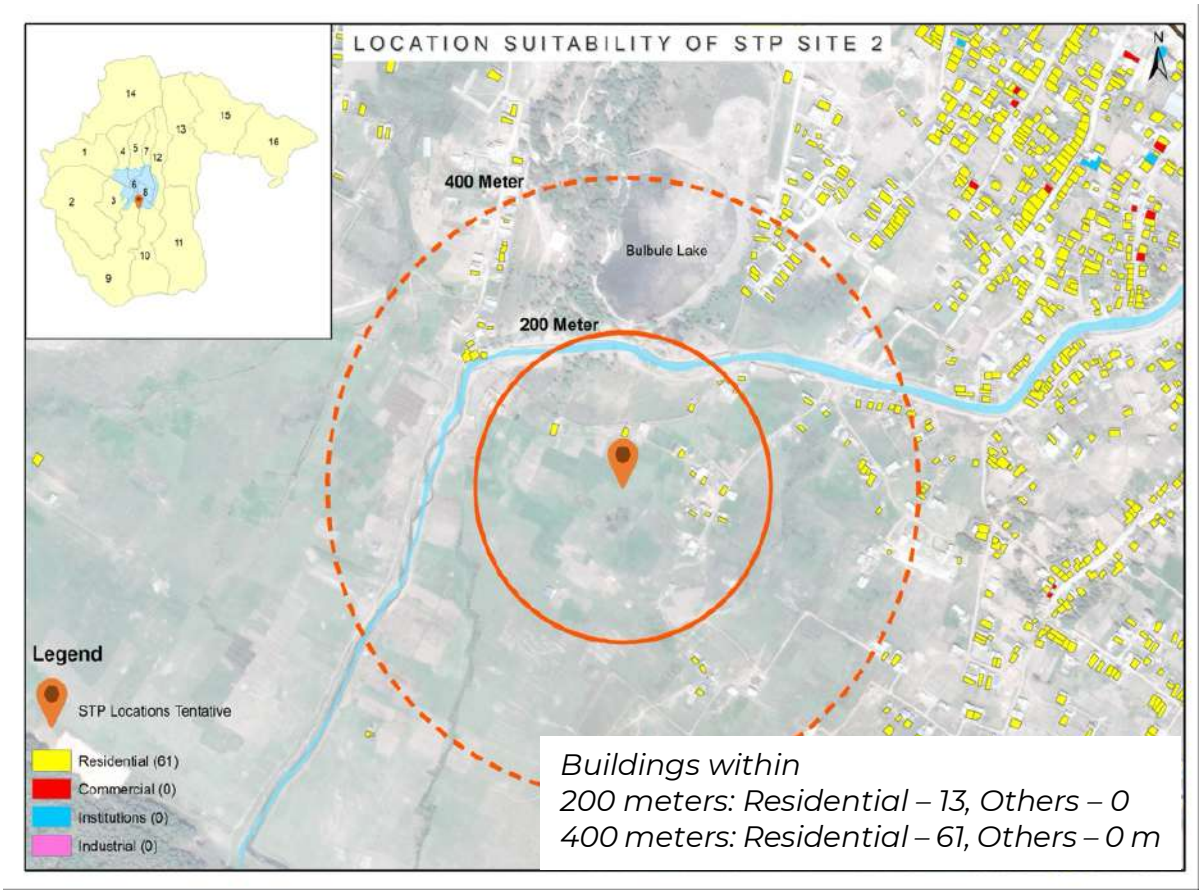
To estimate the maximum quantity of wastewater from the proposed sewerage zone, the trunk lines are drawn in the roads having width greater than 8m. The trunk lines in the roads created several blocks of settlements. The flow direction of trunk lines is determined with the help of ground elevation of the trunk junctions. The number of buildings in each block varies resulting different building densities. The trunk lines are connected to branch lines and branch lines are further connected to lateral lines. To estimate the branches and laterals, the block having moderate density is chosen as sample block. The layout of branches and laterals is overlaid in the sample block. The length of branches and laterals in sample block is calculated so that it can be projected to other blocks with respect to their area. In this way the total trunk, branches and laterals can be estimated. All the buildings in the sewerage zone are considered to have the house connections to discharge wastewater into the nearby lateral.

The hydraulic design based on maximum flow is done to one of the longest trunks delivering wastewater to the wastewater treatment plant. In this case, the interceptor running along the bank of Itram Khola is considered for hydraulic design. The hydraulic design gives the pipe diameter require to accommodate the flows entering into the interceptor. The trunk line has different pipe diameter along its length, smaller diameter at upstream part and bigger diameter at downstream part. The total length of trunk is proportioned with respect to the interceptor considered.

The construction cost of the sewer network is estimated based on the district rate of Surkhet of Fiscal year 078/079.

FIGURE 8: PROPOSED WTP LOCATION MAP





DESIGN APPROACH OF WASTEWATER TREATMENT PLANT

Due to terrain situation of the sewerage zone, two treatment plants, one nearby Bulbule taal and other nearby fish cottage is proposed to treat the wastewater generated from the sewerage zone. The size of the treatment plant is calculated based on the maximum discharge carried by the interceptors. The size of wastewater treatment plant (WWTP) near to the fish cottage is 3.6 MLD and WWTP nearby the Bulbule taal is 2.4 MLD. Refer annexure 7 for calculation reference.

The proposed area for the treatment plant is agricultural land. The required land necessary for the treatment plant has to be acquired. The treatment plant having low footprint, low operation and maintenance cost, simple technology and ambient climate compatible is preferable. Major cities like Kathmandu, Bhaktapur and Lalitpur are developing large treatment plants to treat municipal wastewater. Most of them are under construction. The treatment plants under construction are based on the aeration-based technology called as activated sludge process. The activated sludge process is the conventional wastewater treatment process that has been applied globally and proven to produce excellent effluent quality.

The wastewater treatment plant based on activated sludge process (ASP) has been chosen for both the location considering the land requirement, ambient climate compatibility, and the technology adopted by other cities in Nepal. The treatment plant at Guheswori in Kathmandu is one of the examples of ASP. There are advance treatment plants like membrane bioreactor (MBR), Sequential batch reactor (SBR) etc. available nowadays with low footprint but looking at the development chronology of wastewater treatment technology in Nepal aeration-based technology like ASP is becoming more popular. Although the advance treatment plants like SBR and MBR has lots of comparative advantages of ASP, they are still not common in municipal scale. Thus, ASP technology is chosen in this study considering that the technology can be easily implemented as it has been operating for twenty years back in Kathmandu. Furthermore, the big treatment plants under construction in Kathmandu are also of ASP technology. Thus, the treatment plants nearby the Fish cottage and the Bulbule taal is provisioned in reference to the Guheswori WWTP. The overall cost of the treatment plant is also referred from the Guheswori treatment plant in Kathmandu.

3.3 ESTIMATED INVESTMENT COST

3.3.1 COST FOR NON-SEWERAGE INTERVENTIONS[2]

TABLE 8: PROPOSED INTERVENTION HEAD WISE SUMMARY: NSS

CATEGORY	INTERVENTION	ZONE	BENEFICIARIES	RATE ($)	AMOUNT ($)
Residential					
Urban Poor Households	Containment Improvement	Flood risk area	102	$437	$ 44,574
		Water sensitive	213	$437	$ 93,081
		Inaccessible regions	1844[3]	$245	$ 451,780
		Others[4]	2884	$579	$ 16,69,836
Total					**$ 22,59,271**
Other than Residential[5]					
Institutions	FS+ Greywater	Flood risk area	3	$20,990	$ 62,970
		Water sensitive	2	$20,990	$ 41,980
		Others	162	$20,990	$ 34,00,380
Total					**$ 35,05,330**
Co-treatment					
Co-Treatment/Co-handling Facility	Septage Management	At proposed WTP Campus	2	$57,652	$ 57,652
Total					$ 57,652
Grand Total (in USD)					**$ 58,22,253**

TABLE 9: PROPOSED PROJECT INTERVENTION SUMMARY: NSS

CATEGORY	INTERVENTION	AMOUNT ($)
Urban Poor Households	Containment Improvement	$ 22,59,271
Institutions	FS+ Greywater	$ 35,05,330
Co- Treatment/Co-handling Facility	Septage Management	$ 57,652[6]
Total Cost (in USD)		**$ 58,22,253**
Vat @13%		$ 7,56,893
Grand Total		**$ 65,79,146**

[2] Refer to Annexure 7 for detailed breakdown of NSS cost

[3] There are total 1877 building and 1844 households residing into in-accessible regions of Municipality. Source – Table 15

[4] In the category of residential, Households is proposed for Septic Tank with Soak Pit provision for wastewater management.

[5] Only institutions have been considered in the Other than residential category and proposed for DEWATS for wastewater management. Since each institution's has multiple buildings and only total number of buildings data is available, therefore 3 units of building has been considered as 1 institution.

[6] The cost of co-treatment units of both treatment plant is sourced from FSTP Review report of TA Hub.

3.3.2 COST FOR SEWERAGE INTERVENTIONS[7]

The cost of sewerage system refers to the construction cost of all sewer lines, wastewater treatment plants, and household connections. The district rate published by the Surkhet district coordination committee for the current fiscal year was used for rate analysis of major construction items like hume pipe laying of different diameters and household connections. The cost of wastewater treatment plant is estimated based on the reference data available for the Guheswori Wastewater Treatment Plant in Kathmandu.

The total cost includes the construction cost for 109 km of sewer pipelines, 12213 buildings connections, 3336 sqm land for the proposed treatment plants and two numbers of wastewater treatment plants with total capacity of 6 MLD. The cost can be taken as budgetary cost only. The revision on the costs is required at the time of preparation of DPR of the project.

The cost summary of the sewerage zone is as shown in the table below

TABLE 10: COST SUMMARY FOR SEWERAGE SYSTEM INTERVENTIONS

DESCRIPTION	AMOUNT (IN MILLION NPR)	AMOUNT (IN MILLION USD)
Sewer Network	184.32	15.62
Wastewater Treatment Plant	28.80	2.44
Land for wastewater treatment plant	9.34	0.79
Sub Total Cost	222.46	18.85
Grant Total cost with VAT @13%	251.37	21.30

3.3.3 COST FOR COMPLETE SANITATION SYSTEMS

TABLE 11: SUMMARY OF OVERALL SANITATION INTERVENTION COST: NSS AND SS

DESCRIPTION	AMOUNT (IN MILLION NPR)	AMOUNT (IN MILLION USD)
NSS Interventions		
Urban Poor Households	266	2.25
Institutions	414	3.51
Co- Treatment/Co-handling Facility	7	0.06
Total Cost	**687**	**5.82**
SS Interventions		
Wastewater Treatment Plant	288	2.44
Sewer Network	1843	15.62
Land for wastewater treatment plant	93	0.79
Total Cost	**2225**	**18.85**
Grant Total cost	**2912**	**24.67**
Grant Total cost with VAT @13%	**3291**	**24.67 ~ 25 million USD**

Findings of Phase I which has been mainly focused on NSS and its improvement has been considered as Scenario I. Broad cost estimates mainly for containment improvement and greywater management was proposed in Phase I. While the combination of sewered and non-sewered interventions as well as appropriate technology propositions has been made in Phase II and has been considered as Scenario II for Birendranagar. Although analyzing both these scenarios is beyond the current scope, investments proposed in Scenario I and Scenario II has been presented here for readers understanding.

[7] Refer to Annexure 6 for detailed breakdown of SS cost

CONTAINMENT IMPROVEMENT		
Plan	**IMPACT ON SERVICE CAPACITY**	**COST OF SUPPORTING LICs**
Plan 1: existing containment type remain as it is and only the desludging practices increase by 70% till 2031	• With 70% improvement in desludging practice • Peak FS volume is reached 51.8 m^3/d by 2029	US$ 8,620
Plan 2: assuming all the pits and other containments will be converted into septic tank and number of holding tanks remains same till 2031	• Septic tanks will increase to 36% • Desludging practice will increase according to the conversion rate of containments into septic tank. • Peak FS volume is reached 50.7 m3/d by 2030	US$ 2,714,088
Plan 3: assuming all the pits and other containments and 50% of holding tanks will be converted into septic tank by 2031	• % Of septic tanks will increase to 63% • Peak FS volume is reached 54.9 m3/d by 2028	US$ 4,727,309
Plan 4: assuming all pits, other containments & holding tanks are converted into septic tank by 2031	• % of Septic Tanks will increase to 90.3% • Peak FS volume is reached 56.7 m3/d by 2027	US$ 10,989,807

Greywater Management		
Current water consumption	80	lpcd
% Greywater	64	lpcd, 80% of the water consumed
total generation in year 2021	7,911	m3/d
Expected water supply in 2031	130	lpcd
% Greywater	104	lpcd
total generation in year 2021	15,681	m3/d
Unit rate for HH level treatment systems (US $)	414	
Assumption: the current water supply is designed for 130 lpcd however, based on the KII it was found that around 38% of water is unaccounted for. So, the current water consumption has been considered 80 lpcd. While for the year 2031, it is expected that measures will be taken, and design supply is met.		

	2021		**2031**	
	LIC	TOTAL	LIC	TOTAL
HH number in	20085	30901	24502	37696
Cost of individual HH Level Greywater treatment System (US $)	**8,311,169**	**12,786,414**	**10,138,790**	**15,598,138**

3.4 IMIS

3.4.1 DATA GAP ANALYSIS

The Phase 1 assessment report identified a list of datasets required for IMIS, along with its value proposition and its influences to achieve the CWIS outcomes or functions towards inclusive and sustainable sanitation outcomes. The report highlighted the significant data gap required to initiate the process for implementation of IMIS in Birendranagar Municipality.

Phase 2 of the technical assistance package explored the availability of data and possibility of collecting some of the important data from the field. Various GIS datasets for Birendranagar Municipality were found - which were collected in 2019 for the preparation of GIS database of Birendranagar and a project entitled "DPR preparation of Two Infrastructure Projects for Strategic Urban Infrastructure Development of Surkhet Valley" under Department of Urban Development and Building Construction (DUDBC).

Spatial dataset of LIC, PT/CT, location of FSTP, flood prone areas with their attribute information created under this assignment are additional datasets available for IMIS. GIS data collected and prepared for IMIS is a key source of data and information for sanitation spatial analysis described in section 3.1.

The table below highlights updated status of each individual data layers. Based on the information provided in the table, it can be concluded that many datasets required for IMIS implementation are readily available for Birendranagar Municipality. Nevertheless, a complete census survey to establish the database of containments will be required due to unavailability of data in specific to containment systems.

3.4.2 IMIS DRIVEN IMPROVED SERVICE DELIVERY

EVALUATION OF THE CURRENT BUSINESS PROCESS FOR SANITATION DELIVERY

For any service delivery model to be successful, a strong coordination among implementing stakeholders is very essential. There are several models for sanitation service delivery. Depending on the existing economic, legal, environmental conditions and local context, a municipality may adopt certain service delivery and financial model for sanitation. Often service delivery models are constantly modified and restructured.

The Phase I assessment report (Chapter 4) has extensively covered the existing sanitation delivery practices, prospects for enhancement of service delivery and also formulated potential financial model for Birendranagar municipality. KIIs were conducted with the municipality officials and private entrepreneurs responsible for service delivery which confirmed the findings made during phase I assessment, regarding the mechanism of service delivery.

In a nutshell, Birendranagar municipality adopts a municipal-led service model where private entrepreneurs register themselves in the municipality and provides on-demand desludging services charging a fixed rate/trip to its customers. The only difference is that the municipality now operates a Faecal Sludge Treatment Plant (FSTP), built under financial support and technical supervision of SNV. Hence, private entrepreneurs transport and dispose the emptied sludge at the newly constructed FSTP.

TABLE 12: DATA REQUIRED FOR THE IMIS FOR BIRENDRANAGAR MUNICIPALITY

	DATA INDICATOR & AVAILABILITY	OLD STATUS	NEW STATUS	REMARKS
1	Ward Boundary / Administrative zone boundary	✓	✓	
2	Land use	✗	✓	
3	Soil data	✗	✗	Land use data prepared by Survey department is available, but could not be collected during this assignment, the municipality need additional attempt to collect this data set. The cadastral data of the city is available in this data set, which adds value if it can be included in IMIS.
4	Contour	✗	✓	Contour 10 m interval is available
5	Water table	✗	✗	Explore secondary Government's source, otherwise need to conduct a survey to prepare water table map of the Municipality.
6	Water Logged area	✗	✓	Prepared during suitability analysis based on hydrological modelling, verified on site during field survey.
7	Environmentally sensitive areas	✗	✓	
8	Population density	✗	✓	250 * 250 grid map and distributed household size 4.22 for each residential building unit for population of 2011. And further to this population projection growth data of Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021-Annex VII
9	Settlements	✗	✓	
10	Low Income Community[8]	✗	✓	An elaborate field survey was conducted to collect both spatial and attribute data. All together 63 LIC areas were delineated.
11	Building footprint[9]	✗	✓	Since this data was created in 2019, these building footprints need to be newly digitized or update the missing buildings only. This needs to be decided during the time of project implementation.
12	Road Network	✗	✓	Road networks to be updated to maintain the structure of road data which has been adopted in IMIS.
13	Storm water drainage	✗	✗	Drainage outfall location and catchments need to be generated with field survey and in consultation with Municipality authority.
14	City water supply areas[10]	✗	✓	Water Supply Network data is available, but the area served by water network needs to be delineated based on the water supply system.
15	Sewerage network	✗	✗	Currently it does not exist, needs to be created once city has this network.
16	Containment	✗	✗	A separate containment survey needs to be conducted to know spatial and other details. This is one of the key data points of IMIS.
17	Public services (PT/CT) with service information	✗	✓	An elaborate field survey was conducted. All together 11 PTs/CTs spatial positions and attributes were collected
18	Treatment Plants	✗	✓	
19	Landfill site	✗	✓	
20	Tax zone	✗	✗	Need to develop during the process of IMIS implementation in consultation with the Municipality. If Birendranagar municipality also adopts a prevalent practice of linking tax rate of buildings based on its connection to determined sets of roads, then an additional attribute has to be collected for tax rate in the building layer.
21	Public services	✗	✓	Public service buildings are identified in the existing data but it needs to be updated during census survey of sanitation systems.
22	Place	✗	✓	
23	Emptying and Transportation Infrastructure and Services	✗	✓	Collected all required information during the field survey.
24	Service provider	✗	✓	Collected all required information during the field survey.
25	Faecal sludge data	✗	✗	Currently, Data is not managed systematically but it can be established along with the implementation of IMIS.
26	Customer data	✗	✗	Customer database system needs to be designed during implementation of IMIS.
27	Customer feedback data	✗	✗	Currently, no such mechanism exists but can be established during IMIS implementation.
28	Public service feedback	✗	✗	Currently, no such mechanism exists but can be established during IMIS implementation.

[8] During field survey and also during interaction with municipal staff, it has been confirmed that many house owners of LICs already have land ownership document and others are in the process of getting ownership. Households in these communities are getting all infrastructure services as other citizens in the city. Majority of the buildings structures in LICs are permanent and also have their own sanitation system. Only people in one LIC do not own the land. It is important to discuss and decide with Municipality whether these areas to be considered as LIC or not in the process of IMIS implementation. Structure type of the building has been used as the parameter to identify low income households for sanitation planning whether the house is in LIC or in other settlements. If households are with permanent building structure in the LIC, they are not considered as low-income households.

[9] Building footprints are major data required for IMIS which also need to be mapped with sanitation service available in the buildings; and associated roads, drains, sewerage network, water supply network etc. A census survey needs to be conducted to establish building database with all required attributes.

[10] During field survey, it is also found that small community-based water supply systems are also coming to serve the unserved area. This data needs to be created during IMIS implementation phase.

Some of the key observations from conducted KIIs:

- Three private entrepreneurs are active in Birendranagar municipality for service delivery
  - *Mr. Kushal Thapa (Birendranagar Septic Tank Safai Sewa & Mangalgadhi Septic Tank Safai Sewa)*
  - *Mr. Khagendra Gautam/Mrs. Sita Gautam (Nagar Sarsafai and Transport Sewa)*
  - *Mr. Suresh Thapa (Yeri Chowk Sarasafai Udhyog)*
- All entrepreneurs have used customized drinking water tanker with mechanical suction pump. Tankers body needs maintenance every 2/3 years.
- Majority of desludging requests come from the inner urban area. They get more requests from wards where their office is located at.
- No provision of subsidy for Low-Income Communities (LIC's) to pay for desludging fees
- All entrepreneurs are involved in other businesses as well. Two entrepreneurs are also involved in supplying water business and one entrepreneur is providing vehicle on hire business.
- High turnover rate for field employees (drivers, cleaners). Private entrepreneurs struggle to transfer OHS trainings to their employees.
- No female field employee. Two females are involved in management role.
- Municipality does not have any service level agreement (SLA) with private entrepreneurs. No reporting mechanism.
- No consideration of paying capacity. All buildings regardless of their functional use (e.g. residential, commercial and institutional) are charged the same flat rate.
- No grievance redressal/ feedback mechanism
- No mechanism to control illegal dumping of emptied sludge in nearby open fields/water bodies by private entrepreneurs.

During the field visit, it was apparent that the municipality does not have efficient system or mechanism to manage, monitor and evaluate sanitation services. Additionally, municipality lacks data related to service delivery e.g. frequency of desludging, volume of sludge collected, application response efficiency, response time etc.

With the establishment of IMIS, all relevant data will be collected across the sanitation value chain and stored in a spatially enabled relational database, so that the municipality authorities can enforce an efficient monitoring mechanism. Furthermore, service efficiency accountability mechanisms based on actual performance against goals (e.g. reward/penalty based on KPIs and grievance redressal) can be easily established which will lead to increasing efficacy of sanitation services delivered by private entrepreneurs.

Establishing IMIS will also be a monumental step towards achieving the regular desludging practices by establishing municipal level databases (e.g. customer, containments) which are needed to efficiently plan and track orders, manage payments, record emptied date, and maintain inventory of containment locations and its size. IMIS also adds value for city's overall planning and management including revenue enhancement.

READINESS OF FIELD OPERATORS IN ADOPTING TECHNOLOGY

One of the pre-requisites for effective management and monitoring of sanitation service delivery is through understanding stakeholder's readiness to adopt to the recent technological advancement in internet connectivity and mobile technologies. One of the objectives during the field visit was also to assess the readiness of private desludging service providers and FSTP operators in using technological solutions for their daily operations e.g. maintaining daily logbook, maintaining inventory for desludging

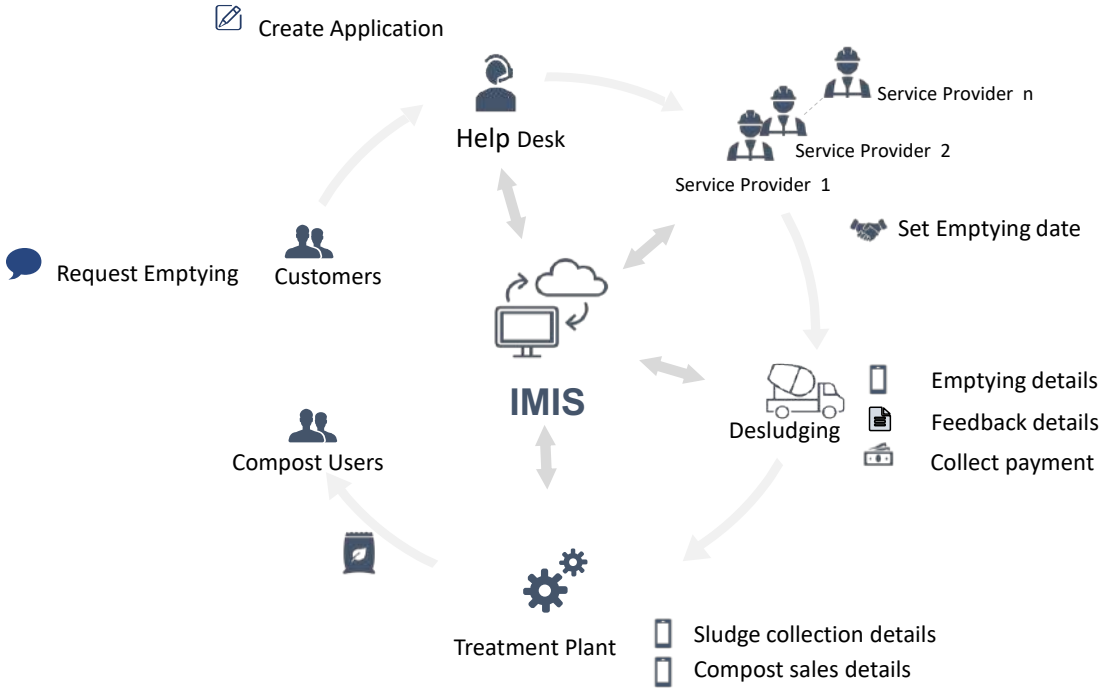
vehicles, maintaining human resources inventory, treatment plant effluent quality test records. It was found that two of the desludging operators document their daily logbook in writing in a register. However, the oldest service provider (Mangalgadhi Septic Tank Safai Sewa/ Birendranagar Septic Tank Safai Sewa) has been using an accounting software to manage its operations and to maintain their daily logbook. FSTP operators also document their daily logbook in writing in a register. Both desludging service providers and FSTP operators expressed their willingness to adopt a web-based information management system as they are accustomed to using internet and mobile based application in their daily life. Furthermore, there is a capacity building program targeted towards field operators during implementation of IMIS.

PROPOSED MODEL FOR SANITATION SERVICE DELIVERY

Based on the assessment of existing business process adopted in the municipality, readiness of private entrepreneurs involved and eagerness of the municipality to have an effective IT-enabled real-time monitoring system, a complete digitalization of business process covering the entire sanitation value chain is proposed in the figure below. Along the entire sanitation value chain, data are collected in real-time through web/mobile applications from relevant stakeholders and securely stored in IMIS.

A concept of unified single help desk is proposed that will be operated by the municipality. The help desk can be established within the municipality premise or can be established elsewhere. The help desk will register applications from customers through a central hotline number. Lodged applications are automatically forwarded to a service provider with an auto forwarding module integrated within IMIS. Customized role-based access control mechanism will be utilized to maintain authorized access into specific modules of IMIS depending on each user's roles (e.g. help desks, service providers, treatment plant operators). IT personal of the municipality is an ideal person to act as administrator who will assign roles to different users to control who has access to what content & functionality of IMIS.

FIGURE 9: DIGITIZATION OF SANITATION SERVICE DELIVERY COVERING THE ENTIRE SANITATION VALUE CHAIN



Step 1: Requesting for emptying services

Customers request for emptying service through phone or visiting office of the unified help desk. In addition, customers can also lodge request through a simple web form in the municipality's website by submitting few basic details (e.g. name, contact).

Step 2: Filling an application

Unified help desk will ask for customer ID that uniquely identifies the house of an applicant. Birendranagar municipality has already collected data for the metric addressing system to provide a unique house number to individual houses but it has not been implemented yet. If implemented and fully enforced, the house number provided for each individual building can be used as the customer ID. In absence of metric addressing system, BIN (Building Identification Number) that will be provided to all buildings during the survey phase of IMIS can be used as the customer ID.

After identifying the applicant through the customer ID, unified help desk will further enquire few additional information such as physical proximity to road, estimated sludge volume for emptying and lodge the application in IMIS. The lodged application will be auto forwarded to a service provider that will be handled by an auto forwarding module of IMIS. Applications received through web will be verified by unified help desk through phone and verified applications will be lodged in the similar way.

The auto forwarding module can be customized based on a waiting list for emptying in each service providers such that service provider with few waiting customers will be prioritized. Service provider who receives the application has an option of accepting or rejecting the application however if service provider rejects any application then a specific reason (e.g. maintenance of desludging vehicle or unavailability of field workers etc.) for denying the service has to be provided. If applicants mentioned that the emptying service is urgently required due to some emergency, then the application will be forwarded to all service providers and whoever accepts the application first will get opportunity to serve. Such emergency emptying request may be charged additional money subject to the municipality policy. The working modality of the auto forwarding module will be finalized during implementation of IMIS through discussion with the municipality and service providers.

Some of the advantages of the auto forwarding module are as follows:

- Ensures that far residing customer will get prompt service
- Provides equal business opportunity to all service providers
- Encourages service providers to reduce service response time to get more business

Step 3: Accepting an application

Service providers will be given an access of IMIS. After accepting an application, the service provider contacts the applicant and sets an agreed date for emptying in IMIS. Accordingly, desludging operators will be informed. IMIS ensures that the service provider do not set more number of applicants than their service providing capacity on a particular date.

Step 4: Performing the actual emptying service

On the agreed date, a desludging vehicle goes for emptying where the driver gathers emptying details such as date of emptying, duration of emptying, field operator (driver and helpers) information, payment details including a photo of a receipt through a mobile application.

After completion of emptying service, customers will be requested to fill handwritten feedback form about the service delivery, which will be subsequently fed into IMIS by the service provider. Having a feedback system will not only help the municipality to closely monitor the perception of customers but also in planning of an enhanced service delivery efficiency.

Step 5: Desludging at FSTP

During desludging, FSTP operator records sludge collection details (e.g. volume of the sludge received and arrival time of desludging vehicle) through a mobile application.

Step 6: Inventory of compost sales at FSTP

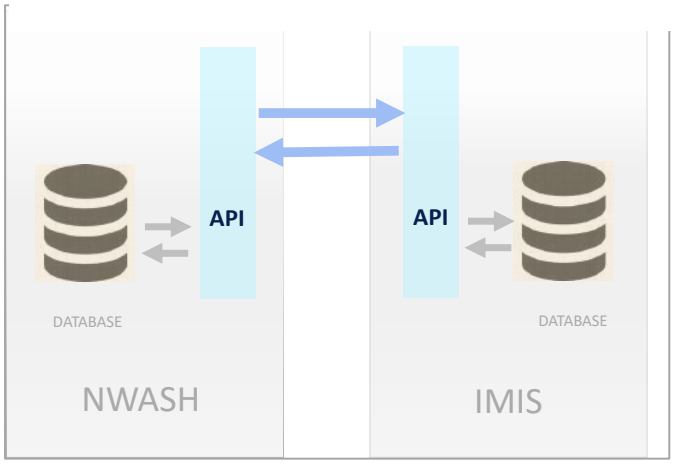
Currently, there is no provision of resource recovery/reuse practice in Birendranagar FSTP. However, if such practice becomes operational, FSTP operator maintains an inventory of compost sales in the system.

3.4.3 INTEGRATION WITH NWASH

The Phase I assessment reviewed the NWASH system which includes water and sanitation components, has developed mobile applications and the spatial and non-spatial data incorporated in the system. The study also assessed whether data points maintained by the system would be sufficient to address CWIS and if there was a possibility of integrating IMIS with NWASH to provide the municipal CWIS status through NWASH platform.

In this part of study, feasibility of integrating these two systems was further verified through interaction with NWASH system developer. The IT expert of the study team interacted with the developer to understand the technology such as the development platform and database system deployed in NWASH. Based on these discussions, it was identified that technologically, integration of IMIS and NWASH is possible. NWASH can also be a platform to provide CWIS status of municipalities which have implemented CWIS principles for their sanitation services. Data points generated through IMIS can be input data points for NWASH.

FIGURE 10: System architecture for NWASH & IMIS integration



For this, NWASH can have a separate dashboard dedicated to CWIS, to show CWIS status of municipalities that have adopted CWIS principles for sanitation service provision. In case of municipalities that implement both CWIS and IMIS, municipalities input CWIS data directly into NWASH through IMIS. Communication between two systems is possible through development of Application Programming Interface (API) as depicted in the figure above. These APIs have to be developed by both IMIS development team and NWASH development team for their respective systems. Data required to present the CWIS status will be pushed automatically into NWASH in a specified time interval as set by NWASH.

In case of municipalities which follow CWIS but do not have IMIS, NWASH needs to develop a small application, that helps municipalities to input CWIS data manually in NWASH. Municipalities will have to compile all data in a standard format and input in NWASH in a specified time interval set by NWASH. For both cases, some additional tables/attributes to maintain the CWIS data need to be added in NWASH's database structure.

Due to limited time and unavailability of key staff and stakeholders in short notice, the team could not have multiple meetings with the stakeholders involved in NWASH. However, the team had interactions with NWASH in-charge for possibility of creating a dashboard and other updates required in NWASH. The NWASH in-charge mentioned that there is a need of in-depth discussions with concerned staff and stakeholders to thoroughly understand IMIS, the data gap in NWASH for monitoring CWIS status, types of data to present in the dashboard and formulate the policy decisions required for implementation. Therefore, further in-depth study is required to address these issues. Costing for this component also cannot be estimated at this stage.

3.4.4 IMPLEMENTATION COST

SN	Component	Budget Estimate
1	Survey Activity	81,558
2	Server for Hosting IMIS for two years	-
3	Computers and Accessories for Municipal Staff	6,820
4	IMIS-System Development	36,000
4	Development of sewerage management & operation module & data updating	8,000
5	System Maintenance & GIS Data updating support for 3.5 Year after implementation	21,000
	Total	**153,378**
	Contingency (20%)	30,675
	Total Cost	**US$ 184,053**

Note:
The cost for implementing IMIS has significantly come down compared to phase I study (US$ 228,000) after the acquisition of GIS data required for IMIS. From the KII with the municipal staff, it is also found that the municipality has enough laptops that can be used for IMIS, therefore, the budget for laptops is deducted. Government of Nepal is providing government cloud to municipalities for hosting their systems so the cost for hosting server is also not included in budget.

CHAPTER 4

4. ENABLING ENVIRONMENT RECOMMENDATIONS – TOWARDS CWIS PLANNING

4.1 CWIS UNDERSTANDING AND ALIGNMENT

CWIS focuses on promoting approaches to ensuring everyone in an urban area is served by safe, equitable, and financially viable sanitation services & systems. Systems are designed to ensure solutions/interventions are based on ground situations regardless of paying capacity and human waste gets safely managed along the entire sanitation value chain (safe containment to safe disposal/reuse).

An understanding of all six principles of CWIS vis-à-vis compliance in terms of recommendations formulated as part of the current study are presented in the table below.

TABLE 13: ALL SIX PRINCIPLES OF CWIS VIS-À-VIS COMPLIANCE IN TERMS OF RECOMMENDATIONS

CWIS	UNDERSTANDING	COMPLIANCE
 **EQUITY**	Services reflect fairness in distribution and prioritization of service quality, prices, deployment of public finance/ subsidies.	• Subsidy on sanitation services • Safe sanitation service outreach to 100% town population regardless of their paying capacity • Improve gender inclusive workforce both in municipality and private entrepreneurs
 **SAFETY**	Services safeguard from safety and health risks by reaching everyone with safe sanitation.	• Set of relevant solution NSS, SS and FS with greywater. • Toilet containment improvement schemes.
 **SUSTAINABILITY**	Services are reliably and continually delivered based on effective management of human, financial and natural resources.	• Inputs in tariff scheme with differential collection system. • Solutions designed in line with environmentally fragile eco-system. • Inputs for exploring re-use potential of treated wastewater and sludge

CWIS	UNDERSTANDING	COMPLIANCE
 **RESPONSIBILITY**	Authority(s) execute a clear public mandate to ensure safe, equitable and sustainable, sanitation services for all	• Inputs for sanitation regulatory reforms with broad responsibility from user, operators, and authority perspective
 **ACCOUNTABILITY**	Authority's(ies') performance against its mandate is monitored and managed with data, transparency, and incentives	• Municipality preparedness for launching IMIS – availability of data and information for planning, management, and M&E of municipal services. • Developing KPI for performance monitoring and system feedback
 **RESOURCE MANAGEMENT & PLANNING**	Resources–human, financial, natural, assets–are effectively managed to support execution of mandate across time/space	• Customized desludging operation • Technology selection approach across sanitation value chain

Some of key inferences and related output (including those having spatial implications) of CWIS principles are analyzed in section below. These includes sanitation tariff & subsidy schemes, containment improvement schemes, customized desludging operations and further wastewater & sludge re-use potentials.

4.2 SANITATION TARIFF SCHEMES

Based on housing conditions (Katcha and Pucca) economically vulnerable populations have been identified within municipal area. Houses having Katcha wall (mud mortar) and/or roof (CGI sheet, timber structure and truss) were categorized as vulnerable economic populations and recommended to be compensated with tariff subsidy to afford the improved sanitation measure. Further to this differential tariff pricing mechanism can be adopted for financially sustainable operations. Building like commercial and institutions are likely to have more user footfall with paying capacity and accordingly higher tariff needs to be imposed. Business plan development would entail exact tariff calculations and sanitation tariff scheme can provide relevant inputs.

FIGURE 11: SANITATION TARIFF SCHEMES - BIRENDRANAGAR MUNICIPALITY

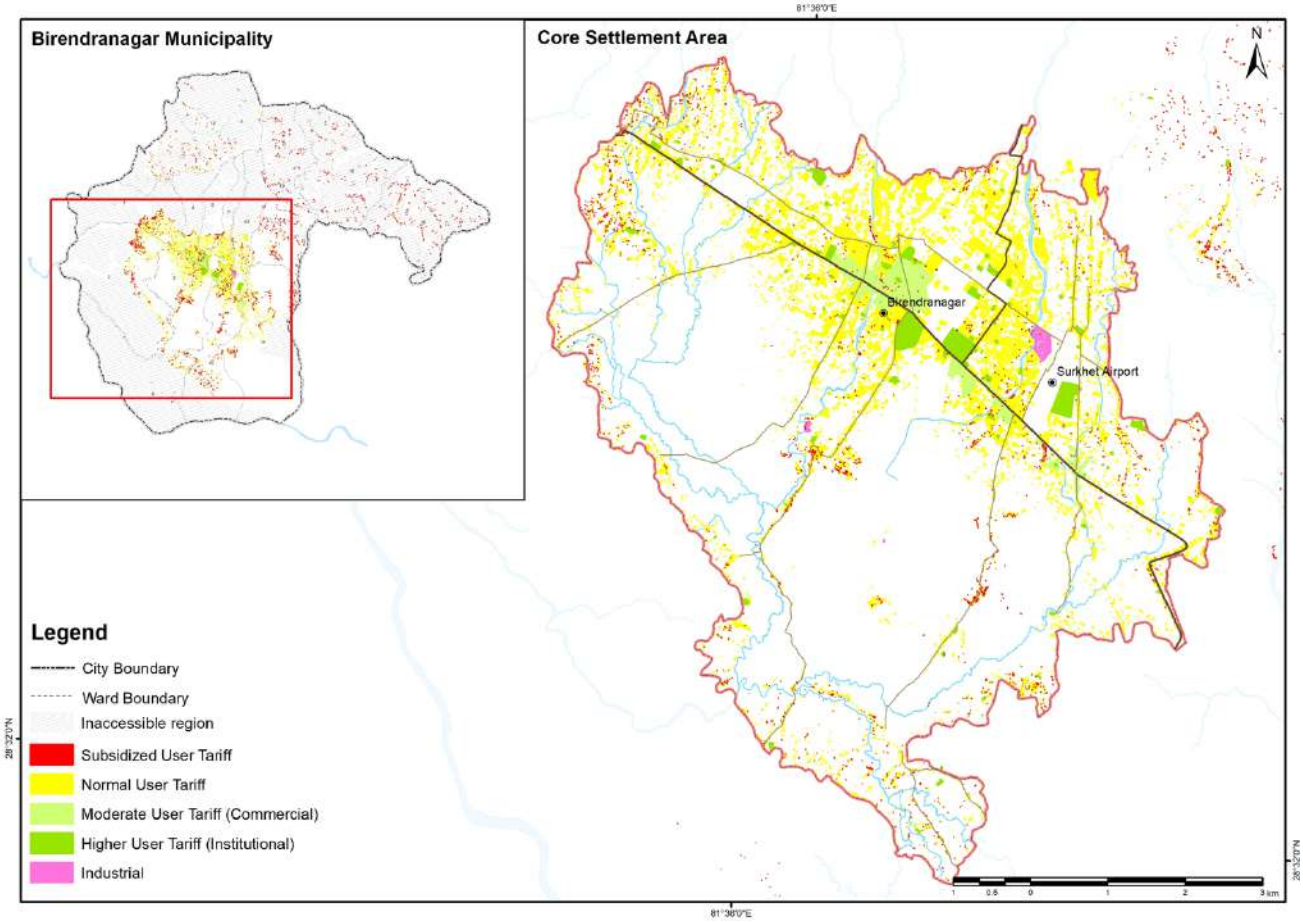


TABLE 14: KEY STATISTICAL INFERENCES FOR SANITATION TARIFF SCHEMES

SL.	ATTRIBUTES	NO.	%	REMARKS
1.1	Economic Vulnerable (EV) HHs	5498	18	Need tariff subsidy in sanitation services
1.2	EV HHs within SS Zone	453	1	Included building from all land uses
1.3	EV HHs within NSS Zone	5045	16	Both private and public institutions
1.4	EV HHs within inaccessible region	1844	6	All households within inaccessible regions are EV
1.5	EV HHs as flood risk	102	2	All commercial units of any scale
1.6	EV HHs as water sensitive (within NSS Zone)	213	11	Need financial help for containment improvement
1.7	EV HHs for FSM interventions	4750	86	Need rebate in sanitation cess during emptying
1.8	No. of institutions buildings	1153		NSS – 653 (57%), SS – 500 (43%)
1.9	No. of commercials buildings	3003		SS – 2190 (63%), NSS – 813 (27%)
While undertaking field visit and conducting KII with the municipal officials, it was observed that water tariff collection efficiency is more than 95% and every single user has volumetric water meter installed where in-line with uses, payments are done on monthly basis. An interesting fact found here is irrespective of economic vulnerability conditions, every user is paying flat tariff and even in poor section of populations, tariff collection efficiency is equally good. This is a huge motivation to opt for a combined water and sanitation user tariff system with incremental sewerage charges percentage in line with recommended tariff schemes of town. This would help to apply volumetric sanitation charges and in-line with wastewater generations.				

4.3 INACCESSIBLE REGIONS OF THE TOWNS

During the KII with desludging operators of Birendranagar, it is observed that up-to hauling distance of 80 meter (250 feet) are being covered by cesspool/desludging trucks. It is also understood that trucks can't get inside road less than 2-meter carriage way. All roads expect less than 2-meter carriage way have been factored as a part of buffer analysis (with 80-meter radial coverage) and left out buildings are categorized as inaccessible premises.

FIGURE 12: INACCESSIBLE REGION, BIRENDRANAGAR MUNICIPALITY

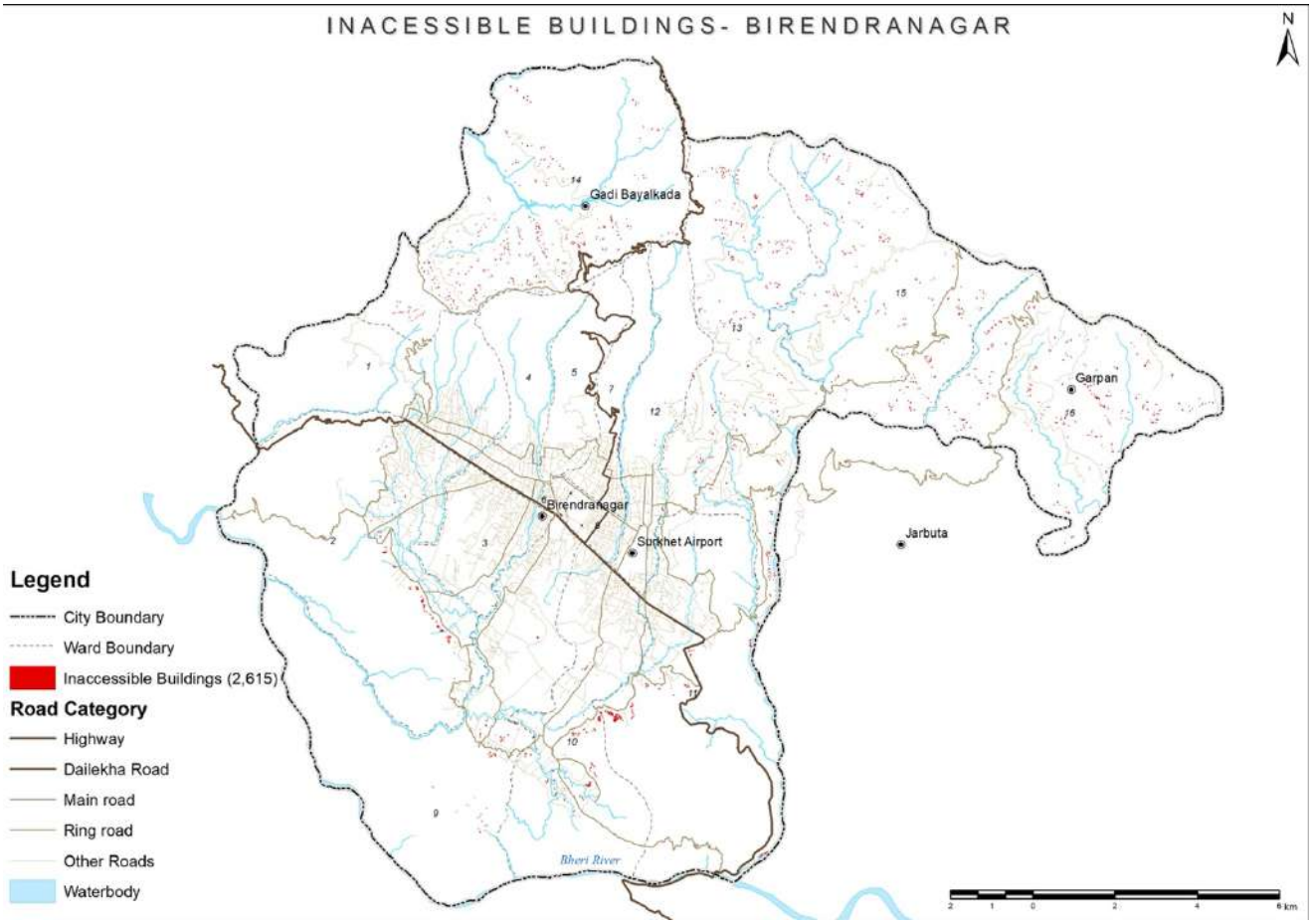


TABLE 15: KEY STATISTICAL INFERENCES FOR INACCESSIBLE REGIONS OF BIRENDRANAGAR MUNICIPALITY

SL.	ATTRIBUTES	NO.	%	REMARKS
1.1	No. of HHs at city level	2575	100	Desludging trucks can't access with pipe
1.2	No. of HHs within SS zone	60	98	Laying down network maty not be feasible
1.3	No. of HHs within NSS zone	2615	2	Partly in core area - need customized desludging
1.4	No. of HHs within inaccessible region	1844	1.4	Can't be accessed/served by desludging truck
1.5	• Inaccessible settlements of out skirts (mainly in high slope and forest area) will not be possible to be accessed and served by desludging trucks and may further will not be economically viable to be catered by any customized means. These settlements will need on-site sludge handling facility units like twin pit toilets. • Inaccessible buildings in core settlement area may needs to explore, the different means like common collection tank at accessible location or other customized desludging vehicle for smooth access even in narrow lanes. • Taking into consideration of required measure for these inaccessible household, going to help towards 100% safe emptying operations for all toilet containment of town. • Prior understanding of demand/desludging request from such location would help to smoothly plan the emptying services.			

4.4 SANITATION CONTAINMENT IMPROVEMENT

Settlement identified for FSM and FS+ Greywater management are applicable for this section. Refer table 5 for an understanding of decision-making process for improved containment and greywater solutions. This analysis is applicable for existing settlements to understand the improvement area and would become guiding frameworks for all future settlement growth and selections of suitable containment system. Town building permit approval may also take this as input while approving toilet containment basis to request raised from different geographical area of municipality.

FIGURE 13: CONTAINMENT IMPROVEMENT SCHEMES, BIRENDRANAGAR MUNICIPALITY

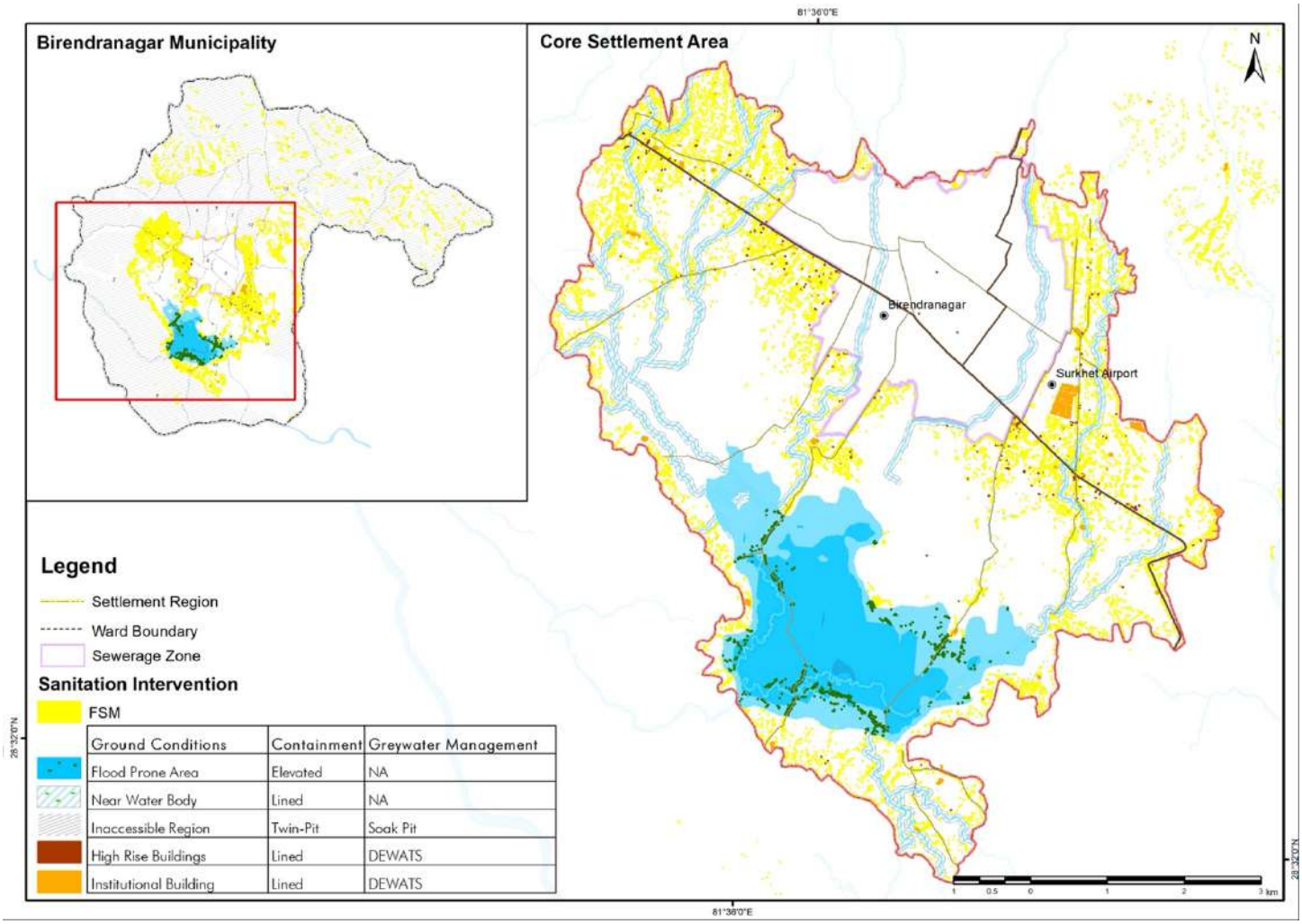


TABLE 16: KEY STATISTICAL INFERENCES FOR SANITATION CONTAINMENT IMPROVEMENT SCHEMES

Sl.	Attributes	Number	%	Remarks
1.0	For Household			
1.1	HHs elevated toilet containment	678	1	HHs of flood risk settlements
1.2	HHs for lined toilet containment as 1st level of priority	6756	1	Combined HHs from flood risk, water sensitive and economic vulnerable houses
1.3	HHs for twin pit toilet containment	1844	1	
1.4	Remaining HHs for lined toilet containment as 2nd level of priority	10514	22	Remining households from FSM zone which also needs lined tank as overall high-water table of city
1.5	Economic vulnerable (EV) HHs needs elevated toilet containment, (%) and improved soak pit within NSS zone	102	2	EV populations will have affordability issue and their vulnerability gets increased in case falling under flood risk areas.

1.6	EV HHs needs lined toilet containment, (%) and soak pit within NSS zone as 1st level of priority	315	6	EV populations within 'FS+ Greywater management' settlements where financial support needed for containment improvement
1.7	EV HHs needs twin pit toilet containment, (%) and soak pit within NSS zone (mainly of inaccessible region) as 1st level of priority	1844	34	EV populations located in inaccessible region would need twin pit toilet containment for on-site sludge handling and soak pit for greywater management.
1.6	EV HHs needs lined toilet containment, (%) and soak pit within NSS zone as 2nd level of priority	2884	54	EV populations within FSM settlements where financial support needed for containment improvement
2.1	Buildings for lined toilet containment, as 1st level of priority	4969	20	Combined buildings unit from flood risk, water sensitive and economic vulnerable houses
1.3	Remaining Buildings for lined toilet containment, as 2nd level of priority	10873	56	Remining buildings from FSM zone which also needs lined tank as overall high-water table of city
2.0	For Buildings			
2.1	No. of institutional units for lined toilet containment, (%) and DEWATS within NSS (as water sensitive and flood prone)	14	1.2	Need to install efficient on-site greywater handling facility in form of DEWAT or any other packaged treatment units
2.2	No. of institutional units for lined and elevated toilet containment, DEWATS within NSS (other than water sensitive)	484	42	Other remaining institutions without flood risk and water sensitive settlements.
2.3	Commercial units for lined toilet containment within NSS zone			There isn't any commercial cluster outside SS zone.
2.4	High rise building (>G+2) for lined containment and DEWATS within NSS zone	317	15	All high-rise buildings within NSS zone needs to have efficient on-site greywater handling facility (preferably DEWATS or more advanced version)

4.5 SERVICE COVERAGE ASSESSMENT OF EXISTING FSTP AND PROPOSED CO-TREATMENT

The objective here is to understand the proximity from existing FSTP and proposed co-treatment to various settlement area vis-à-vis desludging operators' reason for findings the remote settlement challenging to serve. There are inaccessible regions (especially on foothills and along Bheri River) where desludging trucks will not be able to serve any tank emptying trucks and they have separately highlighted in Figure 14. Travel time and distance is factored for actual road distance and time from FSTP and proposed co-treatment units to various building premises. Based on KII from desludging operators, travel time of 30-35 mins (i.e., 15 to 20 Km) is factored as smooth service coverage whereas all settlements beyond this timeline are factored as remote service coverage. Figure 14 below present the service coverage assessment of existing FSTP plant whereas Figure 15 present the possible coverage zone from both of proposed co-treatment units. Figure 16 present the final recommended zone of desludging operations while factoring best possible distance and travel time.

FIGURE 14: FSTP SERVICE COVERAGE AND PROXIMITY ANALYSIS TO VARIOUS PART OF MUNICIPALITY SETTLEMENTS

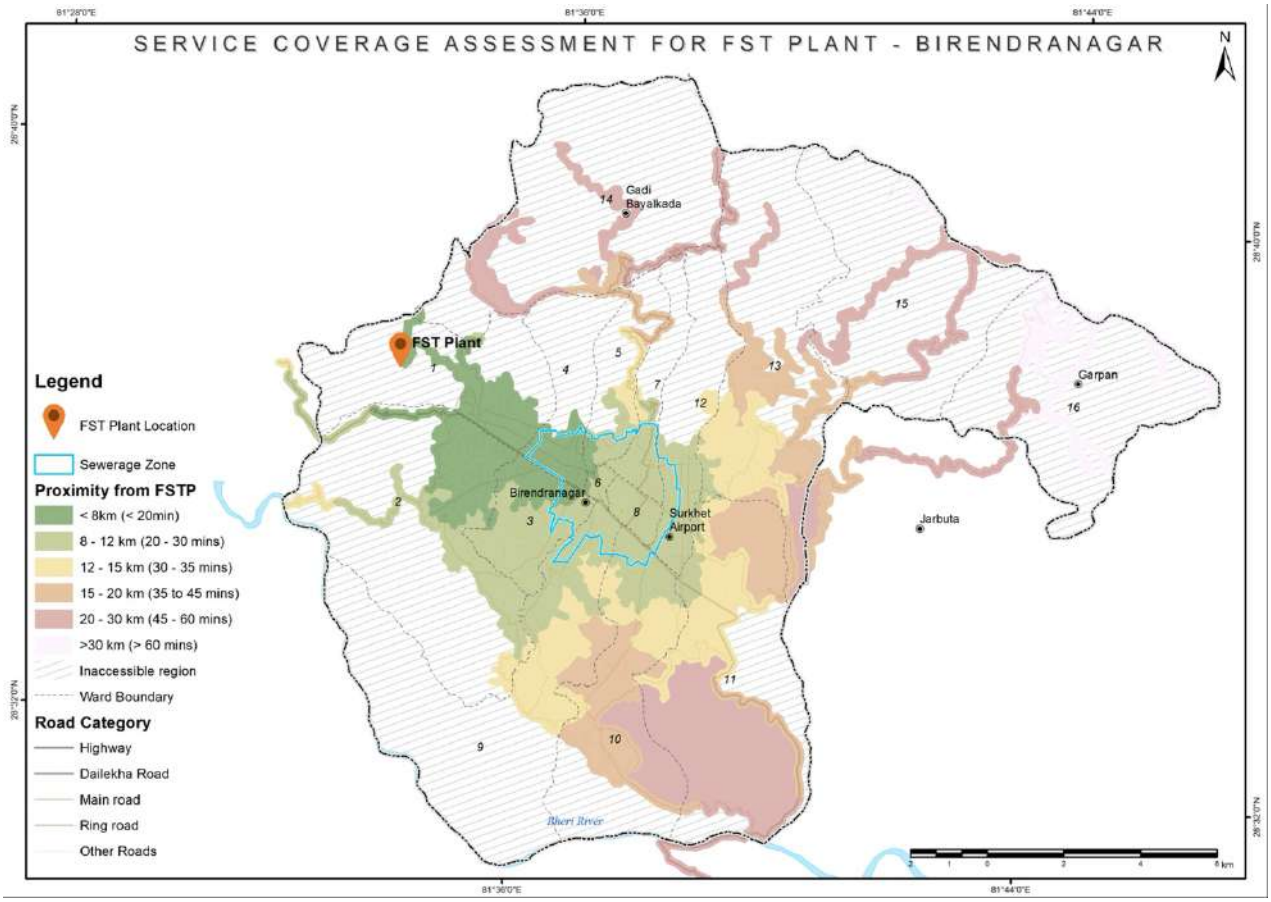


TABLE 17 SERVICE CATCHMENT OF EXISTING FST PLANT

Sl. No	Service Catchment	Buildings (Number, %)	Remarks
1.1	Within 15 Km (up to 30-35 mins)	27517 (85%)	The FSTP currently well located to serve smoothy around 85% of town populations. Proposed sewerage populations are located within same zone and cater to around 12213 buildings.
1.2	Outside 15 Km (more than 30-35 mins)	3073 (9%)	Remote service coverage. Desludging operators find this difficult to serve any request coming from such locality.
1.3	Within inaccessible region	1877 (6%)	Inaccessible region where in current circumstances, providing desludging services is not possible.

FIGURE 15 SMOOTH SERVICE CATCHMENT FOR PROPOSED CO-TREATMENT UNITS AT BOTH WTP

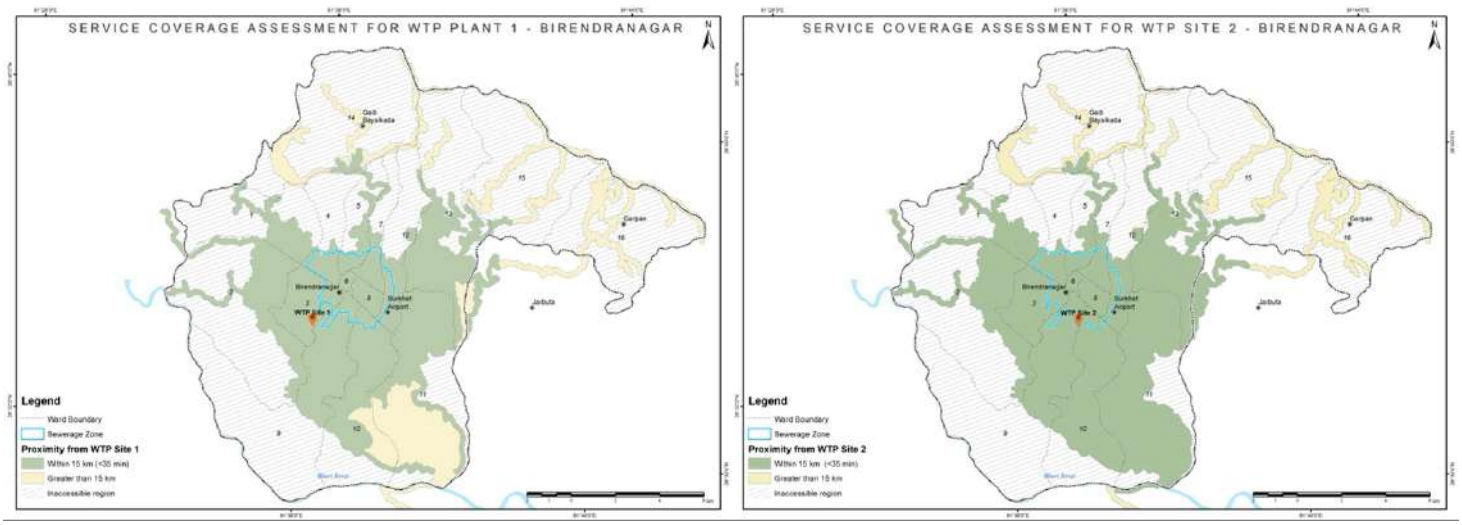


TABLE 18 SERVICE CATCHMENT POTENTIAL OF PROPOSED CO-TREATMENT UNITS

Sl. No	Service Catchment	WTP -1 Coverage	WTP -2 Coverage	Remarks
1.1	Within 15 Km (up to 30-35 mins)	29130	29405	WTP-1 coverage ⊂ WTP-2 Coverage
1.2	Outside 15 Km (more than 30-35 mins)	1589	1314	

FIGURE 16 PROPOSED SERVICE COVERAGE/DESLUDGING ZONES OF EXISTING FSTP AND SUGGESTED CO-TREATMENT UNITS

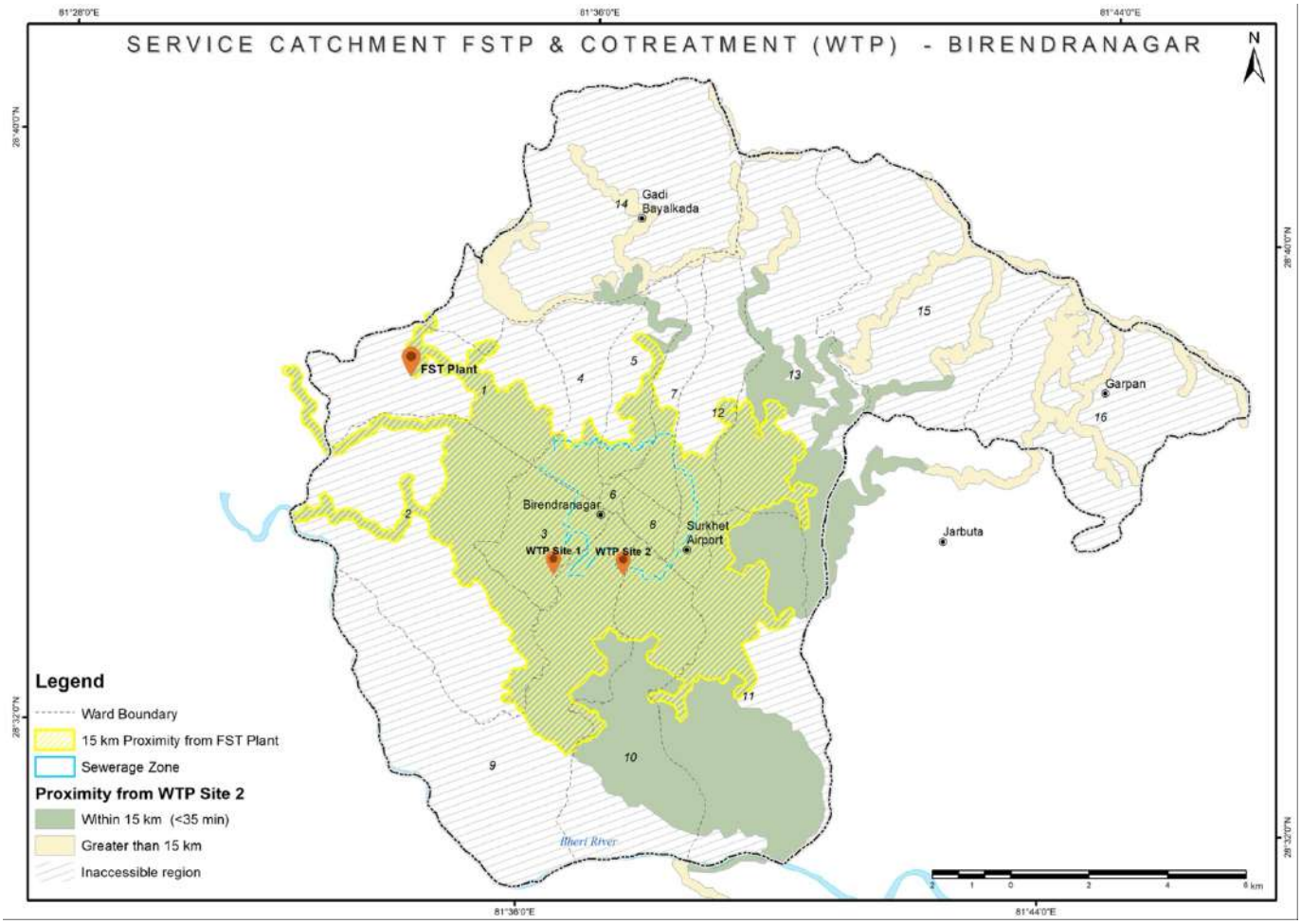


TABLE 19 PROPOSED SERVICE COVERAGE (BUILDINGS) OF EXISTING FSTP AND SUGGESTED CO-TREATMENT UNITS

Sl. No.	Interventions	Buildings		
		< 15 Km	> 15 Km	%
1.1	FST	15304	0	47
1.2	Co-treatment	2039	1034	9
1.3	Sewerage	12213	NA	38
1.4	Inaccessible	1877	NA	6
	Total	32467		100

Inferences –

I. 47% of municipal user demands are going to be catered by existing FSTP site locations. A separate assessment report on FSTP review has been completed and highlight the need of required capacity augmentations of FSTP in near future.

II. Co-treatment unit is proposed at both wastewater treatment plant as to have ease for desludging operators in terms of hauling distance and to distribute high concentration of sludge load at two plants instead of just one. This will help to cater around 9% buildings of town, mainly to premises which are beyond 15 km coverage reach from existing FSTP.

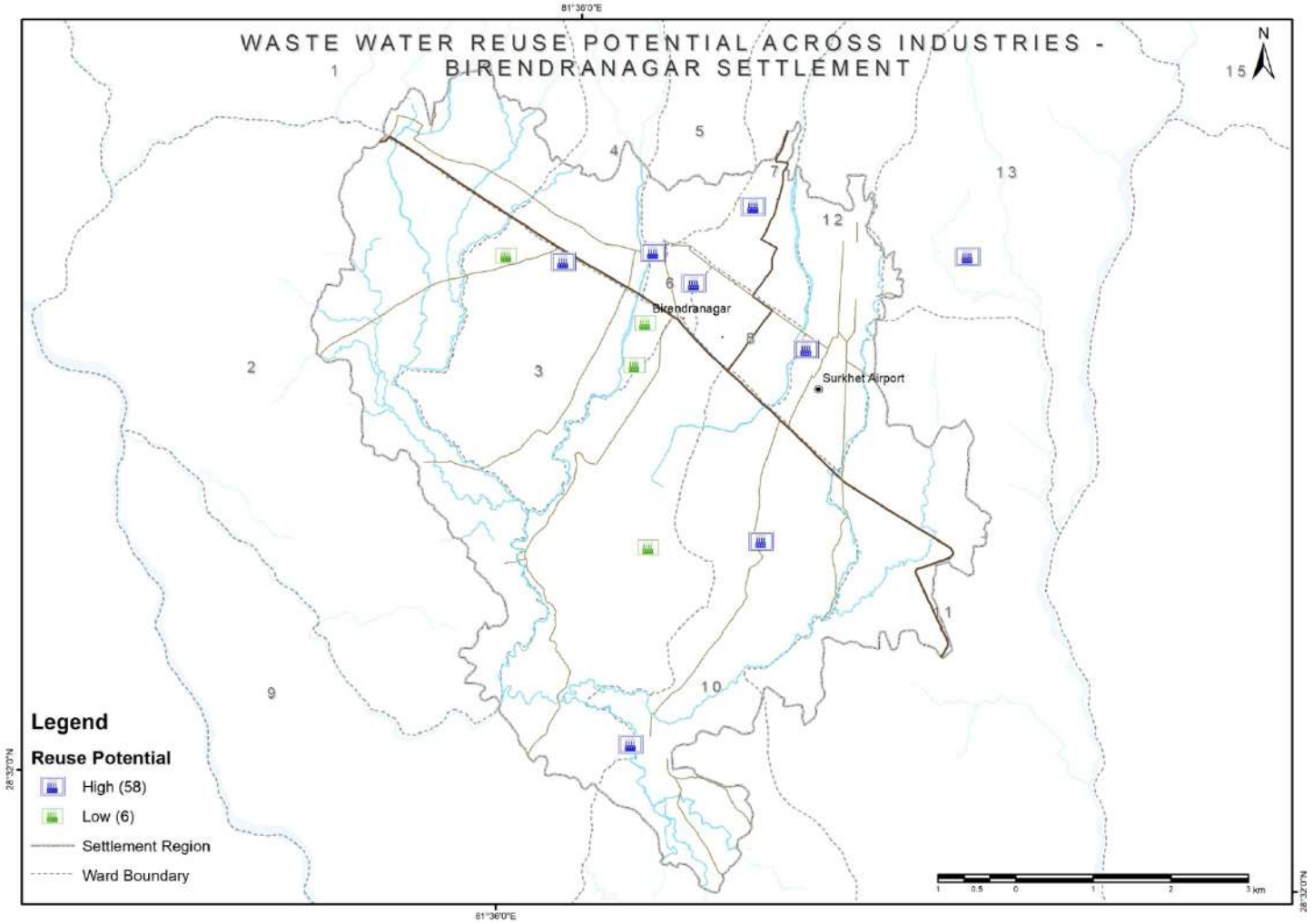
III. Around 38% of populations will depend on network-based sanitation interventions. There would be users within SS zone having continued dependency on desludging services and identification of such few exemptions (like inaccessible buildings, unauthorized houses, low lying units etc.) are not undertaken under this study.

IV. Around 1877 buildings are falling under inaccessible region (mainly outskirts) and will not be able to be catered by desludging services. All such households belong to vulnerable economic group populations and will largely be dependent on twin pit toilet containment for safe handling of generated sludge.

4.6 WASTEWATER AND SLUDGE RE-USE POTENTIAL

Proposed sanitation reforms of Birendranagar would generate large number of treated greywater volume from institutional, commercials, hotels, and other premises. Presence of large number of non-edible industries provides a good opportunity of adequate volume of treated wastewater and also sludge re-use in large number of agricultural (and forest) land uses within municipality.

FIGURE 17: INDUSTRIAL LAND-USE & TREATED WASTE WASTE-WATER RE-USE POTENTIAL MAP, BIRENDRANAGAR MUNICIPALITY



Inferences:

- There is total 64 industrial buildings within municipal area and around 58 of them have high potential towards re-uses of treated wastewater discharge
- Some of prominent industries groups include manufacturing units, mill, power stations, auto and grill workshop etc.
- Settlement with additional greywater treatment set-up can explore diverting the treated grey water to nearby agricultural/green field/forest land/ industrial units,
- Treatment opportunity can be explored for both WTP and/or FSTP and large area spread of agriculture and forest land can be explored for treated sludge uses as safe manure.

4.7 IMIS DRIVEN IMPROVED SERVICE DELIVERY

There must be a strong willingness and commitment from the municipality for adoption and institutionalization of IMIS. Any municipality that intends to implement IMIS must provide an enabling environment through setting up suitable policies which ultimately governs the successful adoption of IMIS leading to the goal of providing safe, equitable and inclusive sanitation to all its citizens as envisioned by CWIS. Municipality must formulate policies to pledging adherence to the principles and approaches of CWIS. Formulation of FSM Bylaws with the support from SNV for Birendranagar is close to completion & this may already address many issues required for implementation of CWIS and IMIS.

However, following are some of the key enabling environments required for successful implementation of IMIS:

- Municipality must adopt a policy that all sanitation service providers must register in the municipality, which is already a practice in Birendranagar. Implementation of IMIS will help maintain database of all service providers in the city.
- Municipality must integrate containment monitoring mechanism with the building permit approval system to ensure that the newly constructed septic are as per the standard design. IMIS's Building Management Information System enables municipality with this integration. Electronic Building Permit System, that municipality is implementing soon can also be integrated with IMIS to make this system more efficient.
- All registered sanitation service providers must adhere to a sanitation business process adopted by the municipality. Business process to be followed for service delivery needs to be endorsed by the municipality. IMIS needs to be customized based on municipality's business model.
- All service providers must agree to maintain information about their human resources and emptying infrastructures through IMIS. This will help maintain the database of human resources and emptying infrastructure of the service providers.
- Municipality must enforce all registered service providers to dispose collected sludge in a designated place or a treatment plant and proactively monitor performance of all service providers along the service chain. IMIS will enable the municipality to monitor if the collected sludge has been disposed of in designated place or treatment plant.
- Service providers are obliged to continuously update service delivery status through IMIS on a daily basis. Service providers must meet a minimum performance standard which will be closely monitored by various KPIs. KPIs have to be set after interactions with all stakeholders. Municipality needs to provides IMIS access to all service providers.
- Customers receiving emptying service must provide feedback after emptying the containment. IMIS maintains this feedback data, which provides invaluable insight into the functionality of service providers and helps to monitor whether all safety measures were followed during emptying process.
- Municipality must take the sole responsibility of establishing uninterrupted update mechanism of spatial data for buildings and containments. There are various modules in IMIS to support these activities. The municipality must record and map newer roads and drains at least in paper-based maps, which can be digitized and updated in the system.
- Municipality must be willing to sign Annual Maintenance Contract (AMC) with a suitable technical partner for maintenance, adding new tools and bug fixing to enhance municipality's IMIS capability. For efficiency and cost effectiveness, municipality may have separate contract with a capable consultant for updating spatial data such as buildings, roads, sewerage network.
- Other municipal functions such as water supply, solid waste management and revenue collection system can also be integrated within the IMIS system, in that case municipality needs to make corresponding departments responsible for providing and updating their concerned data and information through IMIS.

4.8 RECOMMENDED REGULATORY REFORMS

Sl.	Thematic Area and Recommended Regulations
1.1	**Containment Improvement and greywater handling units (within NSS Zone)**
	I. For all construction of new institutional building, multi-story building (pertaining to any land uses and more than G+2), commercial complex, building plan approval should include approving appropriate containment units with efficient on-site waste-water treatment facility (similar to DEWATS). Further to this all-existing building within similar category may be given timeline of 1.5 year for construction/corrections in both containment and greywater handling facility. Funding request from public institutions are encouraged to apply for grant/loan provision from municipality and/or any other legal sources. II. For all toilet type of any land uses, in-case getting constructed in flood prone area, containment needs to be elevated, lined and tank upper edge point needs to be higher than flood levels of past years. Kitchen garden is encouraged to be used for at individual and community levels (in case of space availability) with opening connected to soak pit outlet. Shared septic tank and soak-pit (or DEWATS) can also be explored in case of urban poor settlements while keeping appropriate care of flood resilient design. Similar recommendation is also applicable to water-sensitive area (settlements close to water body) and just elevated toilet containment may not be required in this situation. Funding request from identified economic vulnerable families are encouraged to apply for grant/loan provision from corporations and/or any other legal sources.
1.2	**Inclusion of urban poor in sanitation service delivery and differential tariffs**
	I. All urban poor populations currently residing into flood risk, water sensitive and inaccessible area are eligible to get subsidy on containment tank, greywater handling measure upgradations and sewerage connections. However, any future buildings approval would be incorporating these required measure as pre-requisite for approval of house constructions. *II.* Differential tariff system needs to be introduced in Birendranagar municipality. The economically vulnerable group of populations should be paying lowest cess followed by other residential households, commercial, institutional, and then non-polluting industrial land-use. Municipality with consensus of key stakeholder, should firm-up the tariff scheme.
1.3	**Periodic desludging of toilet containment**
	I. 63% of buildings of Birendranagar within NSS zone, and most of municipal area has high ground water table while using dug-well to supplement the need of water supply. Thus, it is important to have periodic emptying of tank to limit the ground water contaminations.
1.4	**Re-use application of treated wastewater and processed sludge**
	I. Industries should be using at least 25% of treated wastewater for their water applications. This water availability can come from WTP, FSTP and/or any of operational DEWATS of city. This would help to attain significant water-reuse from treatment units and works towards financial sustainability of system. II. Use of processed sludge and treated wastewater are allowed/encouraged for non-edible crops whereas in case edible crops, use only allowed post quality (lab) testing of application. III. Treated DEWAT water needs to be diverted (leftover water after any uses) to abutting drain (and avoided any direct diversion to nearby waterbody) IV. For all institutional building, treated wastewater should be part of most of landscaping and kitchen garden requirement. Similarly, household are encouraged to set-up kitchen garden for application of treated greywater.
1.5	**Adhering to interventions framework of sanitation zone to guide urban growth**
	I. Any new building coming to any of three sanitation interventions zone, will needs to adhere to sanitation containment and greywater management module of respective zone. *II.* Municipality is also encouraged to avoid any excessive building (of any category of land uses) growth in both delineated flood risk areas and water sensitive area. More stringent measure for constructions needs to be developed to discourage any future growth in these regions.
1.6	**Dedicated Desludging Zone for FSTP and Co-Treatment facility**
	I. Municipality is encouraged to adhere to the proposed zone of desludging as to ensure not to have under and/or overload sludge loading at either of treatment facility. Following to the desludging zone will help

Sl.	Thematic Area and Recommended Regulations
	the operators to build clear understanding on place of disposal in line with locations of user premises and IMIS can have key role to automate this entire decision making process.
1.7	**Maintaining efficiency of the wastewater treatment plant**
	I. Every wastewater generating industries established within the sewerage zone should have its own wastewater treatment plant treating effluent to the discharge standard set by the municipality. *II.* Storm water generated within the household compound or roadside should not be mixed into the sanitary sewer. The storm water should be drained separately.
1.8	**Sewer Network connections**
	I. Lateral sewers or branch sewers should be connected to trunk sewer only. *II.* Households within sewer network should approve the house connections with the municipality before discharging the wastewater into sewer network. *III.* Household connecting the sewer network do not need septic tank for black and greywater treatment so,
1.9	**Institutional arrangement**
	I. A sub-unit dedicated for sewer management should be provisioned with the environment department of the municipality. *II.* A waterjet tanker should be provisioned to solve the clogging problem within the sewer network. *III.* Clear database of household taking sewer connections should be updated in regular basis. *IV.* GIS map of sewer network should be updated regularly for easy access to sewer network information.
1.10	**Monitoring of sanitation service operations**
	I. Environment Management and Waste Management Act which addresses the illegal dumping of emptying of sludge in the nearby open fields/and water bodies needs to be strictly followed and ground enforcement can be explored through innovative means like IMIS. II. IMIS can customized various monitoring and system update module and functions for real time information update including fast track redressals of reported user complainant

CHAPTER 5

5. IMPLEMENTATION STRATEGY

5.1 IMPLEMENTATION STRATEGY FOR NON-SEWER SYSTEM

Implementation strategy of improvisations in prevailing NSS practices of Birendranagar would entail both soft and hard infrastructure components. Plan preparations would involve primary level user surveys to identify and validate the shortlisted beneficiaries. Priority NSS interventions of both urban poor and institutional levels needs to be validated through primary surveys and accordingly final list of beneficiaries needs to be identified. Primary survey questions should also involve user willingness to pay/contribute towards sanitation infrastructure upgradation cost.

Detailed project report preparations would be based on the final beneficiary user number and site/premises level system engineering design would be developed as contextual and customized solutions. In parallel, sanitation business plan with provisioning of tariff applicable for various users and draft sanitation regulations of town (combining both SS and NSS measure) needs to be also developed. Some of key target areas of implementation strategy are summarized in proposed implementation schedule in the table below.

5.2 IMPLEMENTATION STRATEGY FOR SEWERAGE SYSTEM

The implementation of the designated sewer area can be done in two phases.

Phase 1

The implementation of sewerage system begins from the acquisition of necessary land for wastewater treatment plant (WWTP) nearby fish cottage and Bulbule taal. There is no public land available at the proposed treatment plant site. Thus, the municipality has to acquire the necessary private land to build the treatment plants. Land area necessary for treatment plant near to fish cottage is around 2000 sqm. Similarly, land area necessary for the other treatment plant near by the Bulbule is around 1335 sqm. Activities like land acquisition for the treatment plant and establishment of trunk line can go parallel. The first trunk line connecting WWTP nearby the fish cottage with the Maslaghari Park and the second trunk line connecting WWTP nearby the Bulbule taal with Kapasay chowk (adjoining to water treatment plant) can be constructed in the first phase. It may take one year for the detail planning, procurement and acquisition of required land. Next two years is necessary to construct the treatment plants and the minor trunk lines. For the fast construction of wastewater treatment plant and major trunk lines, four contract packages can be provisioned in the first phase as shown in table 22 below.

Phase 2

Phase two can be started after construction of the wastewater treatment plant and major trunk lines. Expansion of sewer network can be done giving priority to areas having high built up area like Birendra chowk. Minor trunk sewer, branch sewer and lateral sewers need to be constructed from downstream toward upstream so that drainage issues can be avoided during construction. In total 84 Km sewer line has to be laid in second phase for the coverage of sewerage area in sewer zone. The household connections that connect lateral sewers with individual household is done once the laying of lateral sewer is laid. The first year of second phase can be utilized to prepare detail plan and to accomplish the procurement process. Testing and sewerage network can be done simultaneously to the accomplished

sewer sections. After the accomplishment of first phase six contract packages can be provisioned as shown in the table below.

5.3 IMIS IMPLEMENTATION STRATEGY

Initial phase will concentrate on data collection, understanding endorsed business process and functional requirements of municipality. Accordingly, IMIS will be customized and deployed with necessary capacity development of all involved stakeholders. During commencement, entire area within municipality will be considered as service area for desludging service. Once sewer construction works begins, IMIS needs further customization to incorporate data and necessary tools/functions for sewerage system. Upon finishing incorporating modules for sewerage system, necessary operating trainings must be given for all stakeholders. Similarly, if municipality is interested to incorporate water supply system in IMIS, water supply modules have to be developed in parallel during the development of sewerage system. Preparation of operating manuals of IMIS, necessary support for field survey, data migration, system maintenance and institutionalization support will be provided by IMIS development team. Detail information for IMIS implementation schedule is given in the table below.

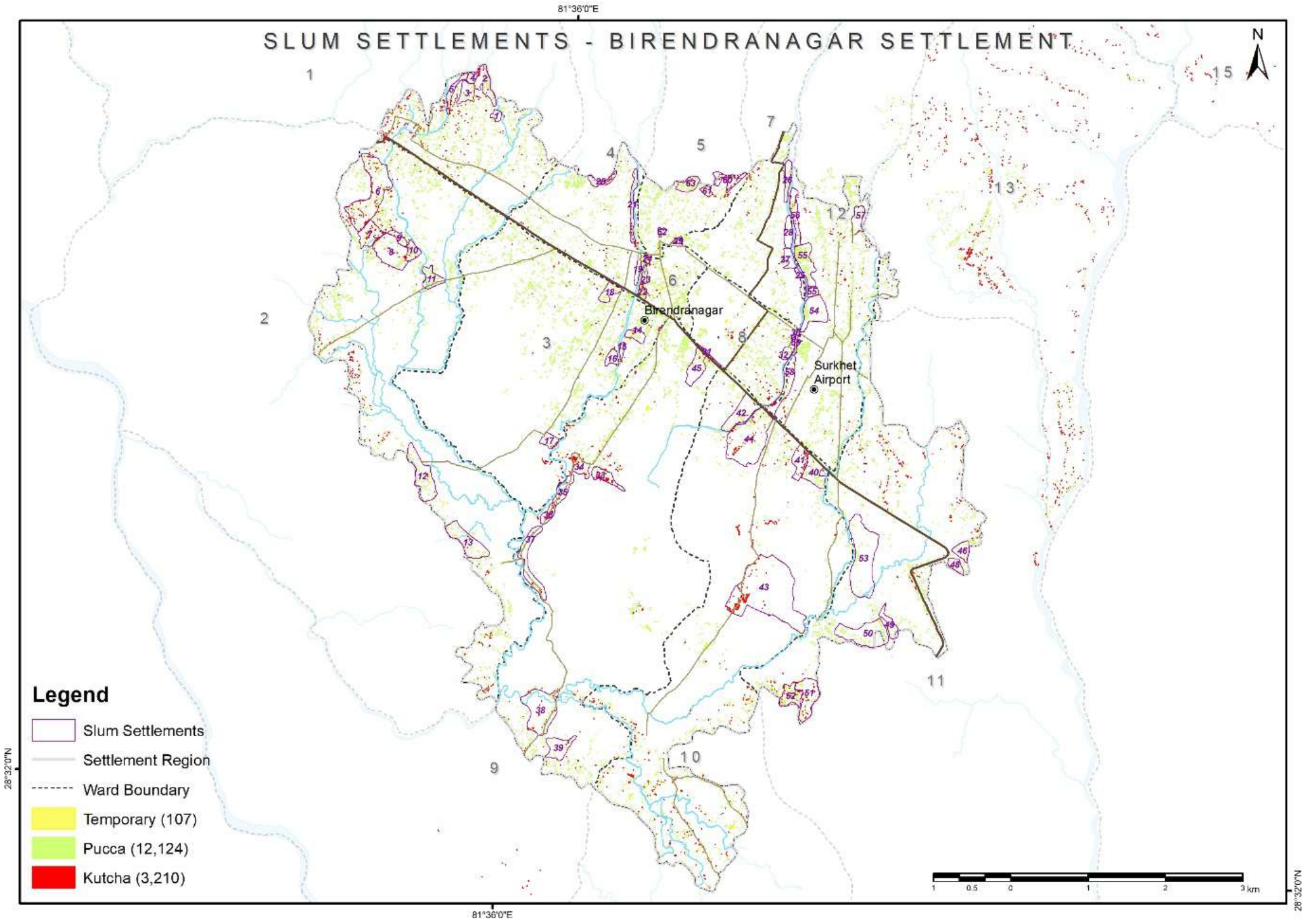
All tasks except task 5 will be performed by IMIS development team. Separate consultant needs to be hired for task 5, but the task will be performed under the supervision of IMIS development team.
.

SL . No.	Activities	Year 1				Year 2				Year 3				Year 4			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
A.	Non-sewerage																
1.0	Preparatory																
1.1	Ground validation of identified beneficiaries – final list of beneficiaries																
1.2	Willingness to pay – user survey																
1.3	Preparations of DPR including surveys of premises for infrastructure development and tender document																
1.4	Business plan preparations and fixing the differential tariff and exploring end product market prospects																
1.5	Development of draft sanitation regulation and performance level service benchmark for municipality																
1.6	Explore provision of soak-pit, kitchen garden and filter media as quick fix intermittent level provision for institutional and larger commercial premises falling under sewerage zone																
1.7	Listing of private property which needs to mandatory follow the on-site premises wastewater handling provisions (for complying of sanitation regulations)																
2.0	Enabling Capacity																
2.1	Gap assessment, target audience identification and module finalization																
2.2	Municipality civil engineers, other l identified civil engineers/masons/skilled construction workers for construction and supervision of DEWATS, Soak pit, Elevated tank containment etc.																
2.3	ULB officials, Elected representative on benefits of proposed system and system augmentation provision																
2.4	Gender inclusive skilled workforce across sanitation domain																
3.0	Launch Construction																
3.1	Urban poor containment improvement																
3.2	Institutional on-site sanitation solutions																
3.3	Flood prone area – subsidized cost of toilet and greywater unit construction																
3.4	Identified private property – containment improvement timeline (1.5 year) with technical support extended from municipality (if requested)																
3.5	Co-treatment setting during construction stage of WTP																
4.0	Cohesive operations of SS and NSS - 100% user access with safe sanitation																

SL . No.	Activities	Year 1				Year 2				Year 3				Year 4			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
B	**Sewerage**																
1.0	Preparatory																
1.1	Formation of land acquisition task committee and acquisition of required land for STPs																
1.2	Preparation of DPR for STPs																
1.3	Preparation of DPR for two major trunk lines																
2.0	Phase I Construction																
2.1	Construction of trunk sewer from Masalaghari Park to Fish Cottage																
2.2	Construction of STP nearby Fist Cottage																
2.3	Construction of trunk sewer from Kapasay chowk to Bulbule Taal																
2.4	Construction of STP nearby Bulbule Taal																
3.0	Phase II Construction																
3.1	construction of branches, laterals and household connections in the catchment (Maslaghari to Fish Cottage)																
3.2	construction of branches, laterals and household connections in the catchment (Kapasay Chowk to Bulbule taal)																
4.0	Testing and commissioning																
4.1	Testing of STP1 and STP2																
4.2	Testing and commissioning of sewer network																
C.	**IMIS**																
1.0	Preparatory stage																
1.1	Data gathering and analysis of data gaps																
1.2	Business process analysis																
1.3	Analyse existing information system and possible integration with IMIS																
1.4	Develop methodologies and tools for GIS data preparation & survey																
2.0	Survey and data update																
2.1	GIS data updating and containment survey																
2.2	Conversion of Data into IMIS Framework																
3.0	IMIS customization and deployment																
3.1	IMIS Customization																
3.2	IMIS Testing																
3.3	Capacity Building of Municipal Staff & Service Providers																
3.4	IMIS Deployment																
3.5	Development of Sustainable Plan																
4.0	Implementation and maintenance support																
4.1	Integration of sewerage system in IMIS																
4.2	Implementation and maintenance support																

Citywide Inclusive Sanitation
Technical Assistance Hub
TA Hub . South Asia

ANNEX 1: SLUM SETTLEMENT DETAILS



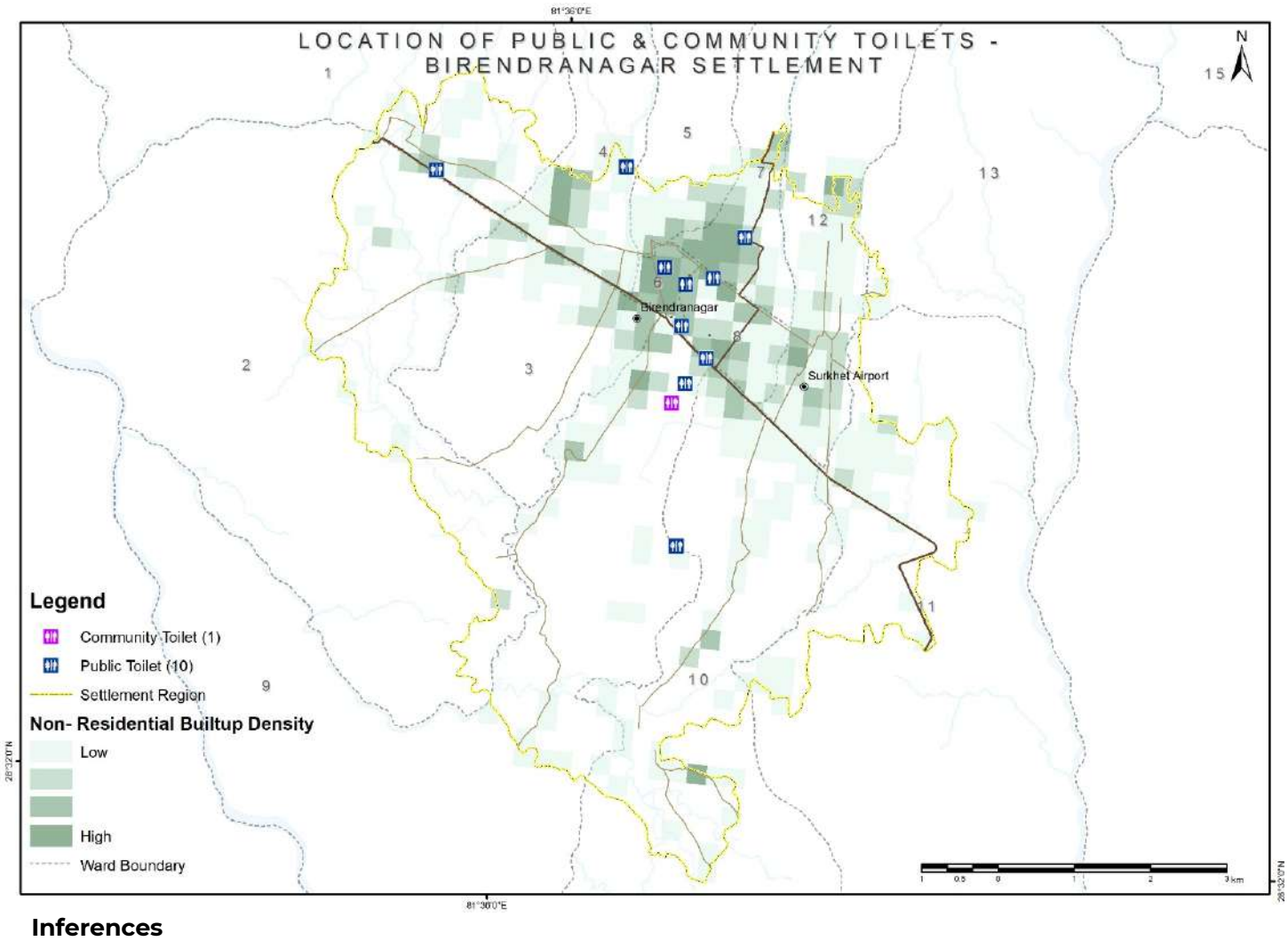
Inference

- 62 notified and 1 non-notified slum communities are identified in the city which has been validated and resurveyed on field

SN	Ward	Name	Status	Location	Population	Household
1	1	Tripureswor Tole	Notified	Belghari	145	30
2	1	Dharapani Tole	Notified	Dharapani	945	210
3	1	Pragatisil Tole	Notified	Dharapani	720	180
4	1	Aapkhola Tole	Notified	Dharapani	365	80
5	1	Laliguras Tole	Notified	Chanabari	580	130
6	2	Janamilan Tole	Notified	Janamilan Tole	320	82
7	2	Ram Mandir	Notified	Ram Mandir Tole	488	121
8	2	Koldada Pragatisil	Notified	Koldada Pragatisil Tole	417	84
9	2	Sagarmatha	Notified	Sagarmatha Tole	580	145
10	2	Pragatisil Tole	Notified	Pragatisil Tole	660	132
11	2	Samabashi Tole	Notified	Samabashi Tole	350	54
12	2	Hariyali Tole	Notified	Hariyali Tole	324	64
13	2	Peepal Chautari Tole	Notified	Peepal Chautari Tole	253	63
14	3	Gandaki Tole Bikas Sastha	Notified	Gandaki Tole	1117	183
15	3	Pancha Koshi Sangam Tole Bikash	Notified	Pancha Koshi Sangam	116	28
16	3	Jharana Tole Bikash Sanstha	Notified	Jharana Tole	417	69
17	3	Etaura Tole Sastha	Notified	Etaura Tole	368	73
18	3	Sahakari Tole Bikash Sastha	Notified	Sahakari Tole	492	84
19	4	Krishna Tole Bikash Samiti	Notified	Krishna Tole	1280	285
20	4	Mitra Nagar Tole Bikash Samiti	Notified	Mitranagar Kalagaun	290	65
21	4	Gairigaun Tole Bikash	Notified	Khorke Khola Line	1050	230
22	6	Shanti Tole Bikash Sastha	Notified	Shanti Tole	1452	242
23	6	Pragati Tole Bikash Sastha	Notified	Pragati Tole	301	68
24	6	Pulchowk Tole Bikash Sastha	Notified	Pulchowk Tole	609	131
25	7	Janajagrati Phulbari Tole	Notified	Janajagrati Phulbari Tole	783	129
26	7	Seetal Tole	Notified	Seetal Tole	303	71
27	7	Jagrati Tole	NA	Jagrati Tole	311	64
28	7	Naulo Sudhar Tole	Notified	Naulo Sudhar Tole	439	108
29	7	Vetenary Khar Kholi Tole Bikash Sanstha	Notified	Vetenary Khar Khola Tole	165	35
30	8	Krishna Manandhar Tole	Notified	Krishna Manandhar Tole	107	25
31	8	Meldanda Tole	Notified	Meldanda Tole, Naulapur	166	38
32	8	Shiva Mandir Tole	Notified	Shiva Mandir Tole	87	17
33	9	Kalimati Tole	Notified	Kalimati Tole	800	98

SN	Ward	Name	Status	Location	Population	Household
34	9	Ghamtapne Tole	Notified	Ghamtapne Tole	229	56
35	9	Tilpur Tole	Notified	Tilpur Tole	251	77
36	9	Samaj Sudhar Tole	Notified	Samaj Sudhar Tole	378	47
37	9	Ghoghali Tole	Notified	Ghoghali Tole	215	50
38	9	Mathillo Parshani Tole	Notified	Mathillo Parshani Tole	323	77
39	9	Baunnechour Tole	Notified	Baunnechour Tole	321	65
40	10	Belaghari Tole	Notified	Belaghari Tole	336	84
41	10	Tallo Padampur Tole	Notified	Tallo Radampur Tole	440	88
42	10	Chandramagar Tole	Notified	Chandramagar Tole	455	93
43	10	Naya Gau Tole	Notified	Naya Gau Tole	664	166
44	10	Budhbudhe Tole	Notified	Budhbudhe Tole	1608	402
45	10	Mil Dara Tole	Notified	Mil Dara Tole	1088	272
46	11	Jagaran Tole	Notified	Jagaran Tole	340	85
47	11	Shantipur Jupra Tole	Notified	Shantipur Jupra Tole	697	149
48	11	Sallaghari Tole	Notified	Shallaghari Tole	220	55
49	11	Amrit Dadha Tole	Notified	Amrit Dadha Tole	188	47
50	11	Simal Kuwa Tole	Notified	Simal Kuwa Tole	355	71
51	11	Salaghari Tole	Notified	Sallaghari Tole	342	82
52	11	Shivashakti Tole	Notified	Shivashakti Tole	490	106
53	11	Dholedhunga Tole	Notified	Dholedhunda Tole	472	118
54	12	Bhabar Tole	Notified	Bhabar Tole	553	139
55	12	Narayan Tole	Notified	Narayan Tole	2535	899
56	12	Saraswoti Tole	Notified	Saraswoti Tole	873	173
57	12	Kailash Tole	Notified	Kailash Tole	821	120
58	12	Naulo Tole	Notified	Naulo Tole	1016	210
59	12	Audhyogik Tole (Industrial Area)	Notified	Audhyogik Tole (Industrial Area)	915	173
60	5	Kalika Mandir Tole	Notified			
61	5	Sital Tole	Notified			
62	5	Saraswoti Tole	Notified			
63	5	Shrenagar	Notified			

ANNEX II: LOCATION OF PUBLIC/ COMMUNITY TOILETS

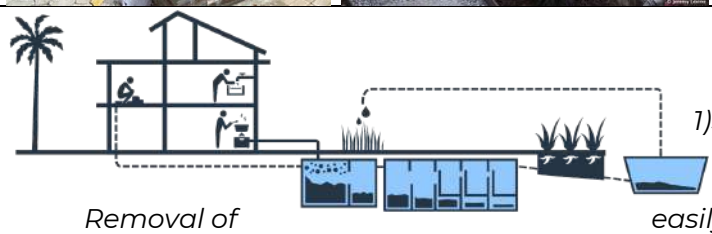


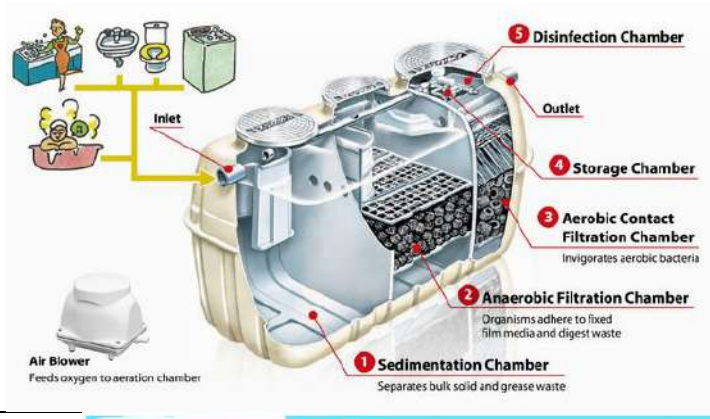
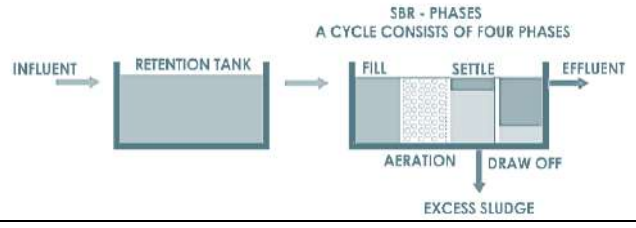
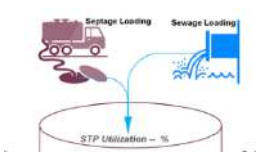
Inferences

- 10 public toilets and 1 community toilet has been identified in the municipal region.
- The location of public toilets overlaid on non-residential density indicates that the core region has lack of adequate public toilets. However more detailed analysis and assessment will need more performance related information

ANNEX

ANNEX III: DESCRIPTION OF BENEFITS & APPLICABILITY OF SUGGESTED TECHNOLOGY MODULE

S.N.	Technology and Benefits/Applicability	Illustrations Images
1.1	**Elevated toilet containment** with tank edge above ground level/flood level *This is also applicable for all flood risk settlement as well as along Khal which tends to go over-flow during rainy seasons. Toilet tank top edge and outlet needs to be above the flood lever occurred in past years. However dry/sealed toilets are preferable in flood prone areas as to avoid any sewage outflow from tank.*	
1.2	**Common/cluster septic tank** at community level, **Septic tank upgradation** for unlined tank *Some of houses toilet tank can be polled together and have shared septic tank. This reduces the construction and operation cost and preferably placed in narrow streets with emptying issues.*	 *Shared Septic Tank Shallow network for connecting houses*
1.3	**Soak pit, Magic pit** *This can be constructed at both individual and community level with/without horizonal and/or vertical planted gravel filters. Circular lined pit with opening at top edge help to settle the solid particle and would need periodical cleaning at regular intervals.*	 *Magic pit - Outer point Soak pit –*
1.4	**Trap** (Grease trap, Kitchen trap/P-Trap, Nahani Trap) *In multiple uses, to filter out the solid particles at source and to develop a water seal to avoid any smells and gas. Grease traps are generally applied in community level greywater units.*	 *Greas P- Naha*
1.5	**Kitchen Garden (Individual, Community)** *Within building natural sand and gravel filter media (or magic pit) can be used to partially treat and divert the used grey water to natural plant with or outside building . PVC small diameter piping system needs to be lay-down to have larger reach within garden area with pumping sets for water sprinkling in case required. Plants that repel mosquitos may be adopted in the kitchen garden.*	 *Kitchen garden is suitable for building having adequate plot size area (in case of area constrain, community garden concept can also be explored)*
1.6	**DEWAT (Natural treatment)** *DEWAT is based on biological treatment mechanism such as sedimentations, floatation, aerobic and anaerobic treatment to treat wastewater. Accumulated and digested sludge gets periodically cleaned whereas system does constant treatment of liquid volume and produce treated wastewater applicable for large re-use purpose. This generally has both low CAPEX and OPEX involved and preferable to set-up in environment with relatively high footfall (at community level). This can be even set-up at individual level in case of space availability.*	 *1)Settler: Removable of easily settlement solids 2)Anaerobic filter: Removal of easily degradable organic solids* *3) Anaerobic Baffled Reactor: Removable of easily degradable organic solids* *4)Planted Gravel Filter: Removal of easily and more difficult degradable organic solids* *5) Polishing Pond: Removal of suspended digested solids and active bacteria mass*

1.7	**Johkasou (Packaged treatment/ Mechanical)** *A compact system runs on electricity and as good as any sewerage plant. Module can be customized at various level and more preferable for institutional, industrial, and larger commercial units. There are five functional chambers (sedimentation, anaerobic, aeration, storage, and disinfection) in a tank. This system is relatively more expensive than DEWAT and works on same principle with mechanized version inbuilt to accelerate and absorb any larger shocks with lesser footprints requirements.*	
1.8	**Phytorid** *Technology involved constructed wetlands with aerobic and plant-based treatment system and maintained hydraulics of water-flow as to ensure wastewater flow does not rise to the surface. The system is based on the specific plants, such as Elephant grass, Cattails, Reeds, Cannas pp. and yellow flag iris normally found in natural wetlands with filtration and treatment capability. This is patented by NEERI India.*	 *1) Sedimentation Tank – For filtering any solid particle* *2) Phytorid Bed – constructed wetlands with specific plant species* *3) Re-usable Water – store and recuse in gardening and other non-portable purpose*
1.9	**Sequencing Batch Reactor (SBR)** *SBR takes lesser footprints and efficiently remove impurity as compared to biological treatment plant units. More detailed assessment can SS treatment module can be done in separate study.*	
1.10	**Co-Treatment at WTP** *NSS areas load can be diverted and accordingly design of WTP can be developed.*	 • *Low-cost operations, Limited infrastructure requirement* • *If not handles well, may lead to possible shock loading at STP and impact the effluent parameters*

ANNEX IV: KEY INFORMANT INTERVIEW (KII) WITH DESLUDGING OPERATORS

1	Which season generally there is a high frequency of desludging operations?	Rainy	Rainy	Rainy
2	Service area	All, mostly Ward No 6	All, mostly from Ward No. 4,8	Ward No 3, 4,5 very seldom request from ward no 11,12
3	Vehicle, Pricing structure	8000L -NRS 8,000; 4000L- 5,000	8000L -NRS 7,000	8000L- NRS 8000
4	Does tariff vary from poor household to rich?	NO	NO	NO
5	Does tariff vary from building use	NO	NO	NO
6	Does tariff vary according to distance	Yes, additional NRS 500/1000 depending on distance	Yes, additional NRS 500/1000 depending on distance	Yes, additional NRS 500/1000 depending on distance
7	Peak demand/day in last 1 year	7-8 trips/day	3-4 trips/day	2-3 trips/day
8	Wards where desludging get difficult	Ward No. 6-chinapool area, ward 11 pipira padampur		Ward No. 1
9	Hauling pipe length	8000L -80 m; 4000L- 30 m	30m pipe additional 20m pipe used when required	30m
10	Desludging tank accessibility according to road width	3.5-5 > easy; 2.5-3.5> easy: less than 2.5m> difficult	3.5-5 > easy; 2.5-3.5> easy: less than 2.5m> difficult	3.5-5 > easy; 2.5-3.5> easy: less than 2.5m> difficult
11	Comment on distance of FSTP	takes 1.5 hr. to reach, little difficult in rainy season	takes 2 hr. to reach, little difficult in rainy season	takes 1 hr. to reach, little difficult in rainy season
12	Types of tank desludge	All, new has septic tank; others holding tank	Mostly holding tank	All, new has septic tank; others holding tank
13	Key challenges in your business	frequent turnover of staffs	Lack of manpower, unwillingness to work as helper	lack of manpower, frequent turnover of staffs
14	How do you connect with customer	Telephone	Telephone	Telephone
15	Do you maintain log book of service delivered?	Yes (Busy accounting software)	Yes (Bill receipt)	Yes
16	Number of people in your organization	Total 7: 3 driver 3 cleaner , 1 administration	Total 4: 1 driver 1 helper 2 Management/Accountant	Total 3: 1 driver 1 helper 1 Management/Accountant
17	Proportion of female staffs	1 (Proprietor)	1 (Proprietor)	N/A
18	Any software/program to manage your business	Busy accounting software	NO	NO
19	How do you collect payment?	Mostly CASH, occasionally through bank, seldom e-sewa	Mostly CASH, occasionally through bank, seldom e-sewa	Mostly CASH, occasionally through bank
20	Interested in using web-based applications for managing your service delivery?	YES	YES	YES
21	Do you collect any sort of feedback from clients?	NO	NO	No, occasionally verbal communication through phone
22	Staff get training about OHS before deployment?	YES	YES	YES
23	Is regular sharing data related to your service required?	Yes (Occasionally about number of trips)	NO	NO

Name
Service Provider 1: Birendranagar ST safai sewa: Birendranagar ST safai sewa
Service Provider 2: Nagar Sarsafai and Transport Sewa
Service Provider 3: Yeri Chowk Sarsafai Udhyog

ANNEX V: DATA FRAMEWORK FOR CWIS PLANNING

Parameter	Rationale	Data Point	Unit	CWIS Outcome (CO) / Functions (CF)	Data Source	Value	Remarks
1. General Characteristics of City							
Population	· Areas with high number of transient/floating population and permanent workers to be prioritized for NSS/FSM	Total Population of the town	Number	General	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021-Annex VII	123,602	Projected population for 2021
		Average Number of transient/floating population in the town per year	Number	General	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021-Annex VII	12,360	10% of population is assumed
		Average Number of permanent workers in the town	Number	General		NA	
		Average Number of tourists visiting the town per year	Number	General		NA	
Settlement Typology	· In planned areas of the town, where the population density is high with moderate built-up density, sewer network is feasible · In unplanned areas of the town and where land tenure issues are prevalent, FSM/NSS is feasible · Areas where population density is low with low built-up density, FSM/NSS has to be prioritized	Population density of the town	Person/Sq. Km	General	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021-Annex VII	503	For sanitation suitability analysis, in case of Birendranagar, greater than 10,000 population per Square Kilometer is considered high as density area
		Built-up density	Sqkm	General	Building foot print data based on municipality's GIS Database, 2019	11	
		Total Number of slums in the area	Number	General	KII with people in Low Income Community	63	Settlement information were collected during the field survey. However, most households have either obtained the temporary document for land ownership (Seto Purja to process for land ownership) or some proportions has already obtained the full land ownership (Lal Purja) as well.
		Total Number of non-notified slums in the area	Number	General	KII with people in Low Income Community	1	Jagriti Tole Settlement
		Total Number of unplanned zones	Number	General	KII with people in Low Income Community	62	Ward no. 10, 11, 13, 14, 15 and 16 (Southern part of highway. All the land there was for Agriculture prospective as earlier planning)
		Total Number of households with land tenure issues	Number	General	KII with people in Low Income Community	64	
Topography	· Areas with flat terrain and consistent slope is feasible for Sewer network	Area with flat terrain	Sq km	General	Analyzed based on SRTM data	34.27	

Parameter	Rationale	Data Point	Unit	CWIS Outcome (CO) / Functions (CF)	Data Source	Value	Remarks
	• Areas with undulating topography and areas prone to flooding/low lying areas preferred for FSM/NSS	Area with consistent slope terrain	Sq km	General	Analyzed based on SRTM data	20.78	
		Area with undulating topography	Sq km	General	Analyzed based on SRTM data	211.58	
		Area with susceptibility to flooding/waterlogging	Sq km	General	Analyzed based on SRTM data	6.8	Watershed analysis using GIS, also verified on site during field visit
Health & Hygiene	• Areas with the highest incidence of sanitation related water borne diseases and recording rise in the sanitation related illnesses and epidemics should be prioritized	Percentage of rise in recorded cases of illness related to unsafe / inadequate sanitation in the last 2 years	Percent	Safety		NA	
		Disease hotspots areas	Sqm	Safety	KII Municipal Health Staff	Ward 9, 10, and 11	Water borne disease are most frequently seen in these wards (southern part from Highway)
		Number of incidences of water-borne diseases related to unsafe / inadequate sanitation in the last 2 years	Number	Safety	KII Municipal Health Staff	1013 & 1111	Diarrheal disease under 5 years were recorded in (2075/76 BS-1326; 2076/77-1111; 2077/78-1013 and 2078/79 until Mangsir-253)
Brand Development	• Potential of the area to contribute to the branding of the city as “green”/ “environmental”/ "smart Inclusive" city should be prioritized	"Green" - Total Number of parks, open spaces that can be protected and where green infrastructure can be promoted	Number	Sustainability	KII Municipal Staff	36	Bulbule Park, Kakrebihar, Shivadada, Dautibajai and the huge open areas of Government Offices, Main Roads, Campus unused open areas
		"Environment" - Total Number of lakes, environmentally sensitive structures in the area that can be protected	Number	Sustainability	KII Municipal Staff	1	Lake - Bulbule
		"Smart inclusive" - Total Number of poor populations in the area whose access to improved sanitation will be facilitated	Number	Sustainability	KII with people in Low Income Community	34,854	
		Budgets allocated for IEC interventions related to branding, promotion of improvements in area	Nepalese rupees	Sustainability	Municipality’s yearly budgetary plan	2,400,000	
Tourism	• Areas with potential to be developed as a tourism attraction site should be prioritized	Number of existing tourist attractions in the area	Number	Sustainability	Gantabya Birendranagar published by Municipality	37	
		Number of planned tourist locations in the area	Number	Sustainability		NA	
		Number of tourists footfall in the area/ year	Number	Sustainability	KII Kakrebihar entrance office staff	9,600	Around 300-500 every holiday during September - May

Parameter	Rationale	Data Point	Unit	CWIS Outcome (CO) / Functions (CF)	Data Source	Value	Remarks
Savings	• Areas that present greater opportunities for prevention of loss of income or redundant investments by government due to the collateral damage caused by inadequate and improper management of sanitation	Municipal finance expenditure related to combating crisis due to sanitation related epidemics	Nepalese rupees	Sustainability	Municipality's yearly budgetary plan	2,994,000	

2. Sanitation Profile of City							
Existing sanitation facility at household level	• Areas with higher Percentage on-site sanitation systems (OSS) is favorable for FSM • Areas where community toilets are prevalent to be connected with nearest sewer network or FSM system • Areas with on-site systems that require upgrading or retro-fitting should be prioritized	Properties with on-site system	Percent	Safety	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021	90%	Out of remaining, 7% connected to open drain, 1% has no access to toilet, 3% status unknown.
		On-site systems accessible for desludging	Percent	Safety	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021	80%	
		Households dependent on community toilets	Percent	Equity	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021	15%	
		On-site systems that are in bad condition	Percent	Safety		NA	
Existing shared sanitation facility	• Areas with high floating population to be accessible to Public Toilet	Number of toilet seats/1000 persons	Number	Equity	PT Survey	10	
Connection of household toilets to sewer and non-sewer systems	• If household toilets in an area are already connected to on-site sanitation systems (OSS) like septic tanks, the area is favorable for FSM	Households connected to OSS	Percent	Safety	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021	90%	
		Households with toilets discharging directly into drains	Percent	Safety	Sanitation Situation Assessment Report-CWIS/TAHUB, July 2021	7%	
	• If a major Percentage of dwelling units in an area have not desludged the OSS in the last 5 years, the area should be prioritized	Dwelling units desludged in last 5 years	Percent	Safety	KII with private operators	6.72 %	Estimation based on the information provided by the Private operators. Estimated number is only for last two years.
	• If manual scavenging is prevalent in the area, the area should be prioritized	Number of manual scavengers in the area	Number	Safety	KII Municipal Staff	2-Groups (number unknown)	Balmiki community in ward 6 and Chaudhary community in ward 8 are two reported areas

		Number of undesignated areas of dumping or sequestering of fecal sludge collected	Number	Safety		NA	
Existing/future sanitation plan	• Existing/future plan or sanitation master plan of the municipality on expansion of sewer/non sewer coverage	Percentage of area covered through central sewerage	Percent	Safety			Sewer lines not exit
		Percentage of area covered through NSS/FSM	Percent	Safety	KII with private operators	100%	
Groundwater vulnerability	• Ground water aquifers are vulnerable to contamination based on the geology and the depth of ground water table	Rock type in unsaturated zone	Type	Sustainability	Final Report on Hydrogeological study for assessment of Groundwater Potential Area at Birendranagar Municipality, Surkhet	Top dry soil/cultivated soil, dry silty soil/sand, saturated silty sand	Soil type found within 30 m. rock data is not available
		Depth to groundwater table	Meter	Sustainability	Final Report on Hydrogeological study for assessment of Groundwater Potential Area at Birendranagar Municipality, Surkhet	50-80	
	• Lateral separation between ground water sources and sanitation facility should not be close to avoid ground water contamination	Sanitation facility located >10 m from groundwater sources	Percent	Safety		NA	
		Sanitation facilities located upstream of groundwater sources	Percent	Sustainability		NA	
	It is important to know the percentage of drinking water supplied through the source of groundwater and whether the source is protected or unprotected	Percentage of drinking water supply from groundwater sources	Percent	Sustainability		NA	The water supplied in the city is mainly from surface water
		Number of protected and unprotected groundwater sources in city	Protected / unprotected	Sustainability		NA	
3. Transport and Accessibility							
Accessibility	• For areas where the source of wastewater (from households / properties) is in close proximity to the nearest main street/road, sewer network is a feasible solution	Number of households with close proximity to main street	Number	Equity	Analysis of Municipal GIS Data	32,596	Within 80meter distance of road (>=2m) is considered as close proximity to main street household
		Average distance of households from main street	Meter	Equity	Analysis of Municipal GIS Data	20	
	• If more than 25 percentage of properties in the area lack or have difficult frontage accessibility (households do not have direct access to a road/street) and at a distance greater than 3 to 15 meter from the road/street access is either through another distribution unit or in some other indirect manner, FSM is the feasible solution	Percentage of properties without direct access to main street	Percent	Equity		9%	

Road shape and width	· If road widths in the area are greater than 4m, area is suitable for Sewer Network	Percentage of area where road width is greater 4 m	Percent	Equity	Analysis of Municipal GIS Data	21%	
	· If road widths in the area are less than 2 m or between 2 m and 4m, area is suitable for FSM or Shallow Sewer/small bores sewer	Road width in the area	Meter	Equity	Analysis of Municipal GIS Data	33% less than 4m 69% greater 4m and less than equal to 8m 9% greater than and equal to 8m	
	· In areas where the road shape is mixed and organic, FSM is feasible and in areas where it is Linear, Sewer network is preferred. Road shapes: L – Linear; M - mixed (mix of shapes, all areas are not planned with organic development); O – organic development of roads, based on settlement development (no planning, walking paths turned roads, and/or just walking paths)	Road shape in the area	L/M/O	Sustainability	Analysis of road network using Municipal GIS Data	M	
Road surface	· Areas with road top surface of bitumen(B), Reinforced cement concrete (CC) / Rock (R) surface are preferred for FSM	Road top surface	RCC/B/R	Sustainability	Analysis of road network using Municipal GIS Data	Foot Trail 5% Gravel 20% Black Top 25% Earthen 50%	
Distance from Treatment Facility	· If the hauling distance between the area and the co-treatment facility is > 15 km, the cost effectiveness is compromised; areas within 15 km from treatment facility will be preferred	Hauling distance between the area and the treatment facility	Km	Sustainability	Analysis of road network using GIS	8 km	Avg distance considered from the city centre (Buspark)
4. Water Supply Profile of City							
MAPPING / Coverage	· In areas where average water supply is <70 LPCD, FSM is feasible	Percentage of households with <70 LPCD water supply	Percent	Sustainability	KII Municipal Staff	100%	
5. Socio-economic Profile							
Economic vulnerability	· Areas with conditions of critical employment and income status resulting in low paying capacity of households should be prioritized	Percentage of low-income households	Percent	Equity	Analysis of Municipal GIS Data	11%	The low income households was inferred from building structure, building made of mud mortar and other temporary structures are considered as low income households
	· While prioritization of low income based dwelling units is criteria, it is also important to ensure mix of low- middle-	Percentage of middle income households	Percent	Equity	Analysis of Municipal GIS Data	89%	The number reported is total excluding the low-income households. There

	upper-income households for cross-subsidization/ affordability and cost-recovery	Percentage high income HHs	Percent	Equity	Analysis of Municipal GIS Data		is no distinction available between middle and high income HHs
Social acceptability	• Areas with high levels of social acceptability for localised solutions and infrastructure, demand for FSM services, level of participation by local residents should be prioritized	Percentage of household willing to pay for services	Percent	Equity	KII with private operators	100%	
		Number of campaigns conducted in the area in the last year	Number	Equity	KII Municipal Staff	100	Approximately 100 in different settlements (orientation, miking, radio jingle, IECs, cleaning campaign), average 8-12 nos. in ward nos. 1 to 12.
		Percentage requests for services in the area in the last year	Percent	Accountability	Private operators	3%	There is no registered data. Data was estimated based on discussion with private operators
6. Readiness and Sustainability							
Organization Mandate	• Areas with mandate for urban sanitation clearly defined and assigned to service authority (i.e.) without overlap, explicitly prioritizing serving the poor is favorable for introducing alternate sanitation solutions like FSM and successful implementation	Clear mandate assigned to service authorities for sanitation service delivery	Yes/No	Responsibility	KII Municipal Staff	Yes	Municipality is about to formulate FSM by laws which is near completion. They have formulated Solid waste management SOP 2020.
		Is the mandate clearly defined in the municipal acts	Yes/No	Responsibility	KII Municipal Staff	Yes	Municipality is about to formulate FSM bye laws which is near completion
		Percentage representation of women in the staff	Percent	Equity	KII with Municipal staff and operators	0%	No female staff in case of municipality but two service operators have engaged women in the overall management
		Number of training workshops related to sanitation for staff, conducted in the past year	Number	RPM	KII Municipal Staff	1	3 days workshop conducted by SNV
		Number of training workshops on FSM/ OSS for staff, conducted in the past year	Number	RPM	KII Municipal Staff	1	3 days workshop conducted by SNV
		Number of adequate staff with technical knowledge	Number	RPM	KII Municipal Staff	2	2 Nos. Engineer (Technical Officer)
Operations Framework	• Areas with good governance measures that promote effective and efficient service delivery that reflect the satisfaction quotient of community members and the high probability of acceptance and success of a sanitation service delivery is favorable	performance metrics assigned and achieved - water, SWM etc.	Yes/No	Accountability	KII Municipal Staff	NA	
		Percentage of bills collected - water, SWM, property, electricity etc.	Percent	Accountability	KII Municipal Staff	More than 90% in case of property tax collection	

		Percentage of grievances redressed	Percent	Accountability		NA	No mechanism of proper monitoring and grievance addressing system
		Average grievance redressal time	Hour	Accountability		NA	No mechanism of proper monitoring and grievance addressing system
		Does the municipality has its own desludging vehicle	Yes/No	Responsibility	KII Municipal Staff	No	Desludging service is outsourced to private operators.
		Does the municipality has its own land to develop FSM related infrastructures	Yes/No	Responsibility	KII Municipal Staff	Yes	Approx. 1320 m2, Tarebhir
Local Governance Ward Level	• Areas with good local governance at ward level that empower community voices in planning and engage communities efficiently is favorable for introducing alternate sanitation solutions like FSM and successful implementation	Is ward-level committees active?	Yes/No	Accountability	KII Municipal Staff	Yes	
		Percentage representation of poor/marginalized in the ward committees	Percent	Equity	KII Municipal Staff	30%	Marginilised = 30% - 40 %
		Percentage representation of women in the ward committees	Percent	Equity	KII Municipal Staff	52%	Female = 52% in the committee
		Ward-level expenditure as part of total budget for IEC/BCC	Nepalese rupees	RPM	KII Municipal Staff	1,000,000	
Enabling Policy Framework	• Areas supported by policies in sanitation to advance the effective planning and implementation of alternate sanitation solutions like FSM and successful implementation	Are there any current policies requiring households to regularly empty the septic tanks?	Yes/No	RPM	KII Municipal Staff	No	In final stage (in two months) of preparation with the support of SNV.
		Is there any scheduled desludging planned?	Yes/No	Accountability	KII Municipal Staff	No	
		Is the scheduled desludging happening?	Yes/No	Sustainability	KII Municipal Staff	No	Only on demand
		What is the likelihood that such a policy can be in place?	Yes/No	RPM	KII Municipal Staff	No	
Political Will: Level of Support by Local Mayor/other Leader(s)	• Areas that demonstrate strong leadership from local Mayor and other elected representatives in office w.r.t performance regulation and accountability, budget setting and expenditure, institutional reforms including tariff setting and enforcement for project viability enforcement and ease of implementation is favorable for introducing alternate sanitation solutions like FSM and successful implementation	Does the local government staff / operators have performance indicators/ targets that are regulated and monitored ?	Yes/No	Accountability	KII Municipal Staff	No	
		Have institutional reforms been introduced in the past two years	Yes/No	Responsibility	KII Municipal Staff	No	
		Have institutional reforms been enforced in the past two years	Yes/No	Accountability	KII Municipal Staff	No	
		Are the regulations favorable for private sector service delivery?	Yes/No	RPM	KII Municipal Staff	Yes	The private operators can register themselves and then after they can operate and use FSTP for desludging

Public Finance	• Areas with availability of adequate financing and revenue opportunities to support the implementation of mandates is favorable for introducing alternate sanitation solutions like FSM and successful implementation	Is public finance available for prioritization for subsidies to the poorest?	Yes/No	RPM	KII Municipal Staff	NO	
		Has public finance been prioritized for subsidies to the poorest?	Yes/No	RPM	KII Municipal Staff	NO	
		Percentage of properties levied user charges	Percent	Sustainability	KII Municipal Staff	0%	
		Percentage of collection efficiency of user charges levied	Percent	Sustainability	KII Municipal Staff	100%	
		Percentage of Operations Cost recovery	Percent	Sustainability	KII Municipal Staff	0%	
		Percentage of efficiency in revenue collection	Percent	RPM	KII Municipal Staff	90%	
Feasibility of Private Sector Participation	• Areas with existing presence of (motivated) private sector and community-based organizations (CBO) is favorable	Is private sector present and actively engaged in the area	Yes/No	Responsibility	KII Municipal Staff	Yes	
		Is there willingness of private sector to participate in sanitation related infrastructure development and service delivery?	Yes/No	Responsibility	Private Operators	No	Not in developing infrastructure but interested in providing emptying service and infrastructures like vehicle and other required accessories
		Number of water tanker operators in the area?	Number	RPM	Private operators	More than 2	
		Is there willingness amongst water tankers to take over the desludging operations once water supply system is operationalised ?	Yes/No	Responsibility	Private operators	Yes	One of the operators provides both desludging and water supply service
		Is there good feasibility of local community-based entrepreneurship for desludging services – sanitation workers cooperatives	Yes/No	Responsibility	Private operators	Yes	
		Numbers of private desludgers in the municipality	Number	RPM	KII Municipal Staff	3	
Market Environment	• Areas with community activities (agrarian, industrial etc.) that can utilise the resources recovered from the treatment of the wastewater and fecal	Is there demand for resources that may be recovered from fecal sludge in local / neighborhood agrarian activities ?	Yes/No	RPM	KII Municipal Staff	No	FSTP is recently established and not yet explored

	sludge and a related market feasibility is favorable	Is there demand for reuse of treated wastewater in local/ neighborhood industrial activities?	Yes/No	RPM	KII Municipal Staff	No	FSTP is recently established and not yet explored
		Is there willingness to pay for the recovered resources by end users?	Yes/No	RPM	KII Municipal Staff	No	FSTP is recently established and not yet explored
		Is the government willing to issue permits for the marketing of recovered resource products	Yes/No	Responsibility		NA	
		Is the local government inclined to reuse treated fecal sludge / wastewater in horticulture, public landscaping and park maintenance	Yes/No	RPM	KII Municipal Staff	Yes	Planning for Manure production after preparing By Laws
		Is their readiness and acceptance by the local government to commercialize the reuse of treated fecal sludge and wastewater through a business model	Yes/No	RPM	KII Municipal Staff	Yes	
7. Desludging Details							
Planning for desludging / Categorization of OSS	• Status of Septic tanks and other OSS	Percent of septic tanks or other OSS out of total desludging	Percent	Safety	KII Municipal Staff	NA	
8. Operator Landscape							
Septage calculations by collection method	• Status of desludging services	Details of desludging operators: public / private? numbers in the city		Accountability	KII Municipal Staff	3 Operators - Mangalgadhi Suppliers and Birendranagar Septic Tank Sarsafaai under same proprietorship; Nagar Sarsafaai Tatha Dhuwani Sewa and Yeri-chowk Sarsafaai	
		Number and types of desludging vehicles Types	Percent by type	Safety	Private operators	4 vehicles of 8000 liters; 1 vehicle of 4000 liters	Vehicles are customized water tankers
Charges/Fees	· Business Models	Fees/Tariffs	Nepalese rupees	Sustainability	Private operators	NRs.8,000/ trip for 8000 L NRS 5,000/trip for 4000L	
9. Worker Safety and Working Conditions							
Certification, training to include information on PPE gear, health hazards; legal recourse; health check-ups; insurance, etc.	• Worker Skill and agency development	Probing condition of workers and working conditions	Yes/No	Safety, equity	KII Municipal Staff	Yes	They use PPE suit, Gumboot, Helmet, Mask, Gloves; operators have also managed health insurance of the workers
Disposal, Treatment and Reuse							

Safety of CTs	• Safety of shared facilities/ who is responsible / models for O & M and infrastructure needs	Percentage of CTs where FS/WW safety transported and treated out of total CTS surveyed	Percent	Safety	CT/PT Survey	100%	
Safety of PTs	• Safety of shared facilities/ who is responsible / models for O & M and infrastructure needs	Percentage of PTs where FS/WW safety transported and treated out of total CTs surveyed	Percent	Safety	CT/PT Survey	100%	
Disposal	• FS Disposal	Is there any designated site for Fecal sludge disposal	Yes/No	Safety	KII Municipal Staff	Yes	FSTP is in function from September 2021
Treatment	• FS Treatment	Is there any existing provision for treatment of Fecal Sludge	Yes/No	Safety	KII Municipal Staff	Yes	
		If Yes, Capacity in KLD	KLD	Safety	KII Municipal Staff	5 m3/day	Planning for 50 m3/day
		Any land available for FSM Plant? How much?	Yes/No	Safety	KII Municipal Staff	Yes	FSTP is already constructed. Approx. 1320 m2
Reuse	• FS Reuse	How is the sludge reused	Options	Safety	KII Municipal Staff	Not used	

ANNEX VI: DETAIL COSTING FOR SEWERAGE INTERVENTION

District Rate			
Site :Birendranagar		District : Surkhet	
		Year	FY - 2078-2079
LABOUR RATE			
S.No.	Description	Unit	Rate
1	Skilled Labour	No.	945
2	Unskilled Labour	No.	630
3	Cement 43 Grade P.P.C.(Nepali)	Bag	700
		M.T.	14000
		Kg.	14
4	Course sand River	Cum.	3000
5	Course sand(washed)	Cum.	3000
6	Brick (made in local chimney) 1- No	Thou.	15750
		No.	15.75
7	Aggregate (River bed) 40 mm	Cum.	2800
i)	20 mm	Cum.	3000
ii)	10 mm	Cum.	3100
8	Aggregate (Broken or Crusher) 40 mm	Cum.	2800
i)	20 mm	Cum.	3000
ii)	10 mm	Cum.	3100
9	Tor steel reinforcement bar	M.T.	96000
i)	6 mm Ø-8mm	Kg.	97
ii)	above 10 mm Ø	Kg.	96
10	Binding wire	Kg.	121
11	Bitumen	Kg.	86.1
12	Firewood	Kg.	13
13	Water proofing compound	Kg.	62
14	Kerosene oil	Liter.	100
15	Road roller	Hr.	2200
16	Water	Liter.	0.3
17	Diesel	Liter.	103
18	Hume pipe NP3 300 dia	rm	2767
19	Hume pipe NP3 450 dia	rm	4150.5
20	Round heavy pipe 24" MH Cover	set	14630
21	Excavator	Hr.	1800
22	Transportation	cum	353
23	300 mm RCC collar	no's	286
24	450 mm RCC collar	no's	429
25	Hume pipe NP3 600 dia	rm	5468
26	Hume pipe NP3 1000 dia	rm	8202
27	600 mm RCC collar	no's	1368
28	1000 mm RCC collar	no's	2052
29	160mm hdpe pipe	rm	807

Estimation of Hume Pipe laying & Manhole									
Height =1.5m									
Hume pipe=300mmdia									
Length=1000m									
SN	DESCRIPTION OF WORKS	NO.	UNITS	LENGTH	BREADTH	HEIGHT	QUANTITY	RATE	AMOUNT
1	Excavation	1	cu.m	1000.00	0.7	1.50	1,050.00	456.64	479,468.40
2	Back Filling	1	cu.m	70%of Earthwork			735.00	186.56	137,120.68
3	Hume pipe 300 dia	1	rm	1000			1000	4,079.82	4,079,822.66
4	Manhole	20	no				20	43,818.98	876,379.60
5	Road re-installment	1	sq.m	1000	1.3		1300	2,448.05	3,182,462.56
Total cost Per Km									8,755,253.90
Total cost per m									8,755.25
USD									76.13

Height =2m									
Hume pipe=450mmdia									
Length=1000m									
SN	DESCRIPTION OF WORKS	NO.	UNITS	LENGTH	BREADTH	HEIGHT	QUANTITY	RATE	AMOUNT
1	Excavation	1	cu.m	1000.00	0.85	2.00	1,700.00	456.64	776,282.17
2	Back Filling	1	cu.m	70%of Earthwork			1,190.00	186.56	222,004.91
3	Hume pipe 450 dia	1	rm	1000			1000	5,737.66	5,737,655.47
4	Manhole	20	no				20	76,348.08	1,526,961.60
5	Road re-installment	1	sq.m	1000	1.45		1450	2,448.05	3,549,669.78
Total cost Per Km									11,812,573.93
Total cost per m									11,812.57
USD									102.72

Height =2.5m									
Hume pipe=600mmdia									
Length=1000m									
SN	DESCRIPTION OF WORKS	NO.	UNITS	LENGTH	BREADTH	HEIGHT	QUANTITY	RATE	AMOUNT
1	Excavation	1	cu.m	1000.00	1	2.50	2,500.00	456.64	1,141,591.43
2	Back Filling	1	cu.m	70%of Earthwork			1,750.00	186.56	326,477.81
3	Hume pipe 600dia	1	rm	1000			1000	6,937.06	6,937,056.81
4	Manhole	20	no				20	86,300.79	1,726,015.86
5	Road re-installment	1	sq.m	1000	1.6		1600	2,448.05	3,916,877.00
Total cost Per Km									14,048,018.91
Total cost per m									14,048.02
USD									122.16

Height =3m									
Hume pipe=1000mmdia									
Length=1000m									
SN	DESCRIPTION OF WORKS	NO.	UNITS	LENGTH	BREADTH	HEIGHT	QUANTITY	RATE	AMOUNT
1	Excavation	1	cu.m	1000.00	1.4	3.00	4,200.00	456.64	1,917,873.60
2	Back Filling	1	cu.m	70%of Earthwork			2,940.00	186.56	548,482.73
3	Hume pipe 1000dia	1	rm	1000			1000	12,230.36	12,230,357.81
4	Manhole	20	no				20	114,286.17	2,285,723.43
5	Road re-installment	1	sq.m	1000	1.5		1500	2,448.05	3,672,072.19
Total cost Per Km									20,654,509.76
Total cost per m									20,654.51
USD									179.60

Inspection Chamber									
HDPE pipe=160dia									
Length=6m									
SN	DESCRIPTION OF WORKS	NO.	UNITS	LENGTH	BREADTH	HEIGHT	QUANTITY	RATE	AMOUNT
1	Excavation	1	cu.m	6.00	0.36	0.60	1.30	456.64	591.80
2	Back Filling	1	cu.m	20%of Earthwork			0.26	186.56	48.36
3	HDPE pipe 160dia	1	rm	6			6	2,161.77	12,970.62
4	Inspection Chamber	1	no				1	21,393.80	21,393.80
Total cost per no									35,004.58
USD									304.39

ANNEX VII: WASTEWATER CALCULTION

Heads	Value	Unit
Water Consumption	100	lpcd
Number of persons in a building	4.25	nos
Total water consumption	425	lit/day
water to wastewater conversion factor	0.8	
Total wastewater production	340	lit/day
Densified cluster (Sample cluster chosen)		
Area of Clusger	0.143	Km2
Nos of buildings	267	Nos of buildings
Density of buildings	1867.13	Buildings/km2
Wastewater production from sample cluster	90780	Lit/day
Wastewater production per km2	634825.17	Lit/km2.day
Total area of sewerage zone	9.136	Km2
Total wastewater production	5799.80	Cum/day
	6	MLD
Area served by WWTP Near by the fish cottage@60% of total area =5.5 km2	3.6	MLD
Area served by WWTP Nearby the Bulbule taal @40% of total area = 3.63 km2	2.4	MLD

ANNEX VIII: DETAIL COSTING FOR NSS INTERVENTIONS

1. **Septic Tank**: A standard size of 5 person's capacity septic tank has been estimated to arrive the block cost asper prevailing schedule of rates. **Per Septic Tank Cost = NPR 51,955**

Construction of Lined Septic Tank - for 1 job						
SN	DESCRIPTION OF WORKS	UNITS	QUANTITY	RATE	AMOUNT	
1	Excavation	cu.m.	2.84	468	1,330	3%
2	Back Filling	cu.m.	1.17	222	260	1%
3	Flat brick Soiling	sq.m	1.80	1,106	1,991	4%
4	PCC 1:2:4	cu.m.	0.36	13,588	4,892	9%
Brick Masonry						
5	Brick works	cu.m.	1.66	15,400	25,503	49%
6	RCC Slab	cu.m.	0.17	19,828	3,346	6%
7	RCC Bottom	cum	0.17	19,828	3,346	6%
7	230mmth.Brick works	cum	0.09	15,400	1,444	3%
Cement plaster						
9	12.5mm thick (1:4) cement sand plaster	sq.m	8.40	433	3,640	7%
		sq.m	2.25	433	975	2%
10	Reinforcement 12mm dia	kg	40.50	129	5,229	10%
Total (in NPR)					51,955	100%
Total (in USD)					437	

2. **Soak Pit**: Making soak pit 1.2 m diameter 1.8 metre deep with honeycomb bricks and drain pipe 110 mm diameter, 1.8 m long complete as per standard design cost app. NPR 30,273., Per Soak Pit Cost in USD = 142

Construction of Soak Pit - for 1 job						
SN	DESCRIPTION OF WORKS	UNITS	QUANTITY	RATE	AMOUNT	%
1	Excavation	cu.m.	3.75	468	1,758	10%
2	Back Filling	cu.m.	1.59	222	353	2%
3	Flat brick Soiling	sq.m	1.65	1,106	1,825	11%
4	Brick works		0.52	15,400	7,984	47%
5	PCC	cu.m.	0.25	13,588	3,364	20%
6	Pipe 110 mm	rm	2.00	807	1,614	10%
Total (in NPR)					30,273	100%

3. Kitchen Garden

SN	DESCRIPTION OF WORKS	UNITS	QUANTITY	RATE	AMOUNT
1	Cleaning and preparation of kitchen farm including ploughing levelling and weeding etc.	1	Nos	750.00	750.00
2	Plantation of different species as required in garden (seasonal)	50	Nos	25	1250
3	Plantation of trees (permanent)	10	Nos	100	1000
3	Fencing of the Nursery Field with locally available material e.g., bamboo, wires etc.	1	LS	2000	2000.00
4	Spreading of sludge farm yard manure or/ and good earth in required thickness (cost of sludge, farm- yard manure or/and good earth to be paid for separately).	2	kg	50	100
5	Providing and laying 50 mm hdpe pipe	10	meter	250	2500
Total (in NPR)					7600
Total (in USD)					64

4. **Decentralized Wastewater Treatment Plant**: In absence of detailed footprint in each institution in the study area, a sample of 200 persons has been assumed in an institution to arrive wastewater generation capacity and block costing as per schedule of rates.

   Persons in the instate = 200 nos.
   Water consumption = 80 lpcd
   Wastewater generation = 12.8 KLD (80% of water consumption)
   Required DEWATS Capacity = 13 KLD
   Cost of DEWATS Per KLD = 1,28,000
   Cost of Polishing Pond per KLD = 67,200
   Cost of Treatment = NPR 24,98,560

Construction of DEWATS of Capacity 13 KLD (ISAF+PGF+PP) – for 1 job								
Description	Unit	ISAF	PGF	PP	Total Quantity	Rate	Amount	%
Excavation	cum	71	92	205	367	468	1,71,964	6.9%
Refilling	cum	14	18	61	94	222	20,866	0.8%
Soling	cum	5	15	7	27	1,106	29,944	1.2%
PCC	cum	3	10	7	21	13,588	2,79,534	11.2%
RCC	cum	19	14	16	49	19,828	9,71,578	38.9%
Brick	cum	3	13	13	29	15,400	4,38,903	17.6%
Reinforcement	Mt	3	2	2	7	129	925	0.0%
Plaster	sq.m	203	216	47	465	433	2,01,667	8.1%
Painting	sq.m	101	108	23	233	480	1,11,684	4.5%
Pipes	m	24	19	15	58	2,642	1,53,243	6.1%
Covers	Nos.	6	4	2	12	9,792	1,17,504	4.7%
Total (in NPR)							24,97,812	100%
Total (in USD)							20,990	

The more accurate cost for each institution can be derived based on the wastewater generation capacity in each institutions using the per KLD estimated cost of DEWATS.

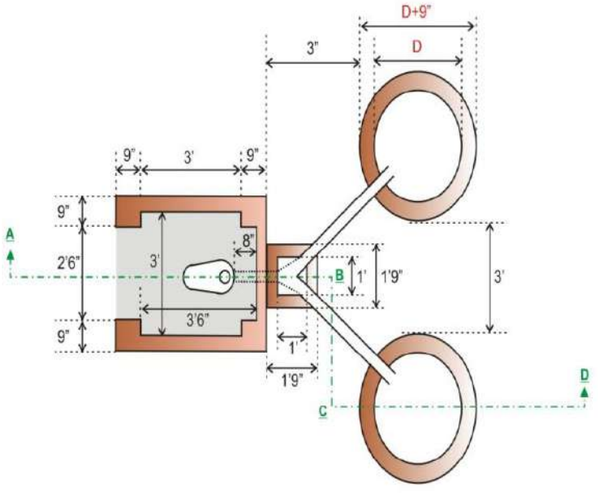
5. **Twin Pit System:** The Twin Pits for Pour Flush consists of two alternating pits connected to a pour flush toilet. The blackwater (and in some cases greywater) is collected in the pits, and this slowly infiltrates into the surrounding soil. Pits are used alternately, and over time (recommended two years) the solids are sufficiently dewatered, and they can be manually removed with a shovel.
   The Twin Pit Pour Flush design is not suitable for areas with a high groundwater table or frequent flooding, or areas with clay or tightly packed soils. Health concerns include the leachate contaminating groundwater, stagnant water in pits promoting possible insect breeding, and pit failure or overflowing during floods.

   The basic working principle of twin pit toilet is the seepage/leaching of water from the leach pit into the surrounding soil. This is possible only if the surrounding soil is permeable. Following soil types are well suited for fulfilling this purpose.
   - White soil
   - Red soil
   - Yellow soil
   - Medium black soil
   - Soft murrum &
   - Hard murrum

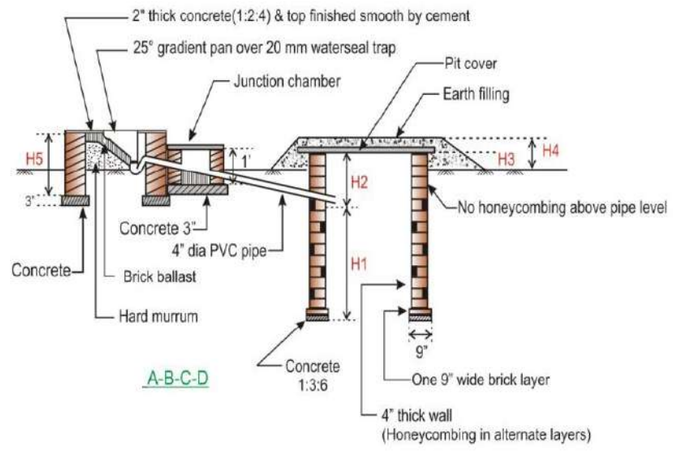
Soft murrum is best suited for twin pit toilet since infiltration rate is very high. Hard murrum is also not very inconvenient for leaching.
In case of black cotton soil some modifications are necessary as per site conditions. In case of rocky strata one should go cautiously for construction of twin pit system. In rocky terrain there are different possibilities:
Possibility 1: Adequate depth of pit (4') obtained but rock struck at the bottom. In such a situation no modifications are necessary. Complete the construction of pit as usual. In this case there will be no vertical downward leaching at the bottom, but it will take place horizontally in upper layers of murrum/ soil.

Possibility 2: Adequate depth of pit not obtained. Rock struck in between. This difficulty can be easily overcome by increasing the diameter of leach pit corresponding to the depth. A minimum depth of 2' 6" is essential. Twin pit toilet is not recommended where depth of pit is less than 2' 6".

Possibility 3: Rock struck before 2' 6" or exposed rock conditions. In such situations twin pit toilet is not recommended.



PLAN



CROSS SECTION

All measurements in Foot & inches

NOT TO SCALE

Dimension guide for varying depths in rocky strata

Sr No	Available Depth (Rock struck at)	D	D+9"	H 1	H2	H3	H4	H5
1	4'	3'	3'9"	3'	1'	3"	9"	1'6"
2	3'6"	3'	3'9"	3'	9"	3"	9"	1'6"
3	3'	3'3"	4'	2'9"	9"	6"	1'	2'
4	2'6"	3'6"	4'3"	2'6"	9"	9"	1'3"	2'3"
5	Less than 2'6" or exposed rock	Twin Pit Toilet not recommended						

Construction of Twin Pit - for 1 job					
S.No.	**Description of Item**	**Unit**	**Quantity**	**Rate**	**Amount**
1	Brick Works	Nos.	600	14.54	8,724
2	Sand	cum	0.45	3110	1,409
3	Cement	bags	3	730	2,190
4	Stone Metal	cum	0.1	2225	189
5	PVC pipe 4-inch dia	m	3	1000	3,000
6	Pit Covers	Nos.	4	2000	8,000
	Manpower Required				-
7	Excavation	Mandays.	1	750	750
8	Mason	Mandays.	2	1030	2,060
9	Labour	Mandays.	4	750	3,000
Total Cost of Twin Pit without superstructure (in NPR.)					**29,322**
Total Cost of Twin Pit without superstructure (in USD)					**245**

Citywide Inclusive Sanitation
Technical Assistance Hub
TA Hub . South Asia