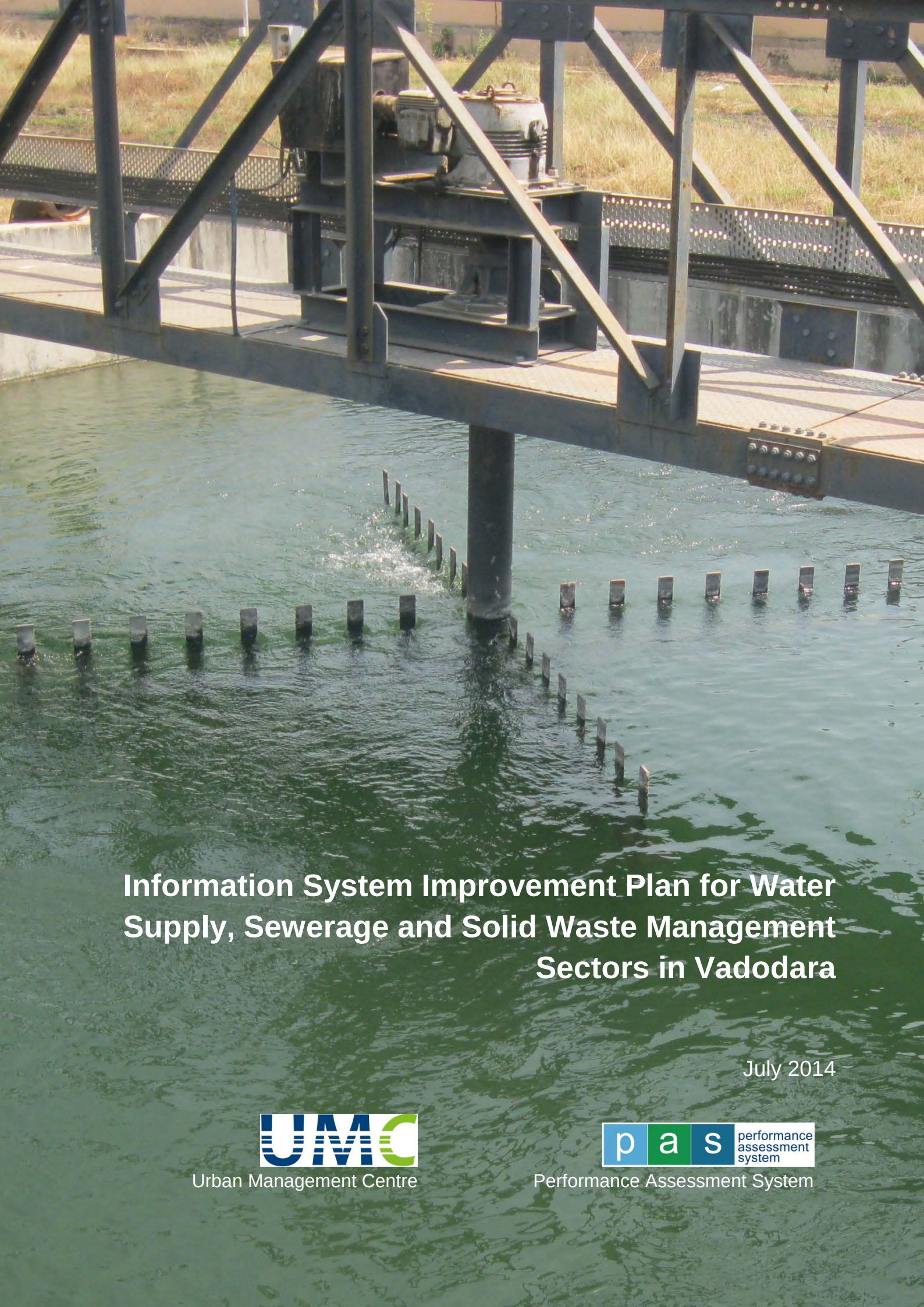

Information System Improvement Plan for Water Supply, Sewerage and Solid Waste Management Sectors in Vadodara

July 2014

Urban Management Centre

Performance Assessment System

Prepared by Urban Management Centre (UMC)

July 2014

The Urban Management Centre (UMC) is a women promoted not-for-profit organization, that works towards professionalizing urban management in India and worldwide. UMC provides technical assistance and support to city governments and facilitates change through peer-to-peer learning processes. It enhances the capacity of city governments by providing expertise and ready access to innovations on good governance implemented in India and abroad. UMC extensively works in the areas of urban water and sanitation, heritage management, planning, urban health, municipal finance, urban management, urban transportation and institutional restructuring. UMC is a legacy organization of International City/County Management Association (ICMA) and hence is also known as ICMA-South Asia. For more information, visit our website: www.umcasia.org.

PAS, a seven-year action research project, has been initiated by Centre for Environment Planning and Technology (CEPT) University with funding from the Bill and Melinda Gates Foundation. PAS aims to develop better information on water and sanitation performance at the local level to be used to improve the financial viability, quality and reliability of services. It uses performance indicators and benchmarks on water and sanitation services in all the 400-plus urban areas of Gujarat and Maharashtra. Urban Management Centre (UMC) and the All India Institute of Local Self Government (AIILSG) are CEPT University's project partners in Gujarat and Maharashtra, respectively. More details are available on www.pas.org.in.

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- Assistant Municipal Commissioner
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- Ex. Engineer, Dy. Ex. Engineers, AE, AAE, Operators, Sewerage & Drainage Dept.
- Head of Dept., Solid Waste Management
- Chemist, Public Health Laboratory, VMSS
- Revenue Department
- Accounts Department
- Tax Department
- JnNURM Cell
- Private operators of various facilities such as water treatment plants, sewage treatment plants, waste processing plants, scientific landfill site, door-to-door collection service, etc.

UMC would also like to thank the team at CEPT University, especially Prof. Meera Mehta and Prof. Dinesh Mehta for their continuous support and guidance for completion of this study. UMC also appreciates the work the efforts put in by its team members including Anurag Anthony, Arvind Singh, Dhruvi Panchal, Hemal Patel, Kinjal Pillai, Meghna Malhotra, Urvi Patel, Vimal Sharma and Vinay Patel.

Manvita Baradi

Preamble

Urban Management Centre (UMC) and Vadodara Mahanagar Seva Sadan (VMSS) signed a Memorandum of Understanding (MoU) in July 2012 to prepare Information System Improvement Plan (ISIP) for water supply, sewerage and solid waste management sectors in Vadodara based on the Service Level Benchmarking (SLB) framework.

Under this MoU, UMC conducted a detailed assessment of the existing information system maintained by water supply, sewerage and solid waste management (SWM) departments; and other departments which provide data for calculation of SLB indicators, such as Electronic Data Processing (EDP) unit, revenue, accounts and tax departments. This draft report is a work-in progress document and presents draft recommendations, implementation plan and its budgetary requirements.

During the course of this study, UMC team conducted numerous visits to Vadodara to understand the water supply, sewerage and SWM system in the city. The team assessed data recording practices at all installations in these sectors and collected various formats being used for recording operational details. In addition to the technical assessment, many other allied activities were undertaken by UMC. Some of them included a) sensitising VMSS staff on SLB indicators and reliability bands of water supply and sanitation sectors, b) discussed and reviewed with VMSS staff their existing monitoring system and data flow within their respective department as well as to other departments, c) informal discussions with the staff to prepare a strategy to improve both service delivery and reliability of data through minimal changes in the existing system, d) discussed the design of a system for automatic update of dynamic data through use of internal MIS, and e) discussed with the EDP unit, various IT/ mobile-enabled solutions for data reporting, sharing and monitoring.

During the course of the study, UMC team has formally and informally worked towards capacity building of VMSS staff for online data entry, reporting and use of hardware/ softwares for ISIP. UMC also conducted an exposure visit for VMSS staff to Nagpur and Navi Mumbai, who have successfully implemented Supervisory control and data acquisition (SCADA) system and 24x7 water supply systems.

Between April 2012 and June 2014, UMC team conducted more than 15 trips to Vadodara for visiting field level facilities or for presentations, review and discussions with VMSS staff.

Disclaimer

The objective of this assignment is to conduct an assessment of existing information system in water-sanitation sectors in VMSS. In the course of the assignment, Urban Management Centre (UMC) was provided with both written and verbal information supplemented by hand drawn sketches, archive pictures, maps and drawings. Nothing has come to our attention to cause us to believe that the data or maps provided by various sources are not true. All the information received is believed to be reliable, and has not been independently verified by UMC.

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List of Abbreviations

APS	Auxiliary pumping station
C&D	Construction and demolition
CPHEEO	Central Public Health and Environmental Engineering Organisation
CTP	Chief Town Planner
DCB	Demand, Collection and Balance
DMA	District Metering Area
EDP	Electronic Data Processing
ESR	Elevated Service Reservoir
GIS	Geographical Information System
GPCB	Gujarat Pollution Control Board
GPS	Global Positioning System
HH	Household
ISIP	Information System Improvement Plan
IT	Information technology
MLD	Million litres a day
MoUD	Ministry of Urban Development
MSW	Municipal Solid Waste
MT	Metric Tons
NMMC	Navi Mumbai Municipal Corporation
NRW	Non-revenue water
O&M	Operation and maintenance
PAS	Performance Assessment System
PGR	Public Grievance Redressal
RC	Residual chlorine
SCADA	Supervisory control and data acquisition
SLB	Service Level Benchmarking
STP	Sewage Treatment Plant
SWM	Solid Waste Management
UCD	Urban Community Development
ULB	Urban local body
UMC	Urban Management Centre
VMSS	Vadodara Mahanagar Seva Sadan
WDS	Water distribution station
WTP	Water treatment plant

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1. Introduction to Service Level Benchmarking

Benchmarking is an important mechanism for introducing accountability in service delivery. It involves measuring and monitoring of service providers performance on a systematic and continuous basis. Sustained benchmarking can help utilities to identify performance gaps and introduce improvements through the sharing of information and best practices, ultimately resulting in better services to people. This initiative has been undertaken by the Ministry of Urban Development (MoUD), Government of India as 'Service Level Benchmarking' (SLB) covering water, sanitation, solid waste management (SWM) and storm water drainage sectors. For the purposes of this Information System Improvement Plan (ISIP), water supply, waste water, storm water drainage and solid waste management sectors have been taken up.

The framework encompasses the following indicators:

1. Water Supply
    1.1. Coverage of water supply connections
    1.2. Per capita supply of water
    1.3. Extent of metering of water connections
    1.4. Extent of non-revenue water
    1.5. Continuity of water supply
    1.6. Efficiency in redressal of customer complaints
    1.7. Quality of water supplied
    1.8. Cost recovery in water supply services
    1.9. Efficiency in collection of water supply related charges

2. Sewerage & Sanitation
    2.1. Coverage of Toilets
    2.2. Coverage of waste water network services
    2.3. Collection efficiency of waste water network
    2.4. Adequacy of waste water treatment capacity
    2.5. Quality of waste water treatment
    2.6. Extent of reuse and recycling of waste water
    2.7. Extent of cost recovery in waste water
    2.8. Efficiency in redressal of customer complaints
    2.9. Efficiency in collection of sewerage related charges

3. Solid Waste Management
    3.1. Household level coverage of Solid Waste Management services
    3.2. Efficiency of collection of municipal solid waste
    3.3. Extent of segregation of municipal solid waste
    3.4. Extent of municipal solid waste recovered
    3.5. Extent of scientific disposal of municipal solid waste
    3.6. Extent of cost recovery in Solid Waste Management services
    3.7. Efficiency in redressal of customer complaints
    3.8. Efficiency in collection of SWM related user charges

4. Storm Water Drainage
    4.1. Coverage of Storm Water Drainage network
    4.2. Incidence of water logging/ flooding

It is important that all cities maintain reliable data about their service delivery and assets for efficient management of the same. Hence, for each of the above indicators, MoUD provides data reliability grading scale. This scale rates the indicators as A, B, C or D based on the parameters laid down for each indicator value in the SLB Handbook prepared by MoUD (Ministry of Urban Development, 2009).

2. Need for Information System Improvement Plan in Vadodara

Vadodara Mahanagar Seva Sadan (VMSS) is one of the progressive urban local body (ULB) in Gujarat. It is the third largest city in the state. VMSS has undertaken many initiatives in the recent past to improve municipal service delivery, especially in water supply, sewerage and SWM sectors.

Some of these initiatives include infrastructural improvements such as water and sewage collection network expansion, augmentation of water treatment capacity, augmentation of sewage treatment capacity, increasing door-to-door municipal solid waste collection (MSW) and setting-up of MSW processing plants.

To ensure efficient use of the infrastructure, VMSS has implemented reforms to improve its information systems and hence, initiate informed decision making process at the operational level. Once such example is geographical positioning system (GPS) based real-time monitoring of SWM vehicular fleet. Similarly, VMSS has shown keen interest in improving information collection, storage, transfer and reporting mechanisms in water supply, sewerage and SWM sectors.

Navi Mumbai Municipal Corporation (NMMC) has implemented fully automated supervisory control and data acquisition (SCADA) system in water supply and Nagpur Municipal Corporation (NMC) has implemented 24x7 water supply in a demonstration zone of Nagpur. In order to provide a first-hand experience to city officials, Urban Management Centre (UMC) conducted an exposure visit to NMMC and NMC for officials of VMSS and municipalities of Kalol, Kadi, Himmatnagar and Mehsana.

VMSS has shown keen interest in implementation of SCADA system in water supply in a pilot zone. VMSS is also exploring implementing 24x7 water supply in the same area. Motivated by the exposure visit, VMSS prepared a detailed project report (DPR) for implementing SCADA system and 24x7 water supply in the city. VMSS has already engaged implementing agency to initiate work in a pilot area.

Based on the learnings from the exposure visit, VMSS also recognised that implementation of a full scale city wide SCADA system may take anywhere between 3 to 10 years. Hence, VMSS feels that it is necessary to streamline the current data collection, transfer, analysis and reporting systems (in water supply, sewerage and SWM) in Vadodara. This would not only be useful in implementing SCADA but would also improve service delivery under the current system.

Based on VMSS' future plans and their existing data systems, UMC outlined the aim of this ISIP as:

> **Improve data recording[1], transfer, analysis and reporting mechanism of VMSS for water supply, sewerage and solid waste management sectors.**

[1] Recording data while improving its reliability as per SLB definitions.

2.1. Methodology

Under this ISIP, information recording, its transfer, analysis and reporting system of VMSS has been studied for water supply, sewerage and SWM systems. The improvements in the same have been undertaken with minimal intervention – both infrastructural and procedural.

The work conducted under this ISIP can be divided in the following 5 stages:

Stage 1: Existing situation assessment of data recording, processing/usage and reporting in water supply, sewerage and SWM sectors

Stage 2: Identification of gaps in existing information system in VMSS

Stage 3: Assessment of use of data gathering/ measuring devices/ equipment required at various installations of water-sanitation utilities

Stage 4: Assessment of field facilities related to water-sanitation utilities where data is generated or should be generated to fulfil SLB requirements. The assessment includes

i. Availability of computers
ii. Availability of connectivity to VMSS head office
iii. Availability of staff trained in basic use of computer application (such as MS Office and web browsing)

Stage 5: Recommending interventions in three categories

i. Design of existing and new forms for gathering data; including surveys wherever required
ii. Installation of measuring equipment at various locations at appropriate
iii. Training and capacity building of staff for implementation of ISIP

2.2. Limitations of the study

UMC encountered several limitations while preparing ISIP for VMSS in water-sanitation sectors as per the SLB framework. UMC modified the SLB framework to suit the existing condition of information systems in Vadodara. These limitations and modifications have been listed below.

- This study has been conducted with the focus on improving reliability of SLB indicators in Vadodara only. The framework may or may not be applicable to other cities in its current form.
- The study has accepted the 'Handbook of Service Level Benchmarking' prepared by MoUD as a general guide. For preparation of ISIP in Vadodara, this study suggests revisions in 'Minimum frequency of measurement of performance indicator' and 'Smallest geographical for measurement of performance indicator' for some indicators. The respective sections have been highlighted wherever SLB norms for these 2 parameters have been revised for Vadodara.
- VMSS has recently initiated consumer metering in newly covered areas (by water supply distribution network). There is lack of clarity within VMSS regarding consumer metering in the existing water supply connections. Hence, for the purposes of this study, reliability improvement for the SLB indicator 'Extent of metering of water connections', has not been undertaken.
- Based on the study, UMC concludes that for implementation of ISIP, installation of bulk flow meters is absolutely necessary at all bulk water production, treatment and distribution points for water supply and inlets & outlets of all STP units. However, errors arising out of malfunction of meters have not been considered.
- It is assumed that linemen, pump operators, engineers and other relevant staff of VMSS would fill forms (both manual as well as digital) diligently. Any inconsistencies in filling of the forms by staff would not be reflected in the reliability of SLB indicators.
- UMC found that many forms contain column/ row heads to capture information which may not be relevant in the present context. UMC has not removed or modified such columns/ rows and retained them as-it-is. Any modifications and/ or additions have been done purely for the purposes of ISIP.
- Storm water drainage sector has not been covered under this study.

3. About Vadodara Mahanagar Seva Sadan

Baroda Municipality was officially formed in 1892 AD with 22 elected councillors and an appointed Sudharai Kamdar (Municipal Commissioner) under the Sudharai Nibandh Municipal Act passed by the Late Maharaja Saiyajirao Gaekwad. The municipality was later governed by The Municipal Act, 1905 and subsequently by the Bombay District Municipal Act until 1951 until its administration was governed by the Baroda Municipal Act. In 1951 itself, Baroda became a Municipal Corporation and functioned under the Bombay Provincial Municipal Corporation (BPMC) Act, 1949[2] (Vadodara Mahanagar Seva Sadan, 2014).

As of 2013-14, there are 23 departments in VMSS. Many departments contribute data directly or indirectly for generating SLB indicators for water-sanitation sectors. The table below lists the departments in VMSS and highlights those that provide data for SLB:

Table 1 List of department in VMSS

Accounts	Fire & Emergency	Storm Water Drainage
Administration	Garden & Museums	Street Lighting
Audit	Gas	Tax
Drainage	Health	Town Development
EDP	Housing & Building	UCD Department
Education	Public Relations	Vigilance
Election	Revenue	Water Supply
Estate	Roads & Bridges	-

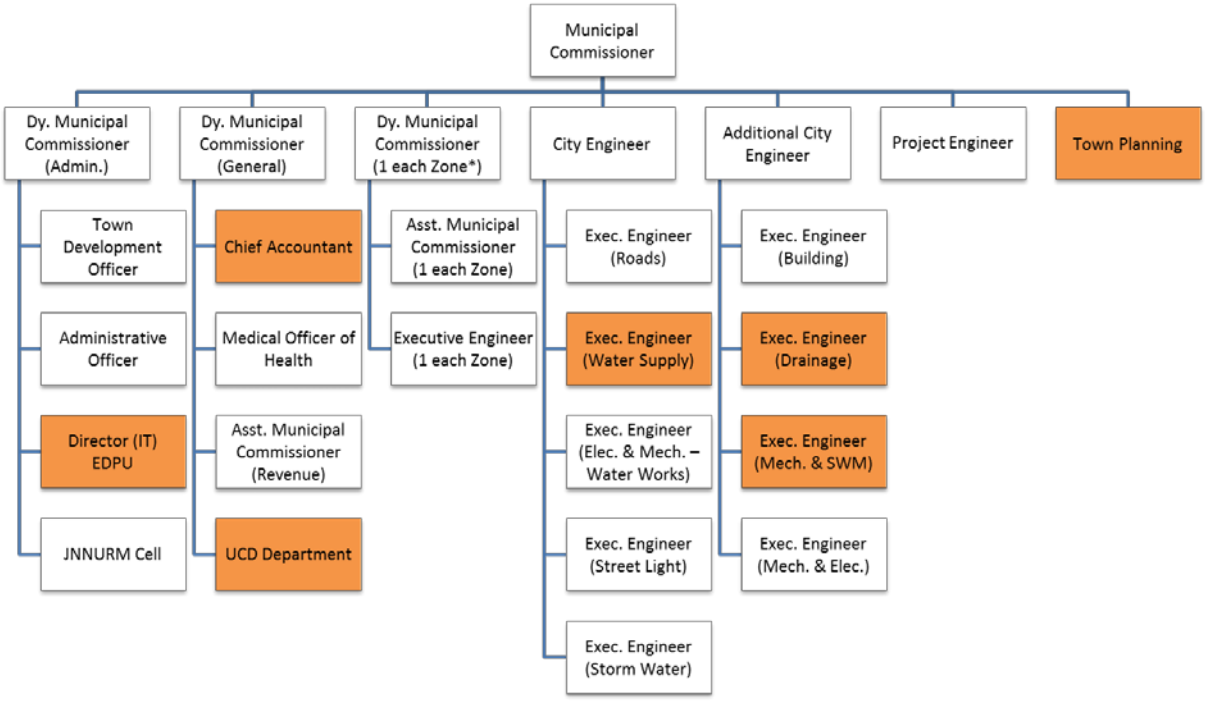
Source: (Vadodara Mahanagar Seva Sadan, 2013b)

Vadodara Mahanagar Seva Sadan Office, Khanderao Market, Vadodara

[2] BPMC Act, 1949 was later renamed as Gujarat Provincial Municipal Corporations Act for Gujarat state.

The following organogram shows head of various departments in VMSS.

Figure 1 Organogram of VMSS[3]



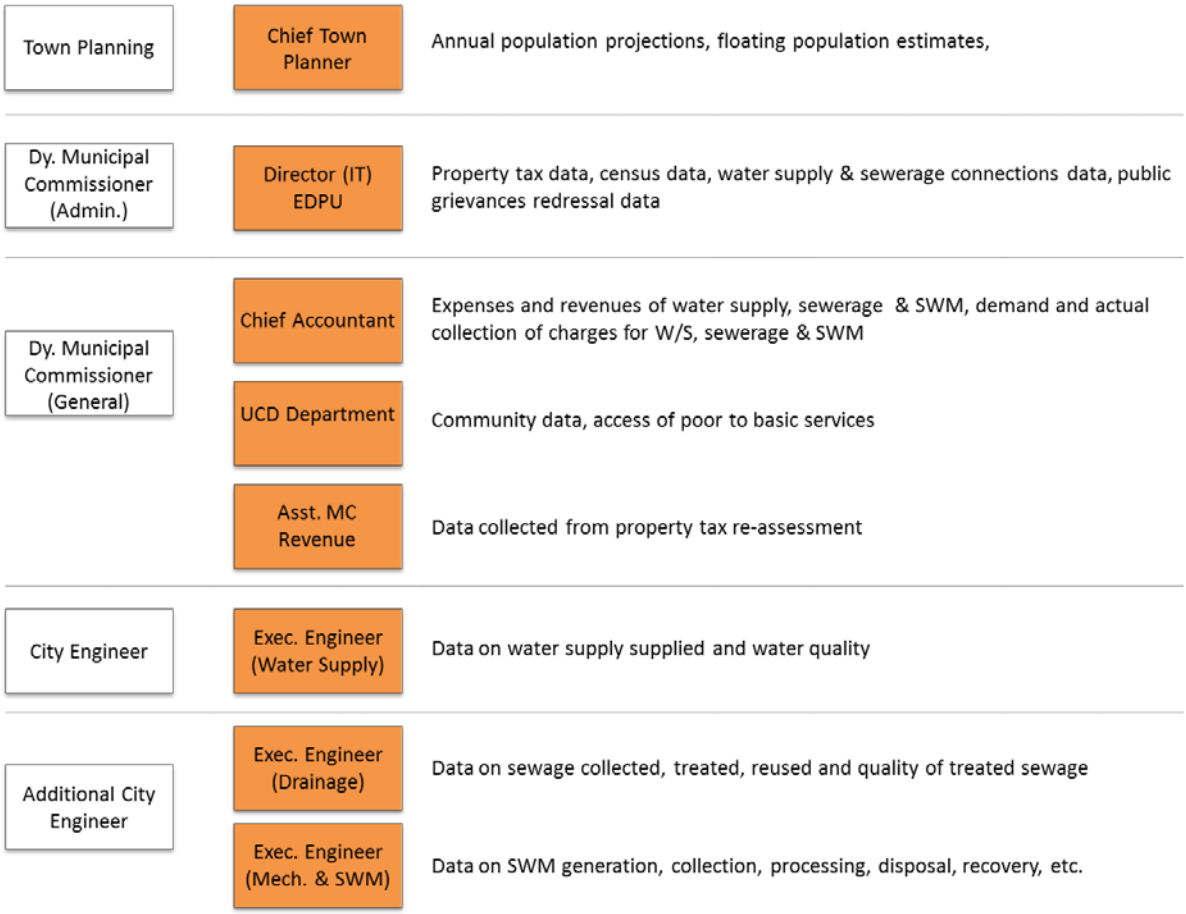
Source: (Vadodara Mahanagar Seva Sadan, No Year)

As highlighted in the Organogram, the relevant departments for ISIP include Electronic Data Processing (EDP) Unit, accounts and offices of Executive Engineers for water supply, drainage and SWM departments. Other relevant departments include Urban Community Development (UCD) and town planning.

Each department provides relevant data for computation of SLB indicators. These have been shown in the diagram below.

[3] Storm water drainage and solid waste management has not been included in this study and hence, the relevant departments have not been highlighted.

Figure 2 Department-wise information relevant for SLB



Source: Urban Management Centre, 2013

Accounts Department

Accounts department is headed by Chief Accountant and is responsible for all budget related functions and maintaining income and expenditure accounts on VMSS. Accounts Department falls in the Administration Section headed by Deputy Municipal Commissioner (Administration). The Accounts Department is crucial for ISIP as it provides data which is used for calculating the 3 SLB indicators – cost recovery in water supply, sewerage and solid waste management sectors.

Electronic Data Processing Unit

The EDPU is the information technology (IT) arm of VMSS. It provides IT support for all functions related to VMSS including maintaining database for properties, taxation, public grievance redressal (PGR), details of water supply and sewerage connections, etc. The department is headed by Director (IT) and reports to the Municipal Commissioner.

Drainage Department

Drainage Department is headed by the City Engineer under the Technical Section and reports to the Municipal Commissioner. The Drainage Department is responsible for providing waste water collection, transportation, treatment and disposal services to the city. The department maintains operational data at various drainage facilities such as sewage treatment plants and auxiliary pumping stations (APS).

Solid Waste Management Department

SWM Department is headed by an Environmental Engineer and reports to the Assistant Municipal Commissioner. SWM Department maintains all data relevant to their operations and monitors performance of private contractors engaged to assist VMSS.

Town Planning Department

The Town Planning Department headed by a Chief Town Planner (CTP) is responsible for planning Town Planning (TP) Schemes in the city. In addition to the TP Schemes, the department is mandated with preparation of the statutory development plan for Vadodara city. However, in practice, Vadodara Urban Development Authority undertakes this activity.

Urban Community Development Department

Urban Community Development (UCD) Department takes care of the community facilities including activities related to development of slums and their access to water-sanitation services.

Water Supply Department

This department is headed by the City Engineer. For functional purposes, activities under this department are divided as 'operations and maintenance' (O&M), and 'projects'. Each vertical is headed by an Executive Engineer. Executive Engineer for O&M generates and maintains water supply related operational data.

The following section presents analysis of existing information system in water supply, sewerage and SWM sectors. Each sector is assessed for its existing data flow including

- location of data generation (field location, office, etc.)
- frequency of data recording
- method of recording (paper based or electronic)
- suitability of formats used for data recording
- data reporting frequency and mode of transfer
- basic assessment of staff capacity and IT infrastructure at field level facilities

4. Water supply

4.1. Existing water supply system in Vadodara

A stage wise break-up of the existing water supply system in Vadodara has been shown in the following sections.

Demand

Vadodara Mahanagar Seva Sadan (VMSS) has a population of 17,12,699 as per the Census of India 2011. VMSS caters to around 3.18 lakh households out of a total of 4.07 lakh households through 2.6 lakh residential connections approximately (Vadodara Mahanagar Seva Sadan, 2013a). Presently, Vadodara needs 231 MLD to serve the entire population of the city for domestic supply. There are no estimates of the industrial and commercial demand of water in Vadodara, but based on the discussions with VMSS staff, an estimated 150 MLD is needed apart from the domestic demand.

Water sources

Against a demand of 231 MLD, VMSS currently supplies 401.8 MLD including bulk supply to industries and commercial establishments. VMSS produces water from the following sources:

- Sayaji Sarovar (surface source)
- 4 French wells at River Mahi (ground water)
- 23 tubewells in the bed of River Mahi (ground water)
- 80 borewells within the city (ground water)

All of the above sources are perennial in nature and suffice the city's current needs. To provide for the expansion of the city, VMSS has proposed augmentation of existing sources and would be sourcing water from the Narmada canal in the future. VMSS is building infrastructure to treat water to be sourced from Narmada canal in the future. This source is

scheduled to become operational in late 2014/ early 2015.

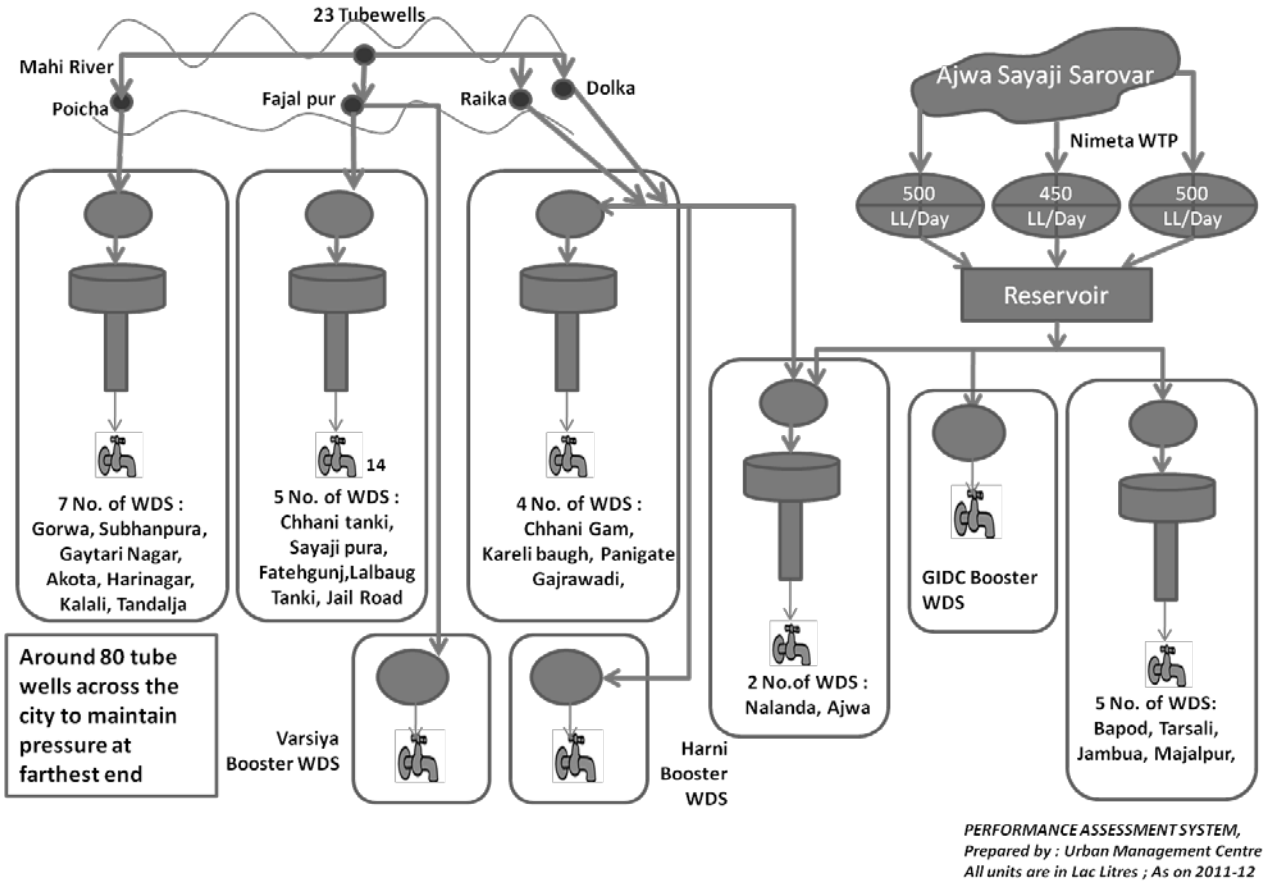
Water sourced from Sayaji Sarovar is taken to water treatment plants (WTP) at Nimeta. Water sourced from the French wells, tubewells in River Mahi and the borewells within the city is supplied directly to the water distribution stations (WDS) and in some cases directly pumped in the distribution network. Water from the borewells is used for maintaining pressure in the distribution system.

There are several private borewells in the city. VMSS has not conducted any survey to assess the number of borewells or the quantity of water extracted from them.

Water treatment

VMSS has 3 WTPs clustered together at Nimeta. They treat water sourced from Sayaji Sarovar. One of the WTP was built during the reign of Gaekwad and has a capacity of 45 MLD. The other 2 WTPs have a capacity of 50 MLD each. Water sourced from the French-wells, tubewells in River Mahi and borewells within the city is supplied after chlorination. As of 2013, VMSS is constructing a WTP to treat water sourced from Narmada canal.

Figure 3 Water Supply Flow Diagram, Vadodara Mahanagar Seva Sadan



Water distribution

VMSS supplies water from various sources using 27 existing WDS covering nearly all urbanised areas of the city. VMSS is constructing 4 new WDS and expanding its distribution network. The treated water supplied from WTPs is stored in a balance reservoir which in-turn feeds several WDS in the city. A list of all WDS in Vadodara has been provided in Annexure 1 and shown on a map in Annexure 2.

Each WDS serves around 3 to 5 district metering areas (DMA) commonly referred to as localities. Supply operation valves are located in and around the WDS and are operated by the linemen for regulating supply to command area.

In all, there are 2.65 lakh municipal water supply connections out of which around 2.50 lakh are domestic individual connections serving around 3.22 lakh households. Rest of the population is served through public stand-posts and private water sources such as tankers and private borewells.

WDS, Water Supply System, Vadodara

4.2. Existing information system in water supply

This section presents an analysis of existing information system in water supply in VMSS. To analyse data generation, UMC conducted field visits at all installations in water supply including sources, intermediate storage facilities, water treatment plants and water distribution stations. In addition, UMC conducted discussions with all levels of staff working in operation and maintenance of water supply. An overview of the data provided by each department for generating water supply indicators has been provided in the figure below.

Figure 4 Department-wise information sources for generating SLB indicators

Department/ officer contributing to water supply indicators		Coverage by connections	Per capita supply	Extent of Metering	NRW	Continuity of water supply	Quality of Water	Efficiency in complaints	Cost recovery	Efficiency in collection of charges
Town Planning	Chief Town Planner		✓							
Dy. Municipal Commissioner (Admin.)	Director (IT) EDPU	✓	✓					✓		
Dy. Municipal Commissioner (General)	Chief Accountant								✓	✓
	UCD Department									
	Asst. MC Revenue									
City Engineer	Exec. Engineer (Water Supply)		✓		✓	✓	✓			
Additional City Engineer	Exec. Engineer (Drainage)									
	Exec. Engineer (Mech. & SWM)									

Source: Urban Management Centre, 2013

During the visits, the team collected data recording formats (maintained as logbooks) at all facilities. Based on the data collected during 2012-13 for Performance Assessment System (PAS) program, the water supply SLB indicators for VMSS were as below:

Table 2 Performance indicators of VMSS in water supply as per the SLB framework

S. No	Water supply indicator values	Unit	FY 2012-13
1	Coverage of water supply connections	%	78
2	Per capita available of water at consumer end	Lpcd	156
3	Extent of metering of water connections	%	3
4	Extent of non-revenue water	%	32
5	Continuity of water supply	Hours/ day	1.00
6	Efficiency in redressal of customer complaints	%	97
7	Quality of water supplied	%	99
8	Cost recovery in water supply services	%	49
9	Efficiency in collection of water supply related charges	%	91

Source: (PAS, 2013)

To conduct assessment of data collation or summarisation and its reporting to higher officials, UMC tracked the flow of information from various facilities to VMSS head office as well as to Harni Tanki – the main data centre for water supply.

The analysis conducted for water supply's existing information system has been presented using the following:

- Water supply flow diagram
- Information flow diagram from various facilities related to water supply to the zonal and main offices of VMSS
- Gap analysis in existing information system clearly identifying data not generated/ recorded and recommendations to capture such data
- Gap analysis in existing data recording formats and recommendations to fulfil them as per SLB framework

While providing recommendations, UMC's approach has been to make minimal modifications in the existing formats. Recommendations provided by UMC to fill data gaps include

a) new formats
b) minor modifications to existing formats
c) computerisation of data and defining its flow
d) outlining equipment and manpower requirements for filling in the data gaps and improving reliability bands

A detailed assessment of the information system reveals that information should be collected from several field locations and administrative offices within VMSS as shown below.

Figure 5 Information flow diagram for calculating water supply related performance indicators as per SLB framework

In the above diagram, the data sets highlighted are the ones which are not recorded by VMSS. Some data from the highlighted sets requires additional infrastructure, studies or surveys to be generated.

Summary of recommendations for improvement of water supply information system

For the purposes of ISIP, new formats have been proposed in the subsequent sections for data sets which are generated by not recorded. This ISIP also proposes format required to capture information through proposed surveys, studies and recording using the proposed infrastructure.

Process improvements, studies and surveys proposed

The following process improvements, studies and surveys have been recommended:

General (departments other than water supply)

1. Digitise complaints logbooks placed at various ward offices and water supply facilities in the city. Alternatively, where manual registers are maintained, a computer should be installed and connected to the main online complaints system of VMSS.
2. Accrual based double-entry accounting system should be adhered to strictly in order to ascertain actual expenses and revenues for each year.
3. Sharing of staff, machinery & equipment and consumables (such as fuel, spares, etc.) should be well documented and expenses incurred should be accounted for respective department/ work proportionately.

Water Supply Department

4. Conduct a sample survey at consumers' end to assess the quantity of water reaching the consumers, duration of supply and pressure at which the water is supplied to the consumer. The sampling methodology has been suggested in 'Indicator 1.5: Continuity of water supply' in the following section.
5. Water quality testing regime should be calculated based on CPHEEO norms. UMC has designed an MS Excel based tool to prepare the regime. Based on this tool, VMSS should conduct location-wise and type-wise quality testing. The details of tests to be conducted have been provided in 'Indicator 1.6: Quality of water supplied'.
6. VMSS should get an independent periodic water quality assessment conducted.
7. The CTP, Town Planning Department at VMSS should prepare estimates of the floating population for the city.

Infrastructure proposed

In addition to the above forms, the following infrastructural improvements have been recommended:

1. Installation of 113 bulk flow meters at all bulk water production points including
    a. Four French wells at River Mahi
    b. Twenty three tubewells along River Mahi
    c. Eighty borewells within the city
    d. Inlet and outlets of all WTPs
2. Purchase of 242 portable meters and pressure gauges for conducting survey of water quantity, duration of supply and pressure head at consumers' end

Forms proposed

S. No.	Proposed/ Modified	Form No.	Title of the form
1.	Proposed	Form GE01	Households, properties and establishment details
2.	Proposed	Form GE02	Complaints received and redressed
3.	Proposed	Form WS01	Bulk flow meter readings
4.	Proposed	Form WS02	Quantity, duration and pressure of water at consumers' end
5.	Proposed	Form WS03	Summary of quality of water

Indicator-wise details including gaps and recommendations have been discussed in the following section.

4.3. Data generation, recording and transfer practices in VMSS – gaps and recommendations

VMSS captures data from various facilities through logbooks. Central office of the water supply department (housed in the main VMSS building at Khanderao Market) collates some of the data captured from various installations. The data collated includes daily production of water from all sources (except 80 borewells within the city) and circulates this information to the Executive Engineer (Electrical & Mechanical) and City Engineer.

While some data is collated and used by engineers in water supply department for operations, a large volume of data is never collated or reviewed to contribute in decision-making process. As per the SLB framework, some data is partially captured or not captured at all by VMSS. In many cases, UMC observed that the formats used by VMSS to capture operational details carry redundant information which could be removed to make the forms simpler and user friendly[4].

UMC team at WDS, Vadodara

The data recording practices are also non-uniform in many cases. In many cases, transfer of data does not take place and the registers are archived without being digitised or its data being used.

In addition to water supply department, the SLB framework requires data from other departments typically including accounts, information technology, slums, tax, revenue and public health laboratory.

[4] As mentioned in the Limitations of the study, redundant information from the formats has not been removed.

The following section analyses existing forms used by VMSS to record data required for generation of water supply related SLB indicators. The analysis also identifies practices adopted by VMSS to capture data, local collation/ summarisation/ totalling, data transfer, city level collation & reporting and review & decision making processes for water supply. The analysis has been conducted indicator-wise.

Indicator 1.1: Coverage of water supply connections

This indicator measures the number of households which are connected to the piped municipal water supply network against the total number of households in the city. This indicator is calculated using the following formula:

$$\text{Coverage of water supply connections} = \frac{\text{Total no. of HHs with direct water connections}}{\text{Total no. of HHs in the service area}} \times 100$$

Minimum frequency of measurement : ~~Quarterly~~ Annually[5]
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Total no. of HHs with direct water connections

EDP Department, VMSS maintains data regarding the total number of water supply connections. Ward offices of VMSS maintain a manual register of new connections provided during the year. Ward offices in the west zone have migrated to using a computer software 'Connection Management Centre' for receiving, forwarding and submitting applications for new water supply and sewerage connections. This software is linked with EDP Department and feeds the data as and when updated. However, data from ward offices in other zones is collated annually (and not quarterly as demanded by SLB framework) in accordance with the property tax billing cycle of VMSS.

Total no. of HHs in the service area

Currently, no department/ officer maintains and updates population (and households) data on a yearly basis in VMSS. Each department projects population for preparing their respective DPRs. UMC believes that Officer on Special Duty (OSD) Census or Town Planning Officer is best suited to project demographic data for the city periodically.

VMSS calculates this indicator based on data from the above 2 sources. Based on this method, the indicator falls in reliability scale 'B'. In order to achieve reliability scale 'A', periodic surveys should be done to ascertain the exact number of households within the municipal area. In addition, new building units approved and constructed should be updated periodically in the database with respective water connection information.

Recommendations

In order to achieve reliability scale A, the actual number of households with direct service connections (for which data are maintained) and the total number of households should be obtained as per a ground survey.

[5] SLB framework recommends calculating this indicator quarterly. However, based on the field experience, UMC recommends this indicator to be monitored annually.

UMC has designed a form for recording this information. The form has been presented below.

Proposed Form GE01: Households, properties and establishment details

Vadodara Mahanagar Seva Sadan

EDP Unit

Month / Year:

Filled by:

Households, properties and establishment details							
Ward No.	**Total population in service area**	**Total number of households in service area**	**Total number of properties in service area**	**Total number of households served with individual water supply connection**	**Total number of properties with sewerage connection**	**Total number of properties with septic tank/ soak-pits**	**Total number of properties with individual toilet**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
Total							

To be filled once a year by EDP Unit.

Assumptions:

The OSD Census or planning department undertakes population projection exercise and providing the information to EDP unit.

Revenue department conducts property tax re-assessment every 4 years. While filling the forms, they record properties with access to septic tanks/ soak-pits. This information should be transferred to EDP unit annually.

During the property tax reassessment, the form would include additional information about whether the HH has an individual toilet. This information would also be transferred to EDP unit annually.

Information relevant for this indicator has been highlighted in Form GE01. 'Total number of households in service area' is to be obtained from the proposed household survey. 'Total number of households served with individual water supply connection' should be taken from the property tax database[6].

UMC believes that quarterly change in the number of connections in VMSS would not be crucial to monitor. Hence, VMSS could measure this indicator annually instead of quarterly as suggested by the SLB handbook.

Indicator 1.2: Per capita supply of water

This indicator provides an overall indication of adequacy of water for every citizen in the city. This indicator measures the water supplied into the distribution system after treatment in a month and divided by the population of the city. The indicator is then divided by the number of days in the month to arrive at litres per capita per day. The formula for this indicator is expressed as:

$$\text{Per capita supply of water} = \frac{\text{(Water supplied to the distribution system in a month / Number of days in a month)}}{\text{Population served}}$$

Minimum frequency of measurement : Quarterly

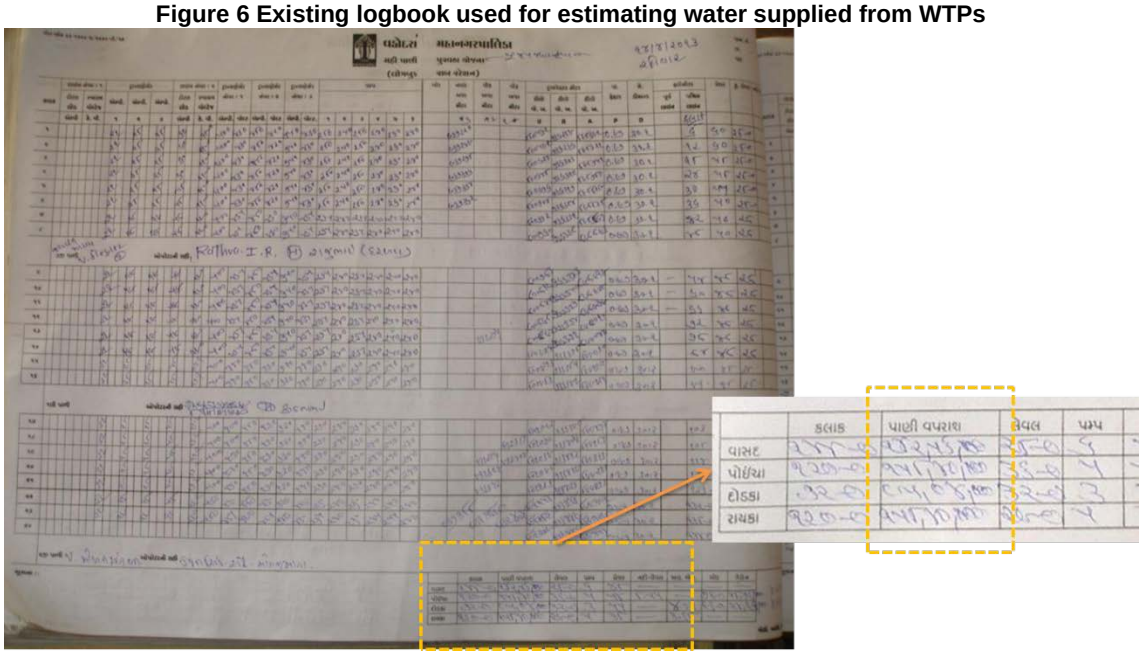
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

[6] For the purposes of this ISIP, it is assumed that 1 property houses 1 household.

Water supplied to the distribution system

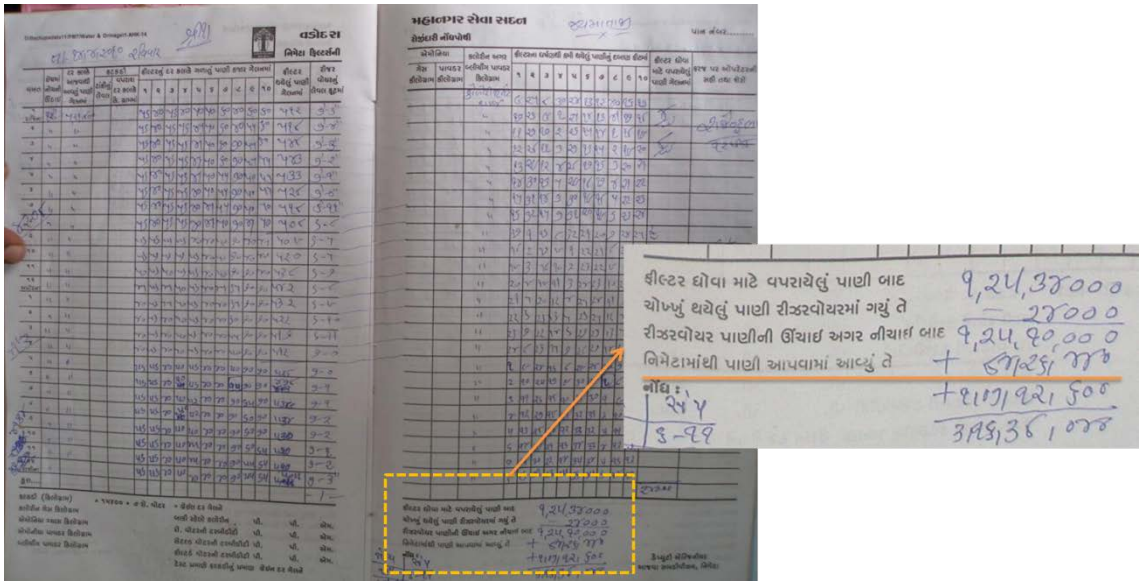
This data can be calculated by taking the sum of water produced from all ground water sources and treated water pumped out from the WTPs. In Vadodara, water produced from ground water sources – 4 French wells and 23 tubewells in River Mahi are estimated based on pumping hours and designed pump capacity. Logbooks are not maintained for capturing the water produced from the 23 borewells. The format used for recording water produced by the French wells has been provided in the figure below.

Figure 6 Existing logbook used for estimating water supplied from WTPs



Operational details of 80 borewells in the city are not recorded and hence the water produced from this source is not estimated. Water produced from surface source (Ajwa Dam) is treated at 3 WTPs at Nimeta. None of the WTPs have flow meters installed at the outlet of the plant. At 1 WTP, flow meter is installed at the inlet of the plant. During UMC's visit in June April 2013, the meter was not functional. At the remaining 2 WTPs, water quantity pumped into the distribution system is estimated based on pumping capacity and the duration of operation.

Figure 7 Existing logbook used for estimating water supplied from WTPs



Population served

Entire population of the city is assumed to be the population served. In case of Vadodara, floating population has not been considered.

Number of days in a month

Calendar days have been taken for calculation of this indicator.

Based on the above computation method, this indicator attains reliability scale of ‘D’.

Recommendations

To improve the reliability scale of this indicator to ‘A’, bulk flow meters should be installed at all bulk production points including 4 French wells, 23 tubewells in River Mahi, 80 borewells in the city and outlets of all WTPs. A total of 110 bulk flow meters would be required. In addition, estimates of floating population should be prepared periodically. In case of expansion of municipal limits, VMSS should conduct a household survey to ascertain water supply service delivery standards.

Proposed Form WS01: Meter readings at all bulk production points and outlets of WTPs

Vadodara Mahanagar Seva Sadan

Location: _____

Month / Year:

Filled by:

Date	Reading at 0000 hrs	Quantity of Water Pumped (Litre)
1		-
2		-
3		-
...		-
...		-
...		-
31		-
Total		-

Assumptions

Bulk flow meters are installed at all bulk production points and reading is taken daily.

Note: Meter readings have to be taken at the same time daily. This time can be fixed as per convenience.

Form WS01 should be maintained at all bulk production points including 80 borewells, 23 tubewells along River Mahi, 4 French wells and outlets of 3 WTPs at Nimeta. This form should be filled by the engineers/ operators at each facility and daily reporting is suggested to water supply head office.

For ascertaining the resident population, Form GE01 should be used. This form has been discussed in 'Indicator 1.1: Coverage of water supply connections'.

Estimates of floating population may be adopted from other planning documents such as the development plan, socio-economic studies or other authentic sources and projected for the current year. UMC recommends that Chief Town Planner or Town Planning Officer at VMSS should maintain this data. No forms are required to capture this information.

Indicator 1.3: Extent of metering of water connections

This indicator is dependent on the decision related to individual metering of water connections. As of 2013, VMSS had not initiated metering of individual connections. For this reason, information system improvement has not been computed in this plan. As per SLB framework, the formula for this indicator is expressed as:

$$\text{Extent of metering of water connections} = \frac{\text{(No. of metered direct service connections + No. of metered public standposts)}}{\text{(Total no. of direct service connections + Total no. of public standposts)}} \times 100$$

Minimum frequency of measurement : Quarterly
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Indicator 1.4: Extent of non-revenue water (NRW)

This indicator highlights the quantity of water produced but which does not earn any revenue to the ULB. This indicator is calculated by finding the gap in the quantity of treated water pumped in the distribution network and the quantity of water supplied to paid connections. The formula for this indicator is expressed as:

$$\text{Extent of non-revenue water} = \frac{\text{(Total water produced and put in transmission and distribution system – Total water sold)}}{\text{Total water produced and put in transmission and distribution system}} \times 100$$

Minimum frequency of measurement : Quarterly
Smallest geographical jurisdiction for measurement : ULB Level

<u>Total water produced and put in transmission and distribution system</u>

Vadodara does not have bulk flow meters installed at the bulk production points (ground water) or at outlets of WTPs to measure the quantity of water put into transmission and distribution system. This quantity is estimated based on the pump capacity and hours of operation. VMSS captures this information in the forms discussed in 'Indicator 1.2: Per capita supply of water' and has been discussed in the respective section.

<u>Total water sold</u>

The quantity of water sold is obtained by multiplying the number of water connections (from the sourced from the property tax database) and estimated water supplied through each connection (based on ferrule size calculations). However, this method does not account for physical losses of water through leakage and illegal connections.

Based on the above formula, reliability scale of this indicator in Vadodara is 'D'.

Recommendations

To improve the reliability scale of this indicator to 'A', metering of all individual connections should be undertaken. VMSS has initiated metering of domestic connections in the areas where new distribution network is being laid. However, for the majority of the city, the

decision to meter all water connections rests with VMSS. In the absence of 100 percent metering of water connections, the reliability scale 'A' cannot be achieved.

In order to achieve the next best possible reliability scale 'B', bulk flow meter should be installed at all bulk production points and outlets of all WTPs. This has already been suggested for improving reliability scale of 'Indicator 1.2: Per capita supply of water'.

To calculate the total water sold, UMC recommends a sample survey[7] at consumers' end. This survey should have a statistically valid sample size to arrive at average water flow through different ferrule sizes. The survey should also capture the duration of supply and pressure at which water is supplied[8]. For bulk consumers, UMC recommends installation of meters and the reading from these be used for measuring the total water sold.

Proposed Form WS02: Form for consumers' end survey for duration of supply, quantity of water supplied and pressure at consumers' end

Vadodara Mahanagar Seva Sadan

Location: _____

Month / Year:

Filled by:

S. No.	Ward	Connection number/ property tax number	Address of the sample	Start time (hh:mm)	Stop time (hh:mm)	Total time (hh:mm)	Quantity of water received (Litre)	Pressure (head in metre)	Remarks
1									
2									
3									
...									
...									
...									

A statistically valid sample size should be taken up by VMSS to conduct the survey. The above form should be filled by surveyors to capture the data. This sample survey should be conducted using portable electro-magnetic meters for duration of 7 continuous days at each location. Sampling methodology has been discussed further in this section and should be suitably adapted by VMSS.

Indicator 1.5: Continuity of water supply

This indicator provides information about average duration of supply to consumers at minimum prescribed pressure. This indicator is calculated by measuring the duration of supply in each water supply zone/ district metering area (DMA) subject to a pressure head of 7 metres at the consumers' end.

[7] Methodology of the sample survey has been discussed in the next section Indicator '1.5: Continuity of water supply'.

[8] A single sample survey for all indicators should be planned and designed. Although, pressure at which water is supplied is not mandatory for computing this indicator, this information would be required for improving reliability scale of 'Indicator 1.5: Continuity of water supply'.

Minimum frequency of measurement : ~~Monthly~~[9] Annually
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

At present, VMSS does not conduct any survey to measure supply duration or pressure at consumers' end. VMSS engineers/ field operators estimate this indicator based on valve operation timing and assume the pressure to be above 7 metres. SLB framework suggests calculation of this indicator on a monthly basis. However, UMC recommends calculating it yearly. The reasons for this recommendation have been explained in the subsequent box.

Based on this method, this indicator has a reliability scale of 'D'.

Recommendations

As discussed in 'Indicator 1.4: Extent of non-revenue water', a sample survey at consumers' end should be conducted to ascertain the exact duration of supply to consumers at a pressure head of more than 7 metres. The sampling methodology for VMSS has been demonstrated in the box below.

Automatic meter reading device, Navi Mumbai Municipal Corporation

[9] As per SLB framework, the indicator should be calculated monthly. In that case, 11,440 samples would be required every month. UMC recommends that for Vadodara, this indicator could be calculated yearly.

Methodology for sample survey

Sample surveys are conducted where survey of the entire population is not possible. Sample survey gives us an overall idea of the information being probed. The data collected by sample survey is projected to present the scenario for the entire population. Hence, it is imperative that the sample is selected carefully to be representative of the entire population as well as statistically valid to make meaningful conclusions.

For ISIP in Vadodara, a sample survey for consumers' end to measure a) quantity of water supplied to each consumer, b) duration of supply, and c) pressure at which water reaches the consumer. To design this survey, samples should be taken from each water zone in the city[10]. A statistically valid sample size from each water zone should be chosen. Within the sample size of each zone, it should be ensured that samples be distributed equally amongst

1. areas in proximity of ESRs
2. areas at the tail-end of the distribution network
3. intermediate areas

As per the SLB framework, each sample location should be surveyed for 7 days continuously. Based on the above principles, samples should be taken from all 31 zones (command areas of 31 WDS). Based on the population being served in each command area, sample size for each zone has been shown in the table below:

Water zone	HHs (2011)	Sample size
Airport booster	10,589	371
Ajwa	27,123	379
Akota	10,700	371
Bapod	5,234	358
Chhani Jakat	8,844	369
Chhani Village*	13,184	374
Extra*	6,302	363
Gajarawadi	12,939	374
Gayatrinagar	12,759	373
GIDC	6,576	363
Gorwa	10,724	371
Harinagar	12,145	373
Harni	14,372	375
Jail	13,025	374
Kalali	15,640	375
Kapurai*	13,076	374

Water zone	HHs (2011)	Sample size
Lalbaug	20,365	378
Manjalpur	9,746	370
Nalanda	11,607	372
North Harni*	6,257	362
Panigate	18,114	377
Sama	14,292	375
Sayajibaug	9,824	370
Sayajipura*	19,484	377
South GIDC	13,578	374
Subhanpura	12,421	373
Tandalja	12,505	373
Tarsali	11,663	372
Vehiclepool Booster	2,210	328
Wadiwadi	12,767	373
Warashia Booster	2,265	329
Total	**3,70,332**	**11,440**

A total of 11,440 sample should be tested in Vadodara for achieving 5 percent margin of error and a confidence level of 95 percent (Raosoft, Inc., 2014).

Note: As per SLB framework, the indicator should be calculated monthly. In that case, 11,440 samples would be required every month. UMC recommends that for Vadodara, this indicator could be calculated yearly.

[10] Typically, command area of each WDS is considered to be a water zone.

Based on the above sampling method, VMSS requires 242 portable meters to be installed in the field simultaneously and an equal number of pressure gauges. The same number of staff is required for noting down the readings and constantly monitoring the duration for which water is supplied at more than 7 metres pressure head.

Indicator 1.6: Quality of water supplied

This indicator measures quality of potable water as per the standards defined by the Central Public Health and Environmental Engineering Organisation (CPHEEO). The formula for this indicator is expressed as:

$$\text{Quality of water supply} = \frac{\text{No. of samples that meet the specified potable standards}}{\text{Total no. of samples taken}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Total number of samples taken

VMSS conducts residual chlorine (RC), bacteriological and physical-chemical tests at different locations in the system. There is no documented regime available with VMSS. Based on the discussions with VMSS staff, currently they conduct water quality tests as indicated in the table below:

Table 3 Water quality testing conducted monthly by VMSS during 2013-14[11]

Type of test	Source/ WTP Outlet	Intermediate	Consumer's end	Total
RC	79	-	11,142	**11,221**
Physical	13	9	-	**22**
Chemical	13	9	-	**22**
Bacteriological	24	-	-	**24**
Total	**129**	**18**	**11,142**	**11,289**

Source: Data provided by VMSS for Performance Assessment System

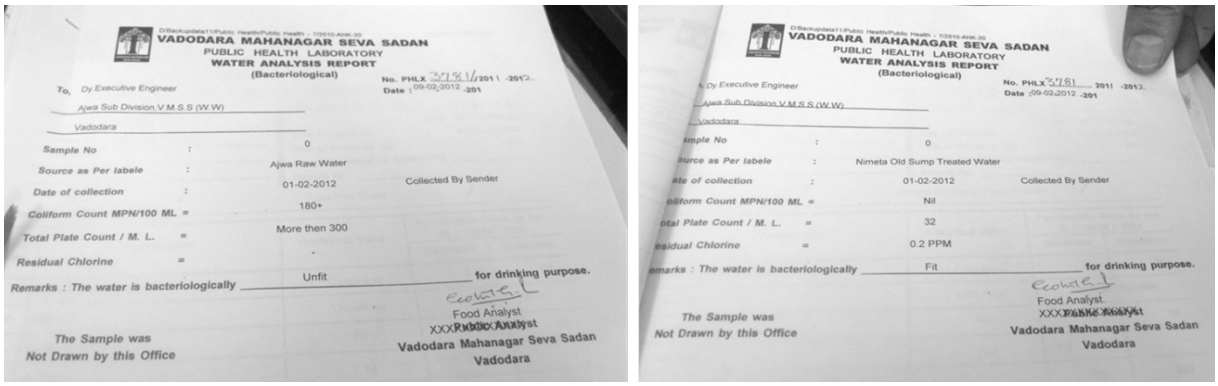
As per the above regime, number of tests carried out seems inadequate as total number of tests required for Vadodara according to CPHEEO regime is close to 2.9 lakh. A detailed break-up of CPHEEO's recommended tests by type and location have been provided subsequently in this section.

Number of samples that meet the specified potable standards

There are no forms to record findings of RC tests conducted at the consumers' end. Also, a summary of all tests conducted with their results is not prepared by VMSS.

[11] The annual number of tests have been divided equally over 12 months.

Figure 8 Water quality testing (bacteriological) report at Ajwa, surface water source (left) and WTP (right)



VADODARA MAHANAGAR SEVA SADAN
PUBLIC HEALTH LABORATORY
WATER ANALYSIS REPORT
(Bacteriological)

Sample No	:	0
Source as Per labele	:	Ajwa Raw Water
Date of collection	:	01-02-2012 Collected By Sender
Coliform Count MPN/100 ML	=	180+
Total Plate Count / M. L.	=	More then 300
Residual Chlorine	=	-

Remarks : The water is bacteriologically Unfit for drinking purpose.

The Sample was Not Drawn by this Office

Food Analyst
Vadodara Mahanagar Seva Sadan
Vadodara

VADODARA MAHANAGAR SEVA SADAN
PUBLIC HEALTH LABORATORY
WATER ANALYSIS REPORT
(Bacteriological)

Sample No	:	0
Source as Per labele	:	Nimeta Old Sump Treated Water
Date of collection	:	01-02-2012 Collected By Sender
Coliform Count MPN/100 ML	=	Nil
Total Plate Count / M. L.	=	32
Residual Chlorine	=	0.2 PPM

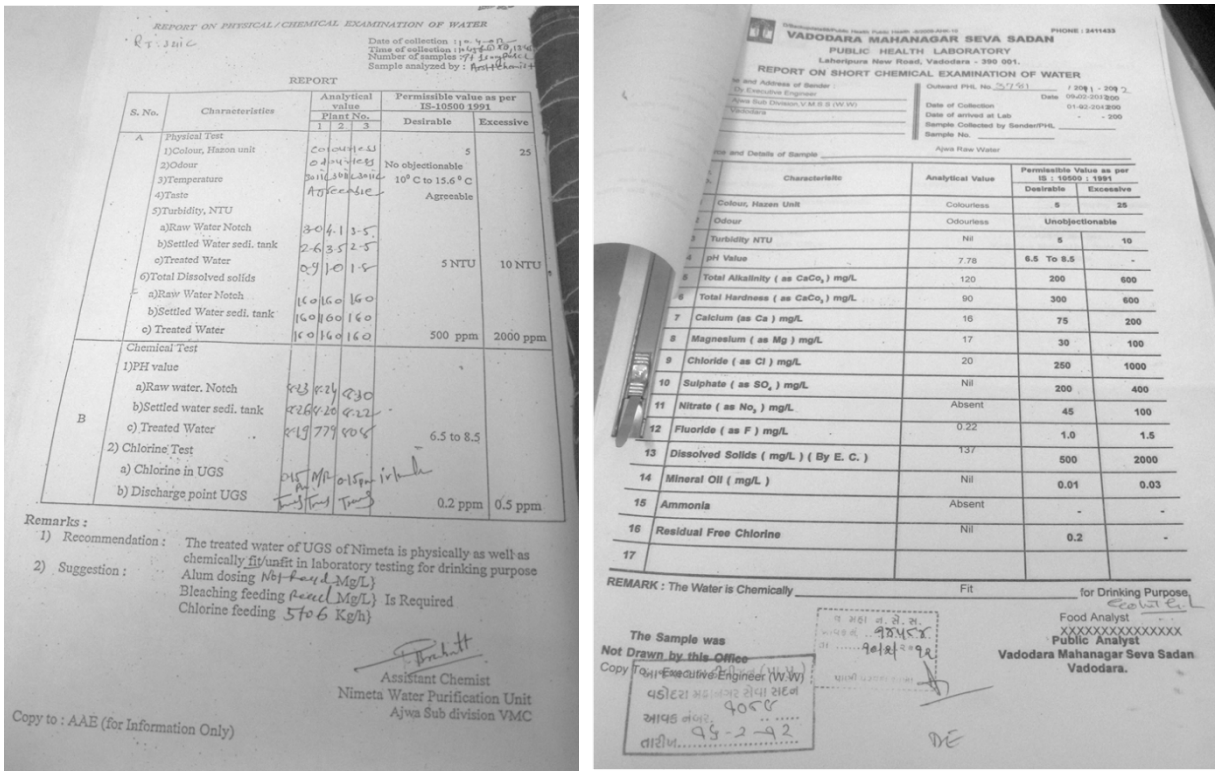
Remarks : The water is bacteriologically Fit for drinking purpose.

The Sample was Not Drawn by this Office

Food Analyst.
Vadodara Mahanagar Seva Sadan
Vadodara

Source: VMSS, 2013

Figure 9 Water quality test report for physical and chemical tests conducted by VMSS



REPORT ON PHYSICAL / CHEMICAL EXAMINATION OF WATER

REPORT

S. No.	Characteristics	Analytical value Plant No. 1	2	3	Permissible value as per IS-10500 1991 Desirable	Excessive
A	Physical Test					
	1)Colour, Hazon unit	Colourless			5	25
	2)Odour	Odourless			No objectionable	
	3)Temperature	Boiled sample			10° C to 15.6 ° C	
	4)Taste	Agreeable			Agreeable	
	5)Turbidity, NTU					
	a)Raw Water Notch	3.0	4.1	3.5		
	b)Settled Water sedi. tank	2.6	3.5	2.5		
	c)Treated Water	0.9	1.0	1.5	5 NTU	10 NTU
	6)Total Dissolved solids					
	a)Raw Water Notch	160	160	160		
	b)Settled Water sedi. tank	160	160	160		
	c) Treated Water	160	160	160	500 ppm	2000 ppm
B	Chemical Test					
	1)PH value					
	a)Raw water. Notch	8.23	8.24	8.30		
	b)Settled water sedi. tank	8.26	8.20	8.22		
	c) Treated Water	8.19	7.79	8.05	6.5 to 8.5	
	2) Chlorine Test					
	a) Chlorine in UGS	0.45 M/L		0.15 for in tank		
	b) Discharge point UGS	Trace		Trace	0.2 ppm	0.5 ppm

Remarks :
1) Recommendation : The treated water of UGS of Nimeta is physically as well as chemically fit/unfit in laboratory testing for drinking purpose
2) Suggestion : Alum dosing Not Required Mg/L} Is Required
Bleaching feeding Reqd Mg/L}
Chlorine feeding 5706 Kg/h}

Assistant Chemist
Nimeta Water Purification Unit
Ajwa Sub division VMC

Copy to : AAE (for Information Only)

VADODARA MAHANAGAR SEVA SADAN
PUBLIC HEALTH LABORATORY
Laheripura Naw Road, Vadodara - 390 001.
REPORT ON SHORT CHEMICAL EXAMINATION OF WATER

Outward PHL No. 5781 / 2011 - 2012
Date 09-02-2012
Date of Collection 01-02-2012
Date of arrived at Lab - - 2012
Sample Collected by Sender/PHL
Sample No.
Ajwa Raw Water

	Characteristic	Analytical Value	Permissible Value as per IS : 10500 : 1991 Desirable	Excessive
1	Colour, Hazen Unit	Colourless	5	25
2	Odour	Odourless	Unobjectionable	
3	Turbidity NTU	Nil	5	10
4	pH Value	7.78	6.5 To 8.5	-
5	Total Alkalinity (as $CaCo_3$) mg/L	120	200	600
6	Total Hardness (as $CaCo_3$) mg/L	90	300	600
7	Calcium (as Ca) mg/L	16	75	200
8	Magnesium (as Mg) mg/L	17	30	100
9	Chloride (as Cl) mg/L	20	250	1000
10	Sulphate (as SO_4) mg/L	Nil	200	400
11	Nitrate (as No_3) mg/L	Absent	45	100
12	Fluoride (as F) mg/L	0.22	1.0	1.5
13	Dissolved Solids (mg/L) (By E. C.)	137	500	2000
14	Mineral Oil (mg/L)	Nil	0.01	0.03
15	Ammonia	Absent	-	-
16	Residual Free Chlorine	Nil	0.2	-
17				

REMARK : The Water is Chemically Fit for Drinking Purpose.

The Sample was Not Drawn by this Office
Copy to : Executive Engineer (W.W)

Food Analyst
XXXXXXXXXXXXXXX
Public Analyst
Vadodara Mahanagar Seva Sadan
Vadodara.

Source: VMSS, 2013

VMSS conducted bacteriological tests in their own laboratory and no external audit of water quality is conducted.

Based on the above method, the reliability scale of this indicator is ‘C’

Recommendations

In order to achieve reliability scale ‘A’, VMSS needs to undertake the following:

1. Prepare a water quality testing regime as per the CPHEEO norms. UMC has prepared an MS Excel based tool to prepare a list of tests by type and location. The tool also provides a daily or a monthly list of tests to be conducted. Using this tool, the proposed number of test for the month of January has been presented below:

Table 4 Proposed list of water quality tests to be conducted by type and location (sample)

Type of test	Source/ WTP Outlet	Intermediate	Consumer's end	Total
RC	6,090	930	4,650	**11,670**
Physical	3,047	930	4,650	**8,627**
Chemical	3,047	31	0	**3,078**
Bacteriological	597	155	155	**907**
Total	**12,781**	**2,046**	**9,455**	**24,282**

2. Prepare a summary of results of all tests conducted for water quality. The proposed form for the summary has been shown below:w

Proposed WS03: Summary of water quality testing

Vadodara Mahanagar Seva Sadan

Location: _____

Month / Year:

Filled by:

Date	Total samples taken			Total Samples Passed		
	Source/ Outlet of WTP	Intermediate Point	Consumer End	Source/ Outlet of WTP	Intermediate Point	Consumer End
1						
2						
3						
4						
..						
..						
..						
31						
Total samples tested :						
Total samples passed :						

3. Get an external water quality audit conducted periodically.

Indicator 1.7: Efficiency in redressal of customer complaints

This indicator provides a measure of effective redressal of complaints related to water supply within 24 hours of being lodged. The formula for this indicator is expressed as:

$$\text{Efficiency in redressal of customer complaints} = \frac{\text{Total number of water supply related complaints redressed within the month}}{\text{Total number of water supply related complaints received per month}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Total number of water supply related complaints received per month

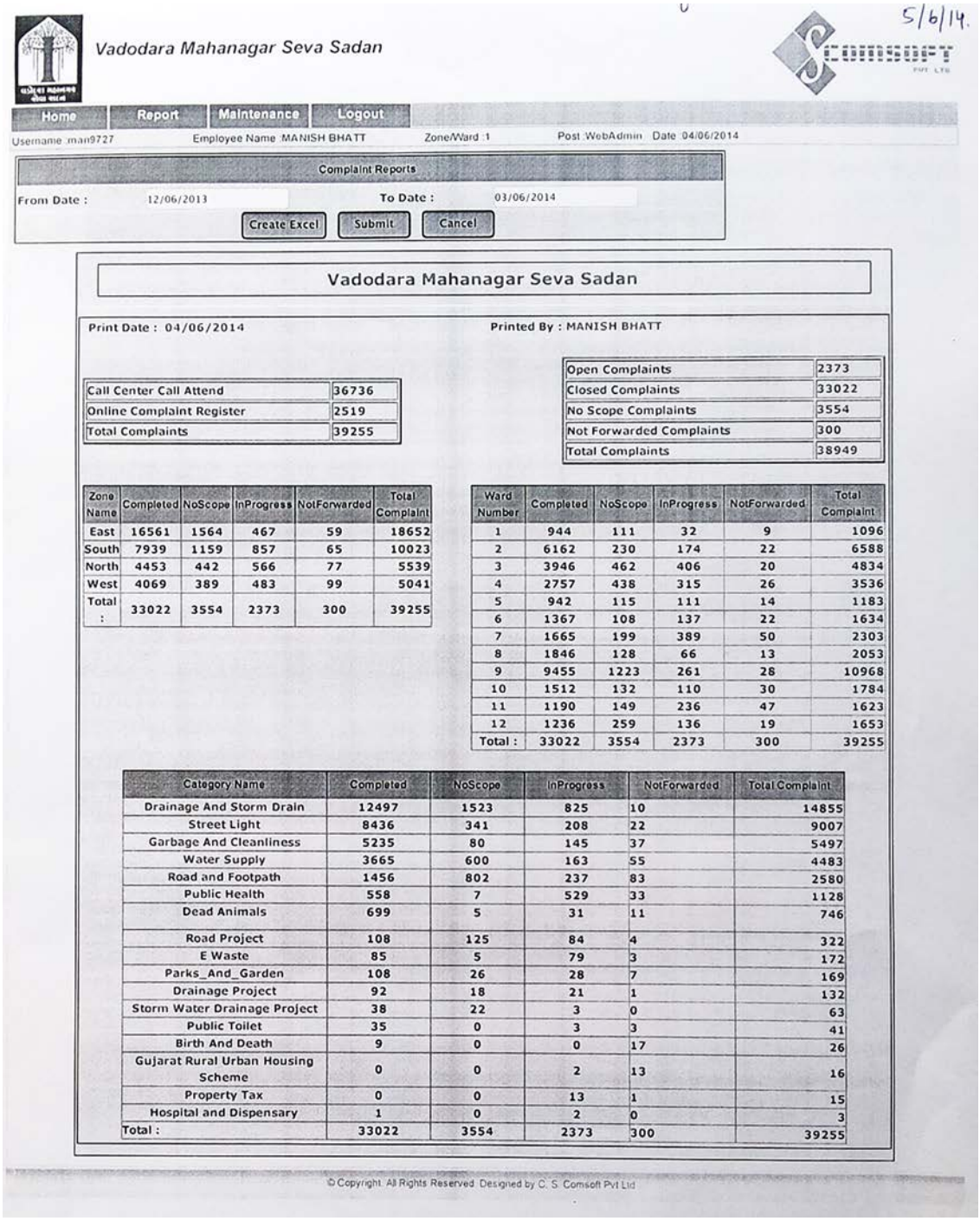
VMSS has a centralised complaints redressal system. This is an online system for registering complaints. In addition to the online system, convention hand written registers are

being maintained at ward offices and water supply related facilities such as WDS. Presently, VMSS uses the complaints from the online system only to calculate this indicator.

Total number of water supply related complaints redressed within the month

The online complaint system is used by VMSS to find out the list of complaints resolved within in the month. This excludes the status of complaints lodged in the manual registers located at ward offices and WDS. The online system generates a summary which is used by VMSS. A sample summary has been provided below:

Figure 10 Summary of all complaints received by VMSS through online complaints system



Vadodara Mahanagar Seva Sadan

5/6/14

Home | Report | Maintenance | Logout

Username :man9727 Employee Name :MANISH BHATT Zone/Ward :1 Post :WebAdmin Date :04/06/2014

Complaint Reports

From Date : 12/06/2013 To Date : 03/06/2014

Create Excel | Submit | Cancel

Vadodara Mahanagar Seva Sadan

Print Date : 04/06/2014 Printed By : MANISH BHATT

Call Center Call Attend	36736
Online Complaint Register	2519
Total Complaints	39255

Open Complaints	2373
Closed Complaints	33022
No Scope Complaints	3554
Not Forwarded Complaints	300
Total Complaints	38949

Zone Name	Completed	NoScope	InProgress	NotForwarded	Total Complaint
East	16561	1564	467	59	18652
South	7939	1159	857	65	10023
North	4453	442	566	77	5539
West	4069	389	483	99	5041
Total :	33022	3554	2373	300	39255

Ward Number	Completed	NoScope	InProgress	NotForwarded	Total Complaint
1	944	111	32	9	1096
2	6162	230	174	22	6588
3	3946	462	406	20	4834
4	2757	438	315	26	3536
5	942	115	111	14	1183
6	1367	108	137	22	1634
7	1665	199	389	50	2303
8	1846	128	66	13	2053
9	9455	1223	261	28	10968
10	1512	132	110	30	1784
11	1190	149	236	47	1623
12	1236	259	136	19	1653
Total :	33022	3554	2373	300	39255

Category Name	Completed	NoScope	InProgress	NotForwarded	Total Complaint
Drainage And Storm Drain	12497	1523	825	10	14855
Street Light	8436	341	208	22	9007
Garbage And Cleanliness	5235	80	145	37	5497
Water Supply	3665	600	163	55	4483
Road and Footpath	1456	802	237	83	2580
Public Health	558	7	529	33	1128
Dead Animals	699	5	31	11	746
Road Project	108	125	84	4	322
E Waste	85	5	79	3	172
Parks_And_Garden	108	26	28	7	169
Drainage Project	92	18	21	1	132
Storm Water Drainage Project	38	22	3	0	63
Public Toilet	35	0	3	3	41
Birth And Death	9	0	0	17	26
Gujarat Rural Urban Housing Scheme	0	0	2	13	16
Property Tax	0	0	13	1	15
Hospital and Dispensary	1	0	2	0	3
Total :	33022	3554	2373	300	39255

Source: VMSS, 2014

Based on the above calculation method, the reliability scale of this indicator is 'B' with the only gap of collation of manual and online complaints systems.

Recommendations

In order to achieve reliability scale 'A', VMSS should install a computer with access to online complaints system at the complaints desks at ward offices. All complaints should be registered on the online system by the computer operator. Any request to lodge a complaint at the WDS should be diverted to the nearest ward office.

Alternatively, VMSS can digitise manual registers located at ward offices and at WDS every month. Once the data is digitised and added to the online system, VMSS should seek endorsement of complaints redressed from the complainants.

In either case, a form to record this information is required. UMC proposes the following form to be used for the same:

Proposed GE02: Summary of complaints

Vadodara Mahanagar Seva Sadan

Location: _____

Month / Year:

Filled by:

Date	Total complaints received	Total complaints resolved within 24 hours
1		
2		
3		
...		
...		
31		
Total		

Indicator 1.8: Cost recovery in water supply services

This indicator provides the financial operating health of the water supply department. This indicator is calculated as a ratio of revenue earned from water supply and expenses made for providing the service to citizens, excluding capital expenditure. The formula for this indicator is expressed as:

$$\text{Cost recovery in water supply services} = \frac{\text{Total annual operating revenues}}{\text{Total annual operating expenses}} \times 100$$

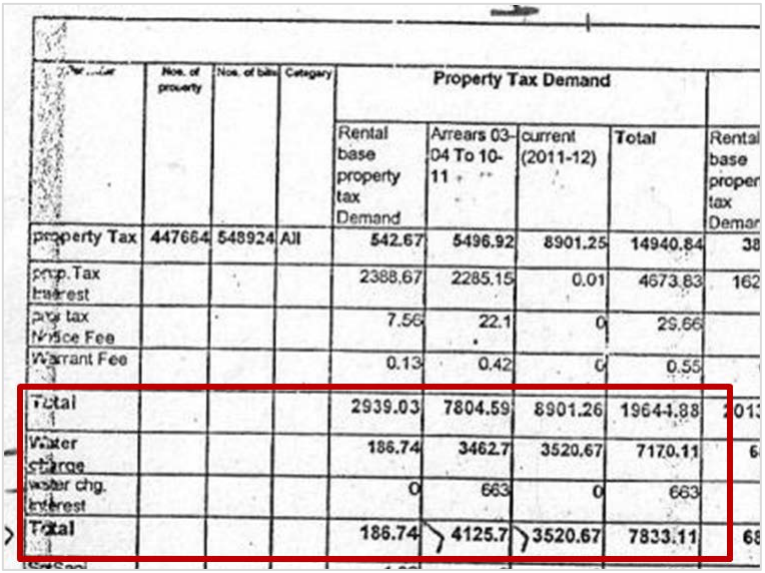
Minimum frequency of measurement : ~~Quarterly~~ Annually
Smallest geographical jurisdiction for measurement : ULB Level

Total annual operating revenues

VMSS issues annual property tax bill to its citizens. This property tax bill includes water supply related taxes and charges (see figure below). VMSS generates an annual demand-collection-balance (DCB) statement for property tax clearly identifying the revenue demand raised for water supply. The SLB framework suggests calculating this indicator on a quarterly

basis. However, UMC feels that this indicator should be calculated annually as the DCB statement and expenses are summarised at the end of the financial year.

Figure 11 Snapshot of the annual DCB statement, VMSS 2011-12



	Nos. of property	Nos. of bills	Category	Property Tax Demand				
				Rental base property tax Demand	Arrears 03-04 To 10-11	current (2011-12)	Total	Rental base proper tax Demar
property Tax	447664	548924	All	542.67	5496.92	8901.25	14940.84	38
prop.Tax Interest				2388.67	2285.15	0.01	4673.83	162
pro tax Notice Fee				7.56	22.1	0	29.66	
Warrant Fee				0.13	0.42	0	0.55	
Total				2939.03	7804.59	8901.26	19644.88	201
Water charge				186.74	3462.7	3520.67	7170.11	6
water chg. Interest				0	663	0	663	
Total				186.74	4125.7	3520.67	7833.11	68

Source: VMSS, 2013

Total annual operating expenses

The total annual operating expenses include all expenses related to repair and maintenance of equipment, energy costs, staff salaries, consumables and transportation costs related to water supply. All these expenses are recorded in the annual summation of budgets. The actual operating expenses are for this indicator is calculated by identifying operational costs from the budget heads of VMSS. A total of 43 budget items[12] (codes) are summed to arrive at this figure. However, there is lateral movement within VMSS' staff while their salaries are drawn from the original departments. This creates some inconsistency in calculating actual operational expenses.

Although, basic principles of double-entry accounting system are followed, accrual based accounting is not followed completely.

Based on the above method, this indicator receives reliability scale 'B'.

Recommendations

To improve the reliability scale of this indicator to 'A', complete accrual based double-entry accounting system should be practiced by VMSS. In addition, in case of lateral movement of staff from one department to another, the salary of the staff should be drawn from the department where he/ she has been shifted. In case of sharing of resources, the salary of the staff should be split between the departments based on the time spent in each department respectively.

[12] The budget items (codes) used for calculating operational expenses in water supply have been provided in Annexure 3.

Indicator 1.9: Efficiency in collection of water supply-related charges

This indicator provides the efficiency of the ULB in collecting water supply related charges from the citizen. This indicator is calculated as a ratio of demand raised (or billed) for water supply related taxes and charges and actual collection done by the ULB. The formula for this indicator is expressed as:

$$\text{Efficiency in collection of water-related charges} = \frac{\text{Current revenues collected in the given year}}{\text{Total operating revenues billed during the given year}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Total operating revenues billed during the given year

This information is generated by VMSS in the annual DCB statement. VMSS uses the DCB statement to calculate this indicator.

Current revenues collect in the given year

VMSS uses this information from the annual DCB statement.

Based on this method, the reliability scale of this indicator is ‘A’ and hence, no improvements are suggested.

5. Sewerage

5.1. Existing sewerage system in Vadodara

A stage wise break-up of the existing sewerage system in Vadodara has been shown in the following sections.

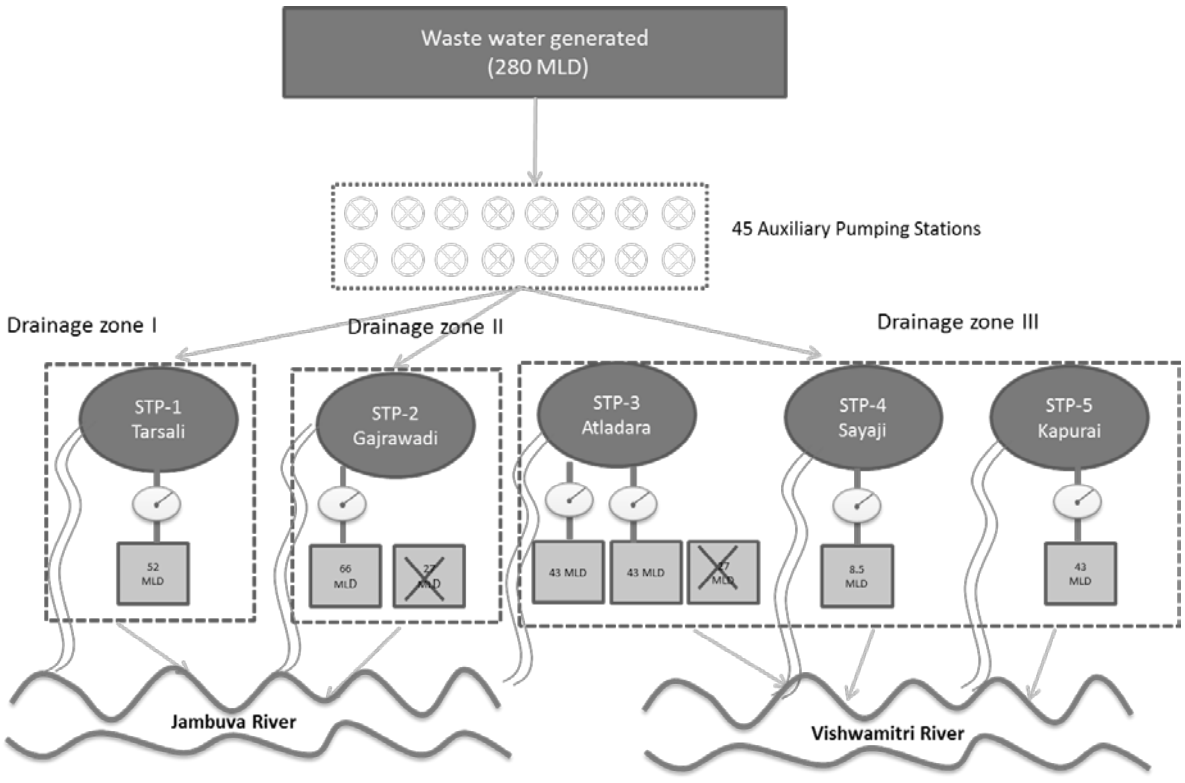
Sewage generation

Vadodara Mahanagar Seva Sadan (VMSS) has a population of 17,12,699 as per the Census 2011. As of 2011-12, VMSS has 5.49 lakh properties in its jurisdiction out of which 4.72 lakh properties have on-premises toilets. Another 1287 households are dependent on functional community toilets (PAS, 2013). Around 4.65 lakh properties are connected to the municipal sewerage system while around 7000 properties are dependent on on-site sanitary disposal systems. Based on the water supplied to the citizens, 80 percent of it is assumed to be the sewerage generated. Based on this calculation, around 290 MLD[13] of sewerage is generated in Vadodara.

Sewage collection and treatment

Against an estimated generation of 290 MLD, VMSS collected 278 MLD through its sewerage network of about 1170 km. This network covers around 145 sqkm of the city's area out of a total of 159 sqkm. The sewerage network is divided in 3 zones and the sewage collected is treated at 5 sewage treatment plants (STP). VMSS has installed 45 auxiliary pumping stations (APS) along the sewerage network for pumping of sewage.

Figure 12 Sewage network diagram, VMSS (2011-12)



Source: Urban Management Centre, 2013

[13] This figure includes sewage generated from ULB as well as non-ULB sources.

The table below provides a zone-wise list of treatment plants and their respective treatment capacity.

Table 5 Details of sewage treatment plants in Vadodara

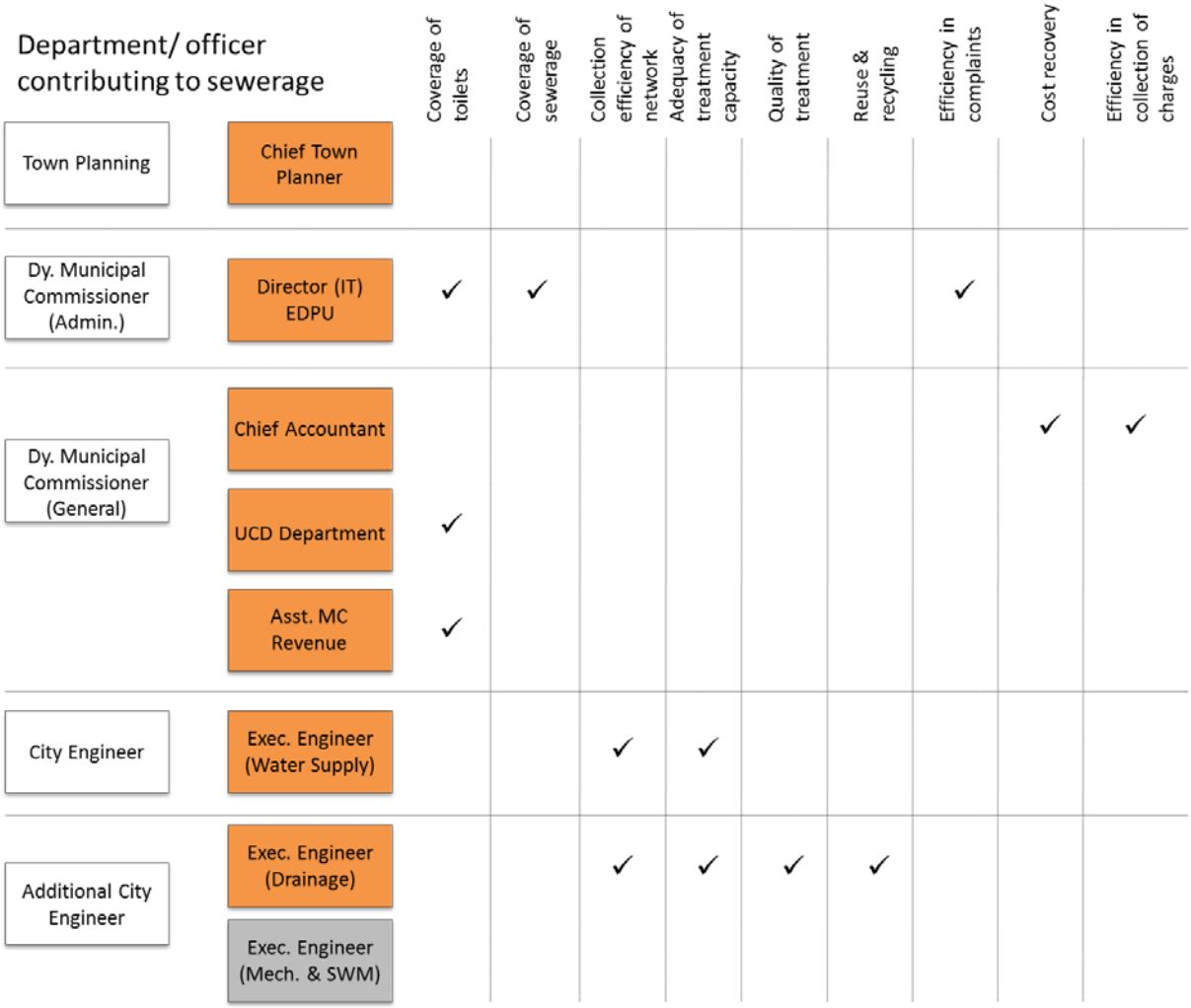
Zone	Details of STP
Drainage Zone I	STP at Tarsali (52 MLD)
Drainage Zone II	STP at Gajarawadi Unit 1 (66 MLD) Unit 2 (27 MLD) (non-functional)
Drainage Zone IIII	STP at Atladara Unit 1 (43 MLD) Unit 2 (43 MLD) Unit 3 (27 MLD) (non-functional) STP at Sayaji Baug Unit 1 (8.5 MLD) STP at Kapurai Unit 1 (43 MLD)

Source: (PAS, 2013)

The treated sewage is disposed in either River Vishwamitri or in River Jambuva. All STPs have a bypass to divert sewage from the treatment plant which is also disposed in the respective outlets in these two rivers.

5.2. Existing information system in sewerage

This section presents an analysis of existing information system in sewerage in VMSS. To analyse data generation, UMC conducted field visits at various installations related to sewerage including some auxiliary pumping stations (APS) and selected sewage treatment plants. In addition, UMC conducted discussion with all levels of staff working in operation and maintenance of sewerage. An overview of the data provided by each department for generating sewerage indicators has been provided in the figure below.



During the visits, the team collected data recording formats (maintained as logbooks) at all facilities. Based on the data collected during 2012-13 for PAS program, the sewerage SLB indicators for VMSS were as below:

Table 6 Performance indicators of VMSS in sewerage as per the SLB framework

S. No	Sewerage indicator values	Unit	FY 2012-13
1	Coverage of Toilets	%	86
2	Coverage of wastewater network services	%	87
3	Collection efficiency of wastewater networks	%	97
4	Adequacy of wastewater treatment capacity	%	107
5	Extent of reuse and recycling of treated wastewater	%	2
6	Quality of wastewater treatment	%	91
7	Efficiency in redressal of customer complaints	%	98
8	Extent of cost recovery in wastewater management	%	109
9	Efficiency in collection of sewerage charges	%	89

Source: (PAS, 2013)

To conduct assessment of data collation or summarisation and its report to higher officials, UMC tracked the flow of information from various facilities to VMSS head office. The analysis conducted for existing information system has been presented using the following:

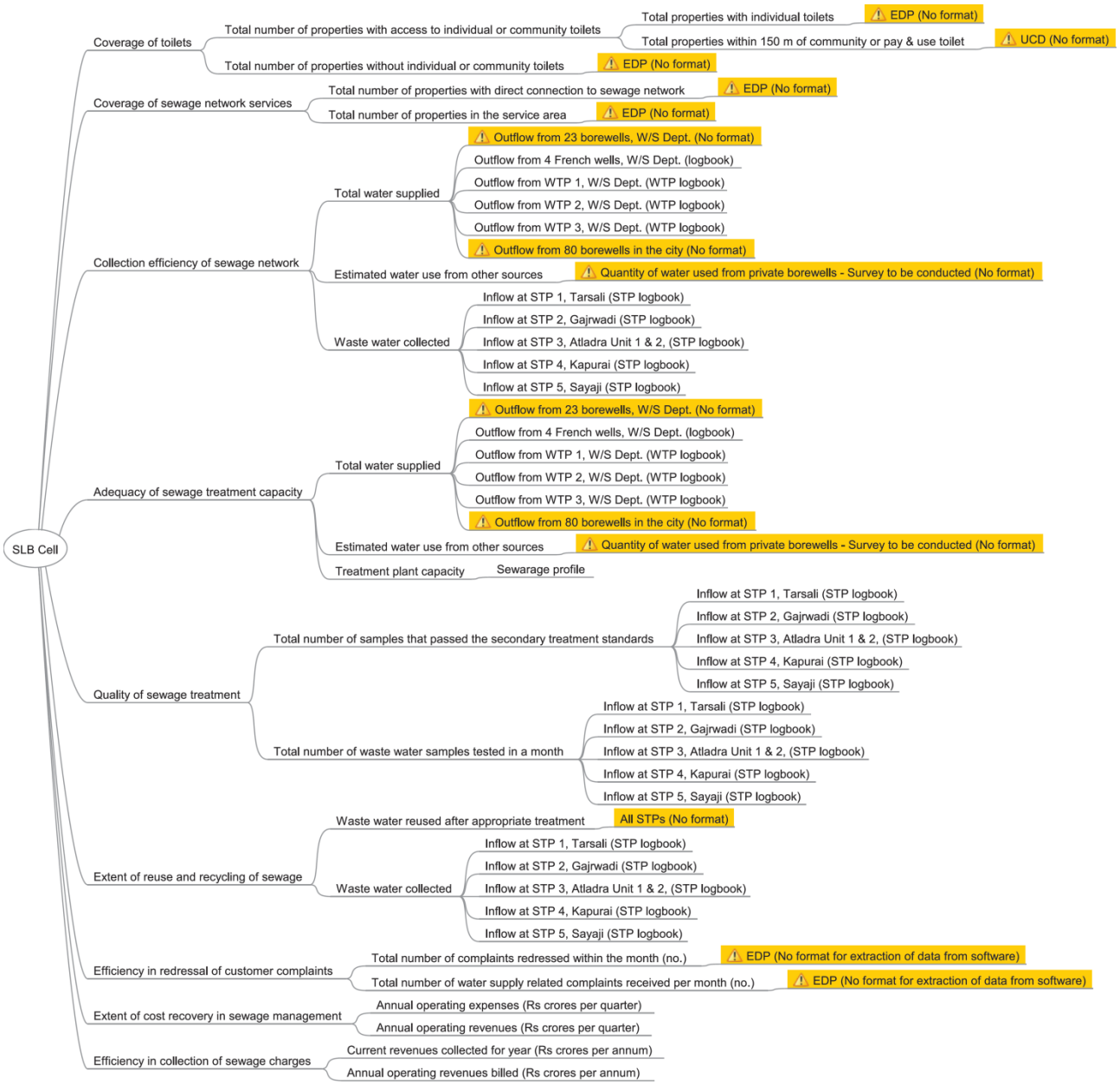
- Sewerage flow diagram
- Information flow diagram from various facilities related to sewerage
- Gap analysis in existing information system clearly identifying data not generated/ recorded and recommendations to capture such data
- Gap analysis in existing data recording formats and recommendations to fulfil them as per SLB framework

While providing recommendations, UMC's approach has been to make minimal modifications in the existing formats. Recommendations provided by UMC to fill data gaps include

e) new formats
f) minor modifications to existing formats
g) computerisation of data and defining its flow (both from bottom to top and vice-versa)
h) outlining equipment and manpower requirements for filling in the data gaps and improving reliability bands

A detailed assessment of the information system reveals that information should be collected from several field locations and administrative offices within VMSS as shown below.

Figure 13 Information flow diagram for calculating sewerage related performance indicators as per SLB framework



Source: Urban Management Centre, 2013

In the above diagram, the data sets highlighted are the ones which are not recorded by VMSS. Some data from the highlighted sets requires additional infrastructure, studies or surveys to be generated.

Summary of recommendations for improvement of sewerage information system

For the purposes of ISIP, new formats have been proposed in the subsequent sections for data sets which are generated by not recorded. This ISIP also proposes format required to capture information through proposed surveys, studies and recording using the proposed infrastructure.

Process improvements, studies and surveys proposed

The following process improvements, studies and surveys have been recommended:

General (departments other than sewerage)

1. Modify the property tax re-assessment form to include information regarding access to individual toilet in each property. The details of this recommendation have been discussed in 'Indicator 2.1: Coverage of toilets'.
2. VMSS' Revenue Department uses hand-drawn maps of the city as a part of the property tax database. UMC recommends that these maps be digitised with property tax information linked as attributes. In addition, locations of all public toilets should also be mapped to ascertain its access by households without individual toilets. This recommendation has been discussed in 'Indicator 2.1: Coverage of toilets'.
3. Digitise complaints logbooks – same as water supply section.
4. Accrual based double-entry accounting – same as water supply section.
5. Sharing of staff, machinery & equipment and consumables – same as water supply section.

Sewerage Department

6. Conduct a survey of private borewells in the city to assess quantity of water produced by these and hence, quantity of sewerage generated.
7. Sewage quality testing regime should be calculated based on CPHEEO norms.
8. Work in close coordination with the Water Supply Department to ascertain the exact quantity of sewage generated based on the water supplied to the city.

Infrastructure proposed

In addition to the above forms, the following infrastructural improvements have been recommended:

1. Installation of a total of 24 bulk flow meters at 8 STP units – 2 meters at the inlet chamber (to measure total inflow and bypass) and 1 at the outlet of treated water for each STP unit.

New forms proposed/ existing forms modified

S. No.	Proposed/ Modified	Form No.	Title of the form
1.	Proposed	Form GE01	Households, properties and establishment details
2.	Proposed	Form GE02	Complaints received and redressed
3.	Modified	Form SE01R	Bulk flow measurement of sewage inflow, sewage bypassed and treated water produced by STP
4.	Proposed	Form SE02	Quantity of water produced by borewells
5.	Proposed	Form SE03	Number of households without individual toilet and not within walking distance (150 metres) of a public toilet

Indicator-wise details including gaps and recommendations have been discussed in the following section.

5.3. Data generation, recording and transfer practices in VMSS – gaps and recommendations

VMSS captures data from various facilities through logbooks. Data is generated at all STPs and reported to the central office of the sewerage department (housed in main VMSS building at Khanderao Market). The data collated includes daily quantity of sewage received at the STPs from the collection network. Operation and maintenance of sewerage system is managed by Executive Engineer of VMSS.

For calculating some SLB indicators, the Sewerage Department borrows data from other departments including water supply, tax, revenue and EDP unit. Some of this data is used by engineers in sewerage department for managing operations of their utilities, a large volume of data is never collated or reviewed to contribute in decision-making process.

As per the SLB framework, some data is partially captured or not captured at all by VMSS.

The following section analyses existing forms used by VMSS to record data required for generation of sewerage related SLB indicators. The analysis also identifies practices adopted by VMSS to capture data, local collation/ summarisation/ totalling, data transfer, city level collation & reporting and review & decision making processes for sewerage. The analysis has been conducted indicator-wise.

Indicator 2.1: Coverage of toilets

This indicator measures the number of households which have access to toilets including on-premises toilet and functional community toilets. This indicator is calculated using the following formula:

$$\text{Coverage of toilets} = \frac{\text{Total no. of properties with access to individual or community toilets within walking distance}}{\text{Total no. of properties within service area}^{14}} \times 100$$

Minimum frequency of measurement : Quarterly
Smallest geographical jurisdiction for measurement : Ward Level

Total no. of properties with access to individual or community toilets within walking distance
VMSS has not conducted any survey to ascertain this information and hence, does not have this information. VMSS calculates this number based on an estimate by field officials from sewerage and slum departments.

Total no. of properties within service area
This information is borrowed by the sewerage department from the tax department for calculating this indicator.

[14] The SLB handbook provided the formula as [a/(a+b)] x 100; where
a = Total no. of properties with access to individual or community toilets within walking distance
b = Total no. of properties without access to individual or community toilets within walking distance
For ease of calculation, 'b' has been replaced to Total no. of properties within service area'.

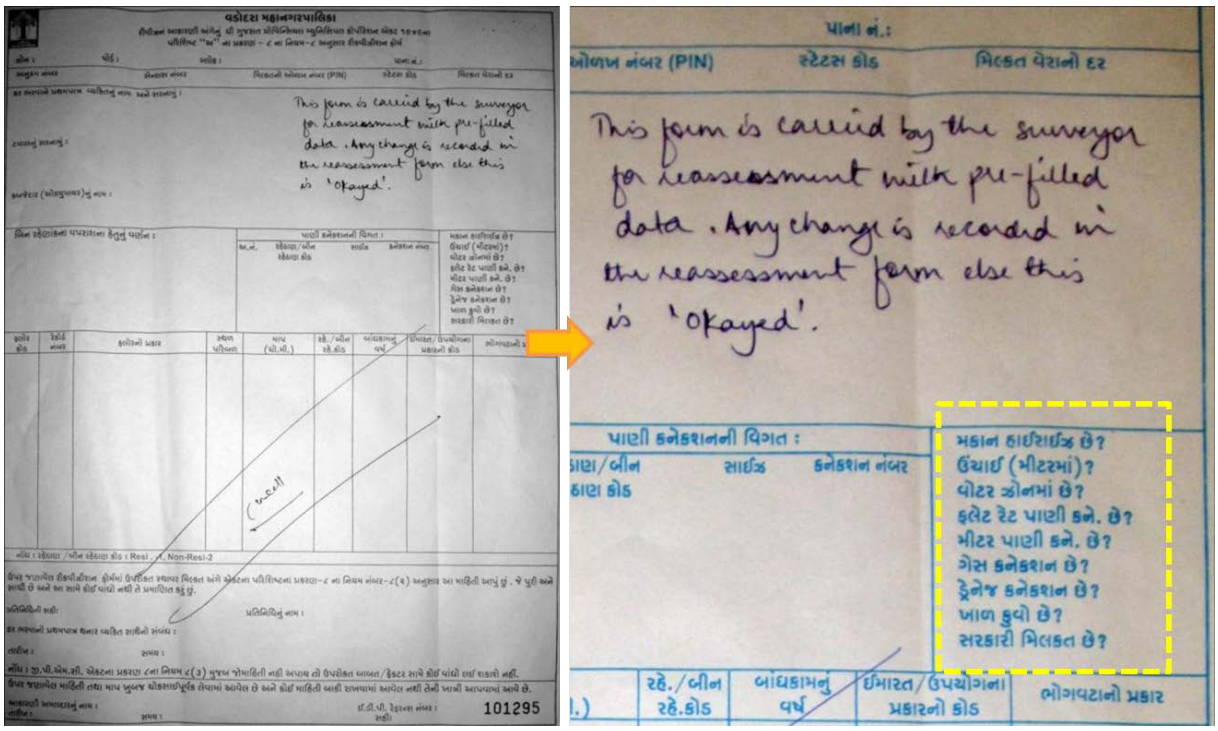
Based on the above calculation method, this indicator attains a reliability of ‘C’

Recommendations

In order to improve the reliability scale to ‘A’, exact number of properties with access to individual toilet or a community toilet within walking distance should be ascertained by a field survey. Further this data should be updated based on the building plan approval for new properties being developed there after. VMSS conducts property tax assessment survey throughout the city in a 4 year cycle.

UMC has recommended that a one-time survey of the city be conducted to ascertain this information. For VMSS to update this information regularly thereafter, UMC recommended during the course of the study, that a question regarding individual toilet on the property being assessed be added to the current property tax re-assessment survey form. VMSS accepted the suggestion and incorporated the question.

Figure 14 Existing property tax re-assessment form and suggested modification



Source: Urban Management Centre, 2013

Once the survey is complete, this information is digitised and the property tax database could be used to find the number of properties without on-premises toilets. In order to extract a summary from the property tax database, Form GE01 (discussed in Indicator 1.1: Coverage of water supply) can be used.

UMC also recommends mapping of all community toilets on GIS and ascertain its access to properties without toilets. Based on this recommendation, exact number of properties without access to toilets can be calculated. Form SE03 can be used for documenting this information.

Proposed Form SE03: Number of households without individual toilet and not within walking distance (150 metres) of a public toilet

Vadodara Mahanagar Seva Sadan

Ward name/ no. : _____

Month / Year:

Filled by:

Ward No.	Number of HHs without individual toilet and not within walking distance (150 metre) of a public toilet
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
Total	

Indicator 2.2: Coverage of sewage network services

This indicator presents a ratio of the number of properties connected to the sewerage network and total number of properties in the service area. This indicator is calculated using the following formula:

$$\text{Coverage of sewage network services} = \frac{\text{Total no. of properties with direct connection to sewage network}}{\text{Total no. of properties in the service area}} \times 100$$

Minimum frequency of measurement : Quarterly
Smallest geographical jurisdiction for measurement : Ward Level

Total number of properties with direct connection to sewage network

The property tax database of VMSS maintains a ward-wise list of properties which are connected to the sewerage network. This information is used by VMSS to calculate this indicator.

Total number of properties in the service area

This ward-wise information is available with VMSS' property tax department and is used for calculating this indicator.

Based on the above method of calculation, this indicator gets a reliability scale of 'A'.

Recommendations

Although no intervention is required to improve the reliability scale of this indicator, adoption of 'Form GE01' would make the process of computation easier for VMSS.

Indicator 2.3: Collection efficiency of the sewage network

This indicator presents a ratio of the sewage collected by the sewerage network and the total sewage generation in the city. This indicator is calculated using the following formula:

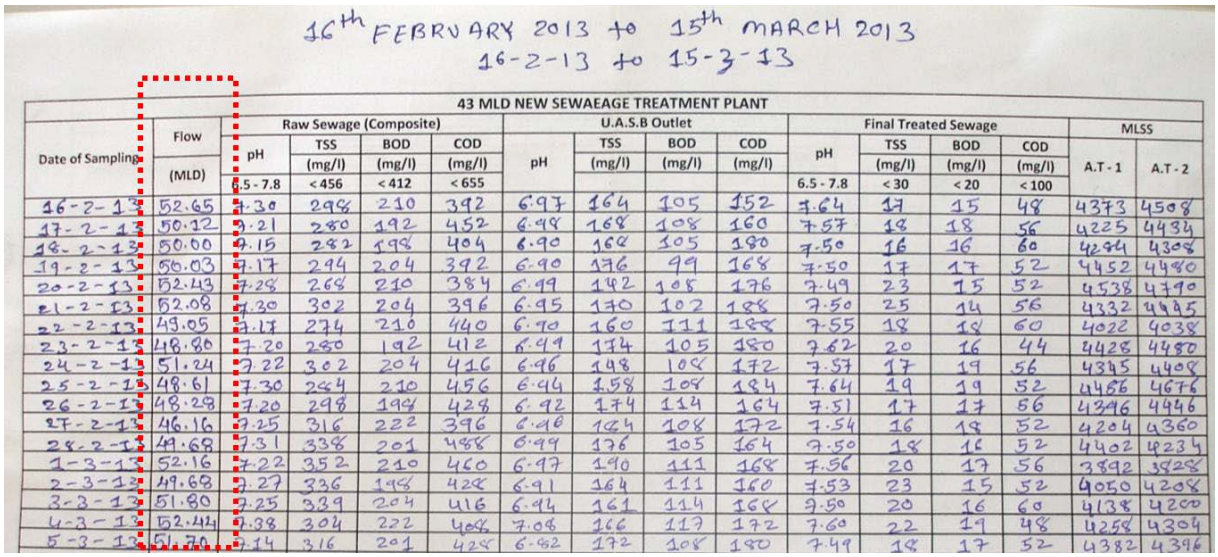
$$\text{Collection efficiency of sewage network} = \frac{\text{Waste water collected}}{\text{(Total water supplied + water used from other sources) X 0.8}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Waste water collected

This information is currently measured in Vadodara based on the flow meters at inlets at a few STP units. On the rest of the STP units, it is estimated based on pumping capacity and hours of operation. The form used for capturing the inflow at STP at Atladara using flow meter has been shown below:

Figure 15 Format used for recording inflow of sewage at STP, Atladara



16th FEBRUARY 2013 to 15th MARCH 2013
16-2-13 to 15-3-13

43 MLD NEW SEWAEAGE TREATMENT PLANT

Date of Sampling	Flow (MLD)	Raw Sewage (Composite) pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	U.A.S.B Outlet pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	Final Treated Sewage pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	MLSS A.T - 1	A.T - 2
		6.5 - 7.8	< 456	< 412	< 655					6.5 - 7.8	< 30	< 20	< 100		
16-2-13	52.65	7.30	298	210	392	6.97	164	105	152	7.64	17	15	48	4373	4508
17-2-13	50.12	7.21	280	192	452	6.98	168	108	160	7.57	18	18	56	4225	4434
18-2-13	50.00	7.15	282	198	404	6.90	162	105	180	7.50	16	16	60	4244	4308
19-2-13	50.03	7.17	294	204	392	6.90	176	99	168	7.50	17	17	52	4452	4480
20-2-13	52.43	7.28	268	210	384	6.99	142	108	176	7.49	23	15	52	4538	4790
21-2-13	52.08	7.30	302	204	396	6.95	170	102	188	7.50	25	14	56	4332	4445
22-2-13	49.05	7.17	274	210	440	6.90	160	111	188	7.55	18	18	60	4022	4038
23-2-13	48.80	7.20	280	192	412	6.99	174	105	180	7.62	20	16	44	4428	4480
24-2-13	51.24	7.22	302	204	416	6.96	148	108	172	7.57	17	19	56	4345	4408
25-2-13	48.61	7.30	264	210	456	6.94	158	108	184	7.64	19	19	52	4456	4676
26-2-13	48.28	7.20	298	198	428	6.92	174	114	164	7.51	17	17	56	4396	4446
27-2-13	46.16	7.25	316	222	396	6.96	164	108	172	7.54	16	18	52	4204	4360
28-2-13	49.68	7.31	338	201	488	6.99	176	105	164	7.50	18	16	52	4402	4234
1-3-13	52.16	7.22	352	210	460	6.97	190	111	168	7.56	20	17	56	3892	3828
2-3-13	49.68	7.27	336	198	428	6.91	164	111	160	7.53	23	15	52	4050	4208
3-3-13	51.80	7.25	339	204	416	6.94	161	114	168	7.50	20	16	60	4138	4200
4-3-13	52.44	7.38	304	222	404	7.04	166	117	172	7.60	22	19	48	4258	4304
5-3-13	51.70	7.14	316	201	424	6.82	172	108	180	7.49	18	17	52	4382	4396

Source: VMSS, 2013

Total water supplied and water used from other sources

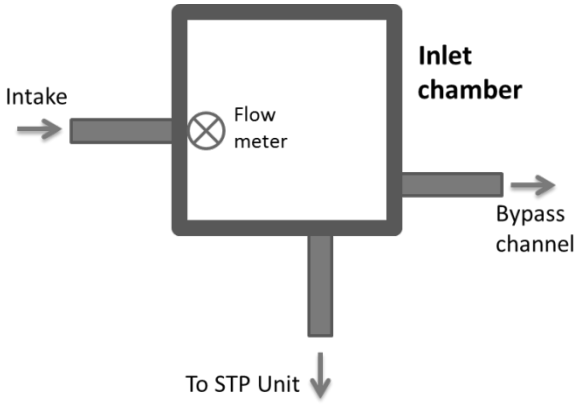
VMSS takes this information from the water supply department. VMSS has not conducted any survey to estimate the quantity of water used from private sources including borewells. Hence, VMSS currently does not have an estimate of the quantity of water from other sources. As a rule of thumb, it is assumed that 80 percent of the water supplied gets converted into waste water.

Based on the above method of calculation in Vadodara and as per the SLB framework, this indicator falls in the reliability scale ‘D’.

Recommendations

VMSS has installed flow meter at inlet chambers of some STP units. The inlet chamber contains a bypass channel for diverting excessive sewage of in case of break-down or repairs of the unit. The quantity of sewage bypassed using this channel is not recorded.

Figure 16 Location flow meter installed at STP inlet chambers in Atladara, Vadodara



UMC recommends that an additional flow meter be placed to measure the actual quantity of sewage sent to the STP for treatment. To record the quantity of sewage bypassed and outflow of treated sewage, VMSS should use the proposed Form 6 provided below.

Modified Form SE01R: Monthly report for quantity and quality of sewage treatment

Vadodara Mahanagar Seva Sadan

Name of the STP and Unit No.: _____

Month / Year:

Filled by:

Date	Inflow (MLD)	Untreated bypass (MLD)	Outflow of treated sewage (MLD)	Raw Sewage (Composite)				U.A.S.B Outlet				Final effluent				MLSS		Pass/ Fail
				pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	A.T.1	A.T.2	
1																		
2																		
3																		
...																		
...																		
31																		
Total																		

Note: This proposed form is a modification on the existing form being used by VMSS.

In addition, UMC recommends that a survey of private borewells be conducted to assess the quantity of water produced by such sources. A form to capture this information has been provided below.

Proposed Form 14: for conducting survey of private borewells

Vadodara Mahanagar Seva Sadan

Ward name/ no. : _____

Month / Year:

Filled by:

S. No.	Property tax number of the property	Number of borewells	Estimated water produced from borewells
1			
2			
3			
..			
..			
..			
n			
Total			

Indicator 2.4: Adequacy of sewage treatment capacity

This indicator presents a ratio of the sewage generated by the city and the designed capacity of all STPs in the city. This indicator is calculated using the following formula:

$$\text{Adequacy of sewage treatment capacity} = \frac{\text{Treatment plant capacity}}{\text{(Total water supplied + water used from other sources) X 0.8}} \text{ X 100}$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : ULB Level

Treatment plant capacity

This information is compiled by summing up the designed capacity all STPs in the city and used for calculating the indicator.

Total water supplied and water used from other sources

Same as calculated in the previous indicator.

Based on the above calculation method, the reliability scale for this indicator is 'D'.

Recommendations

Reliability scale of this indicator is dependent on the reliability scale of 'Indicator 1.4: Extent of non-revenue water (NRW)'. Once reliability scale of Indicator 1.4 is improved, it would automatically improve the reliability of this indicator.

Indicator 2.5: Quality of sewage treatment

This indicator measures quality of treated sewage as per the standards defined by CPHEEO. This indicator is calculated using the following formula:

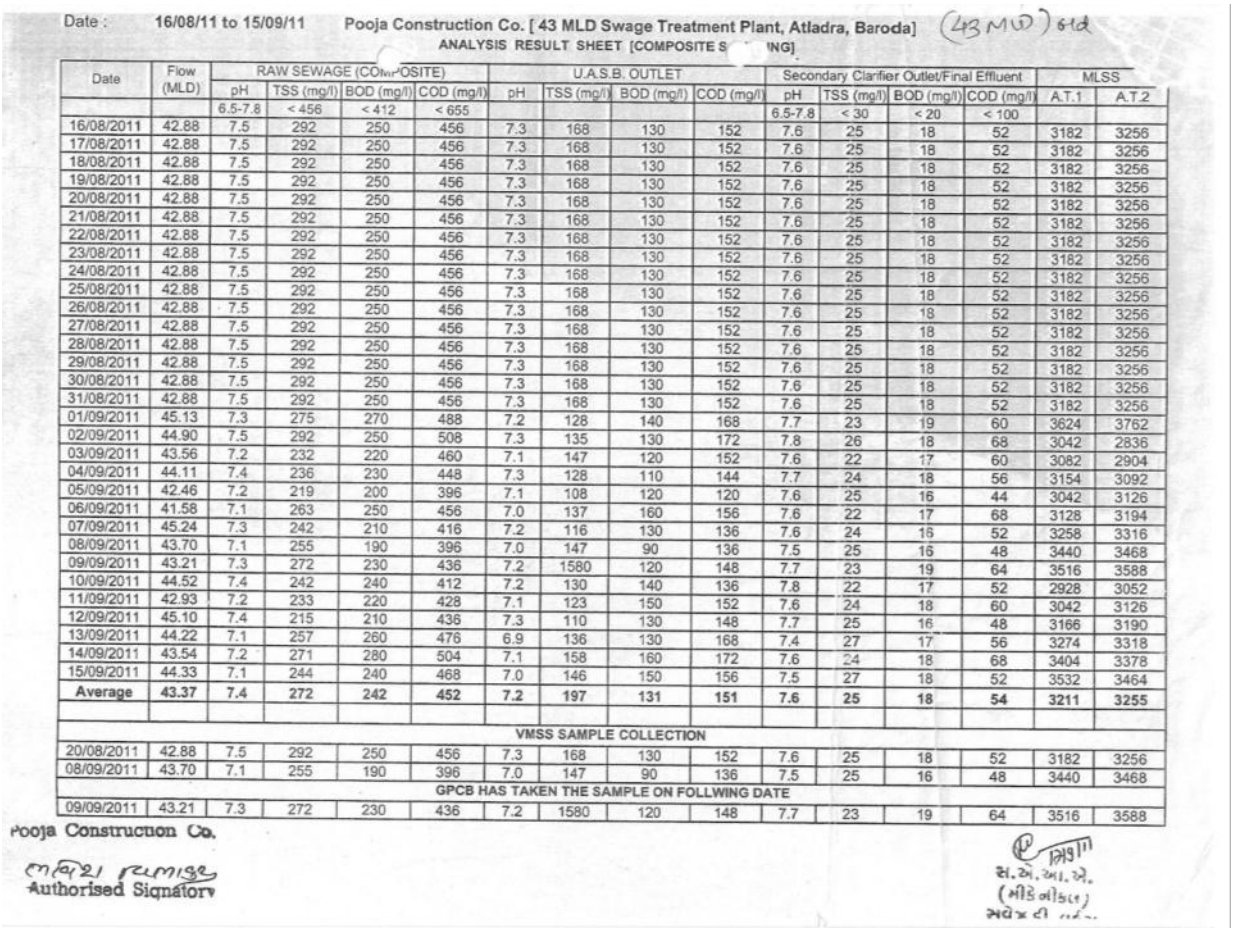
$$\text{Quality of sewage treatment} = \frac{\text{No. of samples that pass the specified secondary treatment standards}}{\text{Total no. of samples tested in a month}} \text{ X 100}$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Total number of samples that pass the specified secondary treatment standards

VMSS is equipped with testing laboratories at all STPs. VMSS has outsourced operation of STPs to private contractor and received periodic quality report from them. The report provides daily measurements of various parameters such as pH, TSS, BOD and COD from various points within the STP (raw sewage, UASB outlet and Secondary Clarifies Outlet/ Final Effluent). However, it does not summarise the results of the tests indicating the number of tests that passed or failed the benchmarks. Information from the report is used for calculating this indicator. A sample of the report has been provided below.

Figure 17 Sample of monthly report submitted by STP operator to VMSS for reporting quantity treated and quality of treatment



Date : 16/08/11 to 15/09/11 Pooja Construction Co. [43 MLD Swage Treatment Plant, Atladra, Baroda] (43 MLD) old

ANALYSIS RESULT SHEET [COMPOSITE S ING]

Date	Flow (MLD)	RAW SEWAGE (COMPOSITE)				U.A.S.B. OUTLET				Secondary Clarifier Outlet/Final Effluent				MLSS	
		pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	A.T.1	A.T.2
		6.5-7.8	< 456	< 412	< 655					6.5-7.8	< 30	< 20	< 100		
16/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
17/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
18/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
19/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
20/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
21/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
22/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
23/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
24/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
25/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
26/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
27/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
28/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
29/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
30/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
31/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
01/09/2011	45.13	7.3	275	270	488	7.2	128	140	168	7.7	23	19	60	3624	3762
02/09/2011	44.90	7.5	292	250	508	7.3	135	130	172	7.8	26	18	68	3042	2836
03/09/2011	43.56	7.2	232	220	460	7.1	147	120	152	7.6	22	17	60	3082	2904
04/09/2011	44.11	7.4	236	230	448	7.3	128	110	144	7.7	24	18	56	3154	3092
05/09/2011	42.46	7.2	219	200	396	7.1	108	120	120	7.6	25	16	44	3042	3126
06/09/2011	41.58	7.1	263	250	456	7.0	137	160	156	7.6	22	17	68	3128	3194
07/09/2011	45.24	7.3	242	210	416	7.2	116	130	136	7.6	24	16	52	3258	3316
08/09/2011	43.70	7.1	255	190	396	7.0	147	90	136	7.5	25	16	48	3440	3468
09/09/2011	43.21	7.3	272	230	436	7.2	1580	120	148	7.7	23	19	64	3516	3588
10/09/2011	44.52	7.4	242	240	412	7.2	130	140	136	7.8	22	17	52	2928	3052
11/09/2011	42.93	7.2	233	220	428	7.1	123	150	152	7.6	24	18	60	3042	3126
12/09/2011	45.10	7.4	215	210	436	7.3	110	130	148	7.7	25	16	48	3166	3190
13/09/2011	44.22	7.1	257	260	476	6.9	136	130	168	7.4	27	17	56	3274	3318
14/09/2011	43.54	7.2	271	280	504	7.1	158	160	172	7.6	24	18	68	3404	3378
15/09/2011	44.33	7.1	244	240	468	7.0	146	150	156	7.5	27	18	52	3532	3464
Average	**43.37**	**7.4**	**272**	**242**	**452**	**7.2**	**197**	**131**	**151**	**7.6**	**25**	**18**	**54**	**3211**	**3255**
VMSS SAMPLE COLLECTION															
20/08/2011	42.88	7.5	292	250	456	7.3	168	130	152	7.6	25	18	52	3182	3256
08/09/2011	43.70	7.1	255	190	396	7.0	147	90	136	7.5	25	16	48	3440	3468
GPCB HAS TAKEN THE SAMPLE ON FOLLWING DATE															
09/09/2011	43.21	7.3	272	230	436	7.2	1580	120	148	7.7	23	19	64	3516	3588

Pooja Construction Co.

Authorised Signatory

Source: VMSS, 2013

Total number of samples tested in a month

This information is extracted by VMSS from the above report submitted by STP operator for calculating this indicator.

VMSS has specified a daily testing for quality of treatment at STPs. However, as per CPHEEO norms, it is inadequate. There is occasional sample testing by Gujarat Pollution Control Board (GPCB). The last row in the figure above shows tests results of the sample taken by GPCB.

Based on the above explained system, the reliability scale for this indicator is 'B'

Recommendations

The indicator reliability scale is 'B'. For improving the process of calculation of the indicator, a column stating the result of each test (whether pass/ fail) should be added to the existing form. In addition, VMSS should ensure compliance with CPHEEO norms for quality testing frequency. The suggested modification has been shown in the table below.

Modified Form SE01R: Monthly report for quantity and quality of sewage treatment

Vadodara Mahanagar Seva Sadan

Name of the STP and Unit No.: _____

Month / Year:

Filled by:

Date	Inflow (MLD)	Untreated bypass (MLD)	Outflow of treated sewage (MLD)	Raw Sewage (Composite)				U.A.S.B Outlet				Final effluent				MLSS		Pass/ Fail
				pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	A.T.1	A.T.2	
1																		
2																		
3																		
...																		
...																		
31																		
Total																		

Indicator 2.6: Extent of reuse and recycling of sewage

This indicator measures the quantity of treated waste water recycled or reused for various purposes. This indicator measures the quantity of water at the outlets of STP. This indicator is calculated using the following formula:

$$\text{Extent of recycling or reuse of sewage} = \frac{\text{Wastewater recycled or reused after appropriate treatment}}{\text{Wastewater received at STPs}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : ULB Level

<u>Wastewater recycled or reused after appropriate treatment</u>

VMSS does not have any meters installed at the outlet of STPs. Hence, VMSS uses an estimate based on the quantity of sewage intake or the designed capacity of the STP. Currently, VMSS does not reuse or recycle treated sewage.

<u>Wastewater received at STPs</u>

VMSS has flow meters installed at the inlet chamber of some STP units. VMSS uses readings from these meters for some STPs while estimates the inflow based on the designed capacity of other STPs. A sample format used for capturing this information has been shown in Figure 15. The summation of these 2 sets of information is used by VMSS to calculate this indicator.

Based on the above explained method of calculation, this indicator falls in reliability scale ‘D’.

Recommendations

In order to improve the reliability scale of this indicator to ‘A’, flow meters should be installed at all inlet and outlet points of all STP units. Flow meters should also be installed to measure the quantity of sewage bypassed (as explained in Figure 16) and accounted in calculating this indicator.

Modified Form SE01R: Monthly report for quantity and quality of sewage treatment

Vadodara Mahanagar Seva Sadan

Name of the STP and Unit No.: _____

Month / Year:

Filled by:

Date	Inflow (MLD)	Untreated bypass (MLD)	Outflow of treated sewage (MLD)	Raw Sewage (Composite)				U.A.S.B Outlet				Final effluent				MLSS		Pass/ Fail
				pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	pH	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	A.T.1	A.T.2	
1																		
2																		
3																		
...																		
...																		
31																		
Total																		

Indicator 2.7: Efficiency in redressal of customer complaints

This indicator provides a measure of effective redressal of complaints related to sewerage within 24 hours of being lodged. The formula for this indicator is expressed as:

$$\text{Efficiency in redressal of customer complaints} = \frac{\text{Total number of sewerage related complaints redressed within the month}}{\text{Total number of sewerage related complaints received per month}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Total number of sewerage related complaints received per month
Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Total number of sewerage related complaints redressed within the month
Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Based on the calculation method adopted by VMSS, the reliability scale of this indicator is 'B' with the only gap of collation of manual and online complaints systems.

Recommendations

Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Indicator 2.8: Cost recovery in sewage management

This indicator provides the financial operating health of the sewerage department. This indicator is calculated as a ratio of revenue earned from sewerage (taxes and charges) and expenses made for providing the service to citizens, excluding capital expenditure. The formula for this indicator is expressed as:

$$\text{Cost recovery in sewerage services} = \frac{\text{Total annual operating revenues}}{\text{Total annual operating expenses}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : ULB Level

Total annual operating revenues

VMSS issues annual property tax bill to its citizens. This property tax bill includes conservancy and sewerage related taxes and charges (see figure below). VMSS generates an annual demand-collection-balance (DCB) statement for property tax clearly identifying the revenue demand raised for conservancy and sewerage. The break-up between conservancy and sewerage has been defined in the annual budget of VMSS. Based on this break-up, sewerage's share is used for calculating this indicator.

Figure 18 Snapshot of the annual DCB statement with sewerage related taxes and charges, VMSS 2011-12

1

	Nos. of property	Nos. of bills	Category	Property Tax Demand				Disputed Prop	
				Rental base property tax Demand	Arrears 03-04 To 10-11	current (2011-12)	Total	Rental base property tax Demand	Arrears 03-04 To 10-11
property Tax	447664	548924	All	542.67	5496.92	8901.25	14940.84	383.04	1662.8
prop.Tax Interest				2388.67	2285.15	0.01	4673.83	1626.02	1129.8
pro tax Notice Fee				7.56	22.1	0	29.66	4.1	9.1
Warrant Fee				0.13	0.42	0	0.55	0.06	0.1
Total				2939.03	7804.59	8901.26	19644.88	2013.22	2802.0
Water charge				186.74	3462.7	3520.67	7170.11	68.18	490.3
water chg. Interest				0	663	0	663	0	103.4
Total				186.74	4125.7	3520.67	7833.11	68.18	593.8
SpSani. Cess (For rental base)				1.02	0	0	1.02	0.68	0
Cons. & sewrege Tax				441.7	1089.52	2729.12	4260.34	307.7	280.1
Cons. & sewrege Tax Intrest				0	226.8	-0.01	226.79	0.71	103.97
Cons. & sewrege Tax Notice Fee				0	5.05	0	5.05	0	1.64
Total				442.72	1321.37	2729.11	4493.2	309.09	386.51
Fire Tax				7.78	29.07	43.43	81.16	5.28	14.14
Fire Tax				0	0.29	0.65	0.94	0	0.1

Source: VMSS, 2013

Total annual operating expenses

The total annual operating expenses include all expenses related to repair and maintenance of equipment, energy costs, staff salaries, consumables and transportation costs related to sewerage. All these expenses are recorded in the annual summation of budgets. The actual operating expenses are for this indicator is calculated by identifying operational costs from

the budget heads of VMSS. A total of 35 budget items[15] (codes) are summed to arrive at this figure. However, there is lateral movement within VMSS' staff while their salaries are drawn from the original departments. This creates some inconsistency in calculating actual operational expenses.

Although, basic principles of double-entry accounting system are followed, accrual based accounting is not followed completely.

Based on the above method, this indicator receives reliability scale 'B'.

Recommendations
Same as 'Indicator 1.8: Cost recovery in water supply services'.

Indicator 2.9: Efficiency in collection of sewage charges

This indicator provides the efficiency of the ULB in collecting sewerage related charges from the citizen. This indicator is calculated as a ratio of demand raised (or billed) for sewerage related taxes and charges and actual collection done by the ULB. The formula for this indicator is expressed as:

$$\text{Efficiency in collection of sewage charges} = \frac{\text{Current revenues collected in the given year}}{\text{Total operating revenues billed during the given year}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : Zone/ DMA Level

Total operating revenues billed during the given year
This information is generated by VMSS in the annual DCB statement. VMSS uses the DCB statement to calculate this indicator.

Current revenues collect in the given year
VMSS uses this information from the annual DCB statement.

Based on this method, the reliability scale of this indicator is 'A'.

Recommendations
There are no improvements are suggested for this indicator.

[15] The budget items (codes) used for calculating operational expenses in sewerage have been provided in Annexure 4.

6. Solid waste management

6.1. Existing solid waste management system in Vadodara

A stage wise break-up of the existing SWM system in Vadodara has been discussed below.

Generation
It is estimated by VMSS that Vadodara generated around 750 MT of municipal solid waste daily. This waste is generated by various category of sources such as households (domestic), markets and institutions, commercial establishments, small hotels/ restaurants/ tea stalls, street sweeping, large hotels/ restaurants/ party plots, dead animals, construction and demolition (C&D) waste, temples and e-waste. VMSS has not conducted any survey to ascertain the quantity of waste generated by each type of source. However, solid waste management (SWM) staff broadly estimates source-wise quantity to plan collection. For example, based on an informal reconnaissance survey, the SWM department estimated the organic waste generation from temples to be around 1 MT.

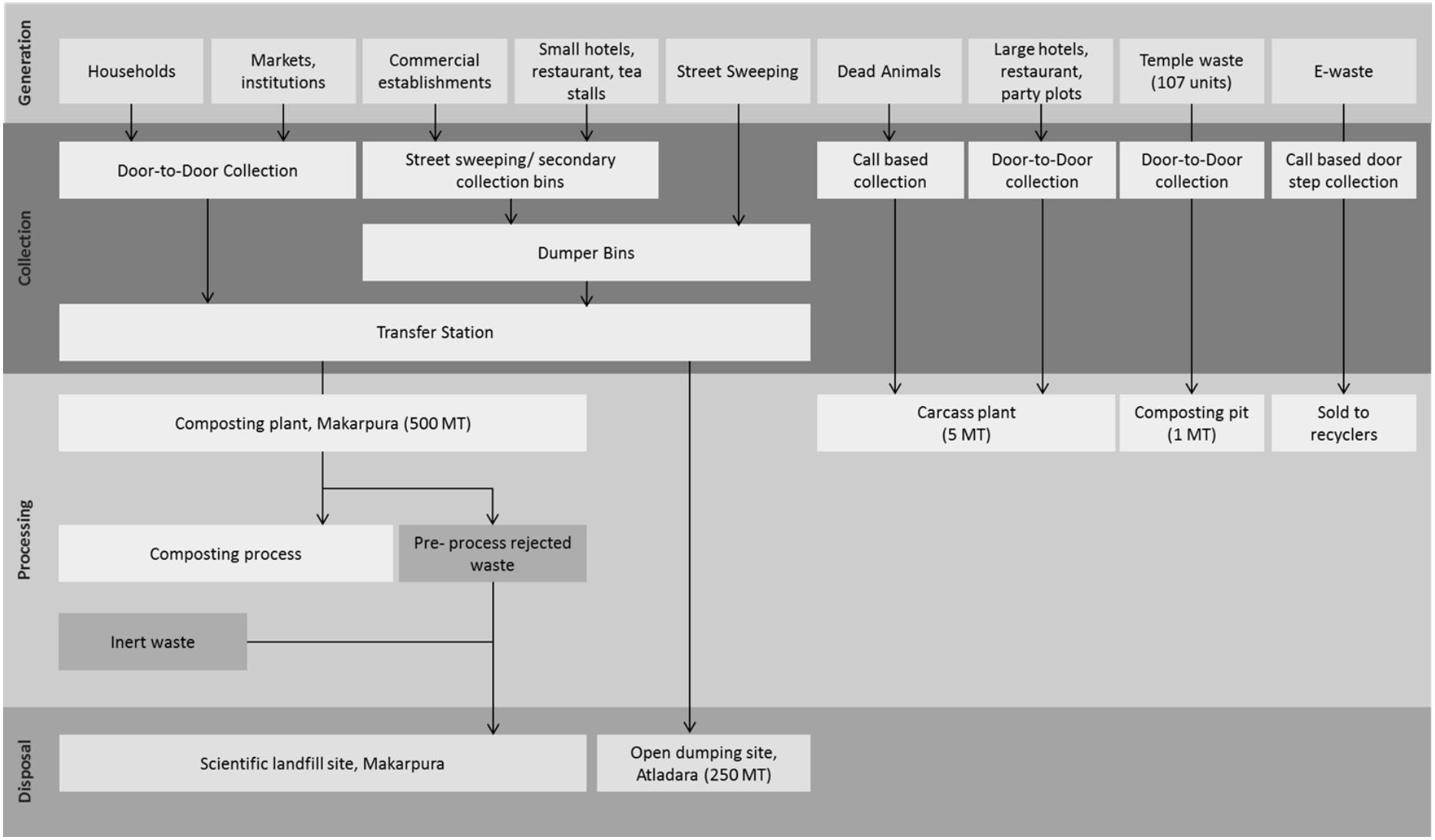
Segregation
As of 2013-14, no segregation of waste is being practiced at source by the generator, except organic waste (comprising of flowers and fruits) from temple and organic waste from kitchens of large hotels and restaurants. All other waste is collected in a mixed state including C&D waste. There is no formal segregation being practiced by VMSS at any intermediate point. Segregation is practiced at the processing plant in order to recycle the waste.

Collection
VMSS collects waste by broadly 6 streams. These are based on the source of generation. The diagram below explains the collection process based on the source of generation. Waste from households and small markets is collected through the door-to-door collection system. VMSS has engaged private contractors for this service. In addition to this waste, organic waste from large hotels' and restaurants' kitchen and from temple is also collected through a special door-to-door service.

Waste generated by street sweeping, C&D, commercial establishments and small hotels/ restaurants/ tea stalls is collected through secondary collection bins while e-waste collection is done through a call-based door step collection service.

Transportation
All waste collected is transport by VMSS or its contractors from the collection points to either waste processing plants or to open dumping sites. VMSS has engaged private contractors for door-to-door collection and transportation service (upto the processing plant/ open dumping site) using mini-vans (1 MT capacity) and compactors (12 MT capacity). Secondary collection bins are transported using dumper placers and nuisance spots are cleared using tractor-trolleys. Special vehicles have been deployed for collection of waste from other sources such as temples, large hotels/ restaurants/ party plots and e-waste. VMSS is constructing a transfer station at Atladara also to double-up as a waste sorting and segregation facility.

Figure 19 Diagrammatic flow of waste and SWM management system in Vadodara



Source: Urban Management Centre, 2013

Processing

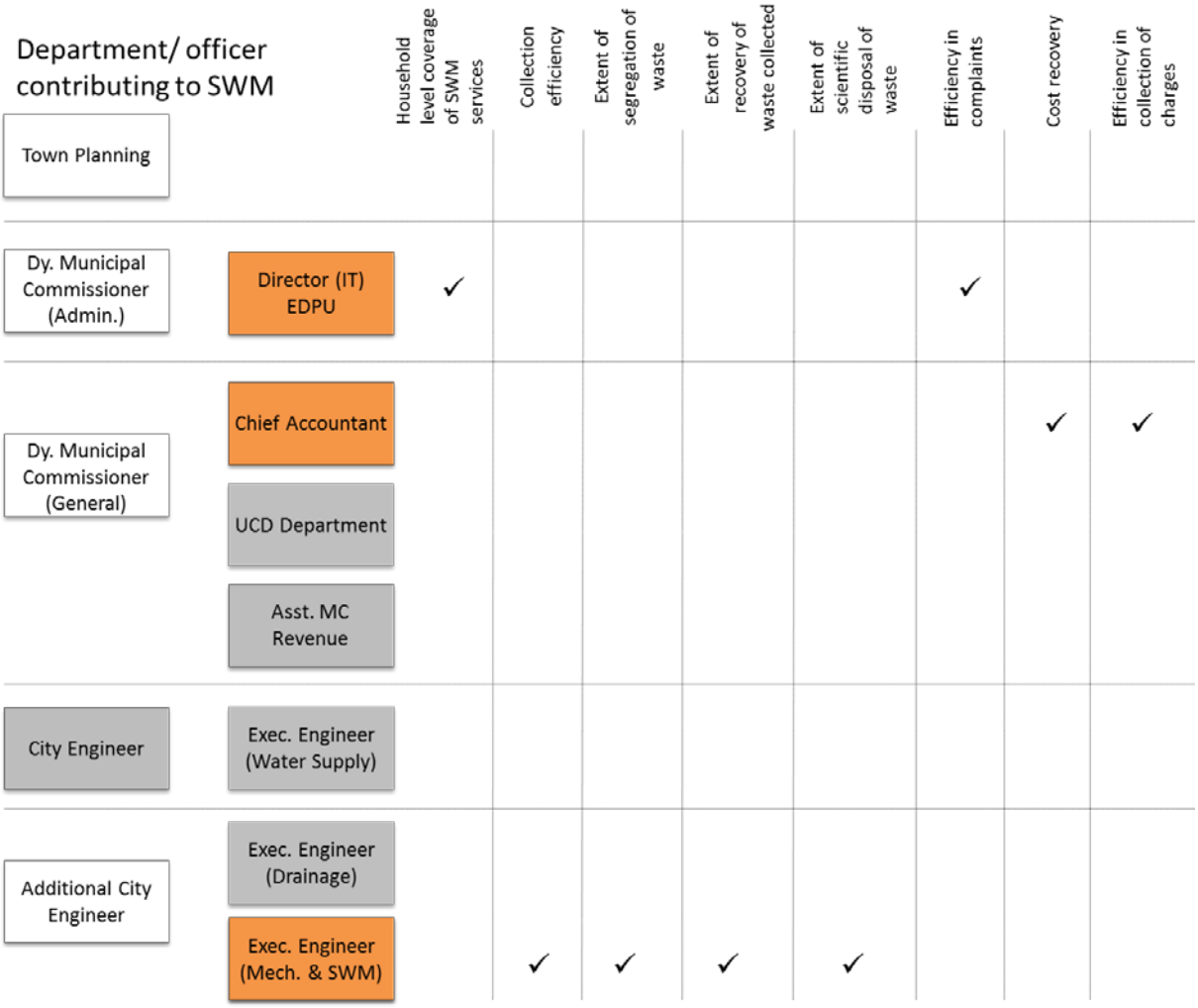
VMSS has a compost and recycling plant of 500 MT daily (operated by a private contractor). Another composting plan of capacity of 150 MT daily is non-function. VMSS has recently constructed and operationalised a carcass plant of 5 MT daily capacity for processing waste from dead animals and organic waste from large hotels/ restaurants/ party plots. In 2014, VMSS has initiated a composting pit at Kamatibaug Garden for processing garden waste comprising of fallen leaves and other organic waste generated in gardens.

Disposal

VMSS has one scientific waste disposal site at Makarpura for disposal of inert waste from its processing plant. The rest of the waste is dumped in the open at the Atladara dump site.

6.2. Existing information system in solid waste management

This section presents an analysis of existing information system in SWM in VMSS. To analyse data generation, UMC conducted field visits at all installations in SWM including secondary collection points/ bins, transfer station, carcass plant at Gajarawadi, waste processing plant at Makarpura, non-functional processing plant at Atladara, scientific landfill site at Makarpura and open dumping site at Atladara.. In addition, UMC conducted discussion with all levels of staff working in operation and maintenance of SWM service. An overview of the data provided by each department for generating SWM indicators has been provided in the figure below.



Source: Urban Management Centre, 2013

During the visits, the team collected data recording formats (maintained as logbooks) at all facilities. Based on the data collected during 2012-13 for PAS program, the SWM SLB indicators for VMSS were as below:

Table 7 Performance indicators of VMSS in SWM as per the SLB framework

S. No	SWM indicator values	Unit	FY 2012-13
1	Household level coverage of solid waste management services	%	100.0
2	Efficiency of collection of municipal solid waste	%	98.56
3	Extent of segregation of municipal solid waste	%	0
4	Extent of municipal solid waste recovered	%	100
5	Extent of scientific disposal of municipal solid waste	%	100.0
6	Extent of cost recovery in solid waste management services	%	6.7
7	Efficiency in collection of solid waste management charges	%	84.2
8	Efficiency in redressal of customer complaints	%	100.0

Source: (PAS, 2013)

To conduct assessment of data collation or summarisation and its report to higher officials, UMC tracked the flow of information from various facilities to VMSS head office. The analysis conducted for SWM's existing information system has been presented using the following:

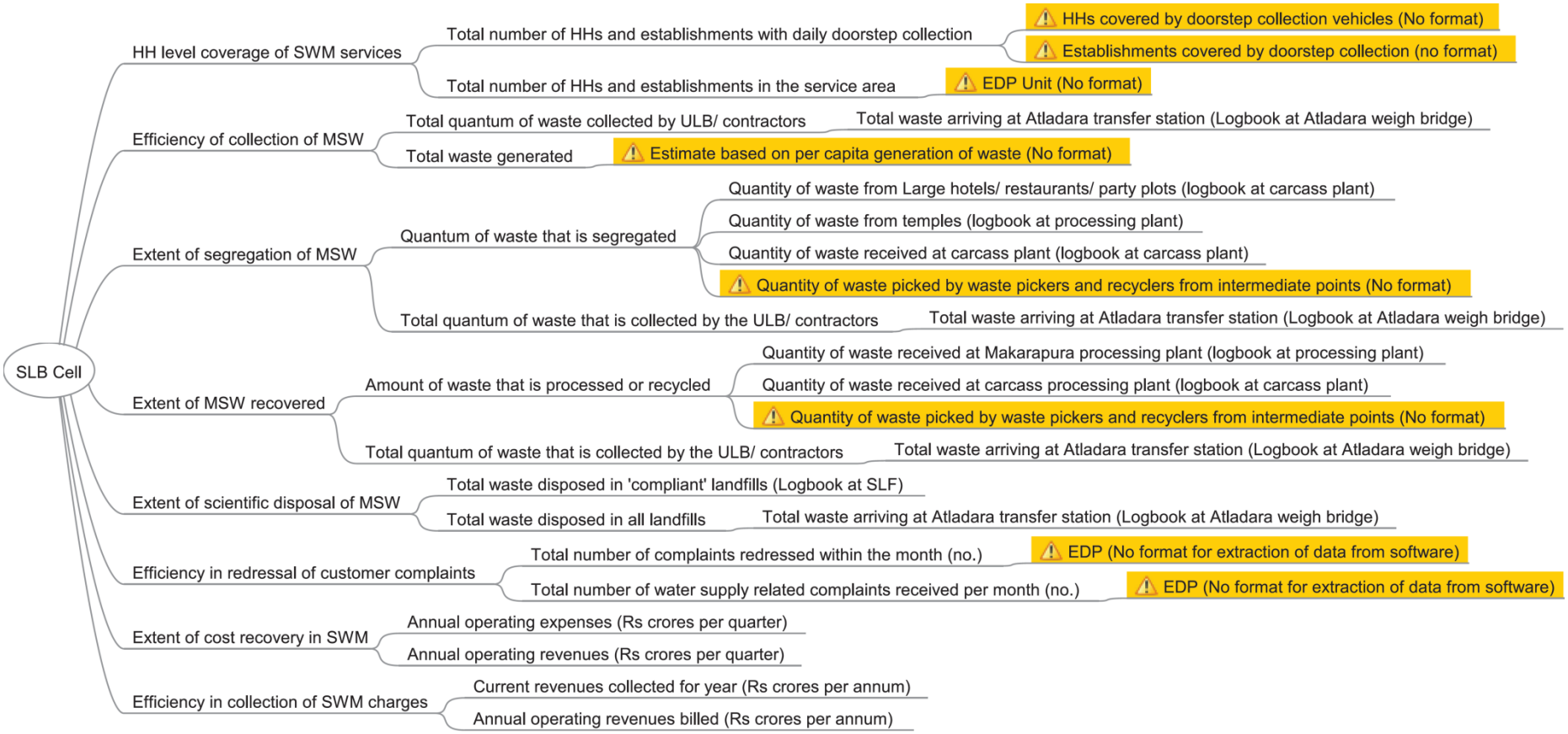
- Flow diagram showing generation, collection, transportation, processing and disposal of waste
- Information flow diagram from various facilities related to SWM to the head office of VMSS
- Gap analysis in existing information system clearly identifying data not generated/ recorded and recommendations to capture such data
- Gap analysis in existing data recording formats and recommendations to fulfil them as per SLB framework

While providing recommendations, UMC's approach has been to make minimal modifications in the existing formats. Recommendations provided by UMC to fill data gaps include

i) new formats
j) minor modifications to existing formats
k) computerisation of data and defining its flow (both from bottom to top and vice-versa)
l) outlining equipment and manpower requirements for filling in the data gaps and improving reliability bands

A detailed assessment of the information system reveals that information should be collected from several field locations and administrative offices within VMSS as shown below.

Figure 20 Information flow diagram for calculating SWM related performance indicators as per SLB framework



Source: Urban Management Centre, 2013

In the above diagram, the data sets highlighted are the ones which are not recorded by VMSS. Some data from the highlighted sets requires additional infrastructure, studies or surveys to be generated.

Summary of recommendations for improvement of SWM information system

For the purposes of ISIP, new formats have been proposed in the subsequent sections for data sets which are generated by not recorded. This ISIP also proposes format required to capture information through proposed surveys, studies and recording using the proposed infrastructure.

Process improvements, studies and surveys proposed

The following process improvements, studies and surveys have been recommended:

General (departments other than SWM)

1. VMSS' Revenue Department uses hand-drawn maps of the city as a part of the property tax database. UMC recommends that these maps be digitised with property tax information linked as attributes. In addition, routes of all door-to-door collection vehicles have already been mapped by VMSS. The 2 sets of spatial information can be overlapped and exact number of HHs/ properties served can be ascertained. Digitisation of the property tax maps has been discussed earlier in 'Indicator 2.1: Coverage of toilets'.
2. Digitise complaints logbooks – same as water supply section.
3. Accrual based double-entry accounting – same as water supply section.
4. Sharing of staff, machinery & equipment and consumables – same as water supply section.

SWM Department

5. Conduct a sample survey on quarterly basis for various types of waste generators to ascertain the average per capita waste generation.
6. Conduct trend analysis of bulk waste generators such as temples, construction and demolition waste, etc.
7. Formulate public health bye-laws for implementing segregation at source.
8. Conduct a study for assessing quantity of waste recycled by waste pickers.
9. Create an inventory and list of private composting initiatives in the city to ascertain the quantity of waste processed at them.

Infrastructure proposed

In addition to the above forms, the following infrastructural improvements have been recommended:

1. Enforce segregation at source as per the public health bye-laws.
2. Create partitioned vehicles for transporting waste in a segregated manner.

New forms proposed/ existing forms modified

S. No.	Proposed/ Modified	Form No.	Title of the form
1.	Proposed	Form SW01	Households and establishments covered by door-to-door collection of waste
2.	Proposed	Form SW02	Waste segregation
3.	Proposed	Form SW03	Waste recovered in the city

Indicator-wise details including gaps and recommendations have been discussed in the following section.

6.3. Data generation, recording and transfer practices in VMSS – gaps and recommendations

VMSS captures data from various facilities through logbooks. Data is generated at West Zone office for door-to-door collection[16] and quantity of waste collected is measured at the temporary transfer station through a weigh bridge operated by VMSS at Atladara. In addition, data related to collection of waste from secondary collection bins, temples, street sweeping and nuisance spots is maintained by the SWM Department located near VMSS head office at Khanderao Market. Data related to quantity of waste collected from dead animals and large hotels/ restaurants/ party plots is recorded at the carcass plant at Gajarawadi. Data of waste processing is generated at the processing plant at Makarpura. The data related to scientific landfill site is also generated at the landfill site at Makarpura. All data generated at various facilities is transferred to the SWM Department office periodically as per the private operators' respective terms of reference.

For calculating some SLB indicators, the SWM Department uses this data. As per the SLB framework, most of the data is captured by VMSS with some gaps.

The following section analyses existing forms used by VMSS to record data required for generation of SWM related SLB indicators. The analysis also identifies practices adopted by VMSS (or its private contractors) to capture data, local collation/ summarisation/ totalling, data transfer, city level collation & reporting and review & decision making processes for sewerage. The analysis has been conducted indicator-wise.

Indicator 3.1: Household level coverage of solid waste management services

This indicator measures the number of households which are covered by daily doorstep collection system. This indicator is calculated using the following formula:

$$\text{HH level coverage of door-to-door collection of waste} = \frac{\text{Total no. of HHs and establishments with daily doorstep collection}}{\text{Total no. of HHs and establishments in the service area}} \times 100$$

Minimum frequency of measurement : Quarterly
Smallest geographical jurisdiction for measurement : Ward Level

Total number of households and establishments with daily doorstep collection

VMSS levies tax and user charges related to conservancy from all properties within its jurisdiction. Hence, exact number of properties served by doorstep collection of waste cannot be ascertained from the property tax data. VMSS currently assumes that all properties are covered by the door-to-door collection service and reports the indicator based on this assumption.

[16] The private contract engaged by VMSS has been provided a GPS-based vehicle monitoring control room at the West Zone office of VMSS.

Total number of households and establishments in the service area

VMSS considers 1 residential property equalling to 1 household. Based on this assumption, the total number of residential properties is considered to be the total number of HHs in the service area. The sum of residential and non-residential properties is used to calculate this indicator.

Based on the above calculation method, the indicator gets a reliability scale 'D'

Recommendations

In order to improve the reliability scale of this indicator to 'A', exact number of households served by door-to-door collection service should be ascertained. There are 2 possible methods to do so in Vadodara. First includes conducting a survey to calculate the number of households covered ward-wise by each door-to-door collection vehicle.

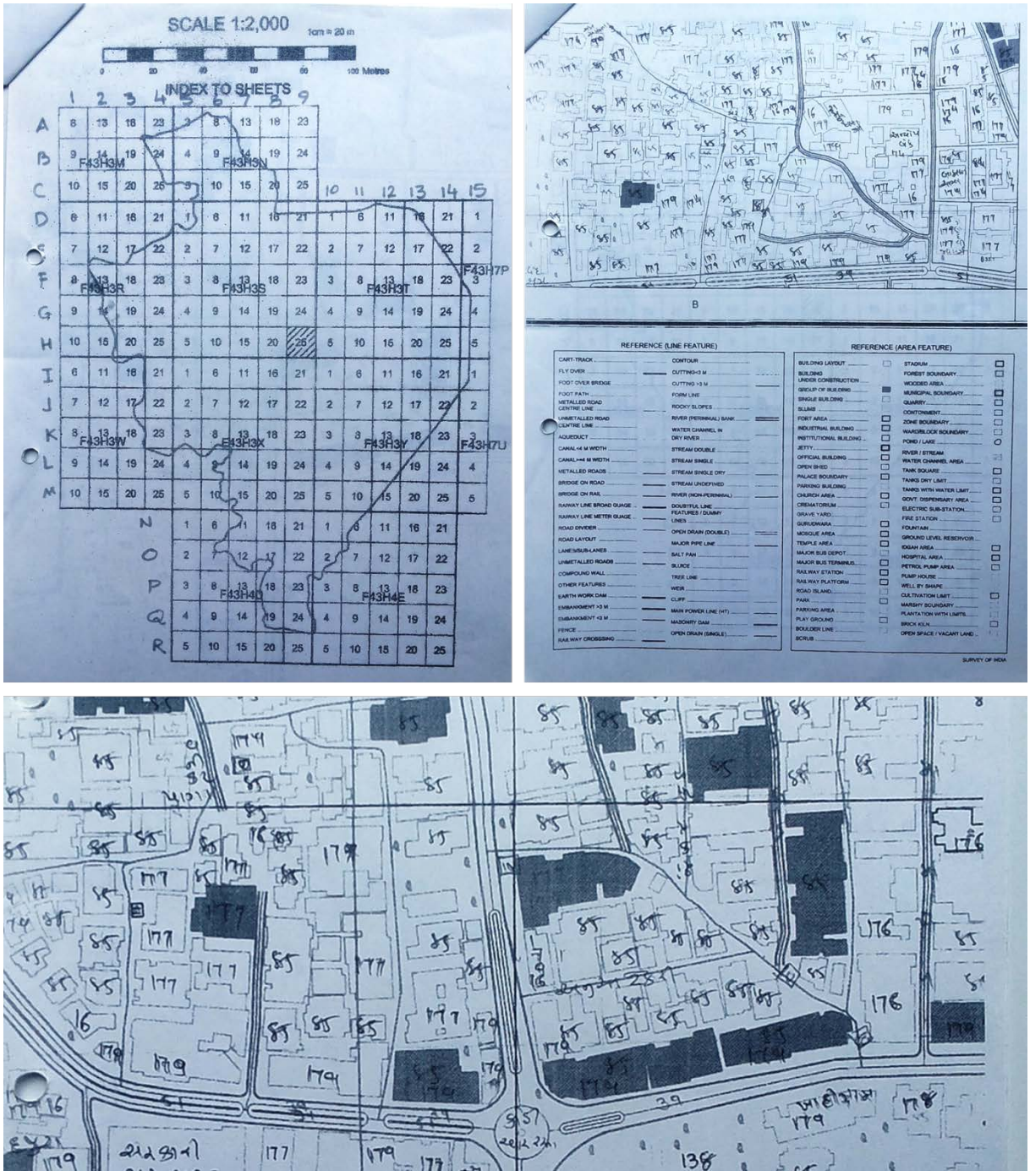
Second method includes using GPS-based monitoring of all door-to-door collection vehicles already being practiced by VMSS. For this method, a GIS based property tax database (with each property identified) should be used and GPS-tracked route of each vehicle should be overlaid on the GIS database. This would provide the exact number of establishments (residential as well as non-residential) covered ward-wise[17] by the doorstep collection. Currently, VMSS' property tax department uses hand-drafted maps identifying each property for its taxation purposes. The same map can be digitised on GIS and used for the purpose. Samples of the hand-drafted map have been shown below:

Figure 21 Door-to-door collection vehicle tracking using GPS, VMSS

Source: VMSS, 2013

[17] Ward-wise information can be obtained by creating a layer of administrative wards on GIS.

Figure 22 Hand-drafted maps identifying each property used by VMSS' property tax department



Key map (top left); Map of a single tile (top right); Close-up of the map with property details (bottom)
Source: VMSS, 2013

The proposed Form SW01 provided below can be used for documenting the number of properties covered by door-to-door collection of waste.

Form SW01: Households and establishments covered by door-to-door collection of waste

Vadodara Mahanagar Seva Sadan

SWM Department

Month / Year:

Filled by:

Households and establishments covered by door-to-door collection of waste					
Ward No.	**Total residential properties service area**	**A. Total residential properties covered by door-to-door collection of waste**	**Total non-residential properties service area**	**B. Total non-residential properties covered by door-to-door collection of waste**	**Total properties covered by door-to-door collection of waste (A+B)**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Total					

Indicator 3.2: Efficiency of collection of municipal solid waste

This indicator is ratio of waste collected through formal municipal system and the total municipal solid waste generated by the city. This indicator is calculated using the following formula:

$$\text{Collection efficiency} = \frac{\text{Total quantum of waste that is collected by the ULB}}{\text{Total waste that is generated and which needs to be collected}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : Ward Level

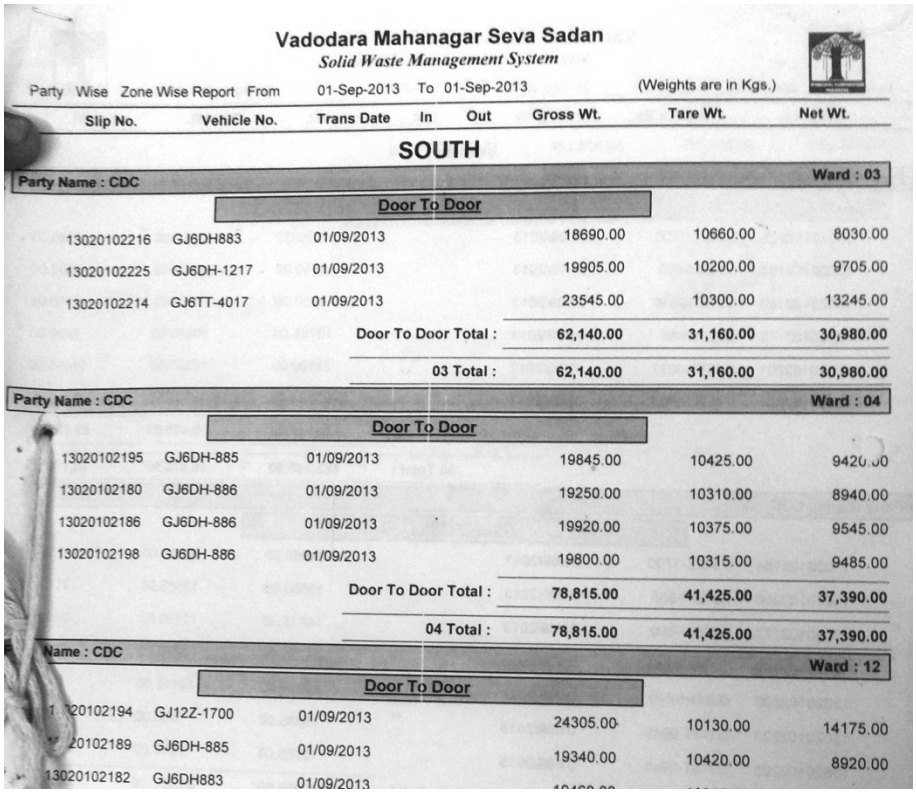
Total waste that is generated and which needs to be collected

VMSS estimates the generation of municipal solid waste with an assumption of 400 grams per capita per day. This assumption is based on empirical standard for a city like Vadodara. No surveys/ sample survey is carried out to update this figure periodically or to assess seasonal variations in waste generation.

Total quantum of waste that is collected by the ULB

VMSS weighs every collection vehicle at its weight bridge at Atladara. VMSS also prepared ward-wise summary of weight collected through various collection mechanisms. VMSS uses this information for calculating this indicator. The format used for recording the weight of each vehicle and the summary form has been provided below.

Figure 23 Format used by VMSS for recording quantity of weight collected by each door-to-door vehicle



Vadodara Mahanagar Seva Sadan

Solid Waste Management System

Party Wise Zone Wise Report From 01-Sep-2013 To 01-Sep-2013 (Weights are in Kgs.)

SOUTH

Slip No.	Vehicle No.	Trans Date	In	Out	Gross Wt.	Tare Wt.	Net Wt.
Party Name : CDC							**Ward : 03**
Door To Door							
13020102216	GJ6DH883	01/09/2013			18690.00	10660.00	8030.00
13020102225	GJ6DH-1217	01/09/2013			19905.00	10200.00	9705.00
13020102214	GJ6TT-4017	01/09/2013			23545.00	10300.00	13245.00
			Door To Door Total :		**62,140.00**	**31,160.00**	**30,980.00**
			03 Total :		**62,140.00**	**31,160.00**	**30,980.00**
Party Name : CDC							**Ward : 04**
Door To Door							
13020102195	GJ6DH-885	01/09/2013			19845.00	10425.00	9420.00
13020102180	GJ6DH-886	01/09/2013			19250.00	10310.00	8940.00
13020102186	GJ6DH-886	01/09/2013			19920.00	10375.00	9545.00
13020102198	GJ6DH-886	01/09/2013			19800.00	10315.00	9485.00
			Door To Door Total :		**78,815.00**	**41,425.00**	**37,390.00**
			04 Total :		**78,815.00**	**41,425.00**	**37,390.00**
Name : CDC							**Ward : 12**
Door To Door							
1 020102194	GJ12Z-1700	01/09/2013			24305.00	10130.00	14175.00
20102189	GJ6DH-885	01/09/2013			19340.00	10420.00	8920.00
13020102182	GJ6DH883	01/09/2013					

Source: VMSS, 2013

Figure 24 Format used by VMSS for preparing ward-wise summary of total waste collected

DETAILS OF TOTAL GARBAGE LIFTING
SOLID WASTE MANAGEMENT DEPARTMENT
Date 30/11/2013

Ward	NOS. OF LIFTING CONTAINERS	NOS. OF SMALL DEPARTMENTAL DUMPER TRIPS	TRACTORS	NOS. OF BIG DEPARTMENTAL DUMPER TRIPS	TOTAL M.T LIFTING BY VMSS (A)	DOOR to DOOR & OPEN SPOT M.T. (CONTRACTOR) (B)			TOTAL (A+B) M.T.
						Atladara Plant	Hanjer Plant	Total	
1	2	0	0	2	16.500	0.000	11.075	11.075	27.575
2	10	0	1	2	27.500	0.000	22.140	22.140	49.640
9	6	0	0	1	14.500	0.000	18.675	18.675	33.175
Total	18	0	1	5	58.500	0.000	51.890	51.890	110.390
3	4	0	2	2	21.000	0.000	22.705	22.705	43.705
4	9	1	5	2	34.250	0.000	39.850	39.850	74.100
12	3	1	0	0	7.750	0.000	27.365	27.365	35.115
Total	16	2	7	4	63.000	0.000	89.920	89.920	152.920
5	10	0	0	0	12.500	44.705	33.750	78.455	90.955
7	16	0	0	0	20.000	44.500	66.295	110.795	130.795
8	12	0	0	0	15.000	19.320	62.475	81.795	96.795
Total	38	0	0	0	47.500	108.525	162.520	271.045	318.545
6	6	0	0	0	7.500	27.995	77.320	105.315	112.815
10	12	0	0	0	15.000	37.185	75.530	112.715	127.715
11	8	0	0	0	10.000	14.585	61.940	76.525	86.525
Total	26	0	0	0	32.500	79.765	214.790	294.555	327.055
Grand TOTAL	98	2	8	9	201.500	188.290	519.120	707.410	908.910

Source: VMSS, 2013

Based on the above method, the reliability scale of this indicator is 'B'

Recommendations

In order to improve the reliability scale of this indicator to 'A', VMSS should conduct quarterly sample surveys as defined by the SLB handbook. The sample survey should include a statistically valid sample from the following generators:

1. Households[18]
2. Hotels/ restaurants/ party plots
3. Shops
4. Institutions

UMC recommends a sample size of 384 HHs for quarterly sample survey for estimating per capita waste generation.

In addition to the sample survey of above generators, VMSS should assess the trend of waste collection from the following sources:

1. Religious institutions such as temples, mosques, etc.
2. Dead animals
3. Street sweeping
4. Construction and demolition (C&D) waste

[18] UMC recommends a sample size of 384 HHs for quarterly sample survey for estimating per capita waste generation. Source: (Raosoft, Inc., 2014). Similar calculation should be done for suggested categories of waste generators respectively.

Indicator 3.3: Extent of segregation of municipal solid waste

This indicator is ratio of waste collected through formal municipal system and the total municipal solid waste generated by the city. This indicator is calculated using the following formula:

$$\text{Extent of segregation of waste} = \frac{\text{Quantum of waste that is segregated}}{\text{Total quantum of waste that is collected by the ULB or authorised service providers}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Quantum of waste that is segregated

VMSS has not enforced segregation of waste by households, commercial or institutional establishments. Hence, mixed waste is collected from these sources. However, segregation has been enforced by VMSS for hotels/ restaurants/ party plots and temples. The waste from these sources is collected and transported in a segregated manner. The quantum of segregated waste from these sources is measured at the municipal weigh bridge at Atladara and then sent to their respective processing or disposal sites. VMSS uses this quantum to calculate this indicator.

Staff of SWM Department does not have any estimate of waste taken away by informal waste pickers and recyclers from intermediate points.

Total quantum of waste that is collected by the ULB or authorised service providers

This information has been discussed in 'Indicator 3.2: Efficiency of collection of municipal solid waste'.

Based on the above computation method, the reliability scale for this indicator is 'D'.

Recommendations

UMC recommends that in order to improve the reliability scale of this indicator to 'A', the following needs to be undertaken:

1. Initiate segregation of waste at household and commercial establishment level
2. Create provision of collection and transportation of waste in a segregated manner to the respective processing or disposal site
3. Each vehicle carrying segregated waste should be weighed at the municipal weigh bridge and data recorded using the proposed SW02 provided below.

Form SW02: Format for recording daily waste segregated

Vadodara Mahanagar Seva Sadan

SWM Department

Month / Year:

Filled by:

Waste segregation						
Date	A. Intake at Carcass plant	B. Intake at composting pit (Kamatibaug)	C. Waste picked by waste pickers/ recyclers	D. Segregated waste intake at proposed composting plant (Atladara)	E. Segregated waste intake at Makarpura composting plant	Total segregated waste (A+B+C+D+E)
1						
2						
3						
...						
...						
...						
31						
TOTAL						

Indicator 3.4: Extent of municipal solid waste recovered

This indicator is ratio of waste collected and the waste which is processed and recycled. This indicator is calculated using the following formula:

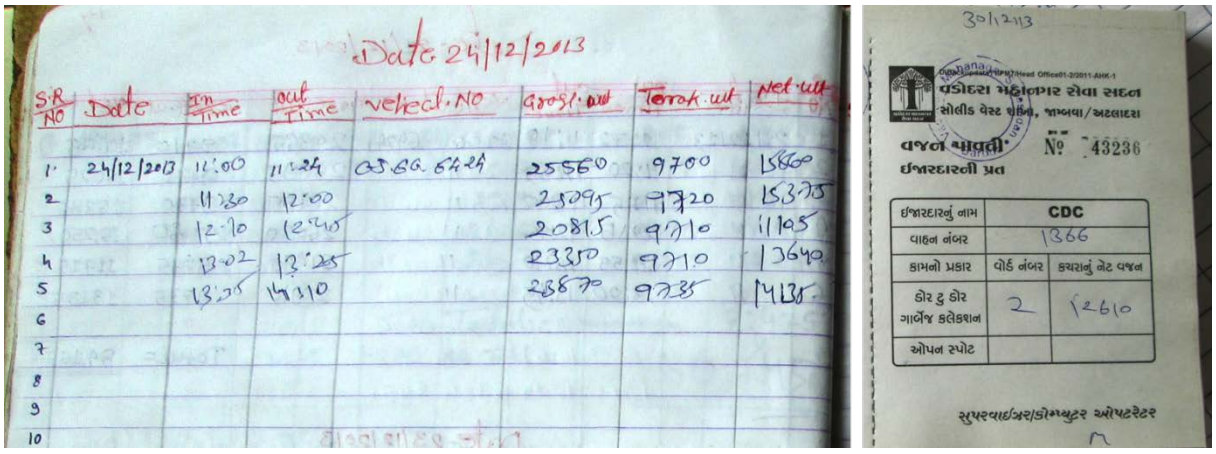
$$\text{Extent of recovery of waste collected} = \frac{\text{Amount of waste that is processed or recycled}}{\text{Total quantum of waste that is collected by the ULB or authorised service providers}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Amount of waste that is processed or recycled

VMSS uses the information reported by processing plant operators for waste processing for calculating this indicator. The sample of formats submitted by processing plant operators have been provided below:

Figure 25 Logbook recording waste intake at processing plant (left); Receipt issued to each vehicle (right)



Source: Urban Management Centre, 2013

VMSS does not have any estimate of waste processed or recycled by waste pickers/ recyclers from intermediate points.

Total quantum of waste that is collected by the ULB or authorised service providers
This information has been discussed in 'Indicator 3.2: Efficiency of collection of municipal solid waste'.

As there are no private decentralised waste processing facilities, based on the above method of calculation, this indictors gets a reliability scale 'B'.

Recommendations
In order to improve the reliability scale of this indicator to 'A', estimate of waste processed or recycled by waste pickers and recyclers should be estimated with relative authenticity. This recommendation has already been provided in 'Indicator 3.3: Extent of segregation of municipal solid waste' and should be implemented.

In future, as more and more decentralised systems – both municipal and private, are initiated in the city, the proposed summarisation of the format could be used to calculate this indicator in the future.

Form SW03: Format for recording daily waste recovered

Vadodara Mahanagar Seva Sadan
SWM Department

Month / Year:
Filled by:

Waste recovered in the city							
Date	A. Intake at composting pit (Kamatibaug)	B. Waste picked by waste pickers/ recyclers	C. Waste intake at proposed composting plant (Atladara)	D. Waste intake at Makarpura composting plant	E. Waste intake at _____ processing plant (for new facilities developed)	E. Waste processed by all private neighbourhood plants	Total waste recovered
1							
2							
3							
...							
...							
...							
31							
TOTAL							

Indicator 3.5: Extent of scientific disposal of municipal solid waste
This indicator is ratio of waste disposed in scientific landfill sites (compliant with norms laid out by Central agencies) and the total waste disposed in all landfill. This indicator is calculated using the following formula:

$$\text{Extent of scientific disposal of waste} = \frac{\text{Total waste disposed in 'compliant' landfills every month}}{\text{Total waste disposed in all landfills in a month}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : ULB Level

Total waste disposed in 'compliant' landfills every month

VMSS has engaged a landfill site operator and received a monthly report of inert waste disposed in the landfill site. VMSS uses this information to calculate this indicator. The reporting format submitted by the private operator has been provided below:

Figure 26 Format reporting quantity of waste disposed in complaint landfill site

GUJARAT ENVIRO PROTECTION AND INFRASTRUCTURE LTD.
DAILY INERT WASTE RECEIVED STATEMENT

Date: 27/3/2012

SR. NO.	SUPPLIERS NAME	TRANSPORTER	TRUCK NO.	GROSS WT. KG	TARE WT. KG	NET WT.KG
1	HANJER	VMC	GJ6G 6406	21250	9520	11,730
2	HANJER	VMC	GJ6G 6406	22880	9520	13,360
3	HANJER	VMC	GJ6G 6406	22300	9525	12,775
4	HANJER	VMC	GJ6G 6406	22215	9520	12,695
5	HANJER	VMC	GJ6G 6424	23185	10030	13,155
6	HANJER	VMC	GJ6G 6406	23790	9520	14,270
7	HANJER	VMC	GJ6G 6424	23680	10010	13,670
8	HANJER	VMC	GJ6G 6406	24935	9525	15,410
9	HANJER	VMC	GJ6G 6424	23255	10015	13,240
10	HANJER	VMC	GJ6G 6424	23420	10010	13,410
11						
12						
13						
14						
	HANJER					
	COMP.ATLADARA					
				Total Wt.in KG		133,715

SIGN. OF CHEMIST

JAYMIN A DESAI
GEPIL VMC SITE MANAGER

Source: VMSS, 2013

The operator of scientific landfill site maintains records of operational practices, routines and quality monitoring of the facility, and submits a monthly report to VMSS. A sample of quality testing report has been provided below.

Figure 27 Report on quality testing at the complaint landfill site submitted by private opoerator to VMSS

WEEKLY ANALYSIS REPORT ON INNERT WASTE RECEIVED AT VMC SITE.

SAMPLE SOURCE - INNERT WASTE RECEIVED FROM M/S Hanjer BIOTECH.
COLOUR- Black
DATE- FROM 17/01/2012 TO 31/01/2012.

Sr.No.	DATE	PH	Specific Gravity	C.V. cal/g	LOI %	MOISTURE CONTENT
1	17/1/2012(Hanjer)	6.55	0.66	1355.24	12.91	22.08
2	18/1/2012(Hanjer)	6.02	0.61	1367.77	11.30	25.10
3	19/1/2012(Hanjer)	6.18	0.71	1283.78	11.95	24.16
4	20/1/2012(Hanjer)	6.09	0.68	1396.08	12.54	21.16
5	21/1/2012(Hanjer)	6.29	0.6	1366.57	12.4	21.63
6	23/1/2012(Hanjer)	7.1	0.75	1287.11	14.05	19.56
7	24/1/2012(Hanjer)	7.12	0.67	1343.57	14.16	18.87
8	25/1/2012(Hanjer)	6.21	0.61	1427.32	11.05	18.64
9	26/1/2012(Hanjer)	6.56	0.73	1112.23	11.96	21.51
10	27/1/2012(Hanjer)	7.10	0.83	1176.32	13.98	25.71
11	28/1/2012(Hanjer)	6.86	0.61	1261.33	13.54	23.94
12	30/1/2012(Hanjer)	6.63	0.64	1459.42	12.13	23.11
13	31/1/2012(Hanjer)	7.08	0.8	1223.36	14.01	25.08

NOTE:- The above report has been prepared form analysis of Composite sample taken form vehicles at VMC site.

For Gujarat Enviro Protection & Infrastructure Ltd. (Unit VMC)

Sign of chemist.

Sign of Site Manager
JAYMIN A DESAI

Gujarat Enviro Protection & Infrastructure Ltd.
VMC-Unit
Weekly Compaction Test Result for Dumped MSW

DATE: 17/01/2012 to 23/01/2012
Location : Secured Landfill Cell (VMC)
Samples Taken: Randomly

Description of Tests		Sample - 1	Sample - 2	Sample - 3
Cutter Vol. (cc)	V	1020.5	1020.5	1020.5
Cutter + Compacted Waste Wt. (gms)	W_1	1860.00	1905.12	1874.36
Empty Wt. of Cutter (gms)	W_2	933.00	933.00	933.00
Wt. of Compacted Soil (gms)	$W_3 = W_1 - W_2$	927.00	972.12	941.36
Wet Density (gm / cc)	$WD = W_3 / V$	0.91	0.95	0.92
Compaction in Kg/M3 (Wet)	= WD x 1000	908.38	952.59	922.45
Average of Compaction in Wet Sample	Kg / m3		927.81	
Moisture Content (%)	M	18.46	19.55	18.78
Dry Density = (in gm/cc)	$DD = \frac{WD \times 100}{100 + M}$	0.77	0.80	0.78
Compaction in Kg/M3 (Dry)	= DD x 1000	766.82	796.81	776.60
Average of Compaction in Dry Sample	Kg / m3		780.08	

For Gujarat Enviro Protection & Infrastructure Ltd. (Unit VMC)

Site Manager

Authorized Signatory
Gujarat Enviro Protection & Infracture Ltd.

Source: VMSS, 2013

Total waste disposed in all landfills in a month

This information should be compiled by totalling the waste disposed at the compliant landfill site and at Atladara open dumping site. Alternatively, the total waste collected by VMSS can be used for calculating this information. The total waste collected has already been discussed in 'Indicator 3.2: Efficiency of collection of municipal solid waste'.

Based on this method, the reliability scale of this indicator is 'A'.

Recommendations

As the reliability scale of this indicator is 'A', there are no improvements proposed in the existing information system.

Indicator 3.6: Efficiency in redressal of customer complaints

This indicator provides a measure of effective redressal of complaints related to solid waste management within 24 hours of being lodged. The formula for this indicator is expressed as:

$$\text{Efficiency in redressal of customer complaints} = \frac{\text{Total number of SWM-related complaints redressed within the month}}{\text{Total number of SWM-related complaints received per month}} \times 100$$

Minimum frequency of measurement : Monthly
Smallest geographical jurisdiction for measurement : Ward Level

Total number of SWM-related complaints redressed within the month
Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Total number of SWM-related complaints redressed within the month
Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Based on the calculation method adopted by VMSS, the reliability scale of this indicator is 'B' with the only gap of collation of manual and online complaints systems.

Recommendations
Same as 'Indicator 1.7: Efficiency in redressal of customer complaints' for water supply.

Indicator 3.7: Extent of cost recovery in SWM services

This indicator provides the financial operating health of the SWM department. This indicator is calculated as a ratio of revenue earned from conservancy (taxes and charges) and expenses made for providing the service to citizens, excluding capital expenditure. The formula for this indicator is expressed as:

$$\text{Cost recovery in SWM services} = \frac{\text{Total annual operating revenues}}{\text{Total annual operating expenses}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : ULB Level

Total annual operating revenues
Same as Indicator 2.8: Cost recovery in sewage management.

Total annual operating expenses
The total annual operating expenses include all expenses related to payments made to a) service providers for SWM facilities/ services, and b) direct expenses in repair and maintenance of equipment, energy/ fuel, staff salaries, consumables and transportation related to SWM. All these expenses are recorded in the annual summation of budgets. The actual operating expenses are for this indicator is calculated by identifying operational costs

from the budget heads of VMSS. A total of 24 budget items[19] (codes) are summed to arrive at this figure. However, there is lateral movement within VMSS' staff while their salaries are drawn from the original departments. This creates some inconsistency in calculating actual operational expenses.

Although, basic principles of double-entry accounting system are followed, accrual based accounting is not followed completely.

Based on the above method, this indicator receives reliability scale 'B'.

Recommendations
Same as 'Indicator 1.8: Cost recovery in water supply services'.

Indicator 3.8: Efficiency in collection of SWM charges

This indicator provides the efficiency of the ULB in collecting SWM related charges from the citizen. This indicator is calculated as a ratio of demand raised (or billed) for conservancy related taxes and charges and actual collection done by the ULB. The formula for this indicator is expressed as:

$$\text{Efficiency in collection of SWM charges} = \frac{\text{Current revenues collected in the given year}}{\text{Total operating revenues billed during the given year}} \times 100$$

Minimum frequency of measurement : Annually
Smallest geographical jurisdiction for measurement : Ward Level

Total operating revenues billed during the given year
This information is generated by VMSS in the annual DCB statement. VMSS uses the DCB statement to calculate this indicator.

Current revenues collect in the given year
VMSS uses this information from the annual DCB statement.

Based on this method, the reliability scale of this indicator is 'A'.

Recommendations
As the reliability scale of this indicator is 'A', there are no improvements proposed in the existing information system.

[19] The budget items (codes) used for calculating operational expenses in sewerage have been provided in Annexure 5.

7. Summary of recommendations and its implementation

Indicator-wise recommendations have been provided in the previous sections wherever applicable. Some recommendations are to be implemented by the water supply, sewerage and SWM department while the rest are to be implemented by other departments of VMSS. This section provides a summary of all recommendations provided in this study alongwith the roles and responsibilities of various departments of VMSS.

Process improvement, studies and surveys proposed

The following process improvement, studies and surveys have been recommended:

General (Accounts, EDP, TP and Revenue Department)

1. Strengthening of the existing SLB cell by employing a full-time coordinator.
2. Develop a software/ intranet system for collating data available on a municipal MIS-like system and generating monitoring reports.
3. Digitise complaints logbooks placed at various ward offices and water supply facilities in the city. Alternatively, where manual registers are maintained, a computer should be installed and connected to the main online complaints system of VMSS.
4. Ensure adherence to accrual based double-entry accounting system to ascertain actual expenses and revenues for each year.
5. Document sharing of staff, machinery & equipment and consumables (such as fuel, spares, etc.) and its related department-wise expenses incurred.
6. Modify the property tax re-assessment form to include information regarding access to individual toilet in each property.
7. Digitise hand-drawn maps of the city (used by Revenue Dept. for property tax) with property tax information linked as attributes.
8. Prepare estimates of the floating population for the city.

Water Supply Department

1. Conduct a sample survey at consumers' end to assess the quantity of water reaching the consumers, duration of supply and pressure at which the water is supplied to the consumer.
2. Plan and conduct water quality tests using UMC's MS Excel based tools in compliance with CPHEEO norms.
3. Engages a 3rd party to conduct an independent periodic water quality assessment.

Sewerage Department

i. Conduct a survey of private borewells in the city to assess quantity of water produced by these and hence, quantity of sewerage generated.
ii. Conduct a survey of all public toilets in the city alongwith precise locations.
iii. Plan and conduct sewage quality testing in compliance with CPHEEO norms.
iv. Work in close coordination with the Water Supply Department to ascertain the exact quantity of sewage generated based on the water supplied to the city.

SWM Department

1. Conduct a sample survey on quarterly basis for various types of waste generators to ascertain the average per capita waste generation.

2. Use the digitised property tax maps and calculate number of HHs served by door-to-door collection vehicles.
3. Conduct trend analysis of bulk waste generators such as temples, construction and demolition waste, etc.
4. Formulate public health bye-laws for implementing segregation at source.
5. Conduct a study for assessing quantity of waste recycled by waste pickers and recyclers.
6. Create an inventory and list of private composting initiatives in the city to ascertain the quantity of waste processed at them.

Infrastructure proposed

In addition to the above forms, the following infrastructural improvements have been recommended:

1. Installation of 113 bulk flow meters at all bulk water production points including
   a. Four French wells at River Mahi
   b. Twenty three tubewells along River Mahi
   c. Eighty borewells within the city
   d. Inlet and outlets of all WTPs
2. Purchase of 242 portable meters and pressure gauges for conducting survey of water quantity, duration of supply and pressure head at consumers' end
3. Installation of a total of 24 bulk flow meters at 8 STP units – 2 meters at the inlet chamber (to measure total inflow and bypass) and 1 at the outlet of treated water

for each STP unit.

4. Create partitions in vehicles for transporting waste in a segregated manner.

List of existing and proposed forms

S. No.	Proposed/ Modified	Form No.	Title of the form
General			
1	Proposed	Form GE01	Households, properties and establishment details
2	Existing	Form GE02	Summary of complaints
Water supply			
3	Proposed	Form WS01	Bulk flow meter readings
4	Proposed	Form WS02	Quantity, duration and pressure of water at consumers' end
5	Proposed	Form WS03	Summary of quality of water
Sewerage			
6	Modified	Form SE01	Bulk flow measurement of sewage inflow, sewage bypassed and treated water produced by STP
7	Proposed	Form SE02	Quantity of water produced by borewells
8	Proposed	Form SE03	Number of HHs without individual toilet and not within walking distance (150 metre) of a public toilet
Solid waste management			
9	Proposed	Form SW01	Households and establishments covered by door-to-door collection of waste
10	Proposed	Form SW02	Waste segregation
11	Proposed	Form SW03	Waste recovered in the city
12	Existing	Form SW04	Total waste collection
13	Existing	Form SW05	Waste disposed at scientific landfill site

Table 8 Proposed indicator-wise forms used for data inputs

Existing forms			SE01		GE02							SW04	SW05	
Proposed forms	GE01	WS01	SE01R	WS02		WS03	SE02	SE03	SW01	SW02	SW03			DCB
Water Supply														
Coverage of Water Supply Connections	✓													
Per capita supply of water	✓	✓												
Extent of metering														
NRW		✓		✓										
Continuity of Water Supply				✓										
Efficiency in redressal of consumer complaints					✓									
Quality of Water Supplied						✓								
Cost Recovery in Water Supply Services														✓
Efficiency in Water Supply-related Charges														✓
Sewerage														
Coverage of toilets	✓							✓						
Coverage of sewage network services	✓													
Collection efficiency of the sewage network		✓	✓				✓							
Adequacy of sewage treatment capacity			✓				✓							
Quality of sewage treatment			✓											
Extent of recycling and reuse of sewage			✓											
Efficiency in redressal of customer complaints					✓									
Extent of cost recovery in sewage management														✓
Efficiency in collection of sewage charges														✓
Solid waste management														
Household level coverage of Solid Waste Management services									✓					
Efficiency of collection of municipal solid waste												✓		
Extent of segregation of municipal solid waste										✓				
Extent of municipal solid waste recovered											✓			
Extent of scientific disposal of municipal solid waste													✓	
Efficiency in redressal of customer complaints					✓									
Extent of cost recovery in Solid Waste Management services														✓
Efficiency in collection of SWM related user charges														✓

Budget for implementation of ISIP

The following table provides a detailed budget estimate for implementation of the recommendations of this ISIP. The key categories of budgeting are:

i. Computerisation
ii. Strengthening of SLB cell
iii. Improvements in information system for water supply
iv. Improvements in information system for sewerage
v. Improvements in information system for SWM

The costs are either one-time costs (such as infrastructure) or annual recurring costs (such as salaries, consumables, etc.). The total amount required for implementation is INR 6.07 crores for the first year and an annual recurring cost of INR 2.33 crores.

All figures in INR.

Calculations are based on prevailing rates as of 2013-14. Detailed estimates should be prepared based on applicable Schedule of Rates.

Items	Unit	Quantity	Rate	Amount (INR)	One-time/ Annual
Computerisation (A)				**32,10,000**	
Digitisation of property tax maps	sqkm	160.0	10,000	16,00,000	One-time
Cost of modifications to property tax re-assessment form	No cost	-	-	-	One-time
Improving complaints mechanism					
Installation of computers at 12 ward offices	No.	12.0	35,000	4,20,000	One-time
Installation of computers at 31 WDS	No.	31.0	35,000	10,85,000	One-time
Installation of computers at 3 WTPs	No.	3.0	35,000	1,05,000	One-time
Strengthening of SLB cell (B)				**14,80,000**	
Salary of SLB Coordinator (Annual)	Lumpsum	1.0	4,80,000	4,80,000	Annual
Software for ISIP	Lumpsum	1.0	10,00,000	10,00,000	One-time
Water Supply (C)				**3,94,20,000**	
Implementing accrual based double entry accounting	No cost		-	-	Annual
Accounting based on sharing of staff and resources	No cost		-	-	Annual

Items	Unit	Quantity	Rate	Amount (INR)	One-time/ Annual
Consumers' end sample survey for quantity, duration and pressure (Yearly)					
Portable consumer meters	No.	242.0	3,000	7,26,000	One-time
Pressure gauges	No.	242.0	2,000.0	4,84,000	One-time
Personnel salary (Annual)	Personnel	242.0	60,000	1,45,20,000	Annual
Compliance to water quality monitoring as per CPHEEO (Yearly)					
Annual cost of personnel for sampling at consumers' end	Personnel	5.0	1,20,000	6,00,000	Annual
Consumables for sampling	Monthly	12.0	10,000	1,20,000	Annual
Lab test costs	No cost	-	-	-	Annual
Independent water quality testing	Monthly	12.0	10,000	1,20,000	Annual
Study for preparing estimates of floating population (yearly)	No.	1.0	5,00,000	5,00,000	Annual
Installation of bulk flow meters				-	
At 4 French wells (meter + automatic meter reading device)	No.	4.0	2,00,000	8,00,000	One-time
At 23 tubewells (meter + automatic meter reading device)	No.	23.0	2,00,000	46,00,000	One-time
At 80 borewells (meter + automatic meter reading device)	No.	80.0	2,00,000	1,60,00,000	One-time
At outlets of 3 WTPs (meter + automatic meter reading device)	No.	3.0	2,00,000	6,00,000	One-time
Software for meter readings	Lumpsum	1.0	3,50,000	3,50,000	One-time
Sewerage (D)				**1,01,50,000**	
Cost of modifications to property tax re-assessment form	Lumpsum	1.0	-	-	
Survey of all public toilets in the city	Lumpsum	1.0	10,00,000	10,00,000	One-time
Installation of bulk flow meters					
Installation of bulk flow meters at inlets and outlets of all STP units (meter + automatic meter reading device)	No.	24.0	2,00,000	48,00,000	One-time
Software for meter readings	Lumpsum	1.0	3,50,000	3,50,000	One-time
Survey of private borewells	Lumpsum	1.0	30,00,000	30,00,000	Annual
Sewage quality testing compliance with CPHEEO	Lumpsum	1.0	10,00,000	10,00,000	Annual

Items	Unit	Quantity	Rate	Amount (INR)	One-time/ Annual
SWM (E)				**65,00,000**	
Sample survey for waste generation per capita by type of users (quarterly)	Lumpsum	4.0	5,00,000	20,00,000	Annual
Comprehensive study on SWM including trend analysis of waste generated by special categories like temples and C&D, etc., waste picking, recyclers, etc.	Lumpsum	1.0	5,00,000	5,00,000	Annual
Prepare Public Health Bye-laws	Lumpsum	1.0	10,00,00	10,00,000	
Inventory of private composting initiatives in the city	Lumpsum	1.0	5,00,000	5,00,000	Annual
Partitioning of all Door-to-door vehicles	No.	250.0	10,000	25,00,000	
TOTAL (A+B+C+D+E)				**6,07,60,000**	

8. Way forward

This ISIP identifies the gaps in existing information system of VMSS to calculate reliable SLB indicators for water supply, sewerage and SWM sectors. The plan also defines roles and responsibilities of each department and outlines overall estimate for each recommendation.

While implementing the recommendations, UMC suggests that the following activities be undertaken

1. Explore technological options for automated SMS/ GPRS based meter/ valve operation data recordings mechanisms and assess their suitability for water supply system in VMSS[20].
2. Design dashboards for staff at various levels (Junior Engg., Deputy Executive Engg., Executive Engg., Additional City Engg., City Engg., Municipal Commissioner, etc.) based on their needs.
3. Design/ modify/ augment internal data flow and reporting within VMSS.

Municipal information improvement is the first step which VMSS has taken towards managing its resources and taking a step towards smart city. World-over cities are utilising 'big data' to improve their service delivery to the citizens. VMSS should study how cities around the world are adopting smart city concepts to improve their services.

[20] Based on the existing situation assessment, it revealed that VMSS has minimal reliable data recording practices/ equipment, and hence most of the indicators fall in reliability grade D. In order to implement any ISIP initiative, a bulk metering to assess the total quantity of water supplied is absolutely essential. With this premise, in order to proceed with the ISIP the following hardware/ equipment installations are necessary

1. Installation of bulk meters at all sources (4 French Wells & 100+ tubewells) and 27 WDS
2. Installation of automatic (SMS/ GPRS based) data recording devices and software at all bulk meters
3. Installation of bulk meters and devices to record valve operation timings for 2000+ valves in the distribution network alongwith installation of SMS/ GPRS based automatic recording devices
4. Software for data compilation, processing and reporting

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Annexures

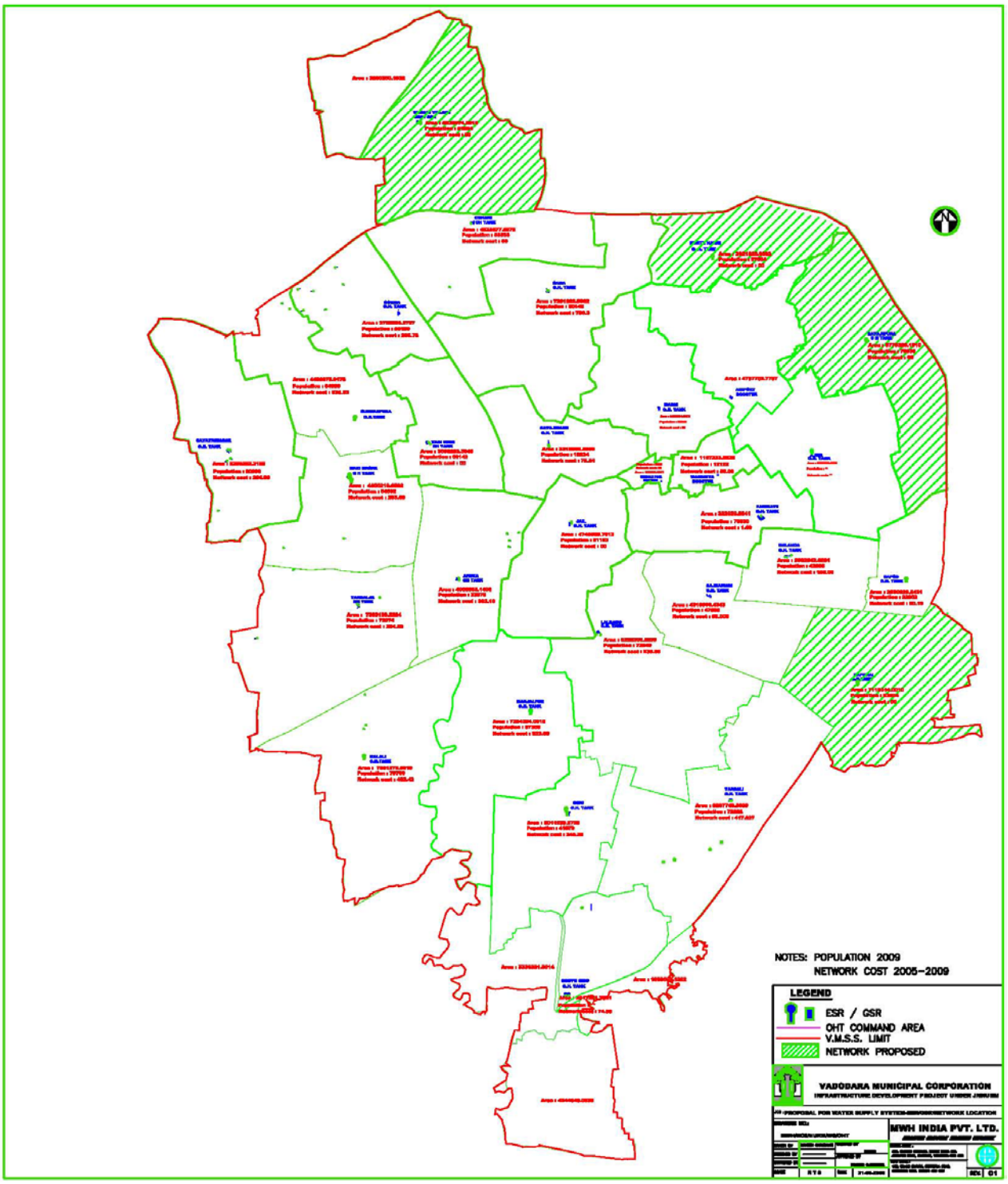
Annexure 1 List of water distribution stations in Vadodara

Zone	S. No.	Tank name	Population (2011)	Command area (sqkm)	Water supplied daily (MLD)
SZ	1	Gajarawadi	58,226	4.37	13.04
	2	Kapurai*	58,842	6.62	-
	3	Nalanda	52,231	3.31	12.49
	4	Bapod	23,553	1.31	1.27
	5	Tarsali	52,484	7.55	12.59
	6	Manjalpur	43,857	6.57	11.27
	7	GIDC	29,593	5.13	1.89
	8	South GIDC	61,103	12.11	2.94
EZ	1	Panigate	81,515	3.74	30.55
	2	Warashia booster	10,191	1.06	2.97
	3	Ajwa	122,052	5.53	20.33
	4	Airport booster	47,651	5.38	6.16
	5	Sayajipura*	87,680	5.26	-
	6	North harni*	28,158	3.18	-
NZ	1	Lalbaug	91,641	8.01	19.34
	2	Jail	58,611	4.37	15.42
	3	Sayajibaug	44,208	3.08	7.37
	4	Vehiclepool booster	9,947	0.49	-
	5	Harni	64,676	4.28	19.40
	6	Sama	64,312	7.19	11.33
	7	Extra*	28,358	3.16	-
	8	Chhani Village*	59,327	6.61	-
	9	Chhani Jakat	39,800	4.43	12.36
WZ	1	Subhanpura	55,896	3.71	16.04
	2	Gorwa	48,259	2.77	11.68
	3	Wadiwadi	57,450	3.27	6.85
	4	Harinagar	54,652	5.54	13.76
	5	Gayatrinagar	57,415	6.77	13.86
	6	Kalali	70,382	7.07	3.64
	7	Tandalja	56,274	6.69	14.19
	8	Akota	48,150	5.28	13.08
Total			**16,66,494**	**153.84**	**293.82**

*Note: * represents the WDS zones in which water distribution network and stations are either under construction or are non-functional.*

Source: VMSS, 2013

Annexure 2 Map showing command areas of various water distribution stations in Vadodara



Source: VMSS, 2013

Annexure 3 Budget codes for calculating water supply related operational expenses, 2012-13

Budget code	Headings
Repairs/maintenance costs	
B0401301	Water storage maintenance
B0401302	To buy pipe and fitting, store(ward)
B0401303	Hand pump maintenance
B0401304	Meters maintenance
B0401310	Maintenance
B0401311	Ajwa water storage construction maintenance
B0401312	Nimeta filter bed maintenance
B0401313	Store
B0401314	Pratapura lake Asoj Vishwamitri feeder maintenance
B0401315	Maintenance
B0401317	Mahi river royalty charge and Panam dam maintenance
B0401318	To expand & maintain surrounding channel pond of Mahi intake well, Panam well 2,3
B0401330	Maintenance
B0401331	Store
B0401345	Maintenance
B0401346	Store
B0401350	Install pumping station valve
B0401351	Harni airport sump maintenance
B0401357	Maintenance of existing tanks
B0401364	Fabrication work of leakage pipe
B0401375	Buster maintenance
B1302301	Maintenance of well, lake
B1302302	Maintenance of Sursagar lake
Parishisht 4- nibhavani	Maintenance
Parishisht 4-store kharidi	Store
Regular staff and administration	
B0401101	Permanent staff (schedule no. 61 to 87)
Outsourced/contract staff costs	
B0401201 to 06	General contingency
Electricity charges/fuel costs	
B0401403 to 05, 11, 17, 19 & *Parishisht* 4	Electricity bill
Chemical costs	
B0401305	Liquid chlorine expense for overhead tank
B0401316 and 19	Store
Other costs	
B0401356	To construct community stand post

Annexure 4 Budget codes for calculating sewerage related operational expenses, 2012-13

Budget code	Headings
Regular staff and administration	
B0501101	Permanent staff(schedule no. 88)
	Permanent staff on work site (schedule no. 89) sewage laboratory staff
	Permanent staff(schedule no. 90)
B0502101	Permanent staff(schedule no. 91)
	Permanent staff on work site (schedule no. 92) sewage laboratory staff
Outsourced /contract staff costs	
B0501201	General contingency
B0501202	General contingency
B0502201	General contingency
B0502202	General contingency
Electricity charges /fuel costs	
B0501401	Electricity bill
B0502421	Electricity bill
Parisist 6 electricity	Electricity bill
Chemicals costs	
B0501330	Sewage laboratory chemicals and glassware maintenance
B0501303	Store
B0502344	Store(ward)
Others (specify)	
B0501329	Inspection fee
B0502342	Water prevention and control pollution cess act 1987
B0504301	Maintenance of toilet & urinal electric light and connection in *chawl*, tribal areas, slums (ward)
B0504302	Sulabh toilets
Budget code	Headings
Repairs/maintenance costs	
B0503301	Gutter maintenance by ward
B0501301	To buy oil and equipment
B0501302	Underground sewerage maintenance
B0501328	Pumping station maintenance
B0502301	To buy oil and equipment
B0502343	Temporary pump maintenance
B0503302	Store(ward)
B0503303	Underground sewerage maintenance by ward
B0503304	Store
B0503305	Drainage line cleaning by ward
B0503306	Store(ward)
B0503307	Drainage pressure and gravity line maintenance and inspection, emergency work
B0503308	Store(ward)
B1303301	Storm water drainage maintenance
B1303302	Store
Parisist 6 nibhavani	Maintenance

Budget code	Headings
Parisist 6 store kharidi	Store(ward)
Contractor costs for O&M	
B1303201	General contingency
B0503309	Drainage line cleaning and to run contract basis temporary electric & diesel pump

Annexure 5 Budget codes for calculating SWM related operational expenses, 2012-13

Budget code	Headings
Regular staff and administration	
B0701101	Road sweeping staff
B0702101	Permanent staff (sch-103,104)
B0703101	Permanent staff (sch-105)
Outsourced /contract staff costs	
B0702310	Door to door contract expenses
Electricity charges /fuel costs	
B0702302	Electricity expenses for composting plant
Chemicals costs	
B0701301	Store purchase
B0701302	Purchase bleaching, powder, phenyl, etc.
Others (specify)	
B0702201	Contingency
B0702202	SWM contingency
B1603310	Scholarship for SWM employee
Repairs/maintenance costs	
B0702301	Container removal expenses
B0702302	Compost manure plant
B0702303	Container platform maintenance
B0702304	Dustbin, handcarts, container maintenance
B0702305	Machinery maintenance
B0702307	Transfer site maintenance
B0702308	Miscellaneous store purchase for repair and maintenance
B0702309	Scientific disposal expenses
B0702311	Scientific disposal of solid waste according to SWM rule 2000 expenses
B0703101	Vehicle repair expenses
B0703102	Tyre tube for vehicle
Contractor costs for O&M	
B0702306	Transportation contract for waste picking from ward
B0702310	Door to door contract expenses
B0702312	Vehicle on contract

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