THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
MINISTRY OF CITY PLANNING AND WATER SUPPLY
MINISTRY OF POLICY PLANNING AND ECONOMIC AFFAIRS
NATIONAL WATER SUPPLY AND DRAINAGE BOARD

THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)

FINAL REPORT

MAY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIHON SUIDO CONSULTANTS CO., LTD.

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SECTION OF THE FINAL REPORT

SECTION I
STRATEGIC SEWERAGE MASTER PLAN

SECTION II
FIVE CITIES' MASTER PLAN

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EXCHANGE RATE
(As of May 2017)

1LKR = 0.74041 JPY
1USD = 150.340 LKR
1USD = 111.313 JPY

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ABBREVIATIONS AND TERMINOLOGY

ADB	Asian Development Bank
AFD	Agence Française de Development
Addl. GM	Additional General Manager
ASRT	Aerobic Solids Retention Time
AGM	Assistant General Manager
ATP	Affordability To Pay
BOD	Biochemical Oxygen Demand
BOI	Board of Investment
CBO	Community Based Organization
CEA	Central Environmental Authority
CMC	Colombo Municipal Council
COD_{Cr}	Chemical Oxygen Demand
DCS	Department of Census and Statistics
DGM	Deputy General Manager
EIA	Environmental Impact Assessment
EPL	Environmental Protection License
EPZ	Export Processing Zone
ERD	Department of External Resource
ETWWA	Energy, Transport, and Water Department of the World Bank
F/S	Feasibility Study
FY	Financial Year
GC	Greater Colombo
GOSL	Government of Sri Lanka
GCS	Greater Colombo Sewerage
IBRD	International Bank for Reconstruction and Development
IEE	Initial Environmental Examination
IFRS	International Financial Reporting Standard
IRR	Internal Rate of Return
JCC	Joint Coordinating Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
JECES	Japan Education Center of Environmental Sanitation
JPY	Japanese Yen
JSWA	Japan Sewage Works Agency
LKR	Sri Lanka Rupee
MASL	Mahaweli Authority in Sri Lanka
M&E	Mechanical and Electrical
MC	Municipal Council
M/M	Minutes of Meeting
MOPPEA	Ministry of Policy Planning and Economic Affairs
MOCPWS	Ministry of City Planning and Water Supply
MOPCLG	Ministry of Provincial Councils & Local Government
MRT	Minimum Rate Test
NWSDB	Notional Water Supply & Drainage Board
O&M	Operation and Maintenance
OD	Oxidation Ditch
PPIAF	Public-Private Infrastructure Advisory Facility

PS	Pradeshiya Sabha
ROA	Return on Asset
ROE	Return on Equity
RSC	Regional Support Center
SHIFT	Sanitation and Hygiene Initiative for Towns
SIDA	Swedish International Development Cooperation Agency
SJKMC	Sri Jayawardenapura Kotte Municipal Council
SLS	Sri Lanka Standard
STP	Sewage Treatment Plant
TA	Technical Assistance
TSS	Total Suspended Solids
UC	Urban Council
UDA	Urban Development Authority
UNDP	The United Nations Development Programme
WACC	Weighted Average Cost of Capital
WAST	Weighted Average Sewerage tariff
WB	World Bank
WDF	Waste Discharge Fee
WHO	World Health Organization
WQI	Water Quality Index
WTP	Water Treatment Plant

ACKNOWLEDGEMENTS

This report was developed from the results of a study titled "Project for the Strategic Master Plan Under the Sewerage Sector in the Democratic Socialist Republic of Sri Lanka" undertaken by the Technical Committee of NWSDB and the JICA Expert Team (JET).

Technical Committee of NWSDB and JET are grateful to all members of the Joint Coordinating Committee (JCC) and Technical Committee including the Chairpersons Secretary to the Ministry of City Planning & Water Supply and Additional General Manager (Addl. GM) (Sewerage) of the National Water Supply & Drainage Board (NWSDB), for contributing their knowledge, comments, opinions and time to the development of this work.

The organizations that have provided support to make this report a reality are too many to list. Here is an attempt to name a few:

- Department of Census and Statistics (DCS)
- Department of Survey
- Central Environmental Authority

Technical Committee of NWSDB and JET are also grateful to the Japanese International Cooperation Agency for providing necessary guidance and its perspectives on various matters during the period of this study.

EXECUTIVE SUMMARY

Chapter 1 describes the water supply and sanitation situation in Sri Lanka where there is only 2.4% sewer coverage and almost all domestic wastewater is discharged into rivers and ocean without treatment. Although the country is realizing 7.3% economic growth (2013) and reaching upper-middle-income (2016), it is still burdened with poor public sanitation and a sharp decline in drinking water quality.

Chapter 2 explains the necessity of a Strategic Sewerage Master Plan.

- Guided by the national policy and Millennium Development Goals (MDG), the government aims to increase the sewerage coverage to 7.0% by 2020.
- The Strategic Sewerage Master Plan proposes the roadmap to achieve this national goal.

The plan focuses on the following:

- Achieving 100% access to sanitation facilities for Sri Lankan citizens by 2025 (from 93% in 2015).
- Developing sewerage systems in major cities and regions, experiencing rapid economic growth.
- Installing and improving on-site facilities where there is no access to sewerage facilities.

One of the Sustainable Development Goals (SDGs) aims "to improve water quality by reducing unprocessed greywater by half". In Sri Lanka, 84% of the greywater is processed in septic tanks. Further water quality improvement must come from more efficient treatment by sewage treatment plants as well as on-site facilities.

Chapter 3 describes Sri Lanka's socio-economic and environmental conditions, and the country's administrative structure. The status of 79 cities in the targeted regions, including population, water supply coverage, wastewater discharge locations, is also presented.

Chapter 4 describes how the country is handling sewage and wastewater:

- Though about 90% of the Sri Lankan population has access to sanitation facilities, the sewerage system coverage is only 2.4%. Sewage is mostly treated in septic tanks (on-site facilities).
- Installation and maintenance of septic tanks is the responsibility of users or homeowners, and inappropriate maintenance and processing of septic tank sludge is common.
- Financing for sewerage systems depends on the financial status of NWSDB's sewerage section. The budget for sewerage is rather unstable. The sewerage tariff must be increased to realize sustainable operation.
- Industrial wastewater is processed properly in industrial parks established by the Board of Investment (BOI) of Sri Lanka and some private industrial parks, but not in other industrial parks. The situation for wastewater from hospitals is similar.

Chapter 5 describes the "City Sewerage Master Plan" for target cities. 79 cities were evaluated based on population, population density, rate of waterborne diseases, water supply coverage, presence/absence of tourist attractions, presence/absence of economic growth centres, water bill collection rate, median household income, presence/absence of water intake points, impact of pollution loads on public water bodies, and sewerage development plan status. The following criteria were established to select the cities for development to bring the sewerage system coverage to 7%.

- Urbanization Status
- Sanitation
- Urban Development
- Sustainability of Sewerage System Business
- Water Environment
- Maturity of Sewerage Projects

15 cities (Colombo Municipal Council (MC), Kandy MC, Sri Jayawardenepura-Kotte MC, Anuradhapura MC, Badulla MC, Kelaniya PS, Nuwara Eliya MC, Galle MC, Dehiwala-Mount Lavinia MC, Negombo MC, Kotikawatta–Mulleriyawa PS, Ratnapura MC, Hambantota MC, Trincomalee UC, Maharagama UC) were selected. These have relatively high population density and are either high economic growth centers or serious polluters of public waterways.

Five cities were further selected from this lot for City Sewerage Master Plan implementation, based on the following considerations:

- Cities that do not have overlapping projects with assistance from CMC or other donors.
- Cities that do not have a sewerage system implementation plan, and which will make important strategic contributions to regional development in Sri Lanka.

The five cities are:

- Sri Jayawardenepura Kotte Municipal Council (MC)
- Anuradhapura MC
- Badulla MC
- Nuwara Eliya MC
- Dehiwala-Mount Lavinia MC

Installation of sewerage systems in the 15 cities is estimated to cost about 3.85 billion dollars.

Chapter 6 describes on-site facility improvement plans. The construction of sewage treatment plants would give priority to regions where septic tank installation is difficult. The biggest problem with on-site facilities is processing and disposal of septic tank sludge. The challenges that some cities face are mainly in the following areas:

- Close to lagoons or reservoirs
- Poor drainage
- Low elevation
- Wet climate with frequent flooding

The 74 cities investigated are grouped into the three categories for action. Excluding cities targeted for sewerage system installation, 11 cities with existing problems are considered for urgent installation. Potential problems are recognized in 13 cities where improvement is recommended. The rest do not warrant priority action at this time.

- Urgent installation (having existing problems)
- Cities in wet zones or dry zones which border on lagoons, cities in coastal wet zones with poor drainage, cities in lowland wet zones with poor drainage.
- Cities requiring improvement (with potential problems)
- Cities in wet zones where wetlands have been filled in, cities in dry zones with poor drainage.
- Other (not priority)

Sewage treatment plant construction for cities requiring urgent installation, will cost about 1.3 billion Sri Lanka Rupee (LKR), 2.4 billion LKR for cities requiring improvement, and 8.5 billion LKR for other cities.

Chapter 7 summarizes the following challenges for achieving 7.0% sewerage coverage by 2020:

- Securing 220 million dollars per year in construction funding
- This amount accounts for 85% of the current government budget for NWSDB (2016 budget was 35 billion LKR or 241 million USD).
- Securing Operation and Maintenance (O&M) staff
- Only Colombo and surrounding areas have sewerage systems at this time. Tripling the coverage from the current level would need a lot of extra human resources.
- Securing land for sewage treatment plants and pumping stations
- Treatment plants require anywhere from 0.8 m^2 (Kandy) to 1.2 m^2 (Soyzapura) of land per cubic meter per day of processing capacity. This land requirement is based on facilities that are being constructed:16,700 m^2 for the oxidation ditch (OD) process in Kandy (capacity 14,000 m^3/d), and 13,000 m^2 for the anaerobic-aerobic (AO) process in Soyzapura (capacity 17,000 m^3/d).
- Based on performance values of 0.02 m^2～0.07 m^2 , 364 m^2 is required for pumping stations in Mount Lavinia [capacity 19,000 m^3/d (=814*24)], and 1,012 m^2 in Kandy.
- Securing sludge disposal site and sludge composting
- 706 m^3 of waste sludge from treatment plants (80% water content) will need to be disposed of per day in 2035. The amount can be cut by 282 m^3/d (water content at 50%), if the dewatered sludge is composted. The disposal of sludge over a 20-year period would require 21 ha, assuming the height of the landfill is 10 m.

The NWSDB sewerage department needs to be expanded to cope with the sewerage:

- Suggestion 1
  Establish two new DGM positions: DGM (planning and engineering) and DGM (O&M); and a new division in the relevant Regional Support Centers (RSCs) to handle O&M for sewerage systems in rural areas. The sewerage department at the head office will provide technical support to these RSC sewerage offices.
- Suggestion 2
  Establish a new DGM (construction) to manage and monitor the increasing number of sewerage projects.

Suggestion 1 should be implemented first, while suggestion 2 can be implemented as more projects come on stream.

The NWSDB sewerage department must implement sewerage tariffs incrementally to secure adequate funding to cover the O&M cost. Rates can be raised by 23.5% in 2019 and again in 2022 (without adjusting for inflation). After the second increment, the average household would only reach 50-60% of its ability to pay (World Bank (WB) Affordability To Pay (ATP) = 1% of average household income). That means the sewerage charges are affordable.

CHAPTER 1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION AND BACKGROUND

The average per capita income in the Democratic Socialist Republic of Sri Lanka is USD 3,162 in 2013. With an economic growth of 7.3% (JETRO: Sri Lanka Economic Index), the country is expected to raise the average per capita income to USD 4,000 by 2016, becoming one of the newly developed industrialized countries. This pace of growth results in rapid urbanization and increased water supply demand, along with increased burden on the disposal of domestic and industrial wastewater.

Urban sewerage coverage in the country was only 2.0% in 2014. A considerable amount of wastewater is discharged into the ocean, rivers, and streams without treatment, causing sanitation problems and environmental degradation.

In 2010, recognizing the importance of potable water supply and sewerage services as an integral element of sustainable development, the Government announced the intention to achieve 100% sanitation coverage by 2025, through the provision of on and off-site sanitation facilities. The Government committed to develop the Strategic Sewerage Master Plan to improve the water environment to meet the stringent environmental standards introduced by the Central Environmental Authority (CEA). The Government sought assistance from Japan in this effort. Japanese government accepted the application; subsequently Japanese International Cooperation Agency (JICA) signed a Record of Discussions with the Sri Lankan side in August of 2015, and carried out a study on the existing situation and formulated the Strategic Strategic Master Plan.

The two sides agreed on the following:

(1) Purpose

Establishing a master plan (M/P) to address the challenges facing the sewerage sector in major cities in Sri Lanka to contribute to mitigating pollution of rivers and oceans.

(2) Outputs

1) Strategic Sewerage M/P for Sri Lanka
2) City Sewerage M/P for priority cities
3) Feasibility Studies (F/S) for selected cities
4) Enhanced capacity of the National Water Supply and Drainage Board and selected cities

This report (Section I) presents the Strategic Sewerage Master Plan, for the development of the sewerage sector and improving on-site facilities.

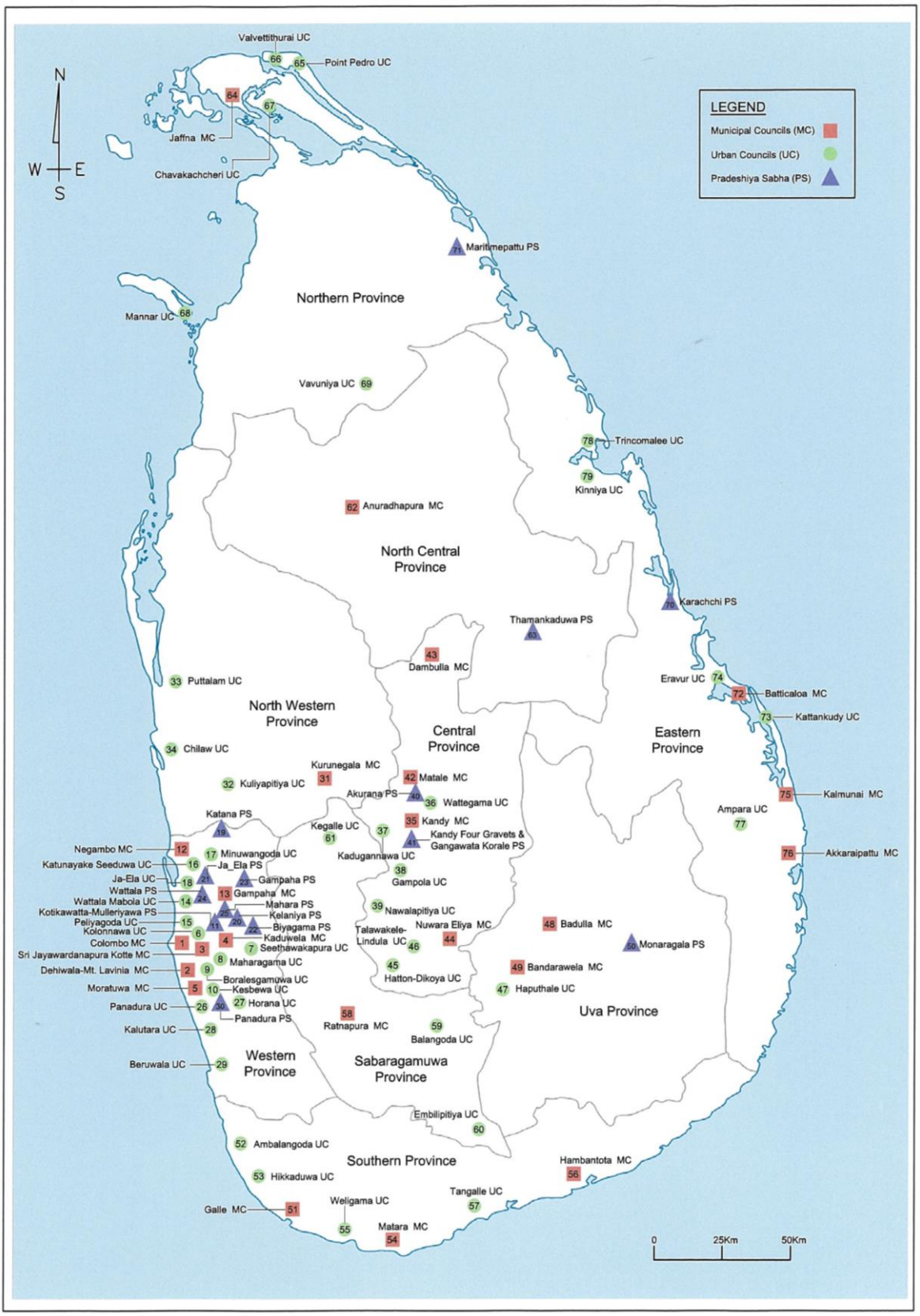
Table 1.1-1 List of 79 MCs/UCs/PSs Surveyed

Local Government Authority	District	**Province**
1. Colombo MC (District Capital)	Colombo	**Western**
2. Dehiwala–Mt. Lavinia MC		
3. Sri Jayawardenapura Kotte MC		
4. Kaduwela MC		
5. Moratuwa MC		
6. Kolonnawa UC		
7. Seethawakapura UC		
8. Maharagama UC		
9. Boralesgamuwa UC		
10. Kesbewa UC		
11. Kotikawatta–Mulleriyawa PS		
12. Negombo MC	Gampaha	
13. Gampaha MC (District Capital)		
14. Wattala - Mabole UC		
15. Peilyagoda UC		
16. Katunayake -Seeduwa UC		
17. Minuwangoda UC		
18. Ja-Ela UC		
19. Katana PS		
20. Kelaniya PS		
21. Ja – Ela PS		
22. Biyagama PS		
23. Gampaha PS		
24. Wattala PS		
25. Mahara PS		
26. Panadura UC	Kalutara	
27. Horana UC		
28. Kalutara UC (District Capital)		
29. Beruwala UC		
30. Panadura PS		
31. Kurunegala MC (District Capital)	Kurunegala	**North Western**
32. Kuliyapitiya UC		
33. Puttalam UC (District Capital)	Puttalam	
34. Chilaw UC		
35. Kandy MC (District Capital)	Kandy	**Central**
36. Wattegama UC		
37. Kadugannawa UC		
38. Gampola UC		
39. Nawalapitiya UC		
40. Akurana PS		
41. Kandy Four Gravets&GangawataKorake PS		
42. Matale MC (District Capital)	Matale	
43. Dambulla MC		
44. NuwaraEliya MC (District Capital)	NuwaraEliya	
45. Hatton-Dickoya UC		
46. Thalawakele-Lindula UC		
47. Haputale UC	Badulla	**Uva**
48. Badulla MC (District Capital)		
49. Bandarawela MC		
50. Moneragala PS (District Capital)	Moneragala	
51. Galle MC (District Capital)	Galle	**Southern**
52. Ambalangoda UC		
53. Hikkaduwa UC		
54. Matara MC (District Capital)	Matara	
55. Weligama UC		

Local Government Authority	District	**Province**
56. Hambantota MC (District Capital)	Hambantota	
57. Tangalle UC		
58. Rathnapura MC (District Capital)	Ratnapura	**Sabaragamuwa**
59. Balangoda UC		
60. Embilipitiya UC		
61. Kegalle UC (District Capital)	Kegalle	
62. Anuradhapura MC (District Capital)	Anuradhapura	**North Central**
63. Thamankaduwa PS (District Capital)	Polonnaruwa	
64. Jaffna MC (District Capital)	Jaffna	**Northern**
65. Point Pedro UC		
66. Velvettithurai UC		
67. Chavakachchery UC		
68. Mannar UC (District Capital)	Mannar	
69. Vavuniya UC (District Capital)	Vavuniya	
70. Karachchi PS (District Capital)	Kilinochchi	
71. Maritimepattu PS (District Capital)	Mullaitivu	
72. Batticaloa MC (District Capital)	Batticaloa	**Eastern**
73. Kathankudi UC		
74. Eravur UC		
75. Kalmunai MC	Ampara	
76. Akkaraipattu MC		
77. Ampara UC (District Capital)		
78. Trincomalee UC (District Capital)	Trincomalee	
79. Kinniya UC		

Source: JET

Table 1.1-1 shows the 79 cities surveyed and their locations in **Figure 1.1-1**.



Source: JET

Figure 1.1-1 Locations of 79 Cities

CHAPTER 2 RATIONALE FOR MASTER PLAN

2.1 CURRENT SITUATION

Most sewerage systems in Sri Lanka do not provide treatment, consisting only of sewers and pumping stations. The sewerage system coverage is only 2.4%. 84% of the population uses an on-site sanitation such as septic tanks, which do not work well in densely populated areas or where the groundwater table is high and soil penetration not effective.

Table 2.1-1 Sanitation Coverage in Sri Lanka (2012)

Type of Sanitation	Estimated Population Coverage	
	Nos.	%
Pipe-borne sewerage facility (off-site)	486,329	2.4
On-site sanitation facility	17,021,528	84.0
Other sanitation (including sharing with another household, common/public toilets)	2,411,383	11.9
Unknown sanitation types (not using toilets)	344,483	1.7

Source: JET

Most existing sewers are in the Western Province: greater Colombo (GC) metropolitan area, Dehiwala-Mt. Lavinia MC and a part of Kolonnawa UC. Wastewater from these areas is discharged, without treatment into the Indian Ocean, through two outfall pipes in Wellawatte and Mutwal. There are also sewers in neighbouring areas of Dehiwala-Mt. Lavinia and Moratuwa, installed through the "Moratuwa/Ratmalana Sewerage Scheme" undertaken by the Swedish International Development Cooperation Agency (SIDA). A portion of the wastewater from these sewers is treated by a sewage treatment plant constructed with SIDA funds.

In the Western Province, sewers are being installed in the industrial region of Ekala and the surrounding residential area under the "Ja-Ela/Ekala Sewerage Scheme", supported by SIDA fund.

Outside the Western Province, small-scale public sewerage systems were developed in Uva province under the Kataragama Sewerage Scheme and in Hikkaduwa province under the Hikkaduwa Sewerage Scheme. The Kataragama Sewerage Scheme serves Uva residents and pilgrims visiting the Kataragama PS, while the Hikkaduwa Sewerage Scheme developed with aid from the Australian Agency for International Development (AusAID), targets the residents and lodging facilities of the tourist area of Hikkaduwa UC.

In addition, some housing schemes have their own sewer networks or sewage treatment facilities.

2.2 GOVERNMENT POLICY AND NATIONAL TARGET

In 2010, the Sri Lankan government declared water and sanitation to be an "inalienable right," and set the goal of developing the infrastructure to provide access to safe drinking water and sanitation facilities for the entire country by 2025. The administration at the time set the following development goals:

> *As environmental pollution progresses, we promote comprehensive sanitation facilities and water supply facilities. Sanitation and water supply cannot be separated from one another. For example, we will provide intensive wastewater facilities on a priority basis to areas where population density is high, such as Galle, Hambantota, Trincomalee, Jaffna, Kandy, Kurunegala, Jayawardenepura Kotte, the holy city of Kataragama, and Kathankudi.*
> *(Mahinda Chinthanaya, 2010, page 65)*

For sanitation, the policy points to the development of sewerage and sanitation systems in the following emerging cities where economic activities and populations are expected to increase significantly by 2020.

- Kandy
- Hambantota
- Trincomalee
- Dambulla
- Jaffna
- Galle
- Gampaha
- Kurunegala
- Nuwara Eliya
- Vavuniya
- Badulla
- Matara
- Anuradhapura
- Ratnapura

The national target to collect 7% of the sewage by 2020 was set under the 2005 Millennium Development Goals (MGD). It is shown in **Table 2.2-1**. To achieve this target the government commits to provide the following:

- Access to adequate sanitation for 93% of population of Sri Lanka by 2015 and 100% by 2025
- Piped sewers in selected growth centres and major urban areas
- Acceptable on-site sanitation to those not connected to sewer systems

Table 2.2-1 Sri Lankan Government Targets for Reticulated Sewerage Systems

Year	2005	2009	2015	2020
Sewer Reticular System Coverage	2%	2.5%	3%	7%

Source: Mahinda Chinthanaya 2010 (Page 61,62)

As of 2012, access to appropriate sanitation in Sri Lanka was 98.3%, only 1.7% from achieving 100% access (**Table 2.1-1**).

The United Nations' Sustainable Development Goals (SDGs) related to sanitation aims to "ensure availability and sustainable management of water and sanitation for all by 2030", and sets forth the following specific targets:

- Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation by 2030.
- Improve water quality by halving the proportion not served by sewerage treatment facilities by 2030.

As of 2012, sewage from 84% of the Sri Lankan population is handled in septic tanks. However, to improve water quality under the SDGs, development of sewage treatment plants is needed to improve the treatment efficiency and effectiveness.

2.3 NECESSITY OF STRATEGIC SEWERAGE M/P

Most of Sri Lanka has on-site sanitation facilities. Septic tanks are not as cost effective as sewerage systems for urban centres with high population density, such as the GC metropolitan area. In many

major cities along the coast, where the groundwater table is high and soil penetration poor, septic tanks do not treat wastewater properly before it is discharge into ditches and rivers.

Sewerage coverage in Sri Lanka is only 2.4%. Compared to 40% water supply coverage, sewerage development is seriously lagging. It is urgently required to improve sewage treatment by replacing septic tanks with sewerage systems. The Strategic Sewerage M/P will provide direction for wastewater infrastructure planning, investment and implementation for an extended planning horizon. The review of existing infrastructure, identification of future needs and appropriate treatment process, and setting of development priority for in this exercise will ensure benefits to public health and meeting of environmental goals.

CHAPTER 3 PROJECT AREA

3.1 ADMINISTRATIVE STRUCTURE

In Sri Lanka, national policies are implemented through local, provincial and central governments, represented by local authorities (LAs) i.e. municipal councils (MCs), urban councils (UCs) and pradeshiya sabhas (PSs), provincial councils (PCs) and a host of government ministries. The principal governmental entities responsible for the provision and regulation of water supply and sewerage services are the Ministry of City Planning and Water Supply (MOCPWS), the NWSDB and local government authorities: MCs. UCs and PSs. **Table 3.1-1** shows the ministry and statutory organizations involved in sewerage management.

Table 3.1-1 Ministries and Statutory Organizations Involved in Sewerage Management

Government Ministry	Department/Statutory Organization Related to Sanitation Sector	Functional Areas and Responsibilities Relevant to Sanitation Sector
MOCPWS	1. NWSDB 2.Community Water Supply and Sanitation Project (CWSSP)	1. Formulation of policies, programs, projects based on national policy in respect of water supply & sewerage services and provide assistance in implementation of such programs and projects 2.Investigation, planning, design, construction, O&M of water supply and sewerage services
Ministry of Provincial Councils & Local Government (MOPCLG)	1. Provincial Councils (PCs) 2. Municipal Councils (MCs) 3. UCs 4. PSs	1. Implementation of policies, plans and programs related to sanitation services in respect of Provincial Councils and Local Government Authorities 2. Government functions relating to Local Authorities 3. Granting loans to Local Government Authorities for public utility works.
Ministry of Mahaweli Development and Environment	1.Central Environmental Authority (CEA) 2.Marine Pollution Prevention Authority (MPAA)	1.Implementation of policies, plans and programs in respect of environment and natural resources 2. Prevention of marine pollution; 3.Environmental protection and management 4.Conservation of river catchments and major reservoirs 5.Conservation and sustainable development of natural resources
Ministry of Megapolis and Western Region Development	1.Urban Development Authority (UDA) 2.Urban Development and Low-Income Housing Project (UDLIHP) 3.Colombo Environment Improvement Project (CEIP) 4.Sustainable Cities and Township Development Project (SCTDP)	1.Formulation of policies, programs and projects in respect of physical planning, urban development and assistance in implementation of such programs and projects 2. Urban planning and development 3.Assist Urban Local Authorities to improve urban Infrastructure facilities and housing 4.Provision of public utility services to under-served settlements 5.Environmental improvement in Colombo Metropolitan Area 6.Provision of water supply and sanitation services in rural areas

Source: JET

MOCPWS is responsible for establishing policy for the water supply and sewerage sectors and for coordination with and management of the financially independent public corporation - NWSDB. MOCPWS introduces large-scale infrastructure plans for water supply and sewerage. This ministry coordinates implementation, but bears no responsibility for securing funding for NWSDB projects. The Ministry of National Policy and Economic Affairs (MONPEA) and External Resources Department (ERD) are responsible for securing foreign aid funding.

MOCPWS establishes the policy to achieve the government's national goals, determines whether local governments or the NWSDB should be implementing water supply and sewer projects, approves

expenses, and resolves disputes. Local governments that have authority over water supply and sewer projects will continue to be responsible for these projects, and set fees for users.

Under the current system, NWSDB and local government jurisdictions sometimes overlap. Under the 1949 Municipal Council and UC regulations, local governments bear legal responsibility to provide a wide array of services, including water supply and sewer services. Local governments also have the right to raise taxes, levy fees, and institute bylaws in relation to these responsibilities.

NWSDB was established in 1974 to implement water supply and sewer plans for the areas under its jurisdiction. While the central government sanctions the activities of NWSDB, the law is unclear about the authority of public corporations. The authority over water supply and sewer projects is held by MOCPWS. Authorities reserved by central government ministries include:

- Appointing the Chairman, Vice Chairman and members of the Board of Directors of the NWSDB.
- Giving the Board general and specific directions in carrying out its obligations in areas that affect national interests (e.g. security, economy, and essential services).
- Approving any voluntary transfer schemes involving NWSDB and any land transfer by compulsory order from local authorities to NWSDB, in the event of mismanagement or default in water supply payments. Compulsory orders must have concurrence from the Ministry in-charge of provincial councils and local government.
- Approving any contract between NWSDB and a private operator.
- Resolving disputes between the NWSDB and a government entity or with the entity that entered in to a joint activity with the NWSDB.
- Approving the Board's rates and charges in consultation with the Ministry of Finance

The responsibility for providing water to rural areas is given to PSs under the 1987 PSs Act.

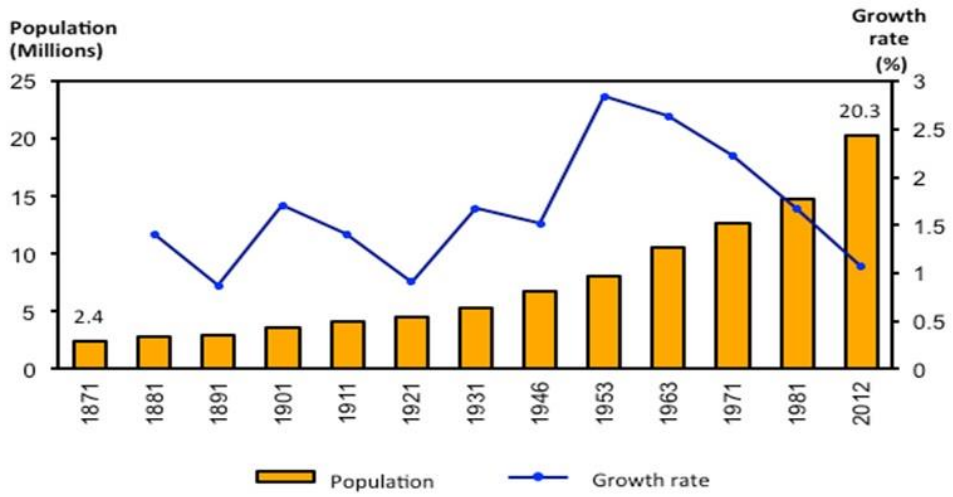
3.2 SOCIO-ECONOMIC SITUATION

3.2.1 Population

The total population of Sri Lanka in 2012 was 20,359,439, an 8-fold increase since 1871.

(1) Population Growth

Population growth has been in decline since 1953 and remains at average annual rate of 1.1 % during 1981-2012 as shown in the figure below. This a result of changing patterns of births and deaths. Birth and death rates were high until 1946, and population growth remained below 1.7 %. After 1946, death rates started to decline rapidly and growth climbed well above 2 %. After 1960 birth rates too started to decline slowing the high population growth. Sri Lanka is still at this stage of declining fertility. **Figure 3.2-1** shows the population and changing growth rates from 1871 to 2012.



Source: DCS

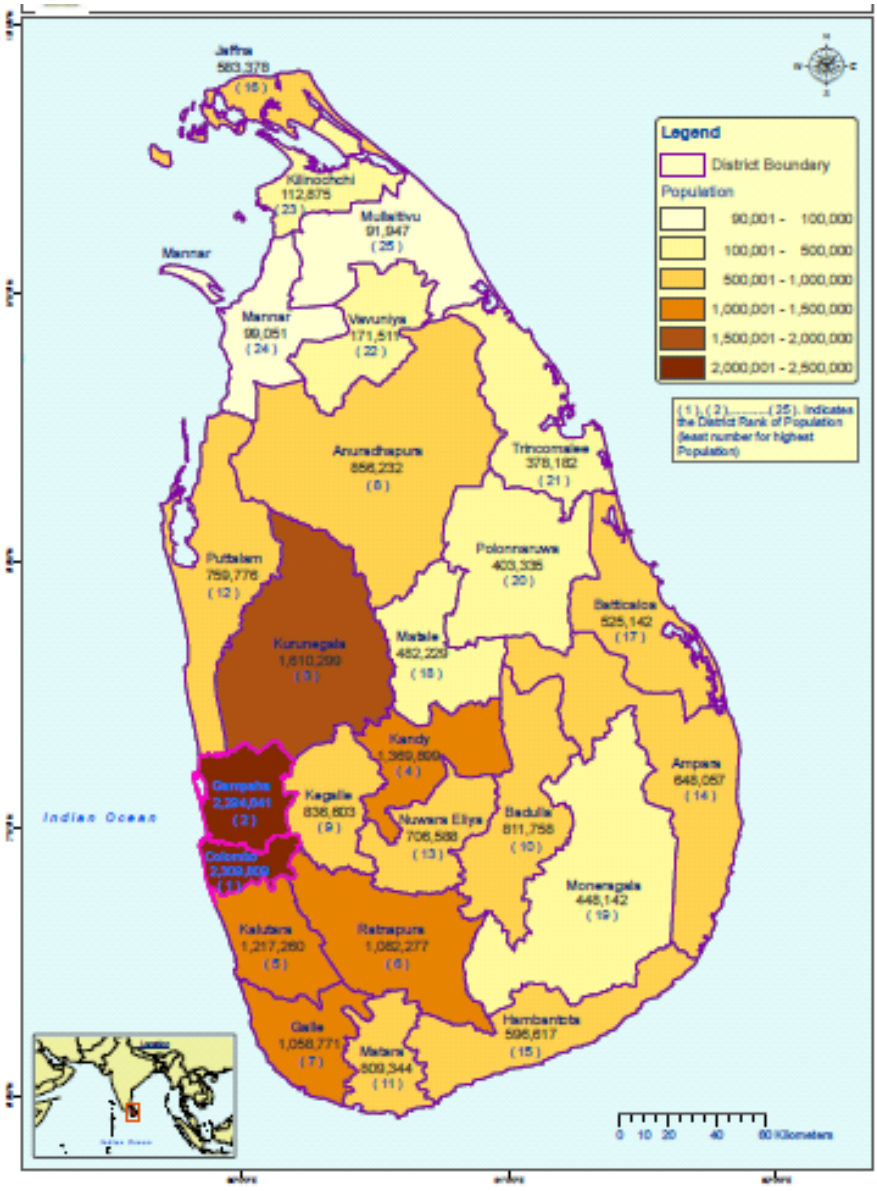
Figure 3.2-1 Population and Growth Rates in Sri Lanka

(2) Population Distribution and Density

Colombo district has the largest population (2.3 million, 11.4%) followed by Gampaha District (2.3 million, 11.3%). Kurunegala, Kandy, Kalutara, Ratnapura and Galle districts have population over 1 million. These seven districts account for 54.0% of the total population while occupying 24% of the total area of the country.

Mullaitivu, Mannar, Killinochchi, Vavuniya districts of the northern province continue to record low population with Mullaitivu and Mannar having less than 100,000 each.

Figure 3.2-2 shows the population distribution on the island.



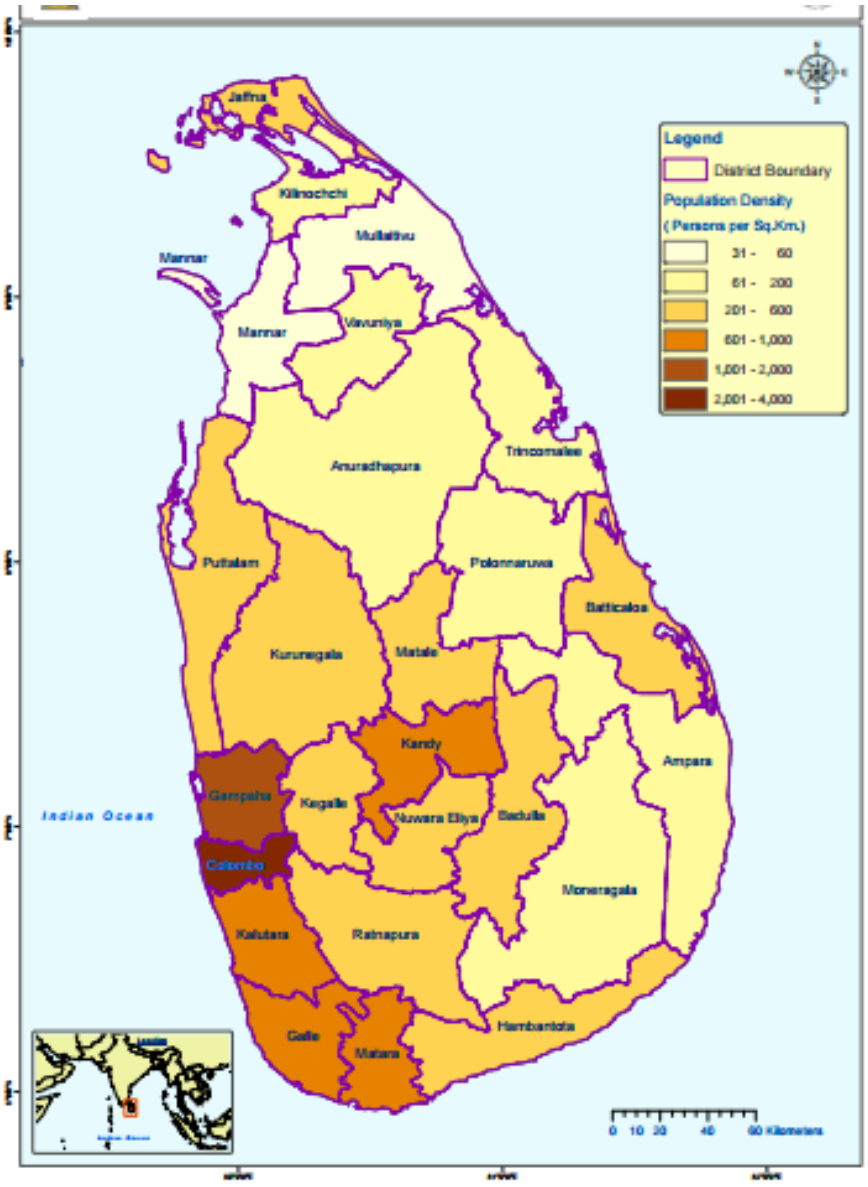
Source: DCS

Figure 3.2-2 Population Distribution in Sri Lanka

(3) Population Density

Average population density of Sri Lanka is 325 persons per square kilometer, an increase of 41 % from 230 persons per square kilometer in 1981.

Population density ranges widely from 38 persons per square kilometer in Mullaitivu (little more than 10% of the national figure) to 3,438 persons per square kilometer in Colombo (more than ten times the national figure). Other high density areas include: adjoining Gampaha (1,719), Kalutara (775) districts in the western province, coastal districts of Galle (658) and Matara (641) in the southern province, Kandy (717) in the central province and Jaffna (629) in the northern province. Districts in the northern (except Jaffna), eastern (except Batticaloa), north-central provinces, and Moneragala in Uva province have population densities of less than 200. **Figure 3.2-3** shows the population density across the country.



Source: DCS

Figure 3.2-3 Population Density by District (2012)

(4) Urbanization

The degree of urbanization is an indicator of economic development and living standards. Proper urban management is vital for beneficial outcomes.

Areas under MCs and UCs are mainly urban centres. Prior to 1987, town councils presided over “urban” areas. When provincial councils were set up in 1987, town councils were absorbed into PSs and areas under their authority became “rural”. The definition of “urban” appears to be based on administrative considerations rather than the characteristics of the population. According to the current definition, the level of urbanization of Sri Lanka in 2012 is 18.2%.

There are 64 MCs and UCs in the country. Colombo MC accounts for 15% of the total urban population. The largest eight cities: Colombo, Kaduwela, Dehiwala-Mt Lavinia, Moratuwa, Negombo, Kotte MCs and Kesbewa, Maharagama UCs, constitute close to 50% of the urban population. All these areas are in the western province; with seven in Colombo district and one in Gampaha district. The main urban clusters in Sri Lanka are in and around Colombo district.

Twenty-six of the 56 cities are very small, each with less than 25,000 people. The distribution of urbanization is quite uneven. In Colombo district, 77.6% of its population lives in urban areas. Batticaloa (28.7%), Ampara (23.6%), Trincomalee (22.4%) districts in eastern province and Mannar (24.5%), Vavuniya (20.2%), Jaffna (20.1%) districts in northern province record urbanization levels higher than the national average. Polonnaruwa, Moneragala, Mullaitivu and Killinochchi districts have no urban centres.

3.2.2 Income

Income refers to wages, salaries, profits, rents, and any earnings received. Income can also be in the form of unemployment or worker's compensation, social security, pensions, interests or dividends, royalties, trusts, alimony, or other governmental, public, or family financial assistance.

Mean household income in Sri Lanka is over 46,000 LKR per month (about 35,700 Japanese Yen (JPY)) in 2012, 3.6 times higher than 12,800 LKR in 2002, (about 9,900 JPY) (**Table 3.2-1)**.

There is a large income gap in Sri Lanka. Mean household income per month in the western province, 47,118 LKR (about 36,500 JPY), is 2 times higher than that of the northern or eastern provinces (**Table 3.2-2**). There are also gaps among urban, rural and housing estates (**Table 3.2-3**).

Table 3.2-1 National Household Income and Expenditures Survey (HIES)

Variable	Unit	HIES Survey period							
		1980/81	1985/86	1990/91	1995/96	2002	2005	2006/07	2009/10	2012
Mean household income per month	Rs.	881	2,012	3,549	6,476	12,803	20,048	26,286	36,451	46,207
Median household income per month	Rs.	642	1,322	2,547	3,793	8,482	13,617	16,735	23,746	30,400
Mean per capita income per month	Rs.	180	395	724	1,439	3,056	4,896	6,463	9,104	11,932
Income receivers mean income per month	Rs.	469	941	1,819	3,367	6,959	10,563	14,457	20,427	25,778
No. of income receivers per household	Persons	1.6	2.0	2.0	1.8	1.8	1.9	1.8	1.8	1.8
Household size	Persons	4.9	5.1	4.9	4.5	4.2	4.1	4.1	4.0	3.9
Monetary income per month per household	Rs.	749	1,334	2,963	5,264	10,386	17,089	22,616	31,209	39,584
Non-Monetary income per month per household	Rs.	132	678	586	1,212	2,419	2,959	3,670	5,242	6,624
Gini coefficient of household income		0.43	0.46	0.43	0.46	0.47	0.47	0.49	0.49	0.48
Gini coefficient of household expenditure		–	–	–	0.36	0.41	0.40	0.41	0.39	0.40
Gini coefficient of income receivers income		0.43	–	0.52	0.52	0.53	0.55	0.55	0.55	0.54
Mean household expenditure per month	Rs.	1,232	2,079	3,905	6,525	13,147	19,151	22,952	31,331	40,887
Expenditure on food and drink	Rs.	801	1,198	2,377	3,552	5,848	7,593	8,641	13,267	15,358
Expenditure on non food items (excluding liquor, narcotic drugs and tobacco)	Rs.	377	802	1,384	2,753	6,993	11,079	13,819	17,399	24,791
Expenditure on liquor, narcotic drugs and tobacco	Rs.	54	79	144	219	306	479	492	655	738
Food Ratio (Food and Drink/Household expenditure)	%	65.0	57.6	64.6	54.4	44.5	39.6	37.6	42.3	37.6
Poverty Head Count Ratio	%	–	–	26.1	28.8	22.7	–	15.2	8.9	6.5

Source: Household Income and Expenditure Survey Series, DCS

Table 3.2-2 Key Socio-economic Indicators by Province (2009/2010)

	Western	Central	Southern	Northern (a)	Eastern	North Western	North Central	Uva	Sabara-gamuwa	All Island
Household Characteristics										
Number of Individuals per Household	4.1	4.0	4.1	4.3	4.2	3.8	3.8	3.9	4.0	4.0
Number of Income Receivers per Household	1.9	1.8	1.8	1.6	1.5	1.6	1.6	1.7	1.8	1.8
Population Distribution										
By Gender, %										
Male	47.2	46.3	47.3	47.3	48.6	48.0	48.0	47.4	48.1	47.4
Female	52.8	53.7	52.7	52.7	51.4	52.0	52.0	52.6	51.9	52.6
By Age Group, %										
0 – 14 Years	23.3	27.3	25.6	27.9	32.5	26.0	27.7	27.7	24.9	26.0
15 – 59 Years	62.4	60.3	60.1	61.1	60.6	62.6	63.8	62.4	62.3	61.8
Over 59 Years	14.3	12.5	14.2	11.0	6.9	11.3	8.4	9.9	12.8	12.3
By Educational Attainment, %										
No Schooling	2.6	6.2	4.9	1.4	4.3	4.1	2.9	7.9	5.1	4.2
Up to Grade 5	18.9	28.1	25.6	28.9	35.1	26.8	25.4	28.3	26.1	25.1
Grade 6 – 10	43.4	42.8	42.1	52.0	41.2	46.3	51.4	44.7	47.5	44.6
Passed G.C.E. (O/L)	19.4	12.2	15.6	10.5	11.9	13.3	12.5	12.0	11.3	14.7
Passed G.C.E. (A/L) and Above	15.4	10.6	11.6	7.0	7.4	9.4	7.5	7.0	9.9	11.2
Income										
Mean Income, Rs. per Month										
Per Household	47,118	31,895	32,514	23,712	23,922	35,586	35,577	28,717	36,173	36,451
Per Person	11,561	8,040	8,035	5,515	5,663	9,352	9,280	7,343	9,132	9,104
Per Income Receiver	24,149	17,865	18,035	14,936	15,739	21,566	21,803	17,112	19,418	20,427
Median Income, Rs. per Month										
Per Household	30,600	21,410	23,253	16,710	18,030	20,961	24,993	19,761	21,676	23,746
Per Person	7,250	5,251	5,637	3,857	4,202	5,295	6,340	4,961	5,445	5,803
Per Income Receiver	15,000	10,743	12,236	11,500	12,390	12,000	14,837	10,900	10,893	12,500
Income Share by Households, %										
Richest 20%	53.3	53.4	48.5	49.2	47.5	58.7	50.2	51.9	57.9	54.1
Poorest 20%	5.0	4.4	5.7	4.9	4.8	4.0	5.5	4.7	4.1	4.5
Middle 60%	41.7	42.2	45.8	45.8	47.7	37.3	44.3	43.3	38.0	41.4
Gini Coefficient, One Month Income										
Gini Coefficient (Households)	0.47	0.48	0.42	*	0.42	0.54	0.44	0.47	0.53	0.49
Gini Coefficient (per Person)	0.48	0.48	0.42	0.41	0.41	0.54	0.44	0.46	0.51	0.49
Gini Coefficient (Income Receivers)	0.55	0.55	0.50	0.47	0.45	0.58	0.51	0.53	0.59	0.55
Expenditure, Rs. per Month										
Per Household	42,399	28,308	28,809	25,656	25,265	25,927	29,480	23,547	25,583	31,331
Household Expenditure Share, %										

Source: Household Income and Expenditure Survey Series, DCS

Table 3.2-3 Key Socio-economic Indicators by Sector 2006/07, 2009/10 and 2012

Item	2006/07 (a)				2009/10 (b)				2012 (c)			
	Urban	Rural	Estate	All Island	Urban	Rural	Estate	All Island	Urban	Rural	Estate	All Island
Household Characteristics												
Number of Individuals per Household	4.3	4.0	4.2	4.1	4.3	4.0	4.2	4.0	4.0	3.8	4.1	3.9
Number of Income Receivers per Household	1.9	1.8	2.0	1.8	1.9	1.7	2.1	1.8	1.9	1.7	2.1	1.8
Population Distribution												
By Gender, %												
Male	47.6	48.0	47.9	47.9	47.7	47.4	47.6	47.4	47.2	47.1	47.7	47.2
Female	52.4	52.0	52.1	52.1	52.3	52.6	52.4	52.6	52.8	52.9	52.3	52.8
By Age Group, %												
0 – 14 Years	24.6	25.5	29.2	25.6	25.3	25.9	29.7	26.0	24.2	25.8	28.6	25.7
15 – 59 Years	64.4	63.1	61.0	63.2	61.9	61.8	59.9	61.8	61.0	61.2	59.1	61.1
Over 59 Years	11.0	11.4	9.8	11.3	12.8	12.3	10.5	12.3	14.8	13.0	12.3	13.3
By Educational Attainment, %												
No Schooling	3.2	4.6	15.8	4.9	2.5	4.0	13.1	4.2	2.6	3.9	12.1	4.0
Up to Grade 5	21.2	25.9	43.5	26.1	21.6	24.6	43.0	25.1	19.5	24.5	41.6	24.4
Grade 6 – 10	40.2	44.2	35.6	43.1	42.1	45.5	37.7	44.6	37.6	44.8	38.7	43.2
Passed G.C.E. (O/L)	20.2	15.0	3.4	15.1	17.5	14.9	3.8	14.7	20.5	15.9	5.6	16.3
Passed G.C.E. (A/L) and Above	15.2	10.4	1.7	10.6	16.2	10.8	2.3	11.2	19.7	10.9	2.1	12.0
Income												
Mean Income, Rs. per Month												
Per Household	41,928	24,039	19,292	26,286	47,783	35,228	24,162	36,451	68,336	42,184	31,895	46,207
Per Person	9,653	5,993	4,589	6,463	11,245	8,916	5,782	9,104	17,150	11,003	7,719	11,932
Median Income, Rs. per Month												
Per Household	23,642	16,379	10,480	16,735	31,000	23,126	17,366	23,746	41,958	28,921	25,664	30,400
Per Person	5,240	4,007	2,400	4,043	6,925	5,758	4,161	5,803	10,167	7,617	6,047	7,871
Income Shares by Deciles of Households, %												
1st Decile	1.5	1.7	1.7	1.6	0.6	1.7	3.2	1.6	1.5	1.4	1.8	1.4
2nd Decile	2.7	3.1	2.9	2.9	1.5	3.1	6.8	2.9	2.7	3.1	3.7	3.0
3rd Decile	3.5	4.2	3.7	3.9	2.0	4.1	9.2	3.9	3.6	4.2	4.8	4.0
4th Decile	4.2	5.1	4.4	4.8	3.0	5.1	10.2	4.9	4.5	5.2	6.1	5.0
5th Decile	5.1	6.2	5.1	5.8	3.7	6.3	10.7	6.0	5.6	6.3	7.5	6.0
6th Decile	6.3	7.5	5.8	7.0	5.7	7.3	11.4	7.1	6.9	7.5	8.7	7.2
7th Decile	7.4	9.1	6.8	8.5	7.7	8.9	9.3	8.7	8.4	9.1	10.0	8.8
8th Decile	9.7	11.3	7.9	10.8	9.9	11.1	8.9	10.8	10.4	11.3	12.1	11.1
9th Decile	13.2	15.2	9.7	14.6	15.7	14.6	8.3	14.6	14.6	14.9	15.8	14.8
10th Decile	46.2	36.5	52.0	40.1	50.3	37.7	22.0	39.5	41.7	37.0	29.5	38.7
Income Share by Households, %												
Richest 20%	59.5	51.8	61.7	54.7	53.3	53.8	49.4	54.1	56.4	51.9	45.3	53.5
Poorest 20%	4.2	4.8	4.5	4.6	4.7	4.5	5.9	4.5	4.2	4.5	5.5	4.4
Middle 60%	36.3	43.3	33.8	40.7	42.1	41.7	44.7	41.4	39.5	43.6	49.2	42.1
Gini Coefficient, One Month Income												
Gini Coefficient (Households)	0.54	0.46	0.57	0.49	0.48	0.49	0.43	0.49	0.51	0.47	0.39	0.48
Gini Coefficient (Income Receivers)	0.60	0.52	0.46	0.55	0.54	0.54	0.50	0.55	0.56	0.53	0.45	0.54
Expenditure, Rs. per Month												
Per Household	**35,274**	**21,440**	**13,456**	**22,952**	**44,928**	**29,423**	**23,988**	**31,331**	**59,001**	**37,561**	**29,779**	**40,887**

Source: Household Income and Expenditure Survey Series, DCS

3.3 ENVIRONMENTAL CONDITIONS

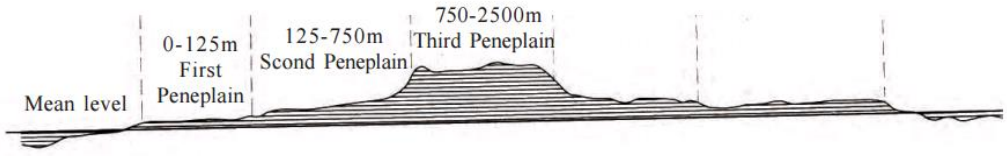
3.3.1 Physical Characteristics

(1) Location

Sri Lanka, an island in the Indian Ocean, is located south of the Indian subcontinent. It lies between 5° 55' and 9° 55' north of the equator and between the eastern longitudes 79° 42' and 81° 52'. The total land area is 65,610 sq. km. (445 km. by 225 km) and the topography is very varied.

(2) Topography

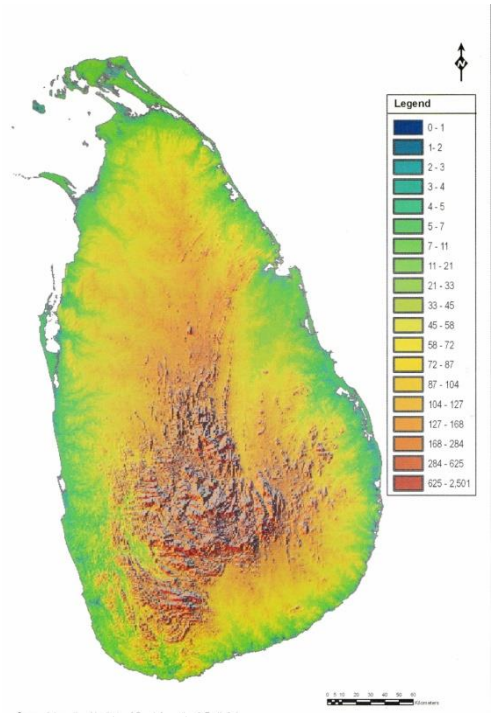
Sri Lanka's topography is full of complex lowlands and highlands, rising in 3 levels to the highest elevation in the inland areas (**Figure 3.3-1**).



Source: International Institute of Geo-Information & Earth Science

Figure 3.3-1 Cross Section Diagram of Sri Lanka

At the centre (3rd peneplain), the highest point is Pidurutalagala peak at 2,524 m. The 2nd peneplain lies between the hill country and the coastal plains. The third topographical level is the coastal lowlands (1st peneplain). These three zones are shown in **Figure 3.3-2**.



Source: International Institute of Geo-Information & Earth Science

Figure 3.3-2 Topography of Sri Lanka

3.3.2 Climate

(1) Temperature

Sri Lanka has a tropical climate and is hot all year round, with the sea breeze mitigating the high humidity and heat to some extent. The average temperature ranges from 16°C (60.8°F) in the central plateau of Nuwara Eliya (with freezing rain on some winter days), to 32°C (89.6°F) in the northeastern coastal region of Trincomalee (with temperatures as high as 38°C or 100.4°F). The average temperature for the whole island is 28 to 30°C (82.4-86.0°F). The difference in temperature between day and night is 4 to 7°C (7.2-12.6°F). The coldest month is January, and in the highlands, temperatures can fall to

5°C (41°F). The hottest season in May is followed by summer monsoon rains.

Table 3.3-1 Temperature Variation of 4 Main Cities in Sri Lanka

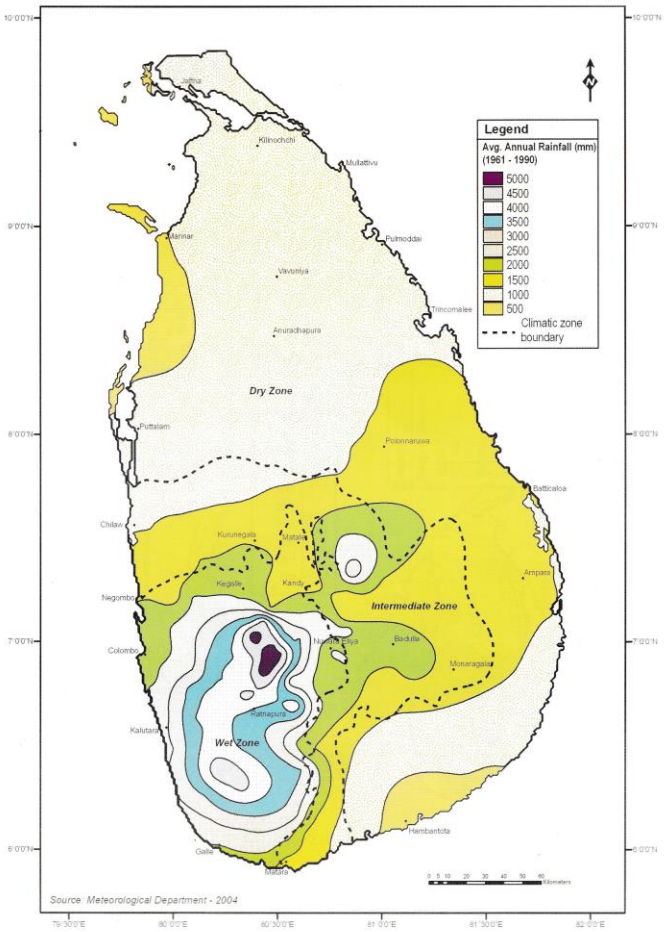
Location	January-April		May-August		September-December	
	Max.	Min.	Max.	Min.	Max.	Min
Colombo	30℃	22℃	30℃	24℃	29℃	22℃
Kandy	31℃	17℃	29℃	21℃	28℃	18℃
Nuwara Eliya	21℃	14℃	18℃	16℃	18℃	15℃
Trincomalee	32℃	24℃	33℃	25℃	33℃	23℃

Source: Department of Meteorology

(2) Precipitation

Rainfall divides Sri Lanka into wet, dry and intermediate zones. The wet zone in the southwest and central hills receives approximately 2,500 mm of rainfall throughout the year. The intermediate zone averages about 1,500 to 2,000 mm of annual rainfall, while the dry zone receives less than 1,000 mm.

Two wind regimes influence Sri Lanka's rainfall: the southwest monsoon from May to September and the northeast monsoon from December to February. These winds encounter the slopes of the central highlands and unleash heavy rain on the mountain slopes and the southwestern sector of the island. The monsoon rain is mainly orographic, whereas the rain during the inter-monsoon periods March–April and October-November is mainly convectional. The following map shows the rainfall distribution of Sri Lanka.



Source: Environmental Atlas Sri Lanka

Figure 3.3-3 Average Annual Rainfall

3.3.3 Environmental Resources

(1) Inland Water Resources

Sri Lanka's location between 5 and 10 degrees north of the equator, and proximity to the Indian subcontinent, gives it a predominantly monsoonal and tropical climate. As an island in the northern half of the Indian Ocean, Sri Lanka is exposed to moisture-laden winds from the southwest and the northeast, which bring heavy seasonal rainfall as described in **Section 3.3.2**.

Sri Lanka receives about 12 million hectare meters of water annually from rainfall, of which more than 50% is lost through evapotranspiration. Another 20 % seeps down to replenish ground water. Only 30% or about 3.5 million hectare meters, is available as stream flow for irrigation or other purposes.

The natural fresh water wetland habitats consist of about 9 large rivers and 94 small rivers (flowing more or less radially and totalling 4,563 km). There are numerous streams (particularly in the wet zone), extensive marshes, which are either connected to rivers or represent seasonally contracted flood plains isolated from the rivers, and many small permanent and seasonal ponds. Although there are no large natural lakes in Sri Lanka, there are many floodplain lakes known as villus, covering a total area of about 12,500 ha. Many of the larger villus are situated in the Mahaweli River system in the east. There are 40 such shallow, seasonal lakes varying in size from 9 to 550 ha. Wilpattu National Park in the west

also possesses many very small freshwater villus along with a unique group of salt villus far inland.

In addition to the natural wetlands, there are numerous man-made freshwater habitats. The most important of these are the tanks or "Wewa", which vary in size from a few to 6,500 ha at full spill level. Some of these date back 1,500 years forming part of an intricate water supply system for rice cultivation. Other man–made wetlands include approximately 2,400 km of irrigation channels and some 833,000 ha. of paddy fields, as well as numerous very small rain-filled tanks and flooded areas caused by spillage and seepage from the irrigation channels.

(2) Coastal Water Resources

Sri Lanka is endowed with a scenic coastline of approximately 1,536 km, with lagoons, coral reefs, sea grass beds, estuaries, salt marshes and dunes. Extensive discussion will be omitted due to their low relevance to the Project. Some details of the nation's rivers, which have more significance related to Project activities, are described below.

(3) Rivers

Wastewater carries pollutants and toxic chemicals, which have a negative impact on surface water and drinking water sources at discharge sites. Contaminants in drinking water resources are regulated under SLS722, and NWSDB monitors surface water quality at intake points. Sri Lanka's major rivers, the Maha River, the Kelani River, and the Gin River, are regularly monitored by CEA, and their status is described below (Source: CEA HP, Surface Water Quality Monitoring By The Laboratory of Central Environmental Authority).

(3 - 1) Maha River

Data from 14 intake points show high levels of E. coli bacteria upstream between Marasana and Hairiwadana, indicating that untreated or insufficiently treated wastewater is flowing into the Maha River. Nitrate levels are higher downstream near the estuary, with increases at Bandaragama and Banbukuriya. High nitrate levels (exceeding allowable limits) are caused by increased agricultural and industrial activities.

(3 - 2) Kelani River

High levels of E. coli are found near the Ambatale water purification plant intake. The CEA report released on March 2th, 2014, states that Kelani River is polluted by industrial wastewater from the Biyagama industrial region toward the Raggahawatta sampling point, and the ecosystem is in dire condition. Turbidity and most contaminants measured, exceeded allowable limits: COD (36%), BOD (7%), dissolved oxygen (27%), and heavy metals (7%)[3-1)].

Under the Clean River Plan initiated by Mahaweli Development and the Ministry of the Environment, the Kelani River Waterway Pilot Project examined the water quality of the river. Major activities implemented in 2015 include identification of sources of environmental pollution, reporting on water quality analysis, and evaluation of water use and pollution burden. Comprehensive research on Kelani River pollution is necessary to establish a long-term strategy for sustainable river management.[3-1)]

CEA admits that "even if industries adhere to environmental protection regulations, there is no monitoring to evaluate the pollution load of their discharge into the Kelani River." [3-1)]

(3 - 3) Gin River

There are two intake facilities, one at Wakewella near the estuary in Galle, and another upstream in Baddegama. The level of E. coli is much higher than acceptable. The level of fluoride is high upstream during the dry season. Water quality seems to be deteriorating due to pollution.

3.4 PRESENT SITUATION OF CITIES STUDIED

3.4.1 Western Province

(1) Colombo District

Colombo District, with an area of 699 km^2, is located on the coast in the southwest of Sri Lanka. It has a tropical monsoon climate with a dry season. Annual rainfall is 1,991 mm (2013), and the average temperature is 28°C (source: DCS). The population is about 2.31 million, and has the highest mean household income in Sri Lanka at 50,071 LKR (about 38,800 JPY). Five MCs, five UCs, and one PS in the district are targeted in this survey. **Table 3.4-1** shows the background information of each municipality.

Table 3.4-1 Cities Studied in Colombo District

Local Government Authority	
1. Colombo MC (District Capital)	Colombo, which is biggest city in Sri Lanka, the center of Sri Lanka's economy and District Capital, is designated as the National Growth Center by National Planning Department. Land geography is mixed with canals and Beira lake, a landmark. Tourist attraction category A: National museum, Colombo Dutch museum, Arcade independence square, Vihara Mahadevi park, Galle-face Green. Population is 561,314. Piped water is supplied to 100% of population by NWSDB, water source being Kelani river. Source not affected by discharge. Water consumption is about 470,000 m^3/d. There is sewage collection system which is developed for about 80 % of the area. Collected sewage is discharged to the ocean without treatment. Discharge point in Indian ocean, 3.5 km away. Asian Development Bank (ADB) is now planning to build a sewage treatment plant. Waterborne diseases: 31 patients in Colombo area in 2015 : Typhoid-15; Hepatitis-1; Diarrhoea-15
2. Dehiwala–Mt. Lavinia MC	Dehiwala–Mt. Lavinia is a highly urbanised and commercialized city. It is located adjoining the southern boundary of Colombo. Its western boundary is the Indian Ocean. The city comes under Metropolis Master Plan of Sri Lanka. High ground in Dehiwala & Mount Lavinia is in the central areas, with some low level areas with canals joining Weras ganga. Tourist attraction category B: National zoological gardens, Mount-Lavinia beach, Air-force museum. Population is184,468. Piped water is supplied to 100% of population by NWSDB, Kelani river being the raw water source. Source not affected by discharge. Water consumption is about 39,000 m^3/d. Discharge into Weras ganga, 1.5 km away. There is a sewage collection system which is developed for about 43 % of area and collected sewage is discharged to ocean without treatment**.** Have F/S. Donor not yet decided.
3. Sri Jayawardenapura Kotte MC	Sri Jayawardenepura Kotte is the national administrative capital of Sri Lanka. It is adjoining Colombo. Most areas is low altitude. There are some marshy lands. Tourist attraction category C: Parliament of Sri Lanka, Diyatha Park. Population is 107,925. Piped water is supplied to 100% of population by NWSDB, Kelani river being the raw water source. Source not affected by discharge. Water consumption is about 35,000 m^3/d. Some areas have lake/canals and marsh & paddy lands. Discharge into Kolonnawa canal, 0.4 km away. Sewage collection system is only available for few institutions. Collected sewage is discharged to the ocean without treatment. Have F/S(Donor has not yet decided).
4. Kaduwela MC..	Kaduwela MC situated east of Colombo on the left bank of Kelani river, and 16 km from Colombo city centre on Colombo - Avissawella

Local Government Authority	
	Old Road. It is adjoining Sri Jayawardenepura-Kotte. Many areas close to river are low-lying. Piped water is supplied to 49% of population by NWSDB, Kelani river being the raw water source. Source affected by pollution. Water consumption is about 55,000 m^3/d. Discharge into Kelani river, 1 km away. No tourist attraction
5. Moratuwa MC	Moratuwa on the southwestern coast of Sri Lanka, adjoining Dehiwala-Mount Lavinia. It is situated on the Galle– Colombo (Galle road) main highway, 18 km south of Colombo city centre. MC is highly urbanized. Most of the area is flat. Population is 168,280. Piped water is supplied to 100% of population by NWSDB, Kalu Ganga river being the raw water source. Source not affected by discharge. Water consumption is about 23,626 m^3/d. Discharge into Weras ganga, 0.9 km away. No tourist attraction
6. Kolonnawa UC	Kolonnawa UC adjoining the eastern boundary of Colombo and bordering left bank of Kelani river. Population is 11,064. Most areas are low-lying. Piped water is supplied to 100% of population by NWSDB, Kelani river being the raw water source. Source not affected by discharge. Water consumption is about 61,628 m^3/d. Discharge into Kelani river, 2 km away. No tourist attraction. Sewage collection system is developed for about 30% of area and collected sewage is discharged to ocean without treatment.
7. Seethawakapura UC	Seethawakapura UC is located to the east of Colombo and bordering the left bank of Kelani river. Population is 30,308. Piped water is supplied to 83% of population by NWSDB, tributary of Kelani river being the raw water source. Source affected by pollution. Water consumption is about 8050 m^3/d. Discharge into tributary of Kelani river, 2 km away. Tourist attraction category C: Wetland botanical garden Sewage collection system which is developed only for 9,000 m^3/d capacity Seethawaka industrial estate and collected sewage is discharged after treatment to Kelani river. Waterborne diseases: 29 patients in Seethawakapura area in 2015: Typhoid-4; Hepatitis-5; Dysentery-20
8. Maharagama UC	Maharagama UC is located to the south-east of Colombo. Population is 196,423. Piped water is supplied to 86% of population by NWSDB, Kelani river & Kalatuwawa reservoir being the raw water sources. Source is not affected by discharge. Water consumption is about 27,300 m^3/d. Discharge into Katu Ela canal, 0.5 km away. No tourist attraction. Have F/S. Donor has decided(China-EXIM Bank). Waterborne diseases: 52 patients in Maharagama area in 2015: Dysentery-13; Enteric fever-13; Food poisoning-26.
9. Boralesgamuwa UC	Boralesgamuwa UC is adjoining and to the east of Dehiwala–Mt. Lavinia. Many areas are low-lying. Also several marshy lands. Population is 60,110. Piped water is supplied to 98% of population by NWSDB, Kelani & Kalu rivers being the raw water source. Source is not affected by discharge. Water consumption is about 9,560 m^3/d. Discharge into Weras Ganga,1 km away. No tourist attraction. Having FS. Donor has decided(China-EXIM Bank)
10. Kesbewa UC	Kesbewa UC is adjoining and to the east of the Moratuwa MC. Population is 185,122. Piped water is supplied to 90% of population by NWSDB, Kalu river being the raw water sources. Source is not affected by discharge. Water consumption is about 21,757 m^3/d. Discharge into Bolgoda lake, 2 km away. No tourist attraction.
11. Kotikawatta–Mulleriyawa PS	Kotikawatta–Mulleriyawa PS is north of Sri Jayawardenapura Kotte MC and bordering on left bank of Kelani river. Population is 131,643. Piped water is supplied to 100% of population by NWSDB, Kelani river being the raw water source. Source is affected by pollution. Water consumption is about 37,326 m^3/d. Discharge into Kelani river, 2 km away. No tourist attraction.

Source: JET

(2) Gampaha District

Gampaha District, with an area of 1,387 km^2, is in western Sri Lanka, bordered on the north by the Maha River, on the south by the Kelani River, and on the east by land mass of 300 m elevation. Because of its location on the coast, it has a tropical monsoon climate with a dry season. Annual rainfall is 2,024 mm (2013), and the average temperature is 28°C (source: estimate from Census and Statistics for Colombo and Katunayake). The population is about 2.29 million, and the mean household income is 38,807 LKR (about 30,100 JPY). **Table 3.4-2** summarizes some background information on the two MCs, five UCs, and seven PS in Gampaha District.

Table 3.4-2 Cities Studied in Gampaha District

Local Government Authority	
12. Negombo MC	(Negombo MC is located around 35 km to the north of Colombo, on Western coast, close to Katunayake International airport. Population is 142,449. Piped water is supplied to 100% of population by NWSDB, Maoya river being the raw water source. Water consumption is about 32,234 m^3/d. Tourist attraction category A : Browns beach, Boat riding, Dutch Fort, Muthurajawela marshy lands. St. Mary's Church, Angurukaramulla Temple. Discharge into Maha oya, 3 km away. Having F/S, Donor has decided Agence Française de Development (AFD))
13. Gampaha MC (District Capital)	Gampaha is situated to the north-east of Colombo. Population is 62,335. Piped water is supplied to 32% of population by NWSDB, Attanagalu oya being the raw water source. Source is affected by pollution. Water consumption is about 7000 m^3/d. Discharge into Attanagalu oya, at 1 km. No tourist attraction Waterborne diseases: 1768 patients in Gampaha area in 2015 : Dysentery-1,735; Hepatitis-33.
14. Wattala - Mabole UC	Situated on Western coast, few kilometers north of Colombo. Flat terrain. Population is 28,031. Piped water is supplied to 93% of population by NWSDB, Kelani river being the raw water source. Water consumption is about 4,000 m^3/d. Discharge into Dutch cana, at 0.1 kml. No tourist attraction
15. Peilyagoda UC	Situated close to Colombo, bordering right bank of Kelani river. Flat terrain. Population is 27,736. Piped water is supplied to100% of population by NWSDB, Kelani river being the raw water source. Water consumption is about 5,778 m^3/d. Discharge into Kelani river, at 0.6 km. No tourist attraction. Having F/S. Donor has decided(AFD)
16. Katunayake -Seeduwa UC	Situated on Western coast , around 26 km north of Colombo. Flat terrain. Tourist attraction category A : International Airport, Water sports, Boat tours. Population is 60,915. Piped water is supplied to 21% of population by NWSDB, Kelani river & Attanagalu oya being the raw water sources. Source is affected by pollution. Water consumption is about 6800 m^3/d. Discharge into Attanagalu oya, at 1 km. However, there is a sewage collection system which is developed only for Katunayaka Export Promotion Zone and collected sewage is discharged after treatment to oya. There is sewage collection system which is developed only for Raddoluwa housing scheme and collected sewage is discharged after treatment to Attanagalu oya. Waterborne diseases: 3 patients in Katunayake Seeduwa area in 2015 : Diarrhoea-3
17. Minuwangoda UC	Situated 35 km north east of Colombo & close to Negombo. Population is 7,523. Piped water is supplied to 100% of population by NWSDB, ground water being the raw water source. Source is

Local Government Authority	
	polluted by pollution. Water consumption is about 1,368 m^3/d. Discharge into Mapalana oya, at 1 km. No tourist attraction
18. Ja-Ela UC	Ja-Ela UC is situated close to Western coast approximately 20 km north of Colombo. Flat area. Population is 31,232. Piped water is supplied to 100% of population by NWSDB, Kelani river being the raw water source. Water consumption is about 8,924 m^3/d. Discharge into Attanagalu oya, at 1.5 km. No tourist attraction Waterborne diseases: 3 patients in Katunayake Seeduwa area in 2015 : Diarrhoea-3
19. Katana PS	Katana PS is located around 35 km to the north of Colombo, close to Western coast. Flat area. Population is 174,063. Piped water is supplied to 15% of population by NWSDB, Ma Oya being the raw water source. Water consumption is about 6,274 m^3/d. Discharge into Maha Oya, 2.5 km. No tourist attraction.
20. Kelaniya PS	Kelaniya PS is located around 10 km north east of Colombo, bordering right bank of Kelani river. Flat area. Population is 109,603. Piped water is supplied to 100% of population by NWSDB, raw water source being Kelani ganga. Source is affected by pollution. Water consumption is about 22,626 m^3/d. Tourist attraction category C : Kelaniya Temple, Manelwatta Temple, Water World. Discharge into Kelani river, at 1.7 km. Having F/S. Donor has decided(AFD) Waterborne diseases: 1 patient in Kelaniya area in 2015 : Hepatitis-1
21. Ja – Ela PS	Ja-Ela PS is situated close to Western coast approximately 20 km north of Colombo. Population is 170,281. Piped water is supplied to 19% of population by NWSDB, Kelani river being the raw water source. Water consumption is about 8,571 m^3/d. Discharge into Attanagalu Oya, at 2 km. No tourist attraction. However, there is a sewage collection system which is developed for Ekala area and collected sewage is discharged after treatment to Attanagalu oya. Waterborne diseases: 2 patients in Kelaniya area in 2015 : Hepatitis-1; Dysentery-1
22. Biyagama PS	Biyagama PS is located around 16 km east of Colombo, bordering right bank of Kelani river. Flat area with some high ground. Population is 186,585. Piped water is supplied to100% of population by NWSDB, Kelani river being the raw water source. Source is affected by pollution. Water consumption is about 29,705 m^3/d. Discharge into Kelani river, at 1 km. No tourist attraction. There is a sewage collection system which is developed only for Biyagama Export Promotion Zone and collected sewage is discharged after treatment to Kelani river. Waterborne diseases: 5 patients in Kelaniya area in 2015 : Typhoid-2; Dysentery-3
23. Gampaha PS	Gampaha PS is situated to the north-east of Colombo. Population is 62,335.. Population is 135,332. Piped water is supplied to18% of population by NWSD, Attanagalu Oya being the raw water source. Water consumption is about 7,000 m^3/d. Discharge into Attanagalu Oya, at 3 km. No tourist attraction.
24. Wattala PS	Situated close to Western coast, few kilometers north of Colombo. Flat terrain. Population is 147,494. Piped water is supplied to 68% of population by NWSDB, Kelani river being the raw water source.Water consumption is about 14,700 m^3/d. Discharge into Kelani river, at 1.5 km. No tourist attraction.
25. Mahara PS	Mahara PS is situated 13 km to the north-east of Colombo. population by NWSDB, Kelani river being the raw water source. Water consumption is about 18,948 m^3/d. Highland/no source to discharge. No tourist attraction.

Source: JET

(3) Kalutara District

Kalutara District, with an area of 1,598 km^2, is in the southwest. It has a tropical rainforest climate and a weak dry season. Average annual rainfall is 2,300-2,400 mm, and average temperature is 27-28°C (2013 estimate by Census and Statistics of Ratesana and Galle). A portion of the Sinharaja Forest Reserve is located in the eastern side of the district. The population is about 1.12 million, and the average household income is 36,512 LKR (about 28,300 JPY). **Table 3.4-3** shows some background information of the four UCs and one PS targeted in this survey.

Table 3.4-3 Cities Studied in Kalutara District

Local Government Authority	
26. Panadura UC	Panadura UC is situated on Western coast , around 25 km south of Colombo. Flat land. Population is 30,069. Piped water is supplied to 100% of population by NWSDB, Kalu Ganga being the raw water source. Source is affected by pollution. Water consumption is about 9,175 m^3/d. Discharge into Indian ocean, at 3.5 km. No tourist attraction Waterborne diseases: 26 patients in Panadura area in 2015 : Typhoid-6; Dysentery-6; Hepatitis-2; Food poisoning-12
27. Horana UC	Population is 9,550. Piped water is supplied to 59% of population by NWSDB, Kalu Ganga river being the raw water source. Source is affected by pollution. No tourist attraction. Water consumption is about 4,845 m^3/d. Discharge into Kalu Ganga river, at 4 km. Waterborne diseases: 27 patients Horana area in 2015 : Typhoid-5; Hepatitis-7; Diarrhoea-15
28. Kalutara UC (District Capital)	Kalutara is located on the Western coast and approximately 40 km south of Colombo, Kalu Ganga river being the raw water source. Population is 32,417. Piped water is supplied to 100% of population by NWSDB, Kalu Ganga river being the raw water source. Water consumption is about 20,973 m^3/d. Discharge into Kalu Ganga, at 0.9 km. Tourist attraction is category C : Kalutara Temple. Richmonde castle, Calido beach.
29. Beruwala UC	Beruwala UC is situated on the Western coast and approximately 53 km south of Colombo Population is 37,793. Piped water is supplied to 100% of population by NWSDB. Water consumption is about 25,808 m^3/d. Discharge into canal, at 0.5 km. Tourist attraction is category C : Light House, Beris Bawa Garden, Beruwala Beach.
30. Panadura PS	Panadura PS is situated on the Western coast approximately 25km south of Colombo. Flat land and high ground. Population is 152,216. Piped water is supplied to 46% of population by NWSDB, Kalu Ganga river being the raw water source. Water consumption is about 20,372 m^3/d. Discharge into Indian ocean, at 5.5 km. No tourist attraction Waterborne diseases: 26 patients in Panadura area in 2015 : Typhoid-6; Hepatitis-2; Dysentery-6; Food poisoning-12

Source: JET

3.4.2 North-western Province

(1) Kurunegala District

Kurunegala District, with an area of 4,816 km^2, is in the northwest of Sri Lanka. Located inland, the district has a tropical rainforest climate and a weak dry season. The annual rainfall is 1,805 mm (2013), and the average temperature is 27.8°C (source: DCS). The population is about 1.61 million, and the average household income is 29,343 LKR (about 22,800 JPY). **Table 3.4-4** summarizes some background information of the MC and UC targeted in the survey.

Table 3.4-4 Cities Studied in Kurunegala District

Local Government Authority	
31 Kurunegala MC (District Capital)	Kurunegala MC is situated around 95 km north-east of Colombo. Large rocks around the city. Beyond that, coconut plantations in the district. Piped water is supplied to 31% of population by NWSDB, Daduru Oya being the raw water source. Source is affected by pollution. Population is 24,833. Water consumption is about 4,500 m^3/d. . Discharge into Maguru oya, at 1.5km. Tourist attraction is category C : World Tallest Granite Buddha statue, Ethagala, Ridee Viharaya.
32 Kuliyapitiya UC	Kuliyapitiya UC is situated around 80 km north-east of Colombo. Flat land. Population is 5,509. Piped water is supplied to 35% of population by UC. Source is affected by pollution. Water consumption is about 1,350 m^3/d. No source to discharge. No tourist attraction. Waterborne diseases: 5 patients in Horana area in 2015 : Dysentery-5

Source: JET

(2) Puttalam District

Puttalam District, with an area of 3,072 km^2, in the northwest of Sri Lanka, has the Wirupatu National Park in the north, and the Indian Ocean to the west. It has a savannah climate with wet and dry seasons. The annual rainfall is 905 mm (2013), and the average temperature is 27.9°C (source: DCS). The population is 760,000, and the average household income is 29,286 LKR (about 22,700 JPY). **Table 3.4-5** shows some background information of the two UCs targeted in the survey

Table 3.4-5 Cities Studied in Puttalam District

Local Government Authority	
33 Puttalam UC (District Capital)	Puttalama UC is situated on western coast around 130 km north of Colombo. Flat land. Population is 45,511. Piped water is supplied to 67% of population by NWSDB, ground raw water being the raw water source. Water consumption is about 6,500 m^3/d. A new water supply scheme with new water source is being constructed. Discharge into Mee Oya, 5.5km. Tourist attraction is category A : Kalpitiya Beach, Whale Watching. Having F/S. Donor has decided(China-EXIM Bank) Waterborne diseases: 4 patients in Puttalama area in 2015 : Hepatitis-1; Dysentery-3
34 Chilaw UC	Chilaw UC is situated on western coast around 75 km north of Colombo. Flat area. Population is 21,441. Piped water is supplied to 94% of population by NWSDB, ground raw water being the raw water source. Water consumption is about 3,360 m^3/d. A new water supply scheme with new water source is being constructed. Discharge into Indian ocean, at 0.1 km. Tourist attraction is category C : Munneswaran Kovil, Chilaw Beach. Having F/S. Donor has decided(China-EXIM Bank) Waterborne diseases: 2 patients in Chilaw area in 2015 : Dysentery-2

Source: JET

3.4.3 Central Province

(1) Kandy District

Kandy District, with an area of 1,940 km^2, has the Peradeniya Botanical Garden located in the west and the Victoria Ratenbe Reserve in the eastern part of the district. It has a tropical rainforest climate. The annual rainfall is 1,925 mm (2013), and the average temperature is 24.9°C (source: DCS). The population is 1.37 million, and the average household income is 30,371 LKR (about 23,500 JPY).

Table 3.4-6 shows some background information of the MC, four UCs, and two PSs targeted in the survey

Table 3.4-6 Cities Studied in Kandy District

Local Government Authority	
35 Kandy MC (District Capital)	City in central hill country. Tea plantations and biodiverse rainforest on surrounding hills. Piped water is supplied to 97% of population by MC, Mahaveli river being the raw water source. Source is affected by pollution. Water consumption is about 6,500 m^3/d. Tourist attraction is category A : Tooth Palace, International Cricket Stadium, Peradeniya Botanical gardens, Hantane Mountain, Commonwealth War Cemetary, Kandy perahera. Population is 98,828. Discharge into Kandy lake, at 0.3 km. At present, a sewerage project is being constructed Waterborne diseases: 10 patients in Kandy area in 2015 : Hepatitis-3; Dysentery-4; Enteric fever-3
36 Wattegama UC	City in central hills, around 10 km north-east of Kandy. Population is 8,157. Piped water is supplied to 77% of population by UC, Punchimola Canal being the raw water source. Water consumption is about 3,000 m^3/d. Highland/no source to discharge. No tourist attraction.
37 Kadugannawa UC	City in central hills, around 15 km west of Kandy. Population is 12,654. Piped water is supplied to 100% of population by NWSDB, Mahaveli river being the raw water source. Water consumption is about 2,435 m^3/d. Discharge into Nanu oya, at 2.5 km. Tourist attraction is category B : Captain Dawson Tower, Knuckes Mountain Range, Tea Factory. 116 patients in Kadugannaw area in 2015 : Hepatitis-3; Waterborne diseases: Dysentery-4; Enteric fever-2; Dengue-100; Leptospirosis-7
38 Gampola UC	City in central hills, around 20 km south-west of Kandy. Population is 37,871. Piped water is supplied to 61% of population by NWSDB, Ulapane Oya being the raw water source. Water consumption is about 7,563 m^3/d. Discharge into Mahaveli river, at 1 km. Tourist attraction is category C : Ambuluwawa Mount Temple, Club Lespri, Deenside Tea Factory.
39 Nawalapitiya UC	City in central hills, around 35 km souh-west of Kandy. Population is 13,338. Piped water is supplied to 31% of population by NWSDB, an Oya being the raw water source.Water consumption is about 2,333 m^3/d. Discharge into Mahaveli river, at 0.1 km. No tourist attraction Waterborne diseases: 5 patients in Nawalapitiya area in 2015 : Hepatitis-3; Dysentery-1; Typhoid-1
40 Akurana PS	City in central hills, around 35 km souh-west of Kandy. Population is 63,397. Piped water is supplied to 43% of population by NWSDB, Mahaveli river being the raw water source. Source affected by pollution. Water consumption is about 5,550 m^3/d. Discharge into Pinga oya, at 1km. No tourist attraction. Waterborne diseases: 150 patients in Akurana area in 2015 : Dysentery-150
41 Kandy Four Gravets & Gangawata Korake PS	City in central hill country adjoining Kandy. Population is 65,015. Piped water is supplied to 57% of population by NWSDB, Mahaveli river being the raw water source.. Water consumption is about 58,466 m^3/d. Discharge into Mahaveli river, at 4.5km. Tourist attraction is category B : Tea Museum, Knuckes Range. Waterborne diseases: 9 patients in Kandy 4 Gravets & Gangawata Korake in2015 : Hepatitis-4; Dysentery-3; Typhoid-2

Source: JET

(2) Matara District

Matara District with an area of 1,993 km^2, and the Wattagam National Park in the east, has a tropical

monsoon climate. The population is 480,000, and the average household income is 26,441 LKR (about 20,500 JPY). **Table 3.4-7** shows some background information of the two MCs targeted in the survey.

Table 3.4-7 Cities Studied in Matara District

Local Government Authority	
42 Matale MC (District Capital)	Population is 36,462. Piped water is supplied to 100% of population by NWSDB, Sudu Ganga river being the raw water source. Source is affected by pollution. Water consumption is about 8,948 m^3/d. . Discharge into Sudu Ganga, at 0.2 km. Tourist attraction is category C : Nalanda Gedige(central point of sri lanka).
43 Dambulla MC	Population is 23,814. Piped water is supplied to 100% of population by NWSDB, Ibbankatuwa tank being the raw water source. Water consumption is about 4,000 m^3/d. . Discharge into Amban Ganga, at 21 km. Tourist attraction is category A : Golden Cave Temple, Sunrise Balooning, Namal Uyana, Prophems Arboretum, Ridiyagama National Park.

Source: JET

(3) Nuwara Eliya District

Nuwara Eliya District with an area of 1,741 km^2, is home to the Victoria Ratenbe Reserve and the Horton Plains National Park in the south. Nuwara Eliya encompasses beautiful highlands in the north with the highest elevation in Sri Lanka. The cool and wet climate is well suited for tea cultivation. The annual rainfall is 2,157 mm (2013), and the average temperature is 16.1°C (source: DCS). The population is 710,000, and the average household income is 28,152 LKR (about 21,800 JPY). **Table 3.4-8** shows some background information of the MC and two UCs targeted in the survey

Table 3.4-8 Cities Studied in Nuwara Eliya District

Local Government Authority	
44 Nuwara Eliya MC (District Capital)	Nuwara eliya district is the most important for tea production in the country. Population is 23,804. Piped water is supplied to 100% of population by MC, ground water being the raw water source. Source affected by pollution. Water consumption is about 19,400 m^3/d Tourist attraction category A : Haggala Botanical Gardens, Victoria Park, Strawberry Farm, Ramboda Waterfalls, Whitewater Rafting, Labukele Tea Factory, Blue Field Tea Garden, Sitha Temple, Havaeliya Adventure Park.. Discharge into Nanu Oya, at 03 km.
45 Hatton-Dickoya UC	Population is 14,585. Piped water is supplied to 84% of population by NWSDB, a branch of Dik Oya being the raw water source. Source is affected by pollution. Water consumption is about 2,262 m^3/d. Discharge into Dik oya, at 0.5 km. Tourist attraction is category B : Caslereigh Reservoir, Laxapana Falls, Horton Place. Waterborne diseases: 5 patients in Hatton Dik oya area in 2015 : Dysentery-5
46 Thalawakele-Lindula UC	It is the largest tea growing area in Sri Lanka. Population is 4,691. Piped water is supplied to 100% of population by NWSDB, Nanu Oya being the raw water source. Water consumption is about 710 m^3/d. Discharge into Kotmale Oya, at 0.1 km. Tourist attraction is category B : Devon Water Fall, St. Clair Water Fall, Galways Land National Park.

Source: JET

3.4.4 Uva Province

(1) Badulla District

Badulla District with an area of 2,861 km^2 is in central Sri Lanka. Its highlands are famous for tea and vegetables, while the lowlands are famous for rice cultivation. The climate varies depending on the

elevation. The annual rainfall is 1,865 mm (2013) and the average temperature is 27.4°C (source: DCS). The population is 810,000, and the average household income is 25,067 LKR (about 19,400 JYP). **Table 3.4-9** shows some background information of two MCs and one UC targeted in the survey

Table 3.4-9 Cities Studied in Badulla District

Local Government Authority	
47 Haputale UC	Haputale is located in central mountain area, with tea plantations around the small city. Piped water is supplied to 100% of population by NWSDB, Badulu Oya being the raw water source. Source is affected by pollution. Tourist attraction is category B : Lipton's Seat, Benedict Monastery, Thangamalai Bird Sanctuary, St. Andrew's Church. Population is 52,88. Piped water is supplied to 47% of population by NWSDB, a natural spring being the raw water source. Water consumption is about 450 m^3/d. No source to discharge/ highland.
48 Badulla MC (District Capital)	Badulla is situated on eastern slope of central mountain area, surrounded by tea plantations. Badulla is the end point of the Colombo- Badulla railway line. Tourist attraction is category B : Dunhinda falls, Ravana Water Fall, Dhowa Rock, Muthiyangana temple, Bogoda Bridge. Population is 42,237. Water consumption is about 9150 m^3/d. Discharge into Badulu oya, at 0.3 km. Having PF/S. Donor has not yet decided. Waterborne diseases: 17 patients in Badulla area in 2015 : Hepatitis-8; Dysentery-9
49 Bandarawela MC	Bandarawela is situated in central mountain area, overshadowed by Namunukula mountain range. Tourist attraction is category B : Dambatenna Tea Factory, Adisham Bungalow, Ravana Ella Temple. Population is 24,168. Piped water is supplied to 84% of population by NWSDB, a branch of Uma Oya being the raw water source. Source is affected by pollution. Water consumption is about 2,812 m^3/d. Discharge into Oya/Ela, at 1 km. Waterborne diseases: 38 patients in Bandarawela area in 2015 : Hepatitis-10; Dysentery-8; Typhoid-20

Source: JET

(2) Moneragala District

Moneragala District with an area of 5,639 km^2, is in south-eastern Sri Lanka. It has Galuoya National Park is in the north, and Udawarae National Park in the west. It has a savannah climate with a rainy season and a dry season. The annual rainfall is 1,559 mm (2013), and the average temperature is 27.4°C (source: DCS). The population is 450,000, and the average household income is 20,686 LKR (about 16,000 yen). **Table 3.4-10** shows some background information of the MC targeted in the survey,

Table 3.4-10 City Studied in Moneragala District

Local Government Authority	
50 Moneragala PS (District Capital)	Moneragala is situated in north- east to Badulla city. Population is 49520. Piped water is supplied to 42% of population by NWSDB, Kumbukkan Oya being the raw water source. Water consumption is about 3,900 m^3/d. Discharge into Kumbukkan Oya, at 5km. No tourist attraction. Waterborne diseases: 260 patients in Moneragala area in 2015 : Hepatitis-254; Dysentery-4; Enteric fever-2

Source: JET

3.4.5 Southern Province

(1) Galle District

Galle District, with an area of 1,652 km^2, in southern Sri Lanka, has the Indian Ocean in the west and south, and the Sinharaja Forest Reserve in the north. The climate is tropical. The annual rainfall is 1,799 mm (2013) and the average temperature is 27.3°C (source: DCS). The population is 1.06 million, and the average household income is 28,205 LKR (about 21,900 yen). In Galle District, **Table 3.4-11** shows some background information of the MC and two UCs targeted in the survey.

Table 3.4-11 Cities Studied in Galle District

Local Government Authority	
51 Galle MC (District Capital)	Galle is a Southern coastal city 119 km south of Colombo, with almost flat terrain. Piped water is supplied to 100% of population by NWSDB, Gin river being the raw water source. Source is affected by Pollution. Water consumption is about 16,772 m^3/d. Population is 86,333. Having F/S. Donor has decided(AFD). Discharge into Gin Ganga, at 3 km. Tourist attraction is category A : Galle Fort, Unawatuna Beach, International Cricket Stadium, National Maritime Museum, Koggala National Park of Martin Wickramasinghe, Madol Duwa, Rumassala Beach, Galle Harbour. Waterborne diseases: 2066 patients in Galle area in 2015 : Hepatitis-60; Dysentery-2004; Typhoid-2
52 Ambalangoda UC	Ambalagoda is a Southern coastal city 107 km south of Colombo, with almost flat terrain. Tourist attraction is category C : Ariyapala Mask Museum, Sea Turtle Hatchery, Mask Cavers, Rock Island Sanctuaries. Population is 19,990. Piped water is supplied to 100% of population by NWSDB, Gin river being the raw water source. Water consumption is about 4,300 m^3/d. Discharge into Madampa lake, at 1.1 km.
53 Hikkaduwa UC	Hikkaduwa is a Southern coastal city 92 km south of Colombo, with almost flat terrain. Tourist attraction is category A : Hikkaduwa Beach, Sinigama Devalaya, Thotagamuwa Temple, Turtle Hatchery, Tsunami Museum, Tsunami Honganji Temple, Naga Viharaya, Hikkaduwa Harbour. Population is 27,075. Piped water is supplied to 100% of population by NWSDB, Gin river being the raw water source. Water consumption is about 9,840 m^3/d. Discharge into canal, at 1.1 km.

(2) Matale District

Matale District, with an area of 1,283 km^2, in southern Sri Lanka, has the Sinharaja Forest Reserve located in the north. It has a savannah climate with a rainy season and a dry season. The annual rainfall is 1,799 mm (2013) and the average temperature is 27.3°C (source: DCS). The population is 810,000, and the average household income is 28,227 LKR (about 21,900 yen). **Table 3.4-12** shows some background information of the MC and UC targeted in the survey.

Table 3.4-12 Cities Studied in Matara District

Local Government Authority	
54 Matara MC (District Capital)	Matara is on the southern coast of Sri Lanka, 160 km south of Colombo. Almost flat terrain. Tourist attraction is category A : Matara Beach, Matara Bodhiya, Light House, Snake Farm, Wind Surfing, Polhena Beach, Kushta Rajagala, Star Fort, Paravi Duwa Temple. Population is 74,193. Piped water is supplied to 100% of population by NWSDB, Nilwala river being the raw water source. Water consumption is about 20,475m^3/d. Discharge into Nilwala river, at 0.9 km. Waterborne diseases: 23 patients in Matara area in

Local Government Authority	
	2015 : Hepatitis-18; Dysentery-5
55 Weligama UC	Weligama is on the south coast of Sri Lanka, 144 km south of Colombo. Almost flat terrain. Tourist attraction is category A : Dophine Whale Watching, Kushta Rajagala Temple. Surfing. Population is 22,377. Piped water is supplied to 100% of population by NWSDB, Kananke river being the raw water source. Water consumption is about 5,832 m^3/d. Discharge into Polwathumodera river, at 0.3 km. Waterborne diseases: 7 patients in Weligama area in 2015 : Hepatitis-1; Dysentery-5; Typhoid-1

Source: JET

(3) Hambantota District

Hambantota District, with an area of 2,609 km^2, in southern Sri Lanka, has the Rangambehela National Park in the north and Yala Nature Reserve in the east. It has a savannah climate with a rainy season and a dry season. The annual rainfall is 966 mm (2013), and the average temperature is 28.0°C (source: DCS). The population is 600,000, and the average household income is 32,267 LKR (about 25,000 yen). **Table 3.4-13** shows some background information of the MC and UC targeted in the survey

Table 3.4-13 Cities Studied in Hambantota District

Local Government Authority	
56 Hambantota MC (District Capital)	Hambantota MC is situated on southern coast, 195 km south of Colombo and 35 km east of Matara city. Almost flat terrain. Population is 23,236. Piped water is supplied to 100% of population by NWSDB, Walawe river being the raw water source. Water consumption is about 6,972 m^3/d. Discharge into Walawe river, at 9 km. Tourist attraction is category A : Bundala National Park, Mahapelessa Hot Springs, Bird Research Center and Resort, Ridiyagama National park. Having FS. Donor has decided (China-EXIM Bank). Waterborne diseases: 5 patients in Hambantota area in 2015 : Hepatitis-3; Dysentery-2
57 Tangalle UC	Tangalle UC is situated on southern coast, 35 km east of Matara city. Flat terrain. Tourist attraction is category B : Mulgirigala Temple, Kite Surfing, Gyambokka Beach, Medaketiya Beach. Population is 8,473. Piped water is supplied to 100% of population by NWSDB, Walawe river being the raw water source. Source is affected by pollution. Water consumption is about 5,932 m^3/d. Discharge into Kirama oya, at 2 km. Waterborne diseases: 1 patient in Tangalle area in 2015 : Dysentery-1

Source: JET

3.4.6 Sabaragamuwa Province

(1) Rathnapura District

Rathnapura District, with an area of 3,275 km^2, in southern Sri Lanka, has the Sinharaja Forest Reserve in the south, Udawarae National Park in the east, wildlife reserves and the Horton Plains National Park in the north. It has a savannah climate. The annual rainfall is 3,575 mm (2013) and the average temperature is 27.6°C (source: DCS). The population is 1.08 million, and the average household income is 27,39 LKR (about 21,200 yen). **Table 3.4-14** shows some background information of the MC and two UCs targeted in the survey,

Table 3.4-14 Cities Studied in Rathnapura District

Local Government Authority	
58 Rathnapura MC (District Capital)	Rathnapura MC is located on Kalu Ganga river bank, 101 km south-east of Co;ombo. Large plantations of tea and rubber surround the town. Tourist attraction is category A : Bopath Ella Water Fall, Kirindi Ella Water Fall, Gemmological Museum, Maha Saman Devalaya, National Museum. Population is 47,105. Piped water is supplied to 77% of population by NWSDB, Kalu Ganga river being the raw water source. Source is affected by pollution. Water consumption is about 7,200 m^3/d. Discharge into Kalu Ganga, at 1 km.
59 Balangoda UC	Balangoda UC is situated 143 km south-east of Colombo and 43 km from Ratnapura city. Tea plantations surround the city. Tourist attraction is category C : Duvilli Ella, Belihul Oya Resort, Fox Mountain. Population is 16,510. Piped water is supplied to 100% of population by NWSDB, Walawe river being the raw water source. Source is affected by pollution. Water consumption is about 4,744 m^3/d. Discharge into Walawe river, at 0.1 km.
60 Embilipitiya UC	Flat terrain. Tourist attraction is category C : Thuduwa Camp, Maduwawela Walawwa, Ridiyagama Safari Park. Population is 36,712. Piped water is supplied to 73% of population by NWSDB.Chandrika wewa being the raw water source. Source is affected by pollution. Water consumption is about 7,200 m^3/d. Discharge into Walawe river, at 6.5 km.

Source: JET

(2) Kegalle District

Kegalle District, with an area of 1,693 km^2, in central Sri Lanka has a savannah climate. The population is 840,000, and the average household income is 28,524 LKR (about 22,100 yen). **Table 3.4-15** shows some background information of the UC targeted in this survey.

Table 3.4-15 Survey Target Cities in Kegalle District

Local Government Authority	
61 Kegalle UC (District Capital)	Kegalle city is situated 78 km north-east of Colombo, between highlands from the east and plains from the west. Population is 15,993. Piped water is supplied to 70% of population by NWSDB, Mao oya & Kuda oya being the raw water source. Source is affected by pollution. Tourist attraction is category B : Rafting & Adventurous Park, Elephant Orphanage. Water consumption is about 15,000 m^3/d. Discharge into Kuda Oya, at 0.5km.

Source: JET

3.4.7 North Central Province

(1) Anuradhapura District

Anuradhapura District, with an area of 7,179 km^2, in northern Sri Lanka, has the Wilpat National Park in the west. It has a savannah climate. The annual rainfall is 1,193 mm (2013) and the average temperature is 28.3°C (source: DCS). The population is 860,000, and the average household income is 29,689 LKR (about 23,000 yen). **Table 3.4-16** shows some background information of the MC targeted in the survey,

Table 3.4-16 City Studied in Anuradhapura District

Local Government Authority	
62 Anuradhapura MC (District Capital)	Anuradhapura city is situated around 170 km north-east of Colombo. Flat land. Nuwara wewa and Tisa wewa are two tanks within the city. Tourist attraction is category A : Eight Historical Places, Nuwara Wewa, Tissa Wewa. Population is 50,595. Piped water is supplied to 94% of population by NWSDB, Turuwila irrigation tank, Nuwara wewa, & Thissa wewa being the raw water sources. Source is affected by pollution. Water consumption is about 20,556 m^3/d. Discharge into Malwathu Oya, at 0.3 km. Having F/S. Donor has not yet decided However, the city is to be developed under the Strategic City Development Plan of the Ministry of Megapolis & Western Development

Source: JET

(2) Polonnaruwa District

Polonnaruwa District has an area of 3,293 km^2 and a savannah climate. The annual rainfall is 1,441 mm (2013) and the average temperature is 28.6°C (Source: DCS). The population is 400,000, and the average household income is 30,145 LKR (about 23,300 yen). **Table 3.4-17** shows some background information of the PS targeted in the survey.

Table 3.4-17 City Studied in Polonnaruwa District

Local Government Authority	
63 Thamankaduwa PS (District Capital)	Thamankaduwa is situated around 178 km north-east of Colombo. Flat land. Population is 82,426. Piped water is supplied to 33% of population by NWSDB, Mahaveli river being the raw water source. Source is affected by pollution. Water consumption is about 25,929 m^3/d. Discharge into Mahaveli river, at 8 km. Tourist attraction is category A Polonnaruwa Watadage, Parakrama Samudraya, Parakramabahu Statue, Historical Museum.

Source: JET

3.4.8 Northern Province

(1) Jaffna District

Jaffna District with an area of 1,025 km^2 at the northern tip of Sri Lanka, it is surrounded by ocean on 3 sides. The Chudiklam National Park is located in the east. The climate is a savannah climate. The annual rainfall is 1,033 mm (2013), and the average temperature is 28.2°C (source: DCS). The population is 580,000, and the average household income is 23,446 LKR (about 18,200 yen). **Table 3.4-18** shows some background information of the MC and UC targeted in the survey.

Table 3.4-18 Cities Studied in Jaffna District

Local Government Authority	
64 Jaffna MC (District Capital)	Jaffna MC is situated on northern coast, 396 km from Colombo, land flat and shallow. Population is 80,829. Piped water is supplied to 24% of population by NWSDB, ground water being the raw water source. Water consumption is about 2,798 m^3/d. Discharge into Indian ocean, at 3 km. Tourist attraction is category A : Nallur Kovil, Jaffna Library, Naga Pooshani Ambal Kovil, Kereemalai Temple, Charty Beach, Casuarina Beach.
65 Point Pedro UC	Point Pedro UC situated on northern coast. Population is 12,334. Piped water is supplied to 27% of population by NWSDB, ground

Local Government Authority	
	water being the raw water source. Source is affected by pollution. Water consumption is about 458 m^3/d. Discharge into Indian ocean, at 4.5 km. No tourist attraction.
66 Velvettithurai UC	Velvetithurai UC situated on northern coast. Population is 8,283. Piped water is supplied to 12% of population by NWSDB, ground water being the raw water source. Source is affected by pollution. Water consumption is about 2,756 m^3/d. Discharge into Indian ocean, at 2.5 km. No tourist attraction.
67 Chavakachchery UC	Chavakachchery UC situated on northern coast. Population is 16,129. Piped water is supplied to 4% of population by NWSDB, ground water being the raw water source. Source is affected by pollution. Water consumption is about 1,924 m^3/d. Discharge into Indian ocean, at 7.5 km. No tourist attraction.

Source: JET

(2) Mannar District

Mannar District, with an area of 1,996 km^2, in the north of Sri Lanka, has a large lake preserve and the Wilpatut National Park in the south. The lowland has is a monsoon climate. The annual rainfall is 918 mm (2013), and the average temperature is 28.1°C (source: DCS). The population is 100,000, and the average household income is 24,200 LKR (about 18,800 yen). **Table 3.4-19** shows some background information of the MC targeted in the survey

Table 3.4-19 City Studied in Mannar District

Local Government Authority	
68 Mannar UC (District Capital)	Mannar UC is situated on western coast, 225 km north of Colombo. Rainfall averages 1,053 mm a year. Average temperature is 28.1°C. Population is 24,417. Piped water is supplied to 73% of population by NWSDB, ground water being the raw water source. Water consumption is about 6,500 m^3/d. Discharge into Indian ocean, at 3 km. Tourist attraction is category A : Shrine of Our Lady of Madhu, Mannar Island, The Doric at Arippu, Thanthirimale Temple, Mannar Fort, Baobab Tree, Yodha Wewa, Thirukitheeswaram Temple.

Source: JET

(3) Vavunia District

Vavunia District, with an area of 1,997 km^2, in northern Sri Lanka, and has an annual rainfall of 1,304 mm (2013) and average temperature of 27.9°C (source: DCS). The population is 170,000, and the average household income is 30,967 LKR (about 24,000 yen). **Table 3.4-20** shows some background information of the UC targeted in the survey.

Table 3.4-20 City Studied in Vavunia District

Local Government Authority	
69 Vavuniya UC (District Capital)	Vavunia UC is situated 215 km north-east of Colombo. Rainfall averages 2106 mm a year. Average temperature is 27.9°C. Population is 34,816. Piped water is supplied to 17% of population by NWSDB, ground water being the raw water source. Water consumption is about 880 m^3/d. Discharge into Vavunia kulama. No tourist attraction

Source: JET

(4) Kilinochchi District

Vavunia District, with an area of 1,967 km^2 in northern Sri Lanka, has a monsoon climate. The annual rainfall is 1,169 mm (2013) and the average temperature is 28.0°C (source: estimate from Census and

Statistics for Vavunia and Jaffna). The population is 110,000, and the average household income is 20,614 LKR (about 16,000 yen). **Table 3.4-21** shows some background information of the PS targeted in the survey.

Table 3.4-21 City Studied in Kilinochichi District

Local Government Authority	
70 Karachchi PS (District Capital)	Population is 61,484. Piped water is not available. Discharge into canal/wewa, at 1.8 km. Tourist attraction is low

Source: JET

(5) Mullaitivu District

Mullaitivu District is located in northern Sri Lanka, and has an area of 2,617 km^2. The annual rainfall is 1,169 mm (2013), and the average temperature is 28.0°C (source: Census and Statistics for Kilinochchi). The population is 90,000, and the average household income is 17,714 LKR (about 13,700 yen). **Table 3.4-22** shows some background information of the PS targeted in the survey.

Table 3.4-22 Survey Target Cities in Mullaitivu District

Local Government Authority	
71 Maritimepattu PS (District Capital)	Population is 28,973. Piped water is not available. Discharge into Indian ocean, at 0.5 km. Discharge into Indian ocean. No tourist attraction

Source: JET

3.4.9 Eastern Province

(1) Batticaloa District

Batticaloa District, an area of 2,854 km^2, in eastern Sri Lanka, is flat and has a savannah climate. The annual rainfall is 1,973 mm (2013), and the average temperature is 28.4°C (source: DCS). The population is 530,000, and the average household income is 20,359 LKR (about 15,800 yen). **Table 3.4-23** shows some background information of the MC and two UCs targeted in the survey.

Table 3.4-23 Cities Studied in Battikaloa District

Local Government Authority	
72 Batticaloa MC (District Capital)	Batticaloa MC is situated on eastern coast, 111 km south of Trincomalee. Flat land. Population is 86,227. Piped water is supplied to 24% of population by NWSDB, Unichchia tank being the raw water source. Water consumption is about 23,594 m^3/d. Discharge into Indian ocean, at 3.5 km. Tourist attraction is category A : Kallady Beach, Pasikuda Beach, Old Dutch Fort, Baticaloa Gte, Science Museum, Unnichchai Tank, Sri Mangalarama Budhist Temple. Having F/S, Donor has not decided.
73 Kathankudi UC	Kathankudi UC is situated on eastern coast. Flat land. Population is 40,356. Piped water is supplied to 57% of population by NWSDB, Unichcha tank being the raw water source. Water consumption is about 3,200 m^3/d. Discharge into Indian ocean, at 0.2 km. Tourist attraction is category B : Kattankudy Beach, Fishing.
74 Eravur UC	Eravur UC is situated close to eastern coast. Flat land. Population is 24,643. Piped water is supplied to 19% of population by NWSDB, Unichcha tank being the raw water source. Water consumption is about 1,188 m^3/d. Discharge into Indian ocean, at 3.5 km. No tourist attraction

Source: JET

(2) Ampara District

Ampara District, with an area of 4,415 km^2 in eastern Sri Lanka, has the Galuoya National Park in the west, and Yala Nature Reserve in the south. It has a tropical monsoon climate. The annual rainfall is 1,613 mm (2013), and the average temperature is 28.4℃ (source: Census and Statistics for Potobira). The population is 650,000, and the average household income is 23,429 LKR (about 18,200 yen). **Table 3.4-24** shows some background information of the two MCs and one UC targeted in the survey.

Table 3.4-24 Cities Studied in Ampara District

Local Government Authority	
75 Kalmunai MC	Kalmunai MC is situated on eastern coast. Flat land. Population is 99,892. Piped water is supplied to 23% of population by NWSDB, Kondawattawana tank being the raw water source. Water consumption is about 6,757 m^3/d. Discharge into Indian ocean, at 2.4 km. No tourist attraction
76 Akkaraipattu MC	Akkaraipattu MC city is situated on eastern coast. Flat land. Population is 30,934. Piped water is supplied to 45% of population by NWSDB, Kondawattawana tank being the raw water source. Water consumption is about 6,691 m^3/d. Discharge into Tillai river, at 2.8 km. Tourist attraction is category B : Arugam Bay Beach, Panama Bridge.
77 Ampara UC (District Capital)	Population is 22,511. Piped water is supplied to 100% of population by NWSDB, Kondawattawana tank being the raw water source. Water consumption is about 6,660 m^3/d. Discharge into Gal Oya, at 2.5 km. No tourist attraction

Source: JET

(3) Trincomalee District

Trincomalee District, with an area of 2,727 km^2, in eastern Sri Lanka, is home to the naval keystone protected area and Kokirai Bird Sancutary in the north. It has a tropical monsoon climate. The annual rainfall is 1,493 mm (2013), and the average temperature is 28.5℃ (source: DCS). The population is 380,000, and the average household income is 24,436 LKR (about 18,900 yen). **Table 3.4-25** shows some background information of the two UCs targeted in the survey.

Table 3.4-25 Cities Studied in Trincomalee District

Local Government Authority	
78 Trincomalee UC (District Capital)	Trincomalee city is situated on eastern coast. Tricomalee is one of the fine natural deep-water harbors in the world. Trincomalee has Population is 48,351. Piped water is supplied to 100% of population by NWSDB, Kanthale tank being the raw water source. Water consumption is about 8,477 m^3/d. Discharge into Indian ocean, at 3.3 km. Tourist attraction is category B : Nilaveli Beach, Koneswaran Kovil, Navy Museum, Paravi Island, War Cemetary, Marble Beach, Fort Federic, Boat Tuors, Arisimale Beach, Tricomalee Natural Harbour.
79 Kinniya UC	Kinniya city is situated on eastern coast, 15 km south of Tricomalee. Population is 36,772. Piped water is supplied to 100% of population by NWSDB, Kanthale tank being the raw water source. Water consumption is about 18,000 m^3/d. Discharge into Uppu Aru ocean, at 2 km. Tourist attraction is category B : Kinniya Hot Water Wells and Springs, Kinniya Bridge.

Source: JET

CHAPTER 4 MANAGEMENT OF SEWERAGE / SANITATION

4.1 GENERAL SITUATION

Sanitation has been improving in Sri Lanka over the past 25 years, reaching coverage close to 90% in 2015 (**Table 4.1-1)**. The country has achieved the Millennium Goals' sanitation target - 'Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation'. This success is very encouraging.

Table 4.1-1 Percentage of Sanitation Improvement in Sri Lanka from 1990 to 2015

Year	Improved (%)	Shared (%)	Unimproved (%)	Open defecation (%)
1990	68	2	14	16
1995	74	3	11	12
2000	80	3	10	7
2005	86	3	9	2
2010	87.5	2	8	1.8
2015	89.3	2	7	1.7

Source: Sacosan VI, which quotes its source as 'UNICEF - Updated with National Census 2012'

Sanitation coverage in Sri Lanka consists of on-site facilities (such as septic tanks and closed pit latrines) and off-site treatment facilities with piped sewerage systems.

4.2 OFF-SITE SEWERAGE SYSTEMS

The sewage system coverage is about 2.4%. Major off-site sewerage facilities are only in operation in Colombo, Kolonnawa, Dehiwala/Mt Lavinia, Ja-ela/Ekala, Hikkaduwa, Kataragama and Hantana. The Colombo system is managed by the CMC and the others are managed by NWSDB. Many housing schemes also have their own sewerage systems, those within the Colombo City are managed by the CMC and those in other cities are managed by NWSDB. **Table 4.2-1** shows the sewerage systems in major urban areas that are connected to sewer networks, served population and coverage ratio. The coverage in major urban areas is about 2.2%. **Table 4.2-2** shows the served population of sewerage systems maintained by NWSDB.

Table 4.2-1 Major Urban Sewerage System Coverage in 2015

Sewerage System	City	Total Population	Population Covered	Population Coverage Ratio % *	WWTP Process
Greater Colombo Sewerage (GCS) System	Colombo	561,314	394,258	1.94	Ocean Outfalls
	Dehiwala/Mount Lavinia	184,468	17,035	0.08	
	Kolonnawa	60,044	10,255	0.05	
	Ratmalana/Moratuwa	168,280	15,445	0.07	Extended Aeration with BNR*
	Ja-Ela/Ekala	9,000	6,600	0.03	Extended Aeration with BNR
Kataragama	Kataragama	18,220	5,045	0.02	Waste Stabilization Pond: WSP
Hikkaduwa	Hikkaduwa	27,075	3,490	0.01	WSP
Total		1,028,401	452,128	2.23	

Note: * BNR: Biological Nutrient Removal
(Population Coverage Ratio) = (Population Coverage)/(Total population of Sri Lanka in 2012 is 20,263,723)
Source: Sacosan VI, which quotes its source as 'UNICEF - Updated With National Census 2012'

The GCS System was developed for the city of Colombo, Dehiwala-Mount Lavinia MC and part of Kolonnawa UC. The system in Colombo city was developed by the British 90 years ago and improvement and expansion works were carried out in the 1980s and 1990s. Sewage is collected and

treated by gravity sedimentation at 18 pumping stations. Treated sewage is discharged to the ocean through outfalls in Mutwal and Wellawatta. The 320 km sewer lines cover 75% of the city. Wastewater in the other parts of the city is treated by onsite sanitation facilities (septic tanks and pour-flush latrines).

5-6% of Dehiwala-Mount Lavinia MC has sewers. 1,650 of the 5,000 houses are connected to the sewerage system. To improve the coverage, promotion of house connection is underway with funds from the WB, the government of Sri Lanka (GOSL), NWSDB and the community.

In Kolonnawa UC, 21 km of sewers installed in 1989 with funds from the WB, the Government of Saudi Arabia and the GOSL, provide coverage to 60% of the city or 1,550 houses.

Sewerage systems other than the above, developed for housing schemes, are operated and managed by NWSDB. **Table 4.2-2** shows the sewage systems for housing complexes. The coverage is about 0.2%.

Table 4.2-2 Population Coverage in 2015 by Piped Sewerage Systems in Housing Schemes

Housing Scheme	No. of Connections	Population Coverage	WWTP Process
Soyzapura Housing Scheme	3,165	8,656	Trickling Filter
Mattegoda Housing Scheme	1,178	5,890	Stabilization Ponds
Jayawadanagama Housing Scheme	816	4,080	Screen + Ocean Outfall
Maddumagewatta Housing Scheme	247	1,235	Screen + Ocean Outfall
Raddolugama Housing Scheme	2,134	10,670	Extended Aeration
Hantana Housing Scheme	409	2,045	Trickling Filter
Digana Village Housing Scheme	409	1,625	Natural Ponds
Total		34,201	

Source: NWSDB

4.2.1 Ongoing Sewerage Projects

The GOSL is carrying out 6 projects with aid from overseas organizations.

(1) Greater Colombo Wastewater Management Project (GCWMP)

This ADB project will address sanitation issues in the Colombo Municipality area, some parts of Kolonnawa UC area and Dehiwala/Mt. Lavinia MC area. Project components within the CMC area are implemented by the CMC at a cost of USD 94.4 million. Pumping stations, part of main sewers and ocean outfalls will be rehabilitated. The project includes capacity development to strengthen the CMC's operational capability in the sewerage sector. The components in Kolonnawa UC and Dehiwala/Mt. Lavinia MC areas are implemented by NWSDB at a cost of LKR 1,012.0 million. Two sewage pumping stations in Dehiwala and Mt. Lavinia areas will be rehabilitated.

(2) Global Partnership for Output Based Aid Project to Expand Sewerage Services in Greater Colombo Area (GPOBAP)

This project is implemented with a WB grant at a total cost of LKR 1,197.0 million. Around 13,107 families (population of 76,400) in low income settlements in Dehiwala, Mt. Lavinia, Moratuwa, Ratmalana, Ja-Ela, Ekala and Kolonnawa will have sewerage connections at a subsidized rate of LKR 3,500. Low income households are encouraged to connect to the sewer networks and thereby expanding the sewerage services in GC area.

(3) Kandy City Wastewater Management Project (KCWMP)

This JICA project is funded at a cost of LKR 22,588.0 million to provide piped sewerage facilities for

Kandy City and sanitary facilities for low income settlements in and around Kandy City. The project will provide 12,600 sewer connections and serve a total population of 55,000. An estimated floating population of 150,000 is taken in to account in designing this project.

(4) Jaffna/Kilinochchi Water Supply and Sanitation Project (JKWSSP)

JKWSSP is co-financed by ADB and AFD. The rehabilitation, re-construction and development of the areas affected by the conflict will improved sanitation infrastructure for residents and encourage the return of internally displaced persons. The total cost for water supply and sewerage schemes is LKR 18,328.0 million. The sewerage project is implemented exclusively for Jaffna Municipal Council area, which entirely depends on on-site sanitation at the moment. It will serve a population of 80,000, with 20,000 household connections.

(5) Greater Kurunegala Water Supply and Sanitation Project (GKWSSP)

This is being implemented by China Machinery Equipment Import & Export Corporation (CMEC) of China at a total cost of LKR 13,248 million to provide piped water supply and sewerage facilities. A population of 65,000 in Kurunegala MC and a part of PS area will benefit under the water supply component. The Teaching Hospital and Kurunegala City area with a population of 34,000 will benefit from the sanitation component, which will provide about 3,400 service connections by 2020.

(6) Kataragama Wastewater Disposal Project

This project is funded by the Uni-Credit Bank Austria AG. The LKR 2,040.0 million project will benefit 26,000 people, by providing sewerage facilities for pilgrim resthouses, hotels, and offices in and around the city limit to avoid pollution of the Menik Ganga and the surrounding environment. The main project scope includes expanding the sewer network and improving the sewage treatment plant. Mechanical aerators will be installed to bring the capacity of the existing treatment plant from 750 m^3 /day to 3,000 m^3/day, to accommodate the huge floating population.

4.2.2 Sewerage Projects included in the Public Investment Program

In addition to the above projects, NWSDB also has plans for the following 11 projects, donors for 7 of these are confirmed.

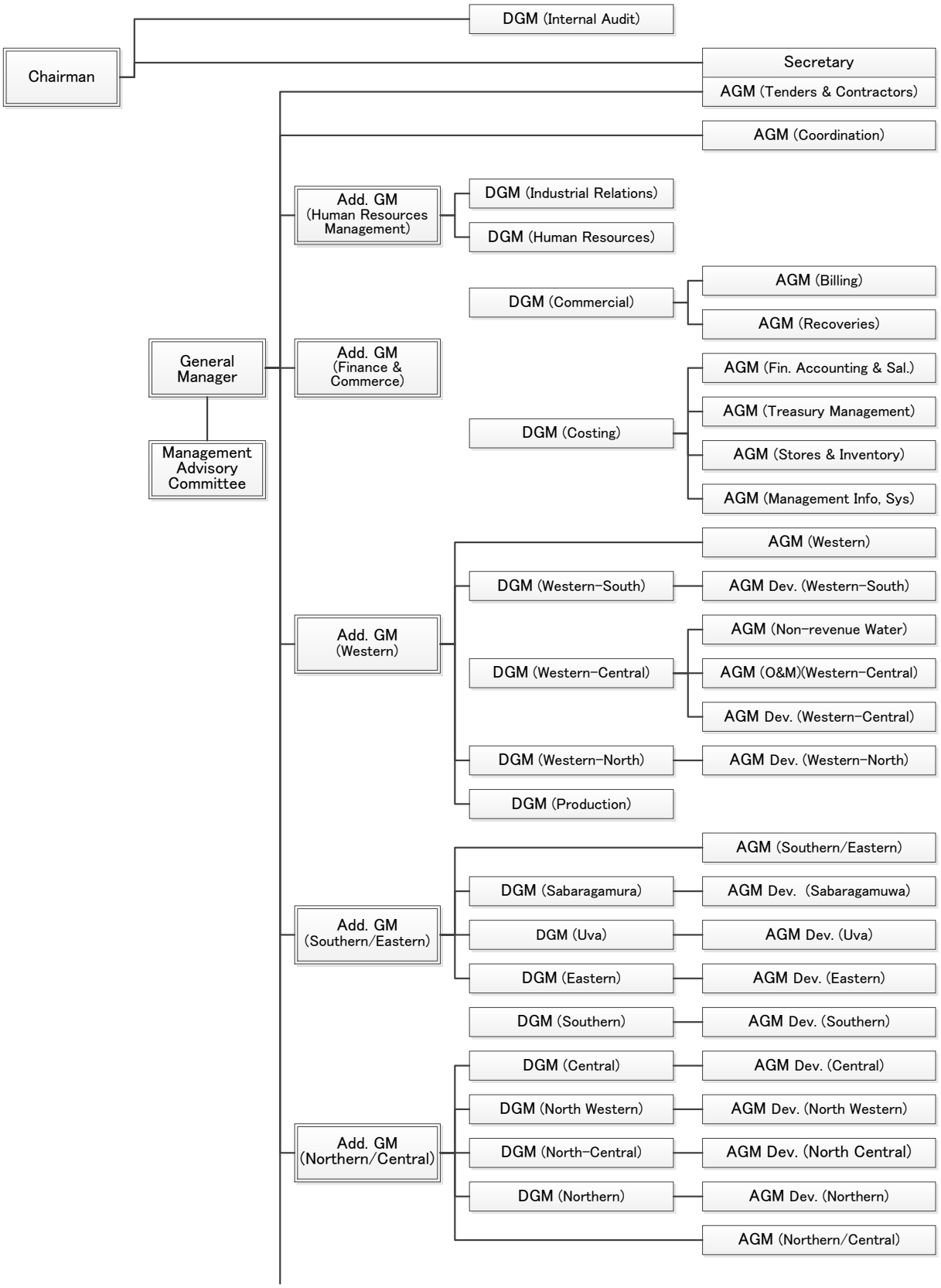
- Negombo Wastewater Disposal Project – To be funded by AFD (Agence Francaise de Development)
- Galle Wastewater Disposal Project – To be funded by AFD
- Kelaniya – Peliyagoda Wastewater Disposal Project– To be funded by AFD
- Hambantota Wastewater Disposal Project– To be funded by China EXIM Bank
- Kattankudy Wastewater Disposal Project – To be funded by China EXIM Bank
- Extension of Piped Sewerage Coverage in Dehiwala/Mt. Lavinia MC Area – Financing not yet found
- Maharagama – Boralesgamuwa Wastewater Disposal Project – To be funded by China EXIM Bank
- Puttalam Township Wastewater Disposal Project– To be funded by China EXIM Bank
- Sri Jayawardanapura Kotte Wastewater Disposal Project – Financing not yet found
- Batticoloa Wastewater Disposal Project – Financing not yet found
- Badulla Wastewater Disposal Project – Financing not yet found

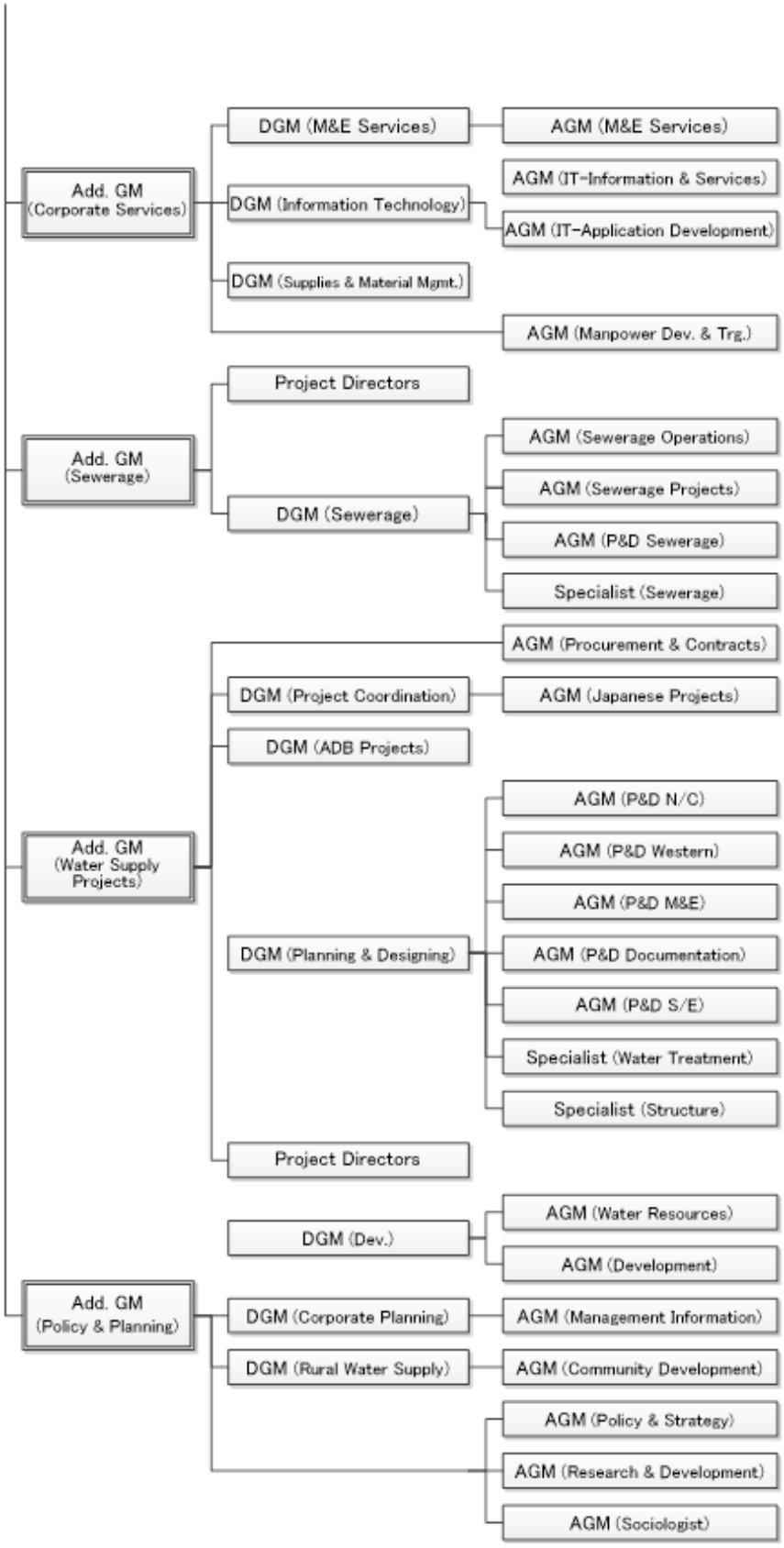
4.3 OPERATION AND MAINTENANCE OF SEWERAGE SYSTEM

4.3.1 Organization for O&M

NWSDB manages sewerage systems for almost the entire country except for Colombo MC. **Figure 4.3-1** shows the organization structure of NWSDB.

Addl. GM (Sewerage) has the responsibility of managing NWSDB sewerage works.


Chairman
DGM (Internal Audit)
Secretary
AGM (Tenders & Contractors)
AGM (Coordination)
General Manager
Management Advisory Committee
Add. GM (Human Resources Management)
DGM (Industrial Relations)
DGM (Human Resources)
Add. GM (Finance & Commerce)
DGM (Commercial)
AGM (Billing)
AGM (Recoveries)
DGM (Costing)
AGM (Fin. Accounting & Sal.)
AGM (Treasury Management)
AGM (Stores & Inventory)
AGM (Management Info, Sys)
Add. GM (Western)
AGM (Western)
DGM (Western-South)
AGM Dev. (Western-South)
DGM (Western-Central)
AGM (Non-revenue Water)
AGM (O&M)(Western-Central)
AGM Dev. (Western-Central)
DGM (Western-North)
AGM Dev. (Western-North)
DGM (Production)
Add. GM (Southern/Eastern)
AGM (Southern/Eastern)
DGM (Sabaragamura)
AGM Dev. (Sabaragamuwa)
DGM (Uva)
AGM Dev. (Uva)
DGM (Eastern)
AGM Dev. (Eastern)
DGM (Southern)
AGM Dev. (Southern)
Add. GM (Northern/Central)
DGM (Central)
AGM Dev. (Central)
DGM (North Western)
AGM Dev. (North Western)
DGM (North-Central)
AGM Dev. (North Central)
DGM (Northern)
AGM Dev. (Northern)
AGM (Northern/Central)

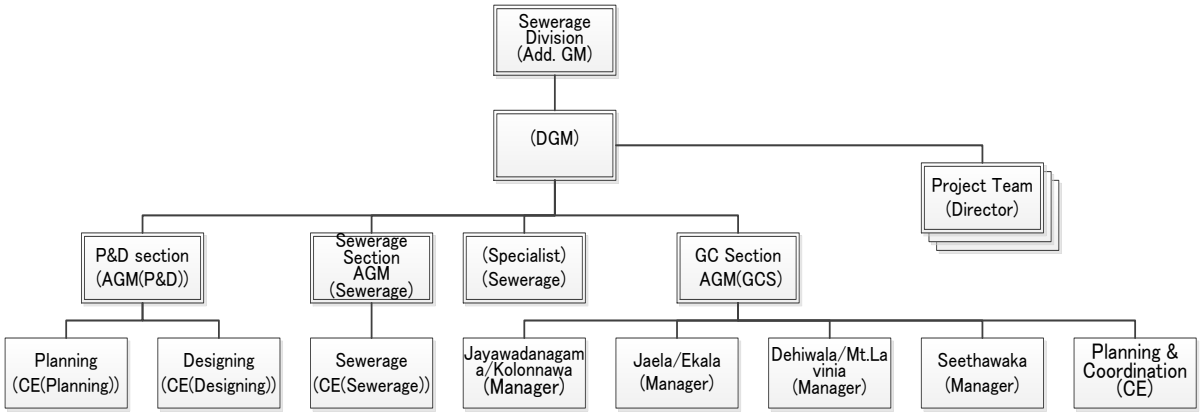


Source: NWSDB Homepage

Figure 4.3-1 Organizational Structure of the NWSDB

(1) Organization of the Sewerage Division

Figure 4.3-2 shows the organization of the sewerage division of NWSDB. A Deputy General Manager (DGM) assists the Addl. GM (Sewerage) in managing projects. The following positions report to the DGM (Sewerage): AGM (GCS) for O&M of sewerage systems in the GC area, a Specialist in charge of technical matters; AGM (Sewerage) in-charge of coordination and budgetary control of the on-going sewerage projects and AGM (P&D) in charge of planning and designing of sewerage projects. The Project Directors/Managers report to Addl.GM (Sewerage)/DGM (Sewerage).



Source: NWSDB

Figure 4.3-2 Organization of NWSDB Sewerage Division

The planning and design section of the sewerage division initiates the implementation of sewerage projects. Responsibilities for planning and design activities are as shown in **Table 4.3-1**.

Table 4.3-1 Responsibilities for Planning and Design

Works		Documentation	Check	Approval
Planning	Sewer system	Sewerage Division	Project Appraisal Committee of NWSDB	Ministry of CP&WS/ Board of Director of NWSDB
	STP	Sewerage Division with the assistance of Local Authority		
Design	Sewer system	Sewerage Division/ Contractor	AGM (P&D)/ Design Consultants	GM of NWSDB
	STP			

Source JET

Construction of Sewerage Facilities

A Project Director oversees construction activities. There are five projects underway in Kandy, Kurunegala, Kataragama and GC areas and each is managed by a Project Director.

House Connections

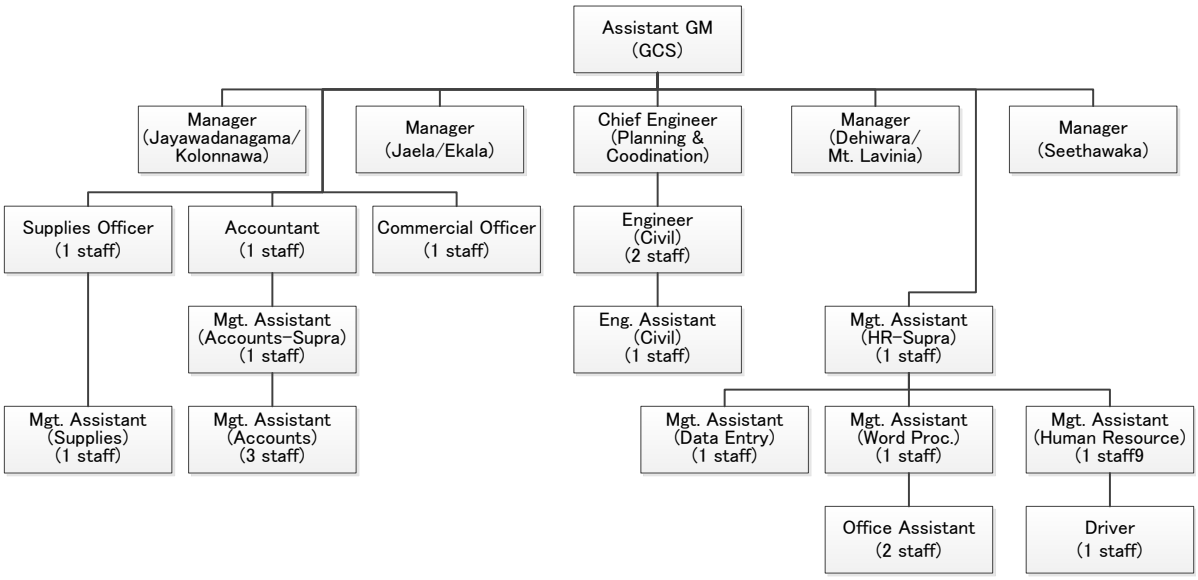
Most of the existing sewerage systems are in the GC area. The GCS section, headed by AGM (GCS) is in charge of house connections.

GCS manages water supply and wastewater for four regions: Jayawadanagama/Kolonnawa, Sri Padastane, Jaela/Ekala, Dehiwala/Mt. Lavinia, as well as the Seethawakapura industrial zone.

Sewer Network & STP

Like house connections, most of the sewerage facilities managed by NWSDB are located in the GC area. AGM (GCS) is in charge of the O&M of sewer networks and STPs. **Figure 4.3-3** shows the organization of the section. Under the Assistant General Manager (AGM), four managers take care of

O&M of sewer networks and STPs in Jayawadanagama/Kolonnawa, Jaela/Ekala, Dehiwala/Mt.Lavinia and Seethawakapura.



Source: NWSDB

Figure 4.3-3 Organization of Greater Colombo Sewerage Section

Sewage Treatment Plants and Ocean Outfalls

Table 4.3-2 shows the sewerage systems with STPs and ocean outfalls. There are 19 STPs in Sri Lanka; 7 are owned and managed by NWSDB, four are owned by BOI or UDA with O&M outsourced to NWSDB. Another 8 with small treatment capacities of 150 to 3,200 m^3/day are owned by BOI, with O&M outsourced to private operators. The extended aeration process is used mainly in large scale STPs and the stabilization pond process in small-scale STPs because it is easy operate and maintain and requires few staff .

Sewage from five facilities along the west coast is discharged into the ocean after screening. These were installed during from 1980 to 1990. Two of these ocean outfalls are pumped, the other three are gravity.

At the moment, all large-scale sewage treatment plants are managed by the GCS section. Soyzapura STP, Ekala STP and Seethawaka STP/WTP owned by BOI in the Seethawaka industrial zone are managed by Dehiwala/Mt. Lavinia, Jaela/Ekala and Seetahwaka regions. STPs at Biyagama industrial zone and Raddolugama Housing Scheme are also managed by Jaela/Ekala region. O&M of the other small-scale STPs located outside GC area are handled by respective RSCs.

Table 4.3-2 STP and Ocean Outfall Facilities in Operation

		Name	Location	Capacity m³/day	Start of Operation	Influent Type	Treatment Process	Owner	O/M
STP	1	Ratmalana-Moratuwa	Soyzapura	17,000	2013	I&D	Extended Aeration	NWSDB	NWSDB
	2	Jaela-Ekala	Ekala	7,250	2012	I&D	Extended Aeration	NWSDB	NWSDB
	3	Hikkaduwa	Hikkaduwa	1,020	2010	D	Stabilization ponds	NWSDB	NWSDB
	4	Kataragama	Kataragama	3,000	1983	D	Stabilization ponds	NWSDB	NWSDB
	5	Raddolugama Housing Scheme	Raddoluwa	6,000	1980	D	Extended Aeration	NWSDB	NWSDB
	6	Hantana Housing Scheme	Kandy	360	1981	D	Trickling filter	NWSDB	NWSDB
	7	Mattegoda Housing Scheme	Mattegoda	1,200	1980	D	Stabilization Ponds	NWSDB	NWSDB
	8	Seethawaka EPZ	Seethawaka	12,900	1999	I&D	Extended Aeration	BOI	NWSDB
	9	Biyagama EPZ	Biyagama	20,000	2012	I&D	Extended Aeration with Aerated lagoons	BOI	NWSDB
	10	Koggala EPZ	Koggala	675		I&D	Extended Aeration	BOI	NWSDB
	11	Modarawila Housing Scheme - STP	Panadura	600	2007	I&D	Activated sludge	UDA	NWSDB
	12	Katunayaka EPZ	Katunayaka	3,200	1981	I$D	Aerated lagoons	BOI	Private Operator
	13	Mirigama EPZ	Mirigama	400		I&D	Package Plant	BOI	Private Operator
	14	Wathupitiwala EPZ	Wathupitiwala	900	2002	I&D	Package Plant	BOI	Private Operator
	15	Polgahawela EPZ	Polgahawela	450	2007	I&D	Extended Aeration	BOI	
	16	Kandy EPZ	Kandy	1,000		I&D	Extended Aeration	BOI	
	17	Mawathagama EPZ	Mawathagama	500		I&D	Extended Aeration	BOI	
	18	Horana EPZ	Horana	1,000		I&D	Package Plant - Rotating Biological Contactors	BOI	Private Operator
	19	Digana Village Housing Scheme	Kandy	150	1983	D	Natural ponds		
Ocean Outfall	1	Dehiwela / Mt.Lavinia Sewerage Scheme	Dehiwela / Mt. Lavinia		1983	D	Screen + Ocean Outfall	NWSDB	NWSDB
	2	Kolonnawa Sewerage Scheme	Kolonnawa	2,100	1982	D	Screen + Ocean Outfall	NWSDB	NWSDB
	3	Jayawadanagama Housing Scheme	Jayawadanagama	1,260	1985	D	Screen + Ocean Outfall	NWSDB	NWSDB
	4	Maddumagewatte Housing Scheme	Maddumagewatte	260	1990	D	Screen + Ocean Outfall	NWSDB	NWSDB
	5	Colombo City Sewerage Scheme	Colombo			D&C	Screen + Ocean Outfall	CMC	CMC

Source: JET

Currently, GCS takes care of most of the O&M for sewerage systems as shown in **Figure 4.3-3.** Regions involved in O&M are Jayawadanagama/Kolonnawa, Sri Padastane, Ja-ela/Ekala, Dehiwela/Mt. Lavinia and Seethawaka in the BOI industrial zone.

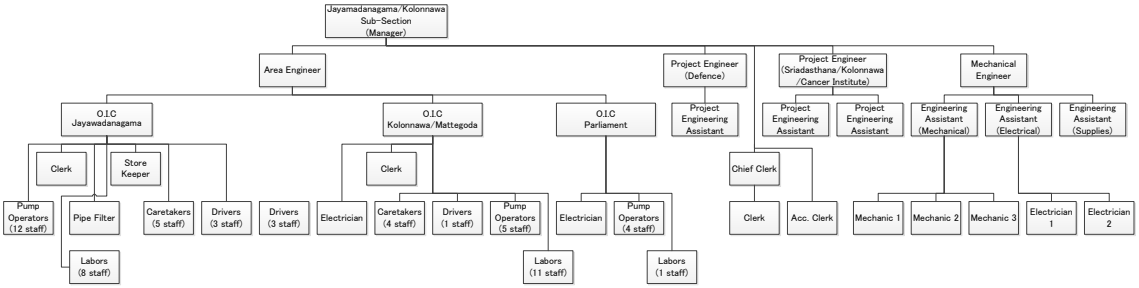
Jayawadanagama/Kolonnawa Region

The organizational chart of the Jayawadanagama/Kolonnawa region is shown in **Figure 4.3-4**. All sewage from this area is pumped and discharged through ocean outfalls. The area engineer oversees the operation of sewerage schemes in three areas: i) Jayawadanagama, ii) Kolonnawa/Mattegoda and iii) Parliament including government offices. A maintenance group for mechanical and electrical (M&E) equipment supports sewerage schemes in all 3 areas. Separate sewerage project groups are overseeing the implementation of projects in Kolonnawa, and Sri Padastane areas and the Defence, Cancer institutes.

There are no serious problems with O&M so far. The work will increase as the service area expands and will require additional staff and equipment such as gully-suckers. It may be worthwhile to consider outsourcing some activities to the private sector as the need arises.

This region also undertakes small to medium scale construction projects to expand the service area.

This is within the region's capabilities when the work falls within the scope of the existing responsibilities and project sites are nearby for convenient supervision.



Source: NWSDB

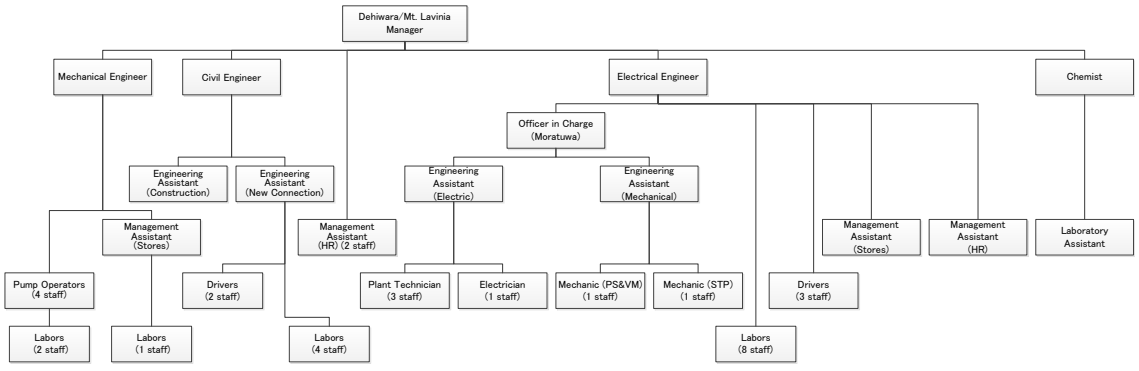
Figure 4.3-4 Organization of Jayawadanagama/Kolonnawa Region

Dehiwala/Mt. Lavinia Region

The organization chart of the Dehiwara/Mt. Lavinia region is shown in **Figure 4.3-5**. The region is divided into Dehiwara/Mt.Lavinia and Moratuwa/Rathmalana service areas. With the former, sewage is collected and discharged to the CMC ocean outfall through pumping facilities, whereas the sewage from the latter is treated by activated sludge process.

Moratuwa/Rathmalana maintains sewer networks and O&M of Soysapura STP. This STP is working satisfactorily. It has only been 4 years since commissioning. The influent quantity is only about 40% of its design capacity and only one treatment train is in operation.

A sludge disposal process has not been established for the STP. It is a serious issue and it is urgent that measures to be taken to cope with the increasing volume of sludge .



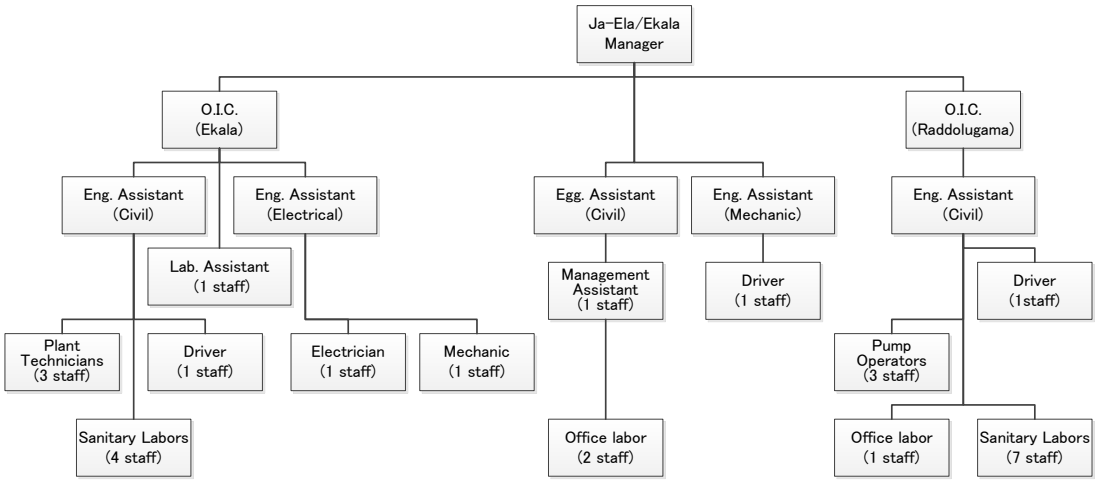
Source: NWSDB

Figure 4.3-5 Organization of Dehiwara/Mt. Lavinia Region

Ja-Ela/Ekala Region

The organizational chart of Ja-Ela/Ekala region is shown in **Figure 4.3-6**. O&M of the STP is placed under the O.I.C (Ekala) and O&M of sewer networks and PSs is placed under the O.I.C (Raddolugama).

The sludge disposal process has not been established in the STP. It is a serious issue and it is urgent that measures to be taken to cope with the increasing sludge volume.



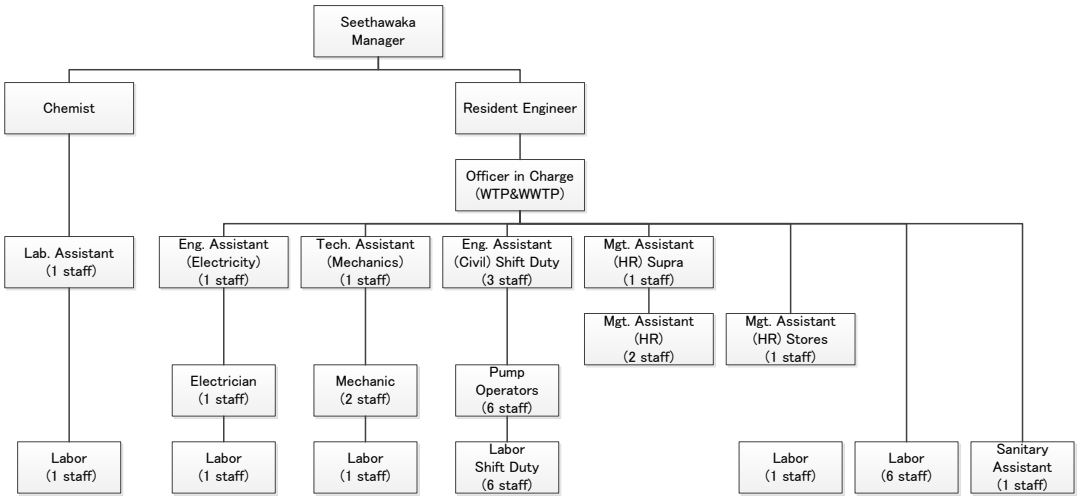
Source: NWSDB

Figure 4.3-6 Organization of Ja-Ela/Ekala Region

Seethawaka Region

Management of WTP and STP in the Seethawaka Export Processing Zone (EPZ) established by BOI is outsourced to NWSDB and the manager from Dehiwala-Mt.Lavinia carries out the O&M. Organizational chart of the region is shown in **Figure 4.3-7**. The two facilities are very close to each other and the industrial zone is isolated from the surrounding area. O&M of both facilities can be carried out together.

The O&M of STP is carried out effectively and efficiently at the moment. It will be more challenging in the future when equipment ages and/or influent quality changes. More staff may be required and replacement, rehabilitation of equipment and facilities has to be considered in negotiation with BOI when the need arises. The sludge generated in this STP is dumped at the solid waste disposal site in the industrial zone and it is not a serious concern.

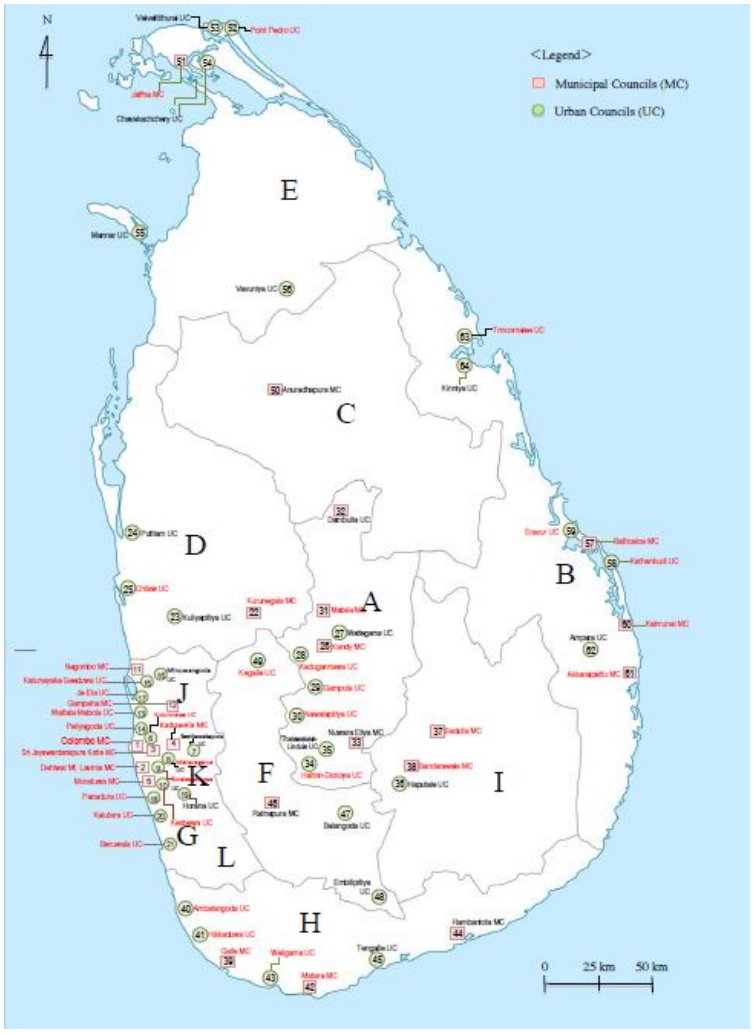


Source: NWSDB

Figure 4.3-7 Organization of Seethawaka Region

(2) Organization of Regional Support Centre (RSC)

In NWSDB, 12 RSCs carry out O&M of water and sewerage systems. **Table 4.3-3** shows the number of staff and main tasks for sewerage systems in each RSC and **Figure 4.3-8** shows the boundaries of each RSC.



Source: NWSDB

Figure 4.3-8 Area Covered by Each RSC

In Sri Lanka, sewer networks are much less extensive than water supply networks. O&M of sewer networks is rather insignificant especially in regions where the population density is low. Sewerage system O&M responsibility centre exists only in a few RSCs such as G, J, K, L, near Colombo MC at the moment.

Table 4.3-3 Number of Staff and Main Sewerage Tasks in RSCs

Position / RSC		Strategic Level	Tactical Level			O&M Level				Sewerage works taken in charge
		2	3	4	5,6	7,8,9	10,11	12,13	14,15	
		DGM	AGM	Chief Level	Senior Engineer/Engineer	EA. Spl./ EA Class I/II	Skilled Labor Spl. Class I/II	Skilled Labor Class I/II	Unskilled Labor	
A	Central	1	5	18	22/78	16/19/80	32/75	170/172	67/112	1. O&M of Hantana Sewerage Scheme 2. Kandy City Waste Water Management Project
B	East	1	4	11	8/50	13/12/92	23/72	198/136	114/211	no
C	North Central	1	2	9	9/24	3/15/45	22/39	70/74	41/89	no
D	North West	1	2	11	10/40	9/8/32	35/41	71/53	49/54	Greater Kurunegara Water Supply & Sanitation Project
E	North	1	2	6	5/24	2/2/29	2/15	25/41	34/45	Jaffna-Killinochchi Water Supply & Sanitation Project
-	Production	1	-	6	4/17	9/13/23	26/37	58/51	64/80	no (only water projects)
F	Sabaragamuwa	1	3	8	9/41	8/14/45	25/66	83/111	58/136	no
G	GCS	-	1	4	1/18	5/5/14	3/22	33/49	6/73	1. O&M of all Sewerage Schemes in the Western RSCs except the CMC area 2. O&M of Seethawaka & Biyagama BOI STPs on contract base 3. O&M of STPs in Housing Schemes in Western RSCs 4. Greater Colombo Wastewater Management Project, Jaela/Ekala & Ratmalana/Moratuwa Wastewater Disposal Project, Global Partnership for Output Based Aid Project for Increasing Sewerage Services in Greater Colombo area
H	Southern	1	1	13	21/59	30/20/95	79/136	222/206	173/238	1. O&M of Hikkaduwa and Kataragama Sewerage Schemes 2. Augmentation and Rehabilitation of Kataragama Wastewater Disposal Project
I	Uva	1	2	9	8/29	4/16/34	11/33	74/95	93/117	no
J	Western North	1	2	12	13/54	19/13/84	47/81	128/148	53/146	Handled by GCS
K	Western Central	1	2	16	22/73	21/24/142	56/187	285/199	126/252	
L	Western South	1	2	13	15/49	13/26/73	50/96	101/105	44/187	

Source: JET

4.3.2 Maintenance Equipment

Clogged sewer pipes affect people's daily lives and must be attended to as soon as possible.

Table 4.3-4 shows the number of vehicles used for maintenance of sewer networks, such as gully suckers and high pressure jetting machines, at the GCS section and their distribution in the three regions.

There will be more breakdowns as the sewerage service area expands. Delays in attending to breakdowns cause problems such as inundation of roads and offensive odour. NWSDB has to provide adequate maintenance equipment so that prompt action can be taken and customers have no cause to complain.

Table 4.3-4 Equipment & Machinery for Maintenance of Sewer Systems in GCS

	Dehiwela/Mt.Lavinia	Jayawadanagama/ Kolonnawa	Ja-ela/Ekala
Gully /Jetting Combined Machine	-	1	-
Gully Bowser	2	1 (with frequent breakdown)	1
Portable Jetting Machine	1	1 (with frequent breakdown)	-
Crane Truck	-	1 (with frequent breakdown)	-
High Pressure Jet Machine	1	1	1
High Pressure Water Spraying Machine	-	1	-

Source: JET

4.3.2 Current Situation of Operation & Maintenance

Maintenance of Sewer Networks

Table 4.3-5 shows the number of customer complaints received and resolved in the 4 regions managed by GCS section of NWSDB. There are no complaints in Seethawaka because the users there are mainly industries. 270 to 395 complaints were received in the other regions. Some complaints were not attended to because the crew was not able to access the blockage location in the premise.

The number of complaints will increase with service area expansion. Adequate distribution of maintenance equipment will be important for prompt attention to complaints and to avoid backlogs.

Table 4.3-5 Complaints Received and Attended to by Region (2015)

Region	Complaints Received	Complaints Attended-To
Moratuwa/Ratmalana	320	320
Jaela/Ekala	270	235
Seethawaka	0	0
Jayawadanagama/Kolonnawa	395	393

Source: JET

Operation & Maintenance of Sewage Treatment Plants

Table 4.3-6 shows the influent and effluent quality in the 3 major STPs managed by NWSDB, i.e. Moratuwa/Ratmalana, Jaela/Ekala and Seethawaka BOI STP. Treatment efficiency of these STPs is high and effluent quality is better than the regulatory standard (BOD=30 mg/L). However, it should be noted that influent quantity in STPs, other than Seethawaka, is less than 50% of the treatment capacity and when the quantity increases, proper O&M will be critical for achieving high treatment efficiency.

Ocean outfall in some sewerage facilities managed by NWSDB and the sewage discharged into the ocean, are meeting inland surface discharge standards. If the effluent standards are revised and become more stringent, construction of treatment facilities or transport of sewage to other sewerage systems has to be considered.

Table 4.3-6 Influent and Effluent Quality of STPs (2015)

Parameter / STP	BOD (mg/L)		COD (mg/L)		SS (mg/L)		T-N (mg/L)		T-P (mg/L)	
	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.	Inf.	Eff.
Moratuwa/Ratmalana	99	3.6	260	42	340	6.3	54	12	2.7	0.71

Jaela/Ekala	190	6.7	630	56	530	18	70	12	-	-
Seethawaka	150	28	400	110	150	55	38	22	-	-

Source: NWSDB

4.4 ORGANIZATIONAL CAPACITY OF THE NWSDB SEWERAGE DIVISION

4.4.1 Planning and Design

Policy and Planning division of the NWSDB decides on the implementation of a new sewerage project, by following a set procedure approved by the Board of Directors, as shown in **Figure 4.3-1**. Having obtained the necessary approvals, Planning and Design section of the Sewerage division undertakes its implementation as shown in **Figure 4.3-1** and **Table 4.3-1**.

Table 4.4-1 shows the staff allocated to planning and design of water and sewerage systems in 2014. The number of staff in sewerage is very small but will increase when more projects are implemented.

At present, there is no mechanical/electrical engineer or engineering assistant assigned exclusively for the planning and design in the sewerage division. M&E inputs are obtained from the M&E section of the P&D Division on an ad hoc basis. A chief engineer, engineers and assistants in the M&E disciplines, are needed in the near future.

Table 4.4-1 Staff in Planning and Design of Water and Sewerage Systems

	Categories	Water Works	Sewerage Works
1	DGM	1	-
2	Specialist	2	1
3	AGM（Civil）	4	1
4	AGM（Mechanical/Electrical）	1	-
5	Chief Engineer (Civil)	9	2
6	Chief Engineer (Mechanical/Electrical)	1	-
7	Engineer (Civil)	21	6
8	Engineer (Electrical)	1	-
9	Engineer (Electronic)	2	-
10	Engineer (Mechanical)	6	-
11	Assistant Engineer	1	-
12	Engineer Assistant (Mechanical)	1	-
Others		91	10
Total		141	20

Source: JET

4.4.2 Construction

A project team, headed by a Project Director will manage the construction phase. As shown in **Figure 4.3-2**, the Project Director reports to the DGM (Sewerage). The AGM (sewerage) assigns the coordination and budgetary control of all projects to a section head.

The organization of the project team depends on the size and requirements of each project. There are 5 on-going sewerage projects: Kandy, Kurunegala, Kataragama, GCWMP and WB Project. When more projects (such as Jaffna, Jayawardana Pura/Kotte and Hambantota) are initiated, adding a DGM (Construction) will facilitate contract administration and construction supervision.

4.4.3 House Connections

Most of the sewerage systems are currently in the GC area. Hence the GCS section mainly handles the supervision of house connections (AGM (Sewerage)).

This responsibility should devolve to units established in each RSC, in order to be more effective in the supervision of O&M of regional STPs and sewer networks.

4.4.4 Operation & Maintenance

- Sewer Networks
- Sewage Treatment Plants and Pumping Stations

Table 4.4-2 shows the staff in WTPs managed by NWSDB and main issues identified in each WTP.

There is more staff in maintenance than operation (11 versus 2 at Biyagama WTP). In spite of the large maintenance staff, repairs of pumps and maintenance of M&E equipment are listed as issues.

Table 4.4-3 shows the situation in STPs. In the Soysapura STP, there are 9 maintenance staff (one of which is a mechanical engineering assistant) and 3 operators. In the Ekala STP, there are 6 maintenance staff (including a mechanic and an electrician) and 3 operators. In both STPs, the maintenance staff oversees maintenance of STPs as well as sewer networks.

NWSDB only started to operate STPs a few years ago. The frequency of equipment failure is still low. As equipment and facilities age, maintenance will become more onerous. The number of staff has to increase to the same level as that of WTPs, or outsourcing to private sector has to be considered.

Table 4.4-2 Number of O&M Staff and Issues in WTPs

		Ambatale WTP	Biyagama WTP	Kandana WTP	Kethhena WTP	Kalatuwawa WTP	Labugama WTP
Operation	Number of shift	3	3	3	3	3	3
	Number of Operators	13	2	2	5	6	5
Maintenance	Number of staff	41	11	13	12	13	21
Water analysis	Number of staff	9	4	5	1	4	1
Issues	In Operation	Raw water Quality deteration, Oil contermination	1.Water level reducing 2. Water Plution, Fuctry discharge	1. Soil Errotion 2. Fertry dicharges	1. Salality problems 2.Factry dirchagers	Amoria & iron presentages are in high level	Amoria & iron presentages are in high level
	In Maintenance	Cannot be purchese good quality goods(as per the tender procedier)	1.Pump repaining 2. Electrical & Mechnical and repaira works	1.Pumps repearing 2.Elactrical & Mechanical reapair works	1.Pretetor to be Construction 2. Circulation Pumps to be purchased	1.Pump repaining 2. Electrical & Mechnical and repaira works	1.Pump repaining 2. Electrical & Mechnical and repaira works

Source: JET

Table 4.4-3 Number of O&M Staff in STP and WTP

		Operator	Maintenance
STP	Soysapura	3	9 (Including a mechanical engineer assistant and a mechanic) Not only maintenance works of STP but also that of sewer networks
	Ekala	3	6 (Including a mechanic and an electrician) Not only maintenance works of STP but also that of sewer networks
WTP	Biyagama	2	11 Maintenance works only in WTP

Source: JET

4.4.5 Capacity Development

Training

The NWSDB Training Centre conducted 41 technical training courses, 36 non-technical courses and 19 computer/IT courses. RSCs also held 13 technical training courses and 13 non-technical courses for

on-site operators and maintenance workers. DGM (Production) supported 10 technical courses. NWSDB also sponsors diploma courses, Masters and PhD studies at universities.

Table 4.4-4 shows the in-house technical training programs related to sewage works. Unfortunately, most programs are more oriented to water supply.

The interviews conducted in the Training Centre on 3rd February 2016, found that the small number of training courses for engineers and labourers in sewerage works is directly related to the small number of sewage systems and STPs, and the small number of staff in these facilities.

Table 4.4-4 Technical Training Related to Sewage Systems (2015)

Category	No. in Attach File	Title of the Program	Target Group	Term (Day)
(In House)				
Estimation and Contract	1	Procurement Management	Executives	1
	2	Pre-Contact activities in NWSDB (preparation Bidding documents, procurement process and Financial aspects of bidding process)	Engineers/EAA/and other related Executives	2
	3	FIDIC Conditions of Contracts	Project Engineers/ Accountants	1
	4	Advance bid Evaluation	Addl(GM)/DGM/AGM	2
	5	Preparation of Estimates pipe lines and structures	Engineers/EAA/QSS	3
Construction	7	Construction Management	Engineers	2
Installation	19	Design Selection Installation & Testing of water pumps	Engineers	2
On-site	15	O&M of Panel boards	EA/TPT /Electricians	1
	16	Maintenance of Air Conditioning Systems	EA/Mechanics/Electricians	1
	17	Maintenance and Repair of Gas Chlorinators	EA/TPT/ Mechanics/ Electricians/ Pump Operators/ labourers	3
	18	Rewinding of Electrical Motors	EA(Elect)/ Electricians	1
	21	O&M of Water Pumps	EAA/TPT/Pump Operators	2
	23	O&M of STP	Engineers/EAA/TPT	2
	30	Waste Water Treatment Process	Engineers/ Chemists	2
	41	Welding Technology	Welders	2
(In RSCC)				
On-site	8	O&M of Electrical Motors and Starters & Panel Board	Pump Operators	1
	9	O&M of Pumps	Pump Operators	1
	11	Safety Transportation of Chlorine Cylinders	Labourers/ Work supervisors	1
	12	Site Safety	Mixed Group	1
	13	Preventive Maintenance	Labourers/ Work supervisors	1
(By DGM Production)				
On-site Management	1	Monitoring and Controlling Production Process by using SCADA Systems	Engineers/EAA/TPT	1
	2	Optimize the Energy Consumption by Operational Excellence	Engineers/EAA/TPT	1
	5	Preventive Maintenance and Asset Management technique to optimize the Operational life of the Plant and Equipment	Engineers/EAA/TPT	2
	6	Energy Saving	Mixed	1
	7	Pneumatic control Systems	Mechanic/ Electrician/TPT	1
ISO	8	Training on ISO 17025	Manager/ Chemist/OICC/ Lab. Assist.	1

	9	Training on ISO 9001:2008	Mixed	1

Source: NWSDB

As the development of sewerage systems continues at a steady pace, adequate training courses must be put in place to anticipate requirements for skilled workers. The training programs required are shown in **Table 4.4-5**.

Table 4.4-5 Training Program Required for Sewage Sector

Category	No.	Title of the Program
Planning	1	Planning of Sewage Works
	2	Principle of Asset Management
Designing	1	Designing of Sewer System
	2	Jacking Method
	3	Rehabilitation of Pipe Networks
	4	Designing of STP
	5	Mechanical System Design in STP
	6	Electrical System Design in STP
O&M	1	Maintenance of Sewer System
	2	Operation of STP
	3	Maintenance of Mechanical System in STP
	4	Maintenance of Electrical System in STP
	5	Water Quality Management
	6	Commercial and Industrial Wastewater Management
Safety Management	1	On-site Safety management
Risk Management	1	On-site Risk Management

Source: JET

Information on salaries and benefits, promotion system is summarized in **APPENDIX 1**.

4.5 FINANCIAL SITUATION OF SEWAGE SECTOR

4.5.1 Financial Situation of the Central Government

Table 4.5-1 shows revenue and expenditures of the GOSL. As shown in "Overall Budget Surplus/Deficit", the Government has massive deficits (450 to 591 billion LKR) over the last 5 years. These deficits are almost as much as the entire "Capital Expenditure". The deficits are funded by foreign and domestic financing. Share of "Foreign Financing (Net)" is about 24 to 59% of total financing. The GOSL relies on foreign financing for capital expenditures, including loans through bilateral aid and international agencies. Annual budget for the "Capital Expenditure" for all public services is less than 500 billion LKR, in recent years.

Table 4.5-1 Annual Budget and Expenditures of Central Government

Unit: billion LKR

Item	2011	2012	2013	2014		2015
				Approved Estimate	Provisional	Approved Estimates
Total Revenue and Grants	983.00	1,067.53	1,153.31	1,469.49	1,204.62	1,534.70
Total Revenue	967.86	1,051.46	1,137.45	1,437.49	1,195.21	1,504.70
Tax Revenue	845.70	908.91	1,005.90	1,274.60	1,050.36	1,337.00
Non Tax Revenue	122.16	142.55	131.55	162.89	144.84	167.70
Grants	15.14	16.07	15.86	32.00	9.42	30.00
Expenditure and Lending Minus Repayments	1,433.18	1,556.49	1,669.40	1,985.62	1,795.87	2,034.08
Current Expenditure	1,024.91	1,131.02	1,205.18	1,328.28	1,322.90	1,552.04
Capital Expenditure	377.81	400.08	454.30	641.12	459.86	472.93
Lending Minus Repayment	30.46	25.39	9.91	16.21	13.11	9.11
Current Account Surplus (+)/Deficit (-)	-57.05	-79.56	-67.73	109.21	-127.69	-47.34

Overall Budget Surplus (+)/Deficit (-)	-450.18	-488.97	-516.09	-516.13	-591.24	-499.38
Financing	450.18	488.97	516.09	516.13	591.24	499.38
Foreign Financing (Net)	218.96	286.46	123.70	286.85	212.52	291.38
Gross Borrowing	317.75	486.82	327.69	382.85	395.63	495.46
Repayments	-98.79	-200.37	-203.99	-96.00	-183.11	-204.09
Domestic Financing	231.22	202.51	392.39	229.28	378.72	208.00
Market Borrowing	236.02	202.51	379.39	229.28	392.08	208.00
Non-Bank	44.17	70.98	82.41	129.28	265.16	138.00
Bank	191.85	131.53	296.98	100.00	126.93	70.00
Other Borrowing	-4.80		13.00		-13.36	
Public Debt Outstanding	5,133.37	6,000.11	6,793.25	n.a	7,390.90	n.a
Domestic	2,804.09	3,232.81	3,832.83	n.a	4,277.78	n.a
Foreign	2,329.28	2,767.30	2,960.42	n.a	3,113.12	n.a

Source: Sri Lanka Socio-Economic Data 2015

NWSDB, responsible for the construction and O&M of most of the sewerage facilities, receives grants from the central government for 100% of the total capital investment of sewerage projects. These funds are loan to the GOSL.

Public investment, which is the sum of Capital Expenditures of Central Government and Lending to Public Enterprises, is shown in **Table 4.5-2**.

Table 4.5-2 Public Investment of Central Government

Unit: billion LKR.

Item	2010	2011	2012	2013	2014	
					Provisional	%
Capital Expenditure	302.09	377.81	400.08	454.30	459.86	94.5
Lending to Public Enterprises	54.43	44.49	43.89	26.90	26.75	5.5
Public Investment	**356.52**	**422.30**	**443.97**	**481.20**	**486.61**	**100.0**
Education	19.05	22.32	28.93	31.98	50.36	10.3
Health	13.33	14.79	17.15	19.92	22.25	4.6
Police and Public Security	1.30	3.82	0.94	1.17	3.34	0.7
Civil Administration	20.21	28.67	26.57	31.63	40.28	8.3
Housing and Common Amenities	5.49	7.10	7.82	8.01	20.57	4.2
Community Services	18.33	19.14	17.27	17.73	19.15	3.9
Agriculture and Irrigation	24.86	28.62	30.35	36.72	57.10	11.7
Energy and Water Supply	66.57	83.19	85.60	87.52	51.32	10.6
(Of which Capital Transfer to NWSDB)	(19.04)	(29.18)	(31.45)	(25.89)	(26.40)	(5.4%)
Transport and Communication	165.51	190.03	204.54	210.40	177.47	36.5
Others	21.87	24.62	24.80	36.12	44.77	9.2

Source: Annual Report 2014, Ministry of Finance, Sri Lanka

As shown in **Table 4.5-2**, public investment in "Transport and Communication" is the largest at 36.5% in 2014, followed by "Agriculture and Irrigation" (11.7%), Energy and Water Supply (10.6%), and "Education" (10.3%). Capital transfer to NWSDB is 5.4% of total public investment and a small portion of which is for the sewerage sector. The budget of the GOSL is not adequate to meet the huge needs in every sector. Therefore, it is of high priority that the sewerage sector secures more budget for future developments.

4.5.2 Financial Situation of NWSDB

(1) Financial Statements

Table 4.5-2 to Table 4.5-4 show the audited financial statements of NWSDB for the past several years. The Auditor General's Department, which audited NWSDB, is an independent and transparent

institution appointed by the President, at arms-length from any ministries or government officials.

NWSDB introduced new accounting system in accordance with new Sri Lanka Accounting Standards (SLFRS/LKAS) in the year 2012 from old Sri Lankan Accounting Standard (SLAS). Since then the structures of financial statements were transformed in accordance with the new standard, referred to the International Financial Reporting Standard (IFRS). Table 4.5-2 Statement of Financial Position corresponds to the usual Balance Sheet. Table 4.5-3 Statement of Comprehensive Income corresponds to the usual Income Statement, but not exactly the same.

Under the present financial statements of NWSDB, revenues and costs data only for sewerage service are not available and included in those of water supply service. The Sewerage Section, NWSDB, collects and analyses the sewerage revenue and cost data, using number of connections and water consumption volume of sewerage customers. These data, while very useful, are not audited and do not have asset data and depreciation costs for sewerage facilities. For better understanding of the financial situation for sewerage service, it is necessary to establish a separate accounting system for sewerage. Otherwise, segment information for sewerage can be added to the financial statements. Segment information is a format of the IFRS. An example of segment information (HONDA) is shown in **Table 4.5-6**.

Table 4.5-3 Statement of Financial Position, NWSDB

Unit: million LKR

Year	2010	2011	2012	2013	2014
ASSETS					
Non-Current Assets					
Property, Plant & Equipment-Net	73,488.50	84,358.60	106,084.07	107,585.12	109,865.64
Intangible Assets	255.07	204.05	153.04	102.03	52.96
Capital Work in Progress	75,122.04	93,616.62	103,647.17	121,418.02	149,059.34
Other Financial assets	65.48	47.02	37.82	31.01	22.81
Total Non-Current Assets	**148,931.09**	**178,226.29**	**209,922.10**	**229,136.17**	**259,000.75**
Current Assets					
Non Operating Assets	186.53	129.52	117.76	117.90	117.90
Inventories	2,888.14	2,942.96	3,193.20	3,749.73	5,623.80
Trade & Other Receivables	3,953.33	4,442.51	4,930.18	5,388.79	5,544.27
Deposit & Advances	5,573.16	4,456.41	3,496.45	4,286.65	9,530.56
Investments	357.41	892.09	12.34	340.97	244.26
Cash & Cash Equivalent	1,415.66	810.40	1,874.27	1,879.88	2,756.52
Total current assets	**14,374.24**	**13,673.89**	**13,624.20**	**15,763.91**	**23,817.31**
TOTAL ASSETS	**163,305.33**	**191,900.17**	**223,546.30**	**244,900.08**	**282,818.05**
EQUITY & LIABILITIES					
Equity					
Assets taken over from Government Dept.	185.48	185.48	185.48	185.48	185.48
Staff Welfare Fund	13.47	13.94	14.42	15.10	15.24
Retained Earnings	-12,920.39	-12,733.33	-13,466.81	-12,240.04	-10,814.26
Grants-Government Grants	62,617.52	69,440.02	77,931.82	81,070.00	88,161.76
Capital Grants	78,517.96	94,049.87	116,361.73	129,350.33	151,974.12
Total Equity & Grants	**128,414.03**	**150,955.99**	**181,026.64**	**198,380.87**	**229,522.34**
Non-Current Liabilities					
Loan Payable	23,070.63	27,838.90	29,011.51	32,146.72	37,715.44
Other Deferred Liabilities	2,485.30	2,529.00	2,152.08	2,152.12	2,194.04
Total Non-Current Liabilities	**25,555.92**	**30,367.90**	**31,163.59**	**34,298.83**	**39,909.48**
Current Liabilities					
Trade & Other Payables	3,654.78	5,290.85	4,923.02	5,246.17	6,961.19
Loan Capital Payable	2,362.32	2,687.80	3,592.78	4,470.62	3,440.62
Loan Interest Payable	3,157.13	2,464.63	2,768.28	2,431.66	2,912.50
Non Operating Liabilities	161.15	133.01	71.98	71.93	71.93
Total Current Liabilities	**9,335.38**	**10,576.29**	**11,356.07**	**12,220.37**	**13,386.23**

TOTAL EQUITY AND LIABILITIES	**163,305.33**	**191,900.17**	**223,546.30**	**244,900.08**	**282,818.05**

Source: NWSDB, website

Table 4.5-4 Statement of Comprehensive Income

Unit: million LKR

Year	2011	2012	2013	2014
Revenue	12,609.70	14,344.21	17,074.99	18,710.05
Cost of Sales	-7,470.49	-8,821.80	-10,015.14	-11,325.83
Gross Profit	**5,139.21**	**5,522.41**	**7,059.85**	**7,384.22**
Other Operating Income and Gains	1,318.54	1,586.51	1,195.41	1,443.78
Administrative Expenses	-4,680.82	-5,848.14	-5,831.43	-5,985.33
Other Operating Expenses	-227.43	-54.48	-559.43	-334.37
Operating Profit/(Loss)	**1,549.51**	**1,206.31**	**1,864.40**	**2,508.30**
Finance Income	131.26	213.96	225.69	213.24
Finance Cost	-943.36	-1,013.25	-1,039.76	-1,242.53
Profit/(Loss) before Tax	**737.41**	**407.02**	**1,050.33**	**1,479.00**
Provision for Income Taxation	-53.06	-40.22	-47.47	-53.11
Profit/(Loss) for the Year	**684.35**	**366.80**	**1,002.86**	**1,425.89**
Other Comprehensive Income for the Year, Net of Taxes	-	-	-	-
Total Comprehensive Income for the Year	**684.35**	**366.80**	**1,002.86**	**1,425.89**

Source: NWSDB, website

Table 4.5-5 Statement of Cash Flows

Unit: million LKR

Year	2011	2012	2013	2014
CASH FLOWS FROM/(Used in) OPERATING ACTIVITIES				
Net Profit/Loss(-) before tax	737.41	407.02	1,050.33	1,479.00
Adjustments for:				
Interest Income	-131.26	-213.96	-225.69	-213.24
Profit (-)/Loss on disposal of Fixed Assets	1.01	3.69	-0.02	-1.54
Depreciation	1,997.68	2,026.53	2,586.09	2,730.44
Amortization of intangible Assets				0.29
Grant amortization against depreciation	-277.80	-336.79	-590.25	-699.69
Revaluation surplus	474.26	776.84	-	-53.71
Retiring gratuity provision	216.76	-146.35	241.66	227.14
Opening Balance Adjustments	-496.35	-76.52	-	0.03
Non conversion adjustment	-0.47	534.44		
Interest Expenses	943.36	1,013.25	1,039.76	1,242.53
Operating Profit before Working Capital Changes	3,464.60	3,988.15	4,101.88	4,711.24
Increase (-)/Decrease in Inventories	-54.82	-250.24	-607.66	-1,874.07
Increase (-)/Decrease in Debtors, Rece'bles & Deposits	685.92	509.98	-1,264.09	-5,402.60
Increase/Decrease (-) in Creditors & Provisions	1,615.81	-463.74	335.18	1,756.95
Cash Generated from Operations	5,711.51	3,784.15	2,565.31	-808.48
Tax Paid	-53.06	-40.22	-47.47	-53.11
Gratuity paid	-180.93	-195.69	-241.66	-227.14
Net Cash Flows from Operating Activities	**5,477.52**	**3,548.24**	**2,276.18**	**-1,088.73**
CASH FLOWS FROM/(Used in) INVESTING ACTIVITIES				
Investments in Fixed Assets & Work-In-Progress	-31,841.84	-36,129.77	-21,595.00	-31,492.38
Withdrawal of other financial assets	18.46	9.20	6.81	8.20
Sale proceeds for disposal assets	4.22	8.96	0.05	5.61
Investment Income Received	129.93	188.02	240.83	216.45
Investment (-)/Withdrawal of Investments	-534.68	879.75	-328.63	96.71
Net Cash Flows used in Investing Activities	**-32,223.91**	**-35,043.84**	**-21,675.93**	**-31,165.42**
CASH FLOWS FROM /(Used in) FINANCING ACTIVITIES				

Government Grant during the Period	8,193.23	9,906.40	5,147.35	7,768.32
Capital Grant during the period	15,786.18	22,623.62	13,530.55	23,177.80
New Loans	4,768.28	2,665.42	4,213.78	5,569.22
Loan Repayments	325.48	-610.99	-200.74	-1,030.50
Interest Paid	-1,635.86	-686.43	-1,376.38	-1,871.94
VAT payments through treasury funds	-1,296.18	-1,338.56	-1,909.20	-482.11
Net Cash Flows from Financing Activities	**26,141.13**	**32,559.46**	**19,405.36**	**33,130.79**
Net Increase in Cash & Cash Equivalents	**-605.26**	**1,063.86**	**5.61**	**876.64**
Cash & Cash Equivalents at the beginning of the year	1,415.66	810.40	1,874.27	1,879.88
Cash & Cash Equivalent at the end of the year	**810.40**	**1,874.27**	**1,879.88**	**2,756.52**

Source: NWSDB, website

Table 4.5-6 Example of Segment Information (IFRS), HONDA

Business Segment Information (IFRS)

Motorcycle business

Unit sales and Net Sales

Unit sales : (thousand)	**FY2014**	**FY2015**
Japan	226	199
North America	278	286
Europe	166	191
Asia	7,858	8,478
Other	1,804	1,571

Financial Data

Yen (millions)	**FY2014**	**FY2015**
Sales revenue		
External customers	1,689,228	1,846,666
Intersegment	-	-
Total	1,689,228	1,846,666
Segment profit	176,898	192,154
Segment assets	1,316,079	1,489,703

Financial Index

	FY2014	**FY2015**
Operating margin	10.5%	10.4%

Automobile business

Unit sales and Net Sales

Unit sales : (thousand)	**FY2014**	**FY2015**
Japan	788	696
North America	1,754	1,750
Europe	171	161
Asia	531	637
Other	286	269

Financial Data

Yen (millions)	**FY2014**	**FY2015**
Sales revenue		
External customers	9,178,773	9,603,335
Intersegment	70,591	154,536
Total	9,249,364	9,757,871
Segment profit	461,156	279,756
Segment assets	6,795,373	7,653,645

Financial Index

	FY2014	**FY2015**
Operating margin	5.0%	2.9%

Source: edited by JET with the data on web site of HONDA; http://world.honda.com/investors/financial_data/segment_ifrs/

(2) Management and Financial Condition of NWSDB

NWSDB uses a self-supporting financial system. Financial support by central government is provided as a grant for part of the construction costs of water supply and sewerage facilities. NWSDB receives no other government subsidies.

As shown in **Table 4.5-3**, NWSDB reports increasing annual net profit for 2011 to 2014. In 2014, the net profit is 7.6% of revenue. Return on asset (ROA=Net Profit of the year/Total Asset) is lowest (0.16%) in 2012 and highest (0.50%) in 2014. Return on Equity (ROE=Net Profit of the year/Equity) is lowest (0.20%) in 2012 and highest (0.62%) in 2014. As a rule, ≥5% ROA indicates good financial condition, 1 to 2% ROA is normal. The ROA of NWSDB although small, is in the positive territory.

'Loan Interest Payable' and 'Loan Capital Payable' in "Current Liabilities" (**Table 4.5-2)** are amounts to be repaid by NWSDB within one year. Loan and interest amounts actually repaid are recorded in the Cash Flow Statement as 'Loan Repayments' and 'Interest Paid' in "Cash Flows from/(Used in) Financing Activities". A negative sum in cash flow indicates repayment of the loan or interest.

As shown in **Figure 4.5-1**, the loan capital and interest payable or amounts to be paid, are more than the actual amounts paid (loan and interest paid). NWSDB is not able to repay the full loan amount. Unpaid loan capital and interest (in green) is between 3.45 to 5.33 billion LKR. More than 96% (2014) of the loan is composed of foreign loans secured through the Treasury. Therefore, the net profit of NWSDB comes from the central government deferring the recovery of loan repayments.

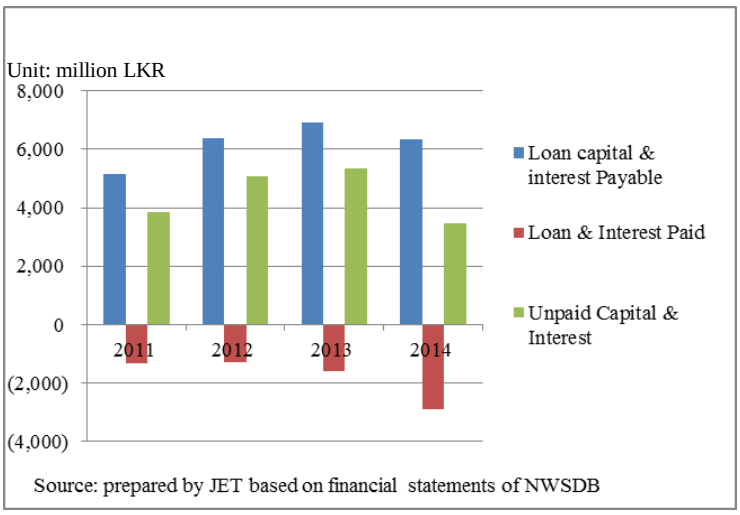


Figure 4.5-1 Unpaid Loan Capital & Interest, NWSDB

According to the 2014 budget speech, the central government's loan (principal and interest) to NWSDB at around 60 billion LKR shall be converted to government equity to strengthen NWSDB's financial capacity and NWSDB shall arrange self-financing of its projects.

In 2015, with the change of government, the Ministry of Finance issued the Cabinet Memorandum on 26 January, 2016, regarding "Regularizing Foreign Financing Mechanism in Relation to Water Supply and Sewerage projects". The Memorandum states that "NWSDB will be the primary borrower for all future loans. If the lender is not willing to lend to NWSDB directly, the GOSL will consider such loans on a case by case basis".

Then, the government grant was re-instated to provide the following percentages of total debt service (capital and interest) for facility construction of urban and rural water supply, and sewerage and wastewater projects funded by local and foreign banks:

Urban water supply project:	50% will be borne by the Treasury, 50% will be borne by the NWSDB
Rural water supply project:	75% will be borne by the Treasury, 25% will be borne by the NWSDB

Sewerage and wastewater project: 100% will be borne by the Treasury

The Memorandum also mentioned that the Treasury will provide the domestic contribution to the water supply and sewerage projects receiving foreign loans.

Other characteristics of the financial condition of NWSDB are as follows:

- 'Property, Plant & Equipment-Net' increased by 36.4 billion LKR over 5 years (2010 to 2014).
- 'Capital Work in Progress' also increased by 73.9 billion LKR for the same period.
- The above 2 asset increases (total 110.3 billion LKR) were funded by 'Grants – Government Grants' (increase of 25.5 billion LKR), 'Capital Grants' (increase of 73.5 billion LKR), and 'Loan Payable' (increase of 14.6 billion LKR) in "Non-Current Liabilities".
- NWSDB does not receive direct subsidy from the central government. Before the aforementioned 2014 Budget Speech: grants were provided for part or all of the construction costs of the water supply and sewerage facilities. The central government covers 100% of the construction costs of sewerage facilities; urban water supply projects are covered by 50% grant and 50% loan to be repaid by NWSDB; rural water supply projects are funded with a 85% to 15% split. The amounts covered by the central government are recorded in the 'Capital Grants' account of the Statement of Financial Position at the time the facilities are transferred to NWSDB.
- 'Grants – Government Grants' are burden on the central government for the local portion of the construction project.
- 'Inventories' doubled to 5.6 billion LKR in 2014 (from 2010) as a result of spare parts provision in foreign funded facility construction projects.

Table 4.5-7 shows the management information of NWSDB regarding water supply. Billing information for December 2015 is not available because NWSDB introduced a new billing system that caused some confusion. NWSDB had 1.71 million household customers and total 1.95 million customers including commercial and industrial ones for water supply as of November 2015.

Household water consumption was about 14.6 to 14.9 m^3/month for 2013-2015 (**Table 4.5-7**). Household water bill was about 559.9 to 583.7 LKR/month for the same period.

Table 4.5-7 Management Information of NWSDB

No.	Items	2013	2014	2015*
1	No. of Customers (Water Supply) (cases)			
1-1	- Household	1,469,386	1,589,341	1,714,506
1-2	- Commercial	98,723	106,807	115,845
1-3	- Industrial	851	873	987
1-4	- Governmental	9,429	8,267	8,572
1-5	- Others	128,166	126,710	107,951
	Total	1,706,555	1,831,998	1,947,861
2	Billed amount of water (m^3/year)			
2-1	- Household	257,700,650	282,463,510	280,301,325
2-2	- Commercial	35,372,555	39,208,012	37,122,609
2-3	- Industrial	2,409,438	2,332,241	2,523,532
2-4	- Governmental	18,137,052	16,879,093	14,255,169
2-5	- Others	70,351,389	74,908,815	70,927,924
	Total billed amount of water	383,971,084	415,791,671	405,130,559
3	Billed amount of money (1,000LKR/year)			
3-1	- Household	10,074,798	11,132,385	10,559,609
3-2	- Commercial	3,561,618	3,938,483	3,733,366
3-3	- Industrial	131,876	137,896	156,983
3-4	- Governmental	1,311,230	1,222,407	1,029,038
3-5	- Others	3,086,993	3,354,108	3,314,637
	Total billed amount of money	18,166,515	19,785,279	18,793,633

Note: *; Up to November
Source: Commercial Section, NWSDB

4	Average water consumption volume (m^3/month)	2013	2014	2015
4-1	- Household	14.6	14.8	14.9
4-2	- Commercial	29.9	30.6	29.1
4-3	- Industrial	235.9	222.6	232.4
4-4	- Governmental	160.3	170.1	151.2
4-5	- Others	45.7	49.3	59.7
5	Average bill amount (LKR/month)	2013	2014	2015
5-1	- Household	571.4	583.7	559.9
5-2	- Commercial	3,006.4	3,072.9	2,929.8
5-3	- Industrial	12,913.8	13,163.0	14,459.2
5-4	- Governmental	11,588.6	12,322.2	10,913.3
5-5	- Others	2,007.2	2,205.9	2,791.4

Source: Prepared by JET, based on the NWSDB data.

Table 4.5-8 and **Table 4.5-9** show the NWSDB water supply tariff. A lower tariff is levied for Samurdhi (welfare benefit) recipients and for Tenement Garden (low income) households.

Draft tariff revisions for water supply or sewerage are prepared by NWSDB and must be discussed and approved by the National Cabinet.

Table 4.5-8 Water Supply tariff: Domestic

Effective: 1st October 2012

No. of units	Domestic - Samurdhi Recipient		Domestic - Non Samurdhi Tenement Garden		Other than for Samurdhi Recipient and Tenement Garden	
	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)
00 - 05	5	50	8	50	12	50
06 - 10	10	50	11	65	16	65
11 - 15	15	50	20	70	20	70
16 - 20	40	80	40	80	40	80
21 - 25	58	100	58	100	58	100
26 - 30	88	200	88	200	88	200
31 - 40	105	400	105	400	105	400
41 - 50	120	650	120	650	120	650
51 - 75	130	1,000	130	1,000	130	1,000
Over 75	140	1,600	140	1,600	140	1,600

Source: The Gazette of the Democratic Socialist Republic of Sri Lanka, No. 1776/13, Wednesday, September 18, 2012

The water supply tariff is an increasing block type which has a step-wise volumetric charge. The rate per unit of water increases as the volume of consumption increases. The unit rate for each block increases quite steeply and is the same for all consumption blocks over 15 m^3/mo.

As an example, the water charges for 10 m^3/month and 30 m^3/month for domestic users "Other than Samurdhi Recipients and Tenement Gardens" would be 205 LKR and 1,370 LKR. In this case consumption volume increases 3-fold from 10 to 30 m^3/month, the water charge increases 6.7 times.

Table 4.5-9 Water Supply tariff: Non-Domestic

Effective: 1st October 2012

No. of units	Commercial		Government Hospital		Industries under SME*		Industries other than SME & Government Institution	
	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)
00 - 25	75	290	53	250	56	265	58	275
26 - 50	75	575	53	500	56	525	58	550
51 - 75	75	1,150	53	1,000	56	1,050	58	1,100
76 - 100	75	1,150	53	1,000	56	1,050	58	1,100
101 - 200	75	1,840	53	1,600	56	1,680	58	1,760
201 - 500	75	2,875	53	2,500	56	2,625	58	2,750
501-1,000	75	4,600	53	4,000	56	4,200	58	4,400
1,001-2,000	75	8,625	53	7,500	56	7,875	58	8,250
2,001-4,000	75	14,375	53	12,500	56	13,125	58	13,750
4,001-10,000	75	28,750	53	25,000	56	26,250	58	27,500
10,001-20,000	75	57,500	53	50,000	56	52,500	58	55,000
Over 20,000	75	115,000	53	100,000	56	105,000	58	110,000

Note: *; Small and Medium Enterprises
Source: The Gazette of the Democratic Socialist Republic of Sri Lanka, No. 1776/13, Wednesday, September 18, 2012

(3) Management and Financial Conditions of Sewerage Division of the NWSDB

Table 4.5-10 shows a present sewerage tariff of NWSDB. Sewerage tariff is set at progressive volumetric rate with relatively lower progressivity against water consumption volume. Sewerage

charges for each $10m^3$/month and for $30m^3$/month water consumption are 210 LKR/month and 320 LKR/month. If water consumption becomes 3 times from 10 to $30m^3$/month, sewerage bill becomes only 1.5 times. By the higher progressivity in water tariff, sewerage charge becomes higher than water charge in less water consumption volume (less than 15 m^3/month, 12 m^3/month, and $10m^3$/month water consumption for each "Sumardhi Recipient", "Non-Samurdhi - Tenement garden", and "Other than for Samurdhi Recipient and Tenement Garden"). It is necessary to review the sewerage tariff structure to improve this situation.

Table 4.5-10 Tariffs for Sewerage Services

Effective: 1st January 2012

Rate I
Domestic Tariff - applied to sewerage services provided to premises for domestic purposes

Water Consumption (m^3)	Sewage Tariff/m^3 (LKR)	Service Charge (LKR)
0		
1 - 10	1.00	200
1 - 15	1.50	200
1 - 20	2.00	200
1 - 25	2.50	200
1 - 30	4.00	200
1 - 40	6.00	200
1 - 50	8.00	200
> 50	10.00	200

Rate II
Commercial Tariff - applied to sewerage services provided for commercial purposes.

Water Consumption (m^3)	Sewerage tariff/m^3 (LKR)
0	
> 0	40.00

Rate III
Industrial Tariff - applied to sewerage services provided to premises for mass production purposes.

Water Consumption (m^3)	Sewerage tariff/m^3 (LKR)
0	
> 0	65.00

The sewerage charge for the relevant month of billing under Domestic tariff, Commercial tariff and industrial tariff shall be devised on the consumption of water, taking into consideration the utilization of sources of water supply.
Disconnection of Supply to Consumer who default to pay Sewerage Charges
Where the water supply charge and sewerage charge payable by a person in respect of any month is not paid within thirty days from the date of an invoice for payment relating to such charges, water services will be cut off in accordance with Section 88 (1) of the National Water Supply and Drainage Board Law, No.2 of 1974.

Note: The above is applied to consumers connected to the sewerage systems/networks owned, operated and maintained by NWSDB
Source: The Gazette of the Democratic Socialist Republic of Sri Lanka, Extraordinary, No. 1738/7, Wednesday, December 28, 2011

Table 4.5-11 shows the financial and management information of the sewerage sector in NWSDB. Collection efficiency of sewage charge is around 100% for the last 2 years. The sewage charge is on the water bill. If the customer does not pay in full, the partial payment will be allocated first to sewerage charge.

In 2014, the sewerage section had a surplus of 57.1 million LKR (**Table 4.5-11**), which is 17% of the total sewerage income. A deficit of 15.8 million LKR was reported in 2015, which is 4% of total sewerage income. The surplus of 2014 was from the massive income from "P&D/Bowser (Planning & Design Service and Gully Bowser for sludge removal for septic tanks)", planning and design contracts, sludge removal at pumping stations or STPs, in addition to O&M contract service for sewerage facilities owned by other organizations (BOI, UDA, municipalities). Because of these large revenues (55% and 44% of total revenue in each 2014 and 2015), sewerage section of NWSDB has surpluses or small deficits.

Table 4.5-11 Financial Management Information of Sewerage Sector, NWSDB

No.	Item Description	Unit	Year	2014		2015	
			Customer Category	Amount	Share	Amount	Share
1.	No of connections[*1]	No.	Domestic	12,251	92%	13,130	92%
		No.	Commercial	910	7%	985	7%
		No.	Industrial	110	1%	176	1%
		No.	Total	13,271	100%	14,291	100%
			(House Connections[*2])	(2,579)		(2,579)	
2.	Consumption [*1]	m^3	Domestic	2,942,400	59%	3,215,115	51%
		m^3	Commercial	1,665,018	33%	2,242,829	36%
		m^3	Industrial	387,440	8%	782,064	13%
		m^3	Total	4,994,858	100%	6,240,008	100%
3.	Billing without VAT [*3]	LKR/year	Domestic	34,434,845	27%	31,674,459	21%
		LKR/year	Commercial	65,832,077	53%	74,894,583	51%
		LKR/year	Industrial	25,186,720	20%	41,233,081	28%
		LKR/year	Total	125,453,642	100%	147,802,122	100%
4.	Average consumption per connection [*4]	m^3/month	Domestic	17.08		17.59	
		m^3/month	Commercial	166.25		199.42	
		m^3/month	Industrial	318.15		449.12	
		m^3/month	Total	27.21		31.86	
5.	Average billing per connection [*4]	LKR/month	Domestic	199.85		209.11	
		LKR/month	Commercial	6,572.88		8,047.81	
		LKR/month	Industrial	20,682.19		29,689.47	
		LKR/month	Total	683.28		910.87	
6.	Income[*5]	LKR/year	Domestic	38,558,281	12%	40,642,725	10%
		LKR/year	Non Domestic	101,383,888	30%	154,074,726	39%
		LKR/year	O&M Bills	0		0	
		LKR/year	Connection Charge	11,093,739	3%	25,531,614	7%
		LKR/year	P&D/Bowser [*6]	184,122,069	55%	174,282,112	44%
		LKR/year	Treasury	0		0	
		LKR/year	Total	335,157,977	100%	394,531,177	100%
7.	Operating Expense[*5]	LKR/year	Salary	192,394,723	69%	288,717,091	70%
		LKR/year	Utility	36,429,394	13%	51,179,459	12%
		LKR/year	Chemical	6,064,805	2%	5,267,955	1%
		LKR/year	Connection Material	5,337,230	2%	6,895,199	2%
		LKR/year	Maintenance Cost	13,462,406	5%	20,621,824	5%
		LKR./year	Establishment cost	14,061,741	5%	18,601,399	5%
		LKR./year	Security & Rent	10,306,325	4%	18,999,938	5%
		LKR./year	Total	278,056,624	100%	410,282,866	100%
8.	Surplus/Minus (-)	LKR./year		57,101,353		-15,751,688	
9.	Collection efficiency	%		100.5%		98.1%	[*3]
10.	Average billing per consumption	LKR./m^3	Domestic	11.70		11.82	
		LKR./m^3	Commercial	39.54		40.07	
		LKR./m^3	Industrial	65.01		63.27	
		LKR./m^3	**Total**	**25.12**		**28.42**	

Note: *1; Nos. of connection (consumption) for each Domestic, Commercial, and Industrial are estimation by JET. Total No of connection (consumption) is based on actual dataof NWSDB,
*2; Total number of households resides in apartment/condominium which has single water meter,
*3; For 2015, as at October 2015,
*4; Yearly average is an average of all month's average value, as customer number increased for the year,
*5; Income and expense data in December 2015 of several schemes were not available in NWSDB by technical problem, in such a case, those data were supplemented by estimations based on the consumption volumes (Jan.-Nov. and Dec.), and so on.
*6; Planning and design service and gully bowser (desludging septic tanks)
Source: Prepared by JET, based on the data from Assistant GM (Sewerage)

In 2015, NWSDB proposed sewerage tariff revision to improve the financial capacity of its sewerage sector. The plan (shown in **APPENDIX 2**) is being discussed by its Board of Directors.

1) O&M Contract Service by the NWSDB

Contract service revenue forms a large portion of the P&D/Bowser revenue. Total contract service revenues in 2014 and in 2015 are 95.9 million and 102.7 million LKR, or 52% and 59% of P&D/Bowser revenue. **Table 4.5-12** shows income minus expenditure for sewerage contract service. There are 6 major contracts in which NWSDB is responsible for O&M of sewerage facilities owned by other organizations. The service fee is calculated to cover staff salary and overtime and not based on metered water consumption volume. As shown in **Table 4.5-12**, all contract services report annual surpluses.

Table 4.5-12 Balance (Income – Expense) from Sewerage Contract Service by NWSDB

Unit: LKR

No.	Scheme Name	Code No.*	2013	2014	2015
1	Sri Jayawardanapura	8101	12,477,391	5,460,967	9,758,402
2	Isurupaya	8104	2,966,510	3,538,910	4,511,075
3	Parliament complex	8110	1,789,832	706,214	794,704
4	Sethsiripaya	8111	1,768,460	1,074,918	906,111
5	Presidential Secretariat	8113	1,899,320	2,018,704	2,396,108
6	Seethawakapura	8200	12,559,646	35,217,298	25,826,453
	Total		33,431,159	48,017,011	44,192,853

Note: *; Code number is an accounting code used by NWSDB. Table misses 3 contract services; Cancer Hospital, Avissawella Hospital, & Havelock City. This is because the income & expense of them are small, and included in those of Jayawadanagama OIC, Seethawakapura, and Dehiwala/Mt. Lavinia scheme, respectively.
Source: prepared by JET, based on the data from NWSDB

2) Gully Bowser and Receiving Sludge from Gully Bowser at Pumping Station or STP

Sludge removal from septic tanks is mainly carried out by private contractors, using vacuum trucks called gully bowsers. NWSDB also owns 5 gully bowsers (as of December 2015) and is offering this service.

Based on the "REVISION OF RATES CHARGED BY THE NWSDB FOR HIRING OF GULLY BOWSER ETC. AND UNLOADING OF GULLY BOWSER LOADS AT NWSDB SEWERAGE SCHEMES" issued by NWSDB on 17th June, 2008, sludge removal fee is 4,000 LKR with an extra charge of 35 LKR/km for locations over 10 km. Private contractors charges 3,000 to 5,000 LKR. The service fee charged by NWSDB is comparable to that of private contractors.

NWSDB also receives sludge from other gully bowser operators, pumping stations and STPs managed by NWSDB. NWSDB charges 450 LKR per gully bowser load (~3.5 m^3/load).

Table 4.5-13 Wastewater Volume from Gully Bowser at Dehiwala/Mt. Lavinia and Estimated Billing 2015

Month - Year	Wastewater vol. by Gully Bowser (m^3)	Estimated No. of Gully Bowser	Estimated billing amount (LKR)
Jan-2015	9,586	2,739	1,232,550
Feb-2015	8,357	2,388	1,074,600
Mar-2015	11,080	3,166	1,424,700
Apr-2015	8,861	2,532	1,139,400
May-2015	9,681	2,766	1,244,700
Jun-2015	9,480	2,709	1,219,050
Jul-2015	9,466	2,705	1,217,250
Aug-2015	8,424	2,407	1,083,150
Sep-2015	9,263	2,647	1,191,150
Oct-2015	4,727	1,351	607,950
Nov-2015	4,394	1,255	564,750
Dec-2015	4,449	1,271	571,950
TOTAL	97,768	27,936	12,571,200

Note: Capacity of Gully Bowser is assumed as $3.5m^3$/unit.
Source: prepared by JET based on the data of NWSDB

Table 4.5-13 shows the wastewater received from gully bowsers at Dehiwala/Mt. Lavinia in 2015 and the estimated billing amount. The annual revenue from gully bowser unloading is about at 12.6 million LKR. Costs associated with the service are marginal - some staff salary and electricity and chemical costs at pumping stations and STPs. The charge for each load (3.5 m^3) is 450 LKR, or 129 LKR/m^3, double the sewerage tariff for industrial customers (65 LKR/m^3). Gully bowser unloading is profitable and a good income source.

3) Sewerage Service by NWSDB's Own Facilities

Table 4.5-14 shows the income and expenditures other than contract service. Huge losses are recorded except for 2014. The surplus for this year corresponds to 3.8% of the income, while the losses are 30.9% (2013) and 20.5% (2015) of the income.

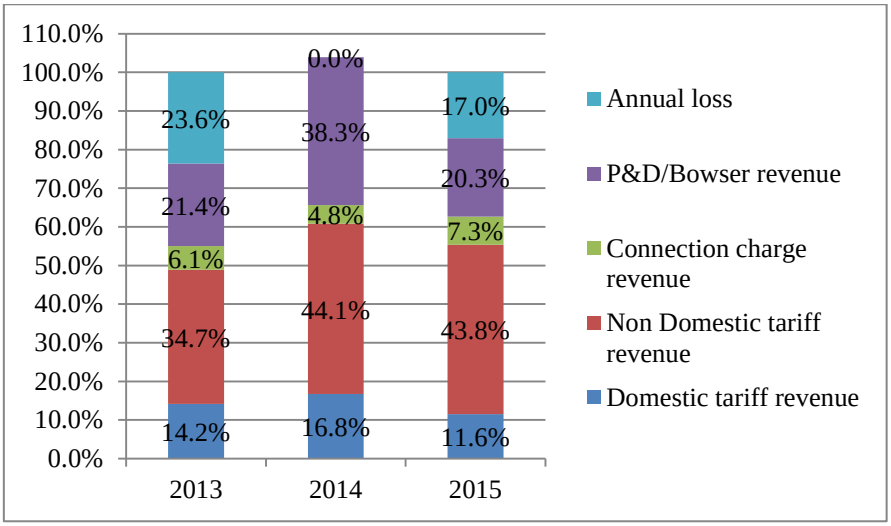
The surplus in 2014 comes from the 88% increase of "P&D Bowser" income (sludge removal for septic tanks, receiving sludge from gully bowser from private contractors, and planning and design contracts) from the previous year with modest 4.7% increase of total "Operating Expense".

Table 4.5-14 Income & Expenditure Sewerage Service Excluding Contract Service - NWSDB for 2013-2015

Item Description	Unit	Items	2013	2014	2015
Income	LKR	Domestic	31,195,840	38,558,281	40,642,725
	LKR	Non Domestic	76,233,988	101,383,888	154,074,726
	LKR	O&M Bills	-	-	-
	LKR	Connection Charge	13,469,508	11,093,739	25,531,614
	LKR	P&D/Bowser	47,034,867	88,196,798	71,567,497
	LKR	Treasury	-	-	-
	LKR	**Total**	**167,934,203**	**239,232,706**	**291,816,562**
Operating Expense	LKR	Salary	140,822,444	150,290,564	235,483,393
	LKR	Utility	37,978,502	35,943,949	51,030,301
	LKR	Chemical	114,130	1,886,416	1,198,744
	LKR	Connection Material	5,070,735	5,337,230	6,895,199
	LKR	Maintenance Cost	10,257,630	12,996,351	20,247,304
	LKR	Establishment cost	13,725,733	13,718,518	17,906,224
	LKR	Security & Rent	11,893,128	9,975,336	18,999,938
	LKR	**Total**	**219,862,302**	**230,148,364**	**351,761,104**
Surplus	LKR		**-51,928,099**	**9,084,342**	**-59,944,541**

Note: The above includes income and expenditure of sewerage section (Head office, P&D, GCS) and any sewerage schemes other than contract services (Sri Jayawardanapura, Isurupaya, Parliament complex, Sethsiripaya, Presidential Secretariat, Seethawakapura).
Source: prepared by JET, based on the data from NWSDB

Structural problem of deficit in sewerage service is a low sewerage tariff level, as was shown in **Figure 4.5-2**. Tariff revenues (domestic and non-domestic) are 48.9% (2013), 60.9% (2014), and 55.4% (2015) of total operating expense. Sewerage tariff increase, in addition to contract services, is necessary to generate a surplus.



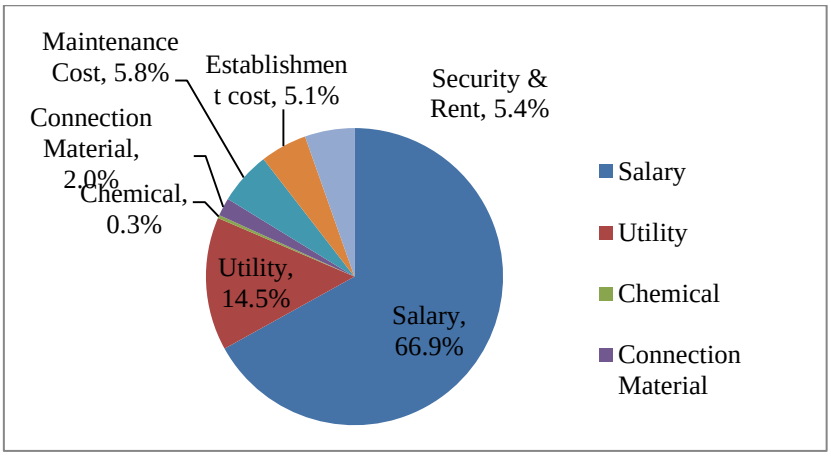
Source: JET, based on the data of NWSDB

Figure 4.5-2 Income vs Expenditure by Income Type & Annual Losses (2013-2015)

Total operating expense in this calculation excludes operating expenses for contract services, which are fully covered by service fee, but it includes expenses for head office, planning and design, manager's offices of the sewerage section (as described in "Note" of **Table 4.5-14**) which is not expended directly for O&M of sewerage facilities.

Figure 4.5-3 shows the share of each type of operating expense in 2015. Salary accounts for most of the total expense, followed by utility (electricity) cost. NWSDB is not experiencing O&M budget

shortfalls. However, with the aging of equipment and facilities, maintenance cost will likely increase in the future.



Source: JET, based on the data of NWSDB

Figure 4.5-3 Share of Operating Expenses (2015)

4.6 ON-SITE FACILITIES

In Sri Lanka, 84% of the sewage is treated by on-site facilities (**Table 4.1-1**). The Urban Development Authority Law and the Development Authority Planning and Building Regulations specify the standards for the construction of such facilities. These regulations state the requirement of on-site treatment as follows: "The primary method of sewage treatment is a sewage system. In the absence of a public sewage system or in case the public sewage system cannot accept raw sewage, sewage should be treated by a septic tank".

House and building owners have the responsibility to install septic tanks. There are funds from donors for sanitary facilities under rural water supply and sanitation projects.

Local governments provide septic tanks emptying service for a fee. Some cities have appropriate sludge treatment facilities, but in some cases, sludge from septic tanks is dumped in forests or landfills.

4.6.1 Operation and Maintenance of On-site Facilities

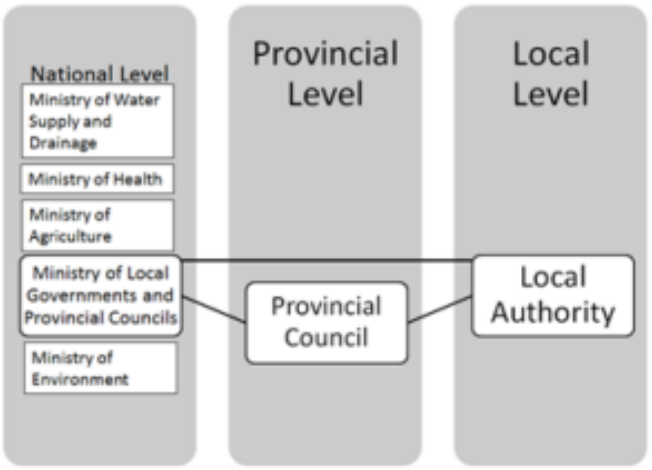
Table 4.6-1 shows the responsibilities associated with the management of on-site facilities, from installation to sludge treatment. Property owners install and maintain the facility, while the local government provides the guidance for installation. Colombo city manages septage collection and treatment. Collected septage is transported to a sewage pumping station and discharged into the ocean. In other areas, NWSDB or a private operator collects septage for treatment in the sewage treatment plant.

Table 4.6-1 Management of On-site Facilities

Item	Responsibility
Guidance for installation	Local Authority
Installation	Private sector upon request of individual
Maintenance	Individual
Sludge withdrawal	NWSDB/Local Authorities/Private Parties
Sludge treatment	NWSDB/Local Authorities

Source: JET

All 3 levels of government are involved in septage management as shown in **Figure 4.6-1**.



Source: "A Review – Septage Management Reltated Regulatory and Institutional Aspects and Needs in Sri Lanka
S. Fernando et al. Sabaragamuwa University Journal, Volume 13, No. 1, 2024

Figure 4.6-1 Government Authorities Involved in Septage Management

Septage collection and disposal is basically the responsibility of the local authorities. In recent years private companies are increasingly involved because of the increased demand. There are no regulations or ordinances related to septage management. This must change. Regulations should be introduced from the national to local levels to ensure proper and sustainable septage management.

4.7 INDUSTRIAL WASTEWATER MANAGEMENT

In Sri Lanka, industry consumes 6.4% of the fresh water, agriculture 87.3% and households 6.2%. Major industrial parks, such as EPZ administrated by BOI, generates 30 million m^3 of wastewater per year. This wastewater should be treated and disposed of according to regulatory requirements. Approximately 10% of industrial wastewater is discharged without treatment, mainly by small-scale manufacturers operating without formal licences[4-1)].

4.7.1 Environmental Regulatory Requirements for Industries

(1) Environmental Protection License

Discharge of industrial wastewater is regulated through the Environmental Protection License (EPL) scheme administered by CEA under the National Environmental Act No: 47 - 1980. The Act was amended in 1988 (No. 56) and in 2000 (No. 53). Industries and service enterprises must have valid EPLs for conducting business operations. The EPL is issued if the applicant demonstrates compliance with existing regulations. The license is valid for 3 years and costs approximately 150 USD. The industry must comply with effluent discharge standards, which are stipulated based on the receiving environment.

Industries and activities, which require an EPL, are listed in Gazette Notification No. 1533/16, dated 25.01.2008. Industries are classified as "A", "B" and "C" depending on their pollution risk.

Category "A" comprises of 80 significantly high polluting industrial activities and "B" comprises of 33 medium level polluting activities. EPL for industries in "A" and "B" must be obtained from CEA provincial or district offices.

25 low polluting industrial activities are listed in "C", under the jurisdiction of local government authorities, such as municipal councils, UCs and PSs. The local authorities issue EPLs, enforce the regulations and monitor for compliance (**APPENDIX 3** on A, B & C category projects).

(2) Objectives of EPL

- prevent or minimize the discharge of pollutants into the environment from prescribed (industrial) activities and ensure compliance with national discharge and emission standards.
- develop an approach to pollution control that considers discharges from prescribed (industrial) processes to air, water, and land.
- minimize the burden on industry, by providing guidance on pollution control for polluting processes.
- ensure that the system responds flexibly to changing pollution abatement technology and to new knowledge such as cleaner production and waste minimization.

(3) Valid Period of an EPL

The valid period of an EPL from the effective date of the licence is:

- prescribed industrial activities under List A – up to one year.
- prescribed industrial activities under List B – up to three years.
- prescribed industrial activities under List C – up to three years.

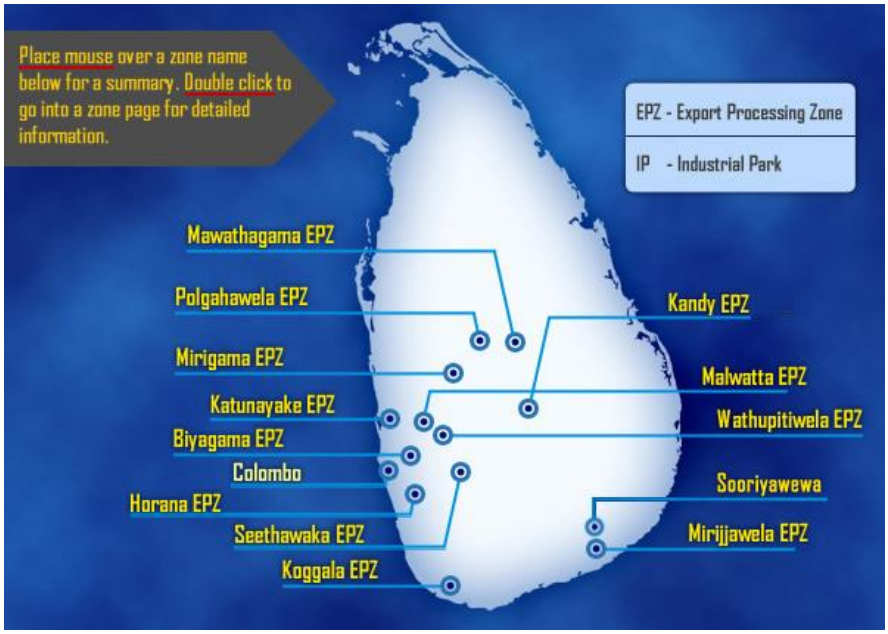
In the current EPL system, the following issues are recognized and, to improve this situation, introduction of Wastewater Discharge Fee (WDF) system (**APPENDIX 4**) is considered.

4.7.2 Industrial Wastewater Treatment Facilities

Both public and private sector organizations are involved in the development of infrastructure needed by industries, as promoted by the industrial policy of the country.

(1) BOI Administered

EPZs and industrial parks (IP), administered by BOI, are established to provide the basic infrastructure for industries involved in foreign direct investment. Those in operation are shown in **Figure 4.7-1**.



Source: http://www.investsrilanka.com/setting_up_in/boi_zones

Figure 4.7-1 Export Processing Zones (EPZ) in Sri Lanka

Table 4.7-1 shows the status of wastewater disposal in EPZ and IPs.

Table 4.7-1 Wastewater Disposal in BOI Export Processing Zones and Industrial Parks

Facility	Location		Land Extent	Status of Wastewater Disposal
	District	Local Authority		
1. Biyagama EPZ	Gampaha	Biyagama PS	180 ha	Central STP (CWTP) of 13,000 m^3/d present in augmentation to 21,000m^3/d capacity is in operation using OD system and aerated lagoon system followed by maturation ponds prior to discharge into the Kelani River along the Ruggahawatta Ela
2. Katunayaka EPZ	Gampaha	Katunayaka-Seed uwa UC	215ha	CWTP of 12,000 m^3/d capacity is in operation with Flow through type aerated lagoon system before discharge into the Dandugam Oya that end up in the Negombo Lagoon.
3. Mirigama EPZ	Gampaha	Mirigama PS	105.5ha	CWTP of 400 m^3/d capacity is in operation with OD technology
4. Malwatta IP	Gampaha	Attanagalla PS	13.3ha	CWTP of 450 m^3/d capacity is in operation with OD technology before discharge into nearby stream
5. Wathupitiwela EPZ	Gampaha	Attanagalla PS	50ha	CWTP of 400 m^3/d capacity is in operation with Sequencing Batch Reactor (SBR) technology before discharge into Attanagalu Oya
6. Polgahawela EPZ	Kurunegala	Polgahawela PS	20ha	CWTP of 400 m^3/d capacity is in operation with OD technology before discharge into Kuda Oya
7. Mawathagama EPZ	Kurunegala	Mawathagama PS	21.8ha	CWTP of 500 m^3/d capacity is in operation with OD technology
8. Kandy EPZ	Kandy	Kundasale PS	83ha	On site wastewater treatment
9. Horana EPZ	Kaluthara	Horana PS	159ha	CWTP of 1,000 m^3/d capacity RBC system is in operation before discharge into Kalu Ganga via maturation pond.
10. Seethawaka EPZ	Colombo	Seethawaka PS	174ha	CWTP of 9,000 m^3/d capacity is in operation using ODes followed by maturation pond prior to discharge into the Kelani River
11. Koggala EPZ	Galle	Habaraduwa PS	92ha	CWTP of 675 m^3/d capacity package plant with extended aeration prior to discharge into the Sea

Facility	Location		Land Extent	Status of Wastewater Disposal
	District	Local Authority		
12. Mirijjawila EPZ	Hambanthota	Hambanthota MC	8.9ha	No CWTP at present
13. Sooriyawewa EPZ	Monaragala	Sooriyawewa PS	414ha	No CWTP at present

Note: All industries shall comply with BOI standards stipulated for industrial effluent discharge into common STP.
Source: BOI

(2) Private Facilities

Table 4.7-2 shows the wastewater disposal at private sector facilities.

Table 4.7-2 Wastewater Disposal in Private Industrial Parks

Facility	Location		Land Extent	Status of Wastewater Disposal
	District	Local Authority		
1. MAS Fabric Park (Pvt Ltd, Thulhiriya	Kegalle	Warakapola PS	68.3ha	CWTP of 4,000 m^3/d capacity using chemical treatment, extended aeration & wetland prior to discharge into the Maoya
2. Lanka Industrial Estate Ltd, (LINDEL) Sapugaskanda	Gampaha	Biyagama PS	51.7ha	CWTP of 2,000 m^3/d capacity using extended aeration prior to discharge into the Kelani River through a stream
3. Flinth Industrial Park, Kadawatha (subsidiary of Swedcord Development AB, Sweden)	Gampaha	Mahara PS	4.1ha	No CWTP

Source: JET

There are industrial parks administrated by other public organizations, such as the Sri Lanka Port Authority (SLPA**)**, Industrial Development Board (IDB), Industrial Service Bureau (ISB), Urban Development Authority (UDA), Urban Development Authority (UDA) and Ministry of Industry & Commerce.

Central STP (CWTP) with disposal facilities are available for industrial zones operated by BOI & some private companies. Other facilities must establish their own STP. Disposal of treated effluent in compliance with regulatory requirements is a problem due to lack of appropriate facilities. Industries located outside the industrial parks have the same problem, if they cannot recycle significant volume of treated wastewater.

There is an urgent need for treatment facilities for sewage as well as treated industrial effluent. Treating sewage and industrial effluent protects natural water resources which is a priority concern of NWSDB.

Industrial effluent needs to be monitored for the following:

- Strength of biodegradable organics other than that presence in the sewage
- Presence of refractory organics
- Presence of toxic substances (heavy metals, pesticide, phenolic compounds, carcinogens, mutagen, cytotoxic drugs, anti-bacterial drugs, radioactive substances)
- Strength of inorganic compounds (inorganic salts, nitrate, free chlorine)
- Strength of nitrogenous compounds
- Availability and reliability of regular monitoring at the source

4.8 MEDICAL WASTEWATER

4.8.1 Hospitals

There are 1,084 state owned healthcare facilities in the country, classified below according to bed capacity and/or speciality.

Table 4.8-1 Type of Hospitals

Hospital Type	Number
National Hospital	01
Teaching Hospitals	20
Provincial General Hospital	03
District General Hospital	18
Base Hospital Type – A	22
Base Hospital Type – B	46
Divisional Hospital type – A (More than 100 patients Beds)	42
Divisional Hospital type – B (Between 50 to 100 patients Beds)	129
Divisional Hospital type – C (Less than 50 patients Beds)	322
Primary Medical Care Unit (Central Dispensaries & Maternity Homes)	474
Board Managed Hospitals	02
Special Hospitals	05

Source: http://www.health.gov.lk/en/index.php?option=com_content&view=article&id=323&Itemid=137

4.8.2 Medical Wastewater Management

NWSDB surveyed government hospitals for rehabilitation of STP and proposed recommendations for improvement of wastewater disposal including cost estimation (refer to **APPENDIX 5**).

More than 80% of the hospitals surveyed had their own STP but most of these were not operating properly. The survey concluded that:

- most of the treatment plants could be rehabilitated.
- main reason for poor performance is the lack of skilled workers to take care of plant operation.
- disposal of treated effluent is not well conceived for the protection of groundwater and surface water resources (discharge standards are normally based on the absorption or removal of residual pollutants in the receiving environment)

CHAPTER 5 OFF-SITE SEWERAGE MANAGEMENT AND DEVELOPMENT

5.1 OBJECTIVES

This Chapter will cover the following:

- development of selection criteria for 79 local authority cities where sewerage systems are to be developed within the next 20 years (by 2035)
- selection of five cities for sewerage development
- collection and sewage treatment options, and disposal issues

5.2 SEWERAGE COVERAGE

The sewerage coverage in 2012 is about 2.4% of the population. Six on-going projects and other planned projects would bring this to 7% by 2020 (See 4.2), using funds from overseas donors.

5.3 SELECTION OF TARGET CITIES

Sri Lanka is administratively divided into 9 provinces and 25 districts, and there are 335 local municipalities under the districts. Local municipalities are divided into MCs (23), UCs (41) and PSs (271).

The 79 cities (**Table 1.1-1**) originally identified for this study include:

- 64 MCs and UCs that were identified on August 31, 2015 (as stated in the Record of Discussions on The Project for The Strategic Master Plan under Sewage Sector in The Democratic Socialist Republic of Sri Lanka agreed upon Between National Water Supply Drainage Board and Japan International Cooperation Agency (JICA))
- 4 district capitals that were not included in the selection of 64 noted above: Monaragala PS of Monaragala District, Thamankaduwa PS of Polonnaruwa District, Karachichi PS of Kilinochchi District and Maritimepattu PS of Mullaitivu District
- 11 PSs with comparatively high population density and cities with population density half that of Kandy MC (40 persons per hectare ÷ 2), where sewage system development was started with a Japanese loan.

Ultimately the evaluation for sewerage development includes74 cities. 5 PSs locations were removed from the list because the MC or UC in which they are located is already included and have been given a higher investment priority (Panaduwa PS, Wattala PS, Gampaha PS, Ja-ela PS and Kandy Four Gravets & Gangawata Korake PS.

5.4 PRIORITY CITIES

5.4.1 Criteria for Selection

Six criteria and 11 parameters, as shown in **Table 5.4-1,** are used for the selection of priorities.

Table 5.4-1Criteria for Selection of Priority Cities

Criteria	Parameter	Source/Measure
1. Urbanization	Population density (Water Supply area)	Sri Lanka Census Department, Survey Department, Survey Department, and NWS&DB
	Population (Equivalent population based on water supply)	

2. Sanitation	Ratio of water borne diseases	Medical Officer of Health (MOH) Public Health Inspector (PHI)
	Water Supply Coverage ratio	NWSDB
3. Urban Development	Presence of Tourist Attraction Places	Tourism Development Authority
	Presence of Growth Centre and Industrial zones	National Planning Department, Board of Investment (BOI)
4.Sustainability of Sewerage Services	Water bill collection ratio as willingness to pay sewerage services	NWSDB
	Median household income as ability to pay sewerage services	Census Department
5. Water Environment	Presence of Drinking Water Supply Source and Environmental Protection Area	NWSDB and CEA
	Potential pollution to public water body	Google Map CEA (kelani River, Ma Oya, Dadugam Oya, Bentota Ganga). Other rivers are not monitored.
6. Maturation for Sewerage Project	Situation of F/S and approval process	NWSDB

※CEA：Central Environmental Authority under Ministry of Environmental and Renewable Energy
Source: JET

(1) Urbanization (APPENDIX 6)

The degree of urbanization can be determined by looking at population density and water supply area.

Usually water supply infrastructure is developed before sewerage facilities are installed. Therefore, population density in piped water supply area is a good parameter to evaluate the necessity of sewerage system. High population density is preferred for sewerage development because the system implemented will serve a large population.

Population data is also an indicator of the number of potential customers. Equivalent population based on water supply is used to determine served population including transiant population such as commuters, tourists. Transient population is not measured in Sri Lanka. Equivalent population is calculated using the following equation.

$$\text{Equivalent population} = \frac{\text{Daily Water consumption (domestic, commercial and industrial)}}{\text{Daily water consumption per capita (130 ltr./day/cap)}^{1)}}$$

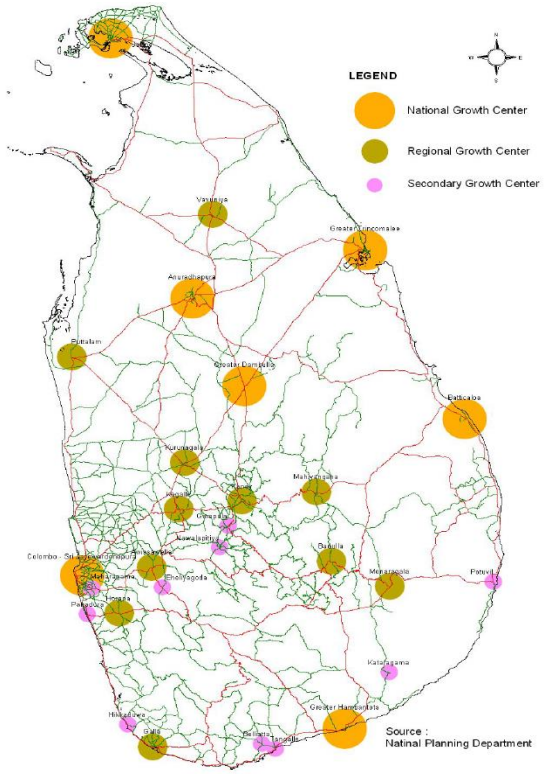
1) 130ltr./day/cp is quoted from Design Manual D7, NWSDB February 2012

(2) Sanitation

Sanitation is evaluated by the incidence of water-borne diseases and percentage of population served by water supply systems. Both parameters provide a sense of the public health situation but the latter adds the information on the risk of water pollution. High access to piped water supply is directly linked to improved public health. It has also increased the amount of wastewater that is generated and has contributed to a higher pollution load.

(3) Urban Development

The degree of urban development is gauged by the existence of growth centres, tourist attractions and industrial zones. Growth centres are identified using information from the National Planning Department. Tourist attractions can be located from the map provided by the Sri Lanka Tourism Development Authority, and industrial zones information can be obtained from BOI. Growth centres and tourist attractions are shown in **Figure 5.4-1**.



Source: National Road Mater Plan 2007-2017, December 2007

Source: Website of Sri Lanka Tourism Development Authority

Figure 5.4-1 Growth Centres and Tourist Attractions

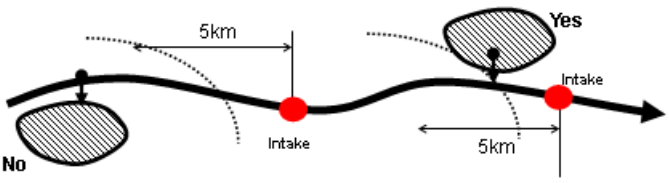
(4) Sustainability of Sewerage Services

Water bill payment reflects the willingness to pay for sewerage services because water and sewage charges are collected on the same bill. Household income shows the ability to pay. This information will determine the financial sustainability of sewerage services.

(5) Water Environment

The impact of sewage on the water environment is evaluated by assessing the potential impacts on drinking water supply intake points, reviewing the criteria in the Environmental Protection Area (EPA) in the National Environmental Act No.47 of 1980, and comparing the pollution load data from each local government authority.

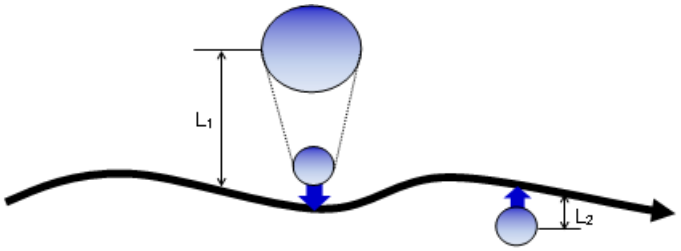
Impact on water supply intake points is shown in **Figure 5.4-2** (**APPENDIX 7**)**.** The impact is evaluated by looking at the distance between the MC or UC area and the closets downstream water supply intake point.



Source: JET

Figure 5.4-2 Evaluating Impact on Water Intake Point

Impact of pollution load on public water bodies is presented in **Figure 5.4-3**. It is assumed that the extent of the impact is directly proportional to the volume that is discharged and inversely proportional to the distance downstream.



Source: JET

Figure 5.4-3 Evaluating Impact of Pollution Load on a Public Water Body

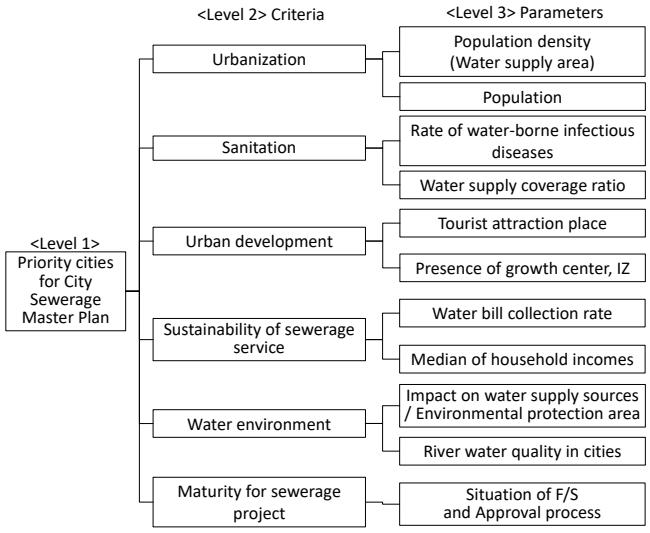
(6) Maturity of Sewerage Project

Maturity of sewerage project is evaluated based on the status of F/S and whether funding has been obtained.

5.4.2 Priority for Sewerage Development

(1) Weighting and Points

Points are assigned to each parameter under the six evaluation criteria. The selections are made using the Analytical Hierarchy Process (AHP) in which criteria and parameters for sewerage development are compared by taking two indicators at a time (**Figure 5.4-4**).



Source: JET

Figure 5.4-4 AHP Hierarchy of Criteria and Parameters

The weighted scores of AHP analysis are presented in **Table 5.4-2**.

Table 5.4-2 Results of AHP

Respondent	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	sum	Combined Weight
URBANIZATION	0.1563	0.1057	0.0885	0.2718	0.2518	0.1673	0.1650	0.1430	0.0806	0.1237	0.1627	0.0794	0.0341	0.0381	0.1110	0.1150	0.0309	2.1249	**0.1259**
SANITATION	0.4013	0.4412	0.1300	0.3901	0.0514	0.3397	0.2261	0.1073	0.1859	0.0589	0.0641	0.3102	0.1369	0.3199	0.0622	0.3387	0.0880	3.6519	**0.2164**
URBAN GROWTH	0.0657	0.0330	0.2345	0.0304	0.0902	0.1670	0.1801	0.2352	0.1549	0.1696	0.1501	0.0734	0.2298	0.0817	0.1418	0.2797	0.0725	2.3896	**0.1416**
SUSTAINABILITY of SERVICE	0.1056	0.1788	0.1673	0.0662	0.1147	0.0826	0.0680	0.0792	0.3540	0.3333	0.1209	0.2233	0.2122	0.1434	0.0724	0.0258	0.2144	2.5621	**0.1518**
EFFECT to WATER ENVIRONMENT	0.2366	0.2059	0.3142	0.1672	0.4082	0.1873	0.2539	0.3783	0.1638	0.2923	0.4042	0.2915	0.2298	0.3599	0.4428	0.1754	0.4822	4.9935	**0.2959**
MATURATION for PROJECT IMPLEMENTATION	0.0350	0.0350	0.0660	0.0740	0.0084	0.0056	0.1070	0.0570	0.0610	0.0220	0.0980	0.0220	0.1570	0.0570	0.1700	0.0660	0.1120	1.153	**0.0683**

Source: JET

"Urbanization" scored 0.13, "Sanitation state" 0.22, "Urban development" 0.14, "Sustainability of sewage works" 0.15, "Water environment" 0.30 and "Maturity of sewage plan" 0.06. A heavier weight will be placed on the "water environment" which has the highest score.

The maximum score is set at 100 points for "water environment", 43 for "urbanization", 73 for "sanitation state", 48 for "urban development", 51 for "sustainability of sewage works" and 23 for "maturity of sewage plan" – 338 points in total. It was found that the evaluation score for "water environment" alone determined the ranking, indicating that may be too much weight is given to the "water environment". Subsequently, the maximum score for "water environment" is changed from 100 to 73 points, the same as "sanitation", and the maximum total score becomes 311 points.

The points of each parameter are presented in **Table 5.4-3** based on results of the AHP.

Table 5.4-3 Points for Each Parameter

Ⅰ. Urbanization **【0.1259/0.2959 ⇒Max:43points】**		**Ⅱ.Sanitiation** **【0.2164/0.2959 ⇒Max:73points】**	
(1)Poputation Density **【43×0.87=37Points】**	**(2)Population including Tourinst** **【43×0.13=6Points】**	**(3)Water Supply Coverage Ratio** **【73×0.67=49Points】**	**(4)Ratio of Waterborne Disease** **【73×0.33=24Points】**
【Calculation Method】 37 points correspond to category below. 【Category】 A : Pd ≧150 ⇒37points B : 100≦Pd <150 ⇒32points C : 40≦Pd < 100 ⇒27points	【Calculation Method】 6 points correspond to category below. 【Category】 A : Ep≧100,000⇒6points B :50,000<Ep<100,000⇒3points C : 10,000<Ep<50,000⇒1.5points	【Calculation Method】 49 points correspond to maximum rate. Max100%, in case, 50%. ∴ 49×50/100=24.5points	【Calculation Method】 24 points correspond to category below. 【Category】: A : 50≦R <100 ⇒24points B : 0< R <50 ⇒12poins
Ⅲ.Development **【0.1416/0.2959⇒Max:48points】**		**Ⅳ.Sustainability** **【0.1518/0.2959 ⇒Max:51points】**	
(5)Tourist Attraction **【48×0.40=19Points】**	**(6)Growth Center & Industral Zone** **【48×0.60=29Points】**	**(7)Tarrif Ratio** **【51×0.57=29Points】**	**(8)Household Income** **【51×0.43=22Points】**
【Calculation Method】 19 points put the council having attraciton places. 【Category】 A : 19points B : 9.5points C : 4.75points	【Calculation Method】 29 points put the council having growth center,industrial zone or district capital. 【Category】 National GC: 29points Regional GC : 14.5poins Secoundary GC : 7.25 points Industrial Zone : 7.25 points District Capital : 7.25 points If a council has multiple factor then take higher one category.	【Calculation Method】 29 points correspond to maximum rate. Max100%, in case, 50%. ∴ 29×50/100=14.5points	【Calculation Method】 22 points correspond to maximum rate. Max10,000Rs, in case, 5,000Rs. ∴ 22×5,000/10,000 =11points
Ⅴ.Water Environment **【0.2959⇒Max:100points】⇒Revised Max:73points as well as Ⅱ.Sanitation**		**Ⅵ.Maturation** **【0.0683/0.2959 ⇒Max:23points】**	
(9)Impact on Water Source **【73×0.50=36.5Points】**	**(10)Potential of Impact on Water Environment** **【73×0.50=36.5Points】**	**(11)Feasibility Study and Approval Process** **【23×1.00=23Points】**	
【Calculation Method】 36.5 points put the council having negative Impact to water source. Yes⇒36.5points Ground water Source⇒18.25Points For Ground Water Pollution=2points Yes means that polltion of the council could affect water source quality of intake point for water treatment plant at down stream.	【Calculation Method】 36.5 points correspond to these calculation. PL⇒Pollution Load =10,000kg/day L⇒Distance from a discharge points = 5km ∴ 10,000×1/5/1000=2.0 Then correspond to maximum rate. Max 2.0, in case, 1.0. ∴36.5×1.0/2.0=18.25points	【Calculation Method】 23 points put the council corresponding to category below. 【Category】 A: having F/S (Donor has decided.) ⇒23points B: having F/S (Donor has not yet decided) or PF/S ⇒11.5points C: Under Planning of F/S or PF/S ⇒5points	

Source: JET

(2) Results of Prioritization

The data and results of prioritization are presented in **Table 5.4-4** and **Table 5.4-5**.

Table 5.4-4 Data of Cities

Sl No		Local Government Authority	【Parameters and Characters】																											
			Ⅰ.Urbanization⇒P.S.W : 0.43							Ⅱ.Sanitation ⇒P.S.W : 0.73							Ⅲ.Development ⇒P.S.W : 0.48				Ⅳ.Sustainability ⇒P.S.W : 0.51		Ⅴ.Water Environment ⇒P.S.W : 1.00						Ⅵ.Maturation ⇒P.S.W : 0.23
			i.Population Density (Urban Area) ⇒S.S.W : 0.87			【Reference】 Entire Area	ii.Population 【Activity Indicator】 ⇒S.S.W : 0.13			i.Water Supply Coverage Ratio ⇒S.S.W : 0.67				【Reference】 Ground water is currently used as portal water	ii. Disease ⇒ S.S.W : 0.33		i.Tourist Attraction ⇒ S.S.W : 0.40		ii.Growth Center & Industrial Zone ⇒ S.S.W : 0.60		i.Tariff Ratio ⇒ S.S.W : 0.57	ii.Household Income ⇒ S.S.W : 0.43	i.Affectiveness on Water Source ⇒ S.S.W : 0.70	ii.Pollution Impact on Water Environment ⇒ S.S.W : 0.30				i.F/S and Approval Process ⇒ S.S.W : 1.0
			Population 【2012】 ① 【pers.】	Residential Area 【2012】 ② 【km²】	(1)Population Density ③=①/②/100 【pers./ha】	【km²】	Water Consumption 【Domestic+ Commercial+ ④ 【m³/day】	Water Consumption per Capita ⑤ 【ℓ/pers./day】	(2)Equivalent Population ⑥=④/⑤×1000 【pers.】	Water Supply Coverage Ratio 【NWSDB】 ⑦ 【%】	Water Supply Coverage Ratio 【Other Authorities】 ⑧ 【%】	Water Served Population ⑨ 【pers.】	(3)Actural Water Supply Coverage Ratio 【Population ⑩=⑨/①×100 【%】	(●)	Number of Waterbone Diseases 【2015】 ⑪ 【pers.】	(4)Rate of Waterbone Diseases ⑫=⑪/⑨×10,000 【pers. /10,000pers.】	(5)Attractive to Tourist 【 Attraction Places】 -		(6-1)Presence of Growth Center & Industrial Zone -	(6-2)Urban Type	(7)Recovery of Water Tariff Ratio ⑬ 【%】	(8)Median of Household Income ⑭ 【Rs】	(9)How much affect to Intake Points -	Pollution Load Generated ⑮=⑥ ×54g/pers./day 【as BOD】 【kg/day】	Impact Potential 【Distance from Council Center】 Distance from Discharging Point 【km】	Name of Major Waters	(10)Pollution Impact on Water Environment ⑯=⑥×⑬/1000 【kg/day/m】	(12)Situation of F/S and Approval Process -
1	M-01	**Colombo M.C**	561,314	36.3	154.6	41.7	472,086	130	**3,631,431**	1.00	-	561,314	100	-	31	0.55	Yes	**A**	**National GC**	Dist.Cap.	103.0	50,071	No	196,097	3.5	Indian Ocean	56.0	-
2	M-02	**Kolonnawa U.C**	60,044	3.2	**187.6**	5.2	61,628	130	474,062	1.00	-	60,044	100	-	30	5.00	No	-	-	-	103.0	50,071	No	25,599	2.0	Kelani Enga	12.8	-
3	M-03	**Kattankudy U.C**	40,356	3.3	122.3	4.6	3,200	130	24,615	0.57	-	23,000	57	-	12	2.97	Yes	**B**	-	-	92.4	20,359	No	1,329	0.2	Indian Ocean	6.6	**A (China- EXIM Banh)**
4	M-04	**Dehiwala - Mount Lavinia M.C**	184,468	17.3	106.6	21.6	39,000	130	300,000	1.00	-	184,468	100	-	92	4.99	Yes	**B**	-	-	105.0	50,071	No	16,200	1.5	Weras Ganga	10.8	**A**
5	M-05	**Moratuwa M.C**	168,280	17.0	99.0	19.8	23,626	130	181,738	1.00	-	168,280	100	-	182	10.82	No	-	-	-	105.0	50,071	No	9,814	0.9	Weras Ganga	10.9	-
6	M-06	**Beruwala U.C**	37,793	3.2	118.1	4.6	25,808	130	198,523	1.00	-	37,793	100	-	2	0.53	Yes	**C**	-	-	105.0	36,512	No	10,720	0.5	Ela (naturla canal)	21.4	-
7	M-07	**Peliyagoda U.C**	27,736	2.2	126.1	3.5	5,778	130	44,445	1.00	-	27,736	100	-	14	5.05	No	-	-	-	102.0	38,807	No	2,400	0.6	Weras Ganga	4.0	**A (AFD)**
8	M-08	**Eravur U.C**	24,643	2.0	123.2	3.2	1,188	130	9,141	0.19	0.17	4,590	19	-	22	8.93	No	-	-	-	92.4	20,359	No	494	3.5	Indian Ocean	0.1	-
9	M-09	**Wattala Mabola U.C**	28,031	2.5	112.1	3.8	4,000	130	30,769	0.93	-	26,136	93	-	14	4.99	No	-	-	-	102.0	38,807	No	1,662	0.1	Dutch Canal	16.6	-
10	M-10	**Boralesgamuwa U.C**	60,110	7.9	76.1	11.6	9,560	130	73,538	0.98	-	58,784	98	-	30	4.99	No	-	-	-	103.0	50,071	No	3,971	1.0	Weras Ganga	4.0	**A (China- EXIM Bank)**
11	M-11	**Hatton - Dik Oya U.C**	14,585	1.7	86.3	2.0	2,262	130	17,398	0.84	-	12,184	84	-	3	2.06	Yes	**B**	-	-	96.0	28,152	Yes	939	0.5	Dick Oya (small river)	1.9	-
12	M-12	**Sri Jayawardanapura Kotte M.C**	107,925	12.5	86.3	16.9	35,000	130	269,231	1.00	-	107,925	100	-	54	5.00	Yes	**C**	Additional GC	-	103.0	50,071	No	14,538	0.4	Colonnawa Canal	**36.3**	**B (NWSDB)**
13	M-13	**Akkaraipattu M.C**	30,934	4.2	73.7	5.3	6,691	130	51,469	0.45	-	13,882	45	-	6	1.94	Yes	**B**	-	-	92.4	23,429	No	2,779	2.8	Tillai River	1.0	-
14	M-14	**Nawalapitiya U.C**	13,338	1.9	70.2	2.4	2,333	130	17,946	0.31	-	4,200	31	-	5	3.75	No	-	Secondary GC	-	96.0	30,371	No	969	0.1	Mahaveli River	9.7	-
15	M-15	**Maharagama U.C**	196,423	34.2	57.4	38.3	27,300	130	210,000	0.86	-	169,902	86	-	236	12.01	No	-	-	-	103.0	50,071	No	11,340	0.5	Katu Ela	22.7	**A (China- EXIM Bank)**
16	M-16	**Negombo M.C**	142,449	14.8	96.2	28.5	32,234	130	247,954	1.00	-	142,449	100	-	1	0.07	Yes	**A**	-	-	102.0	38,807	No	13,390	3.0	Maha Oya (small river)	4.5	**A (AFD)**
17	M-17	**Panadura U.C**	30,069	3.6	83.5	6.4	9,175	130	70,577	1.00	-	30,069	100	-	3	1.00	No	-	Secondary GC	-	105.0	36,512	Ground Water Source	3,811	3.5	Indian Ocean	1.1	-
18	M-18	**Galle M.C**	86,333	15.1	57.2	19.1	16,772	130	129,015	1.00	-	86,333	100	-	325	37.64	Yes	**A**	Regional GC	Dist.Cap.	101.0	28,205	Yes (Ccoastral City)	6,967	3.0	Gin Ganga	2.3	**A (AFD)**
19	M-19	**Jaffna M.C**	80,829	15.8	51.2	18.1	2,798	130	21,523	0.24	-	19,503	24	●	89	11.01	Yes	**A**	**National GC**	Dist.Cap.	89.3	23,446	No	1,162	3.0	Indian Ocean	0.4	-
20	M-20	**Chilaw U.C**	21,441	2.5	85.0	5.0	3,360	130	25,846	0.94	0.85	20,197	94	-	3	1.40	Yes	**C**	-	-	99.5	29,286	No	1,396	0.1	Dedru Oya	27.9	**A (China- EXIM Bank)**
21	M-21	**Weligama U.C**	22,377	4.4	50.9	5.3	5,832	130	44,862	1.00	-	22,377	100	-	14	6.26	Yes	**A**	-	-	101.0	28,227	No	2,423	0.3	Polwatu madara Ganga	8.1	-
22	M-22	**Kalutara U.C**	32,417	5.6	57.9	7.9	20,973	130	161,331	1.00	-	32,417	100	-	13	4.01	Yes	**C**	-	Dist.Cap.	105.0	36,512	No	8,712	0.9	Kalu Ganga	9.7	-
23	M-23	**Badulla M.C**	42,237	6.4	66.0	10.5	9,150	130	70,385	1.00	-	42,237	100	-	23	5.45	Yes	**B**	Regional GC	Dist.Cap.	97.4	25,067	Yes	3,801	0.3	Badulu Oya	12.7	**(NWSDB)**
24	M-24	**Trincomalee U.C**	48,351	9.8	49.3	12.7	8,477	130	65,205	1.00	-	48,351	100	-	20	4.14	Yes	**A**	**National GC**	Dist.Cap.	92.4	24,436	No	3,521	3.3	Indian Ocean	1.1	-
25	M-25	**Ja - Ela U.C**	31,232	7.5	41.6	8.3	8,924	130	68,646	1.00	-	31,232	100	-	3	0.96	No	-	-	-	105.0	38,807	No	3,707	1.5	Aharagulu Oya	2.5	-
26	M-26	**Kalmunai M.C**	99,892	9.8	101.9	27.0	6,757	130	51,977	0.23	-	22,942	23	-	20	2.00	No	-	-	-	92.4	23,429	No	2,807	2.4	Indian Ocean	1.2	-
27	M-27	**Kandy M.C**	98,828	18.7	52.8	27.2	30,443	130	234,177	0.97	-	96,060	97	-	10	1.01	Yes	**A**	Regional GC	Dist.Cap.	96.0	30,371	Yes	12,646	0.3	Kandy Lake	42.2	-
28	M-28	**Matara M.C**	74,193	15.3	48.5	20.5	20,475	130	157,500	1.00	-	74,193	100	-	23	3.10	Yes	**A**	-	Dist.Cap.	101.0	28,227	No	8,505	0.9	Nilwak Ganga	9.5	-
29	M-29	**Hikkaduwa U.C**	27,075	9.8	27.6	14.1	9,840	130	75,692	1.00	-	27,075	100	-	108	39.89	Yes	**A**	Secondary GC	-	101.0	28,205	No	4,087	1.1	Kmlong Canal	3.7	-
30	M-30	**Kesbewa U.C**	185,122	36.1	51.3	51.3	21,757	130	167,365	0.90	-	167,365	90	-	93	5.02	No	-	-	-	103.0	50,071	No	9,038	2.0	Bolgoda Lake	4.5	-
31	M-31	**Matale M.C**	36,462	10.9	33.5	11.7	8,948	130	68,828	1.00	-	36,462	100	-	255	69.94	Yes	**C**	-	Dist.Cap.	96.0	26,441	Yes (Coastral City)	3,717	0.2	Sudu Ganga	18.6	-
32	M-32	**Tangalle U.C**	8,473	1.7	49.8	2.8	5,932	130	45,634	1.00	-	8,473	100	-	1	1.18	Yes	**B**	Secondary GC	-	101.0	32,267	Yes (Coastral City)	2,464	2.0	Kirama Oya	1.2	-
33	M-33	**Point Pedro U.C**	12,334	2.6	47.4	4.4	458	130	3,523	0.27	-	3,375	27	●	57	46.21	No	-	-	-	89.3	23,446	Ground Water Source	190	4.5	Indian Ocean	0.04	-
34	M-34	**Ambalangoda U.C**	19,990	4.0	50.0	6.9	4,300	130	33,077	1.00	-	19,990	100	-	80	40.02	Yes	**C**	-	-	101.0	28,205	No	1,786	1.3	Madanpa Lake	1.4	-
35	M-35	**Kaduwela M.C**	252,041	64.2	39.3	90.6	55,000	130	423,077	0.49	-	124,367	49	-	126	5.00	No	-	-	-	103.0	50,071	Yes	22,846	1.0	Kelani Ganga	22.8	-
36	M-36	**Bandarawela M.C**	24,168	6.7	36.1	8.7	2,812	130	21,631	0.84	-	20,250	84	-	38	15.72	Yes	**B**	-	-	97.4	25,067	Yes	1,168	1.0	Oyal Ela	1.2	-
37	M-37	**Haputhale U.C**	5,288	0.8	69.6	2.0	450	130	3,462	0.47	-	2,475	47	-	3	5.67	Yes	**B**	-	-	97.4	25,067	No	187	-	No Watr Source/Highland	-	-
38	M-38	**Kadugannawa U.C**	12,654	3.0	42.2	4.9	2,435	130	18,731	1.00	-	12,654	100	-	9	7.11	Yes	**B**	-	-	96.0	30,371	No	1,011	2.5	Nanu Oya	0.4	-
39	M-39	**Katunayake Seeduwa U.C**	60,915	14.0	43.5	24.7	6,800	130	52,308	0.21	-	12,650	21	-	3	0.49	Yes	**A**	LZ(Q=12,000m³/day) Extended Aeration	-	102.0	38,807	Yes (Coastral City)	2,825	1.0	Attanagalu Oya	2.8	-
40	M-40	**Gampaha M.C**	62,335	16.7	37.3	27.8	7,000	130	53,846	0.32	-	20,038	32	-	142	22.78	No	-	-	Dist.Cap.	102.0	38,807	Yes	2,908	1.0	Hanagalu Oya	2.9	-

(to be continued to next page)

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Sl No		Local Government Authority	【Parameters and Characters】																							
			Ⅰ.Urbanization⇒P.S.W : 0.43							Ⅱ.Sanitation ⇒P.S.W : 0.73							Ⅲ.Development ⇒P.S.W : 0.48				Ⅳ.Sustainability ⇒P.S.W : 0.51		Ⅴ.Water Environment ⇒P.S.W : 1.00				Ⅵ.Maturation ⇒P.S.W : 0.23
			i.Population Density (Urban Area) ⇒S.S.W : 0.87			【Reference】 Entire Area	ii.Population 【Activity Indicator】 ⇒S.S.W : 0.13			i.Water Supply Coverage Ratio ⇒S.S.W : 0.67				【Reference】 Ground water is currently used as portal water (●)	ii. Disease ⇒ S.S.W : 0.33		i.Tourist Attraction ⇒ S.S.W : 0.40		ii.Growth Center & Industrial Zone ⇒ S.S.W : 0.60		i.Tariff Ratio ⇒ S.S.W : 0.57	ii.Household Income ⇒ S.S.W : 0.43	i.Affectiveness on Water Source ⇒ S.S.W : 0.70	ii.Pollution Impact on Water Environment ⇒ S.S.W : 0.30				i.F/S and Approval Process ⇒ S.S.W : 1.0
			Population 【2012】	Residential Area 【2012】	(1)Population Density		Water Consumption 【Domestic+ Commercial+ Industrial】	Water Consumption per Capita	(2)Equivalent Population	Water Supply Coverage Ratio 【NWSDB】	Water Supply Coverage Ratio 【Other Authorities】	Water Served Population	(3)Actural Water Supply Coverage Ratio 【Population base】		Number of Waterbone Diseases 【2015】	(4)Rate of Waterbone Diseases	(5)Attractive to Tourist 【 Attraction Places】		(6-1)Presence of Growth Center & Industrial Zone	(6-2)Urban Type	(7)Recovery of Water Tariff Ratio	(8)Median of Household Income	(9)How much affect to Intake Points	Pollution Load Generated	Impact Potential 【Distance from Council Center】		(10)Pollution Impact on Water Environment	(12)Situation of F/S and Approval Process
			①	②	③=①/②/100		④	⑤	⑥=④/⑤×1000	⑦	⑧	⑨	⑩=⑨/①×100		⑪	⑫=⑪/③×10,000	-		-		⑯	⑰	-	⑱=⑰×54g/pers./day 【as BOD】 【kg/day】	Distance from Discharging Point ⑲ 【km】	Name of Major Waters	⑳=⑱×⑲/1000 【kg/day/m】	-
			【pers.】	【km²】	【pers./ha】	【km²】	【m³/day】	【ℓ/pers./day】	【pers.】	【%】	【%】	【pers.】	【%】		【pers.】	【pers. /10,000pers.】					【%】	【Rs】			【km】		【kg/day/m】	
41	M-41	Kurunegala M.C	24,833	6.7	37.1	11.5	4,500	130	34,615	0.31	-	7,600	31	-	25	10.07	Yes	C	Regional GC	Dist.Cap.	99.5	29,343	Yes	1,869	1.5	Maguru Oya	1.2	-
42	M-42	Minuwangoda U.C	7,523	2.9	25.9	3.5	1,368	130	10,523	1.00	-	7,523	100	-	4	5.32	No	-	-	-	102.0	38,807	Ground Water Source	568	1.0	Mapalana Oya	0.6	-
43	M-43	Gampola U.C	37,871	9.6	39.4	18.3	7,563	130	58,177	0.61	-	23,154	61	-	105	27.73	Yes	C	Secondary GC	-	96.0	30,371	No	3,142	1.0	Mahavali Ganga	3.1	-
44	M-44	Kegalle U.C	15,993	5.3	30.2	7.8	15,000	130	115,385	0.70	-	11,187	70	-	14	8.75	Yes	B	Regional GC	Dist.Cap.	100.0	28,524	Yes	6,231	0.5	Kuda Oya	12.5	-
45	M-45	Batticaloa M.C	86,227	19.5	44.2	43.2	23,594	130	181,492	0.24	-	21,051	24	-	215	24.93	Yes	A	**National GC**	Dist.Cap.	92.4	20,359	No	9,801	3.5	Indian Ocean	2.8	B (NWSDB)
46	M-46	Puttalam U.C	45,511	8.9	51.1	23.0	6,500	130	50,000	0.67	-	30,678	67	-	8	1.76	Yes	A	Regional GC	Dist.Cap.	99.5	29,286	No	2,700	5.5	Mee Oya	0.5	A (China- EXIM Bank)
47	M-47	Kinniya U.C	36,772	6.2	59.3	19.5	18,000	130	138,462	1.00	-	36,772	100	-	5	1.36	Yes	B	-	-	92.4	24,436	No	7,477	2.0	Uppu Ani	3.7	-
48	M-48	Nuwara Eliya M.C	23,804	4.4	54.1	13.0	19,400	130	149,231	1.00	-	23,804	100	●	5	2.10	Yes	A	-	Dist.Cap.	96.0	28,152	Ground Water Source	8,058	0.3	Nanu Oya	26.9	-
49	M-49	Ratnapura M.C	47,105	10.8	43.6	26.2	7,200	130	55,385	0.77	-	36,112	77	-	141	29.93	Yes	A	-	Dist.Cap.	100.0	27,391	Yes	2,991	1.0	Kalu Ganga	3.0	-
50	M-50	Horana U.C	9,550	3.9	24.5	4.9	4,845	130	37,269	0.59	-	5,661	59	-	27	28.27	No	-	Regional GC	-	105.0	36,512	Yes	2,013	4.0	Kalu Ganga	0.5	-
51	M-51	Mannar U.C	24,417	6.0	40.7	14.0	6,500	130	50,000	0.73	-	17,928	73	-	21	8.60	Yes	A	-	Dist.Cap.	89.3	24,200	No	2,700	3.0	Indian Ocean	0.9	-
52	M-52	Talawakele - Lindula U.C	4,691	3.0	15.6	2.7	710	130	5,465	1.00	-	4,691	100	-	1	2.13	Yes	B	-	-	97.4	28,152	No	295	0.1	Kaotmale Oya	3.0	-
53	M-53	Wattegama U.C	8,157	3.6	22.7	4.8	3,000	130	23,077	0.77	-	6,270	77	-	8	9.81	Yes	C	-	-	96.0	30,371	No	1,246	5.0	high land	0.2	-
54	M-54	Vavuniya U.C	34,816	12.7	27.4	22.3	880	130	6,769	0.17	-	6,026	17	-	133	38.20	No	-	Regional GC	Dist.Cap.	89.3	30,967	No	366	1.5	high land	0.2	-
55	M-55	Valvettithurai U.C	8,283	5.1	16.2	5.4	2,756	130	21,200	0.12	-	954	12	●	38	**45.88**	No	-	-	-	89.3	23,446	Ground Water Source	1,145	2.5	Indian Ocean	0.5	-
56	M-56	Kuliyapitiya U.C	5,509	1.5	36.7	4.2	1,350	130	10,385	0.35	-	1,920	35	-	5	9.08	No	-	-	-	99.5	29,343	Yes	561	-	No Watr Source	-	-
57	M-57	Seethawakapura U.C	30,308	21.6	14.0	21.1	8,050	130	61,923	0.83	-	25,187	83	-	29	9.57	Yes	C	-	-	103.0	50,071	Yes	3,344	2.0	Kelaningay Ganga	1.7	-
58	M-58	Anuradhapura M.C	50,595	21.0	24.1	46.7	20,556	130	158,123	0.94	-	47,676	94	-	11	2.17	Yes	A	**National GC**	Dist.Cap.	102.3	29,689	Yes	8,539	0.3	Malawe Ganga	28.5	F/S Under Preperation (NWSDB)
59	M-59	Balangoda U.C	16,510	13.9	11.9	19.3	4,744	130	36,492	1.00	-	16,510	100	-	43	26.04	Yes	C	-	-	100.0	27,391	Yes	1,971	0.1	Nalwe Ganga	19.7	-
60	M-60	Chavakachcheri U.C	16,129	17.5	9.2	20.8	1,924	130	14,800	0.04	-	725	4	●	53	32.86	No	-	-	-	89.3	23,446	Ground Water Source	799	7.5	Indian Ocean	0.1	-
61	M-61	Ampara U.C	22,511	2.7	83.4	31.7	6,660	130	51,231	1.00	-	22,511	100	-	4	1.78	No	C	-	Dist.Cap.	92.4	23,429	No	2,766	2.5	Gal Oya	1.1	-
62	M-62	Embilipitiya U.C	36,712	24.2	15.2	53.0	7,200	130	55,385	0.73	-	26,843	73	-	52	14.16	No	C	-	-	100.0	27,391	Yes	2,991	6.5	Walawe Ganga	0.5	-
63	M-63	Dambulla M.C	23,814	22.7	10.5	55.2	4,000	130	30,769	1.00	-	23,814	100	-	159	**66.77**	Yes	A	**National GC**	-	96.0	26,441	No	1,662	21.0	Amban Ganga	0.1	-
64	M-64	Hambantota M.C	23,236	22.4	10.4	82.3	6,972	130	53,631	1.00	-	23,326	100	-	5	2.15	Yes	A	**National GC**	Dist.Cap.	101.0	32,267	No	2,896	9.0	Walawe Ganga	0.3	A (China- EXIM Bank)
65	P-01	Katana P.S	174,063	21.4	81.3	83.7	6,274	130	48,264	0.15	-	26,460	15	-	87	5.00	No	-	-	-	102.0	38,807	Yes	2,606	2.5	Maha Oya	1.0	-
66	P-02	Kotikawatta - Mulleriyawa P.S	131,643	21.2	62.1	21.2	37,326	130	287,123	1.00	-	131,643	100	-	66	5.01	No	-	-	-	103.0	50,071	Yes	15,505	2.0	Kakani Ganga	7.8	-
67	P-03	Kelaniya P.S	109,603	13.2	83.0	18.0	22,626	130	174,045	1.00	-	109,603	100	-	55	5.02	Yes	C	-	-	102.0	38,807	Yes	9,398	1.7	Kelani Ganga	5.5	A (AFD)
68	P-04	Biyagama P.S	186,585	47.7	39.2	60.6	29,705	130	228,503	1.00	-	186,585	100	-	93	4.98	No	-	UZ(Q=20,000m3/day) Extended Aeration	-	102.0	38,807	Yes	12,339	1.0	Kelani Ganga	12.3	-
69	P-05	Mahara P.S	207,782	61.7	33.7	96.2	18,948	130	145,753	0.58	-	121,500	58	-	104	5.01	No	-	-	-	102.0	38,807	No	7,871	5.0	high land	1.6	-
70	P-06	Akurana P.S	63,397	23.5	27.0	30.5	5,550	130	42,691	0.43	-	27,081	43	-	150	23.66	No	-	-	-	96.0	30,371	Yes	2,305	1.0	Pinga Oya	2.3	-
71	P-07	Karachchi P.S	61,484	90.0	6.8	674.4	-	-	61,684	-	-	-	-	-	184	29.93	Yes	C	-	Dist.Cap.	89.3	20,614	Yes	3,331	1.8	Canal	1.9	-
72	P-08	Moneragala P.S	49,520	67.2	7.4	286.7	3,900	130	30,000	0.42	-	20,583	42	-	261	52.71	No	-	Regional GC	Dist.Cap.	97.4	20,686	No	1,620	5.0	Kuwbukkan Oya	0.3	-
73	P-09	Thamankaduwa P.S	82,426	43.5	18.9	435.4	25,929	130	199,454	0.33	-	27,444	33	-	17	2.06	Yes	A	-	Dist.Cap.	102.3	30,145	Yes	10,771	8.0	mahaveli Ganga	1.3	-
74	P-10	Maritimepattu P.S	28,973	8.5	34.2	699.2	-	-	28,973	-	-	-	-	-	78	26.92	No	-	-	Dist.Cap.	89.3	17,714	No	1,565	0.5	Indian Ocean	3.1	-
75	P-11	Panadura P.S	152,216	29.3	52.0	37.3	20,372	130	156,708	0.46	-	70,619	46	-	61	4.01	No	-	-	-	105.0	36,512	No	8,462	5.5	Indian Ocean	1.5	-
76	P-12	Ja - Ela P.S	170,289	38.9	43.7	52.6	8,571	130	65,931	0.19	-	33,071	19	-	85	4.99	No	-	-	-	102.0	38,807	No	3,560	2.0	Aflangalu Oya	1.8	-
77	P-13	Wattala P.S	147,494	26.5	55.7	54.6	14,700	130	113,077	0.68	-	99,644	68	-	74	5.02	No	-	-	-	102.0	38,807	No	6,106	1.5	Kerani Ganga	4.1	-
78	P-14	Gampaha P.S	135,332	48.2	28.1	65.2	7,000	130	53,846	0.18	-	24,817	18	-	68	5.02	No	-	-	-	102.0	38,807	Yes	2,908	3.0	Attanagalu Oya	1.0	-
79	P-15	Kandy Four Gravets & Gangawata Korale P.S	65,015	22.0	29.6	33.2	58,466	130	449,738	0.57	-	36,782	57	-	65	10.00	Yes	B	-	-	96.0	30,371	Yes	24,286	4.5	Mahaweli River	5.4	-

Source: JET

Table 5.4-5 Results of Prioritization

Ranking in this study	Local Government Authority	【Ranking Table】 I. Urbanization 【0.1259/0.2959 ⇒Max:43points】 (1)Population Density 【43×0.87=37Points】	(2)Population including Tourinst 【43×0.13=6Points】	Ⅱ.Sanitiation 【0.2164/0.2959 ⇒Max:73points】 (3)Water Supply Coverage Ratio 【73×0.67=49Points】	(4)Ratio of Waterborne Disease 【73×0.33=24Points】		Ⅲ.Development 【0.1416/0.2959⇒Max:48points】 (5)Tourist Attraction 【48×0.40=19Points】	(6)Growth Center & Industral Zone 【48×0.60=29Points】	Ⅳ.Sustainability 【0.1518/0.2959 ⇒Max:51points】 (7)Tarrif Ratio 【51×0.57=29Points】	(8)Household Income 【51×0.43=22Points】	Ⅴ.Water Environment 【0.2959⇒Max:100points】⇒Revised Max:73points as well as Ⅱ.Sanitation (9)Impact on Water Source 【73×0.50=36.5Points】	(10)Potential of Impact on Water Environment 【73×0.50=36.5Points】	Ⅵ.Maturation 【0.0683/0.2959 ⇒Max:23points】 (11)Feasibility Study and Approval Process 【23×1.00=23Points】	Total Points
		【Calculation Method】 37 points correspond to category below. 【Category】 A : Pd ≧150 ⇒37points B :100≦Pd <150 ⇒32points C : 40≦Pd < 100 ⇒ 27points	【Calculation Method】 6 points correspond to category below. 【Category】 A: Ep≧100,000⇒6points B :50,000<Ep<100,000⇒ 3points C : 10,000<Ep<50,000⇒ 1.5points	【Calculation Method】 49 points correspond to maximum rate. Max100%, in case, 50%. ∴ 49×50/100=24.5points	【Calculation Method】 24 points correspond to category below. 【Category】: A : 50≦R <100 ⇒24points B : 0< R <50 ⇒12points		【Calculation Method】 19 points put the council having attraciton places. 【Category】 A : 19points B : 9.5points C : 4.75points	【Calculation Method】 29 points put the council having growth center,industrial zone or district capital. 【Category】 National GC: 29points Regional GC : 14.5poins Secoundary GC : 7.25 points Industrial Zone : 7.25 points District Capital : 7.25 points If a council has multiple factor then take higher one category.	【Calculation Method】 29 points correspond to maximum rate. Max100%, in case, 50%. ∴ 29×50/100=14.5points	【Calculation Method】 22 points correspond to maximum rate. Max10,000Rs, in case, 5,000Rs. ∴ 22×5,000/10,000 =11points	【Calculation Method】 36.5 points put the council having negative Impact to water source. Yes⇒36.5points Ground water Source⇒ 18.25Points For Ground Water Pollution = 2 Points Yes means that polltion of the council could affect water source quality of intake point for water treatment plant at down stream.	【Calculation Method】 36.5 points correspond to these calculation. PL⇒Pollution Load =10,000kg/day L⇒Distance from a discharge points = 5km ∴ 10,000×1/5/1000=2.0 Then correspond to maximum rate. Max 2.0, in case, 1.0. ∴36.5×1.0/2.0=18.25points	【Calculation Method】 23 points put the council corresponding to category below. 【Category】 A: having F/S (Donor has decided.) ⇒23points B: having F/S (Donor has not yet decided) or PF/S ⇒11.5points C: Under Planning of F/S or PF/S ⇒5points	【points】
1	Colombo M.C	37.0	6.0	49.0	12.0	B	19.00	29.00	28.4	22.0	2.0	36.5	0.0	**240.9**
2	Kandy M.C	27.0	6.0	47.6	12.0	B	19.00	14.50	26.5	13.3	36.5	27.5	0.0	**229.9**
3	Sri Jayawardanapura Kotte M.C	27.0	6.0	49.0	12.0	B	4.75	29.00	28.4	22.0	2.0	23.7	11.5	**215.4**
4	Anuradhapura M.C	0.0	6.0	46.2	12.0	B	19.00	29.00	28.3	13.0	36.5	18.5	5.0	**213.5**
5	Badulla M.C	27.0	3.0	49.0	12.0	B	9.50	14.50	26.9	11.0	36.5	8.3	11.5	**209.2**
6	Kelaniya P.S	27.0	6.0	49.0	12.0	B	4.75	0.00	28.2	17.1	36.5	3.6	23.0	**207.1**
7	Nuwara Eliya M.C	27.0	6.0	49.0	12.0	B	19.00	7.25	26.5	12.4	20.3	17.5	0.0	**196.9**
8	Galle M.C	27.0	6.0	49.0	12.0	B	19.00	14.50	27.9	12.4	2.0	1.5	23.0	**194.3**
9	Dehiwala - Mount Lavinia M.C	32.0	6.0	49.0	12.0	B	9.50	0.00	29.0	22.0	2.0	7.0	23.0	**191.5**
10	Negombo M.C	27.0	6.0	49.0	12.0	B	19.00	0.00	28.2	17.1	2.0	2.9	23.0	**186.1**
11	Kotikawatta - Mulleriyawa P.S	27.0	6.0	49.0	12.0	B	0.00	0.00	28.4	22.0	36.5	5.1	0.0	**186.0**
12	Ratnapura M.C	27.0	3.0	37.6	12.0	B	19.00	7.25	27.6	12.0	36.5	1.9	0.0	**183.9**
13	Hambantota M.C	0.0	3.0	49.2	12.0	B	19.00	29.00	27.9	14.2	2.0	0.2	23.0	**179.5**
14	Trincomalee U.C	27.0	3.0	49.0	12.0	B	19.00	29.00	25.5	10.7	2.0	0.7	0.0	**178.0**
15	Maharagama U.C	27.0	6.0	42.4	12.0	B	0.00	0.00	28.4	22.0	2.0	14.8	23.0	**177.6**
16	Chilaw U.C	27.0	1.5	46.2	12.0	B	4.75	0.00	27.5	12.9	2.0	18.2	23.0	**174.9**
17	Puttalam U.C	27.0	3.0	33.0	12.0	B	19.00	14.50	27.5	12.9	2.0	0.3	23.0	**174.2**
18	Matara M.C	27.0	6.0	49.0	12.0	B	19.00	7.25	27.9	12.4	2.0	6.2	0.0	**168.7**
19	Hatton - Dik Oya U.C	27.0	1.5	40.9	12.0	B	9.50	0.00	26.5	12.4	36.5	1.2	0.0	**167.5**
20	Peliyagoda U.C	32.0	1.5	49.0	12.0	B	0.00	0.00	28.2	17.1	2.0	2.6	23.0	**167.3**
21	Boralesgamuwa U.C	27.0	1.5	47.9	12.0	B	0.00	0.00	28.4	22.0	2.0	2.6	23.0	**166.5**
22	Kolonnawa U.C	37.0	6.0	49.0	12.0	B	0.00	0.00	28.4	22.0	2.0	8.3	0.0	**164.8**
23	Beruwala U.C	32.0	6.0	49.0	12.0	B	4.75	0.00	29.0	16.0	2.0	14.0	0.0	**164.8**
24	Biyagama P.S	0.0	6.0	49.0	12.0	B	0.00	7.25	28.2	17.1	36.5	8.0	0.0	**164.0**
25	Panadura U.C	27.0	1.5	49.0	12.0	B	0.00	7.25	29.0	16.0	20.3	0.7	0.0	**162.8**
26	Dambulla M.C	0.0	1.5	49.0	24.0	A	19.00	29.00	26.5	11.6	2.0	0.1	0.0	**162.7**
27	Kalutara U.C	27.0	6.0	49.0	12.0	B	4.75	7.25	29.0	16.0	2.0	6.3	0.0	**159.3**
28	Kattankudy U.C	32.0	1.5	27.9	24.0	A	9.50	0.00	25.5	8.9	2.0	4.3	23.0	**158.7**
29	Kegalle U.C	0.0	3.0	34.3	12.0	B	9.50	14.50	27.6	12.5	36.5	8.1	0.0	**158.0**
30	Balangoda U.C	0.0	1.5	49.0	12.0	B	4.75	0.00	27.6	12.0	36.5	12.8	0.0	**156.2**
31	Weligama U.C	27.0	1.5	49.0	12.0	B	19.00	0.00	27.9	12.4	2.0	5.3	0.0	**156.1**
32	Batticaloa M.C	27.0	6.0	12.0	12.0	B	19.00	29.00	25.5	8.9	2.0	1.8	11.5	**154.8**
33	Moratuwa M.C	27.0	6.0	49.0	12.0	B	0.00	0.00	29.0	22.0	2.0	7.1	0.0	**154.1**
34	Tangalle U.C	27.0	1.5	49.0	12.0	B	9.50	7.25	27.9	14.2	2.0	0.8	0.0	**151.1**
35	Wattala Mabola U.C	32.0	1.5	45.7	12.0	B	0.00	0.00	28.2	17.1	2.0	10.8	0.0	**149.2**
36	Kesbewa U.C	27.0	6.0	44.3	12.0	B	0.00	0.00	28.4	22.0	2.0	2.9	0.0	**144.7**
37	Kinniya U.C	27.0	6.0	49.0	12.0	B	9.50	0.00	25.5	10.7	2.0	2.4	0.0	**144.2**
38	Ampara U.C	27.0	3.0	49.0	12.0	B	4.75	7.25	25.5	10.3	2.0	0.7	0.0	**141.5**
39	Kadugannawa U.C	27.0	1.5	49.0	12.0	B	9.50	0.00	26.5	13.3	2.0	0.3	0.0	**141.1**
40	Kaduwela M.C	0.0	3.0	24.2	12.0	B	0.00	0.00	28.4	22.0	36.5	14.9	0.0	**141.0**
41	Matale M.C	0.0	3.0	49.0	24.0	A	4.75	7.25	26.5	11.6	2.0	12.1	0.0	**140.2**
42	Thamankaduwa P.S	0.0	6.0	16.3	12.0	B	19.00	7.25	28.3	13.2	36.5	0.9	0.0	**139.4**
43	Bandarawela M.C	0.0	1.5	41.1	12.0	B	9.50	0.00	26.9	11.0	36.5	0.8	0.0	**139.2**
44	Ja - Ela U.C	27.0	1.5	49.0	12.0	B	0.00	0.00	29.0	17.1	2.0	1.6	0.0	**139.2**
45	Horana U.C	0.0	1.5	29.0	12.0	B	0.00	14.50	29.0	16.0	36.5	0.3	0.0	**138.9**
46	Jaffna M.C	27.0	1.5	11.8	12.0	B	19.00	29.00	24.7	10.3	2.0	0.3	0.0	**137.5**
47	Ambalangoda U.C	27.0	0.1	49.0	12.0	B	4.75	0.00	27.9	12.4	2.0	0.9	0.0	**136.0**
48	Mannar U.C	27.0	3.0	36.0	12.0	B	19.00	0.25	24.7	10.6	2.0	0.6	0.0	**135.1**
49	Hikkaduwa U.C	0.0	3.0	49.0	12.0	B	19.00	7.25	27.9	12.4	2.0	2.4	0.0	**135.0**
50	Katana P.S	27.0	1.5	7.4	12.0	B	0.00	0.00	28.2	17.1	36.5	0.7	0.0	**130.4**
51	Embilipitiya U.C	0.0	1.5	35.8	12.0	B	4.75	0.00	27.6	12.0	36.3	0.3	0.0	**130.3**
52	Minuwangoda U.C	0.0	1.5	49.0	12.0	B	0.00	0.00	28.2	17.1	20.3	0.4	0.0	**128.3**
53	Seethawakapura U.C	0.0	3.0	40.7	12.0	B	4.75	0.00	28.4	0.0	36.5	1.1	0.0	**126.5**
54	Katunayake Seeduwa U.C	27.0	1.5	10.2	12.0	B	19.00	7.25	28.2	17.1	2.0	1.8	0.0	**126.0**
55	Kurunegala M.C	0.0	1.5	15.0	12.0	B	4.75	14.50	27.5	12.9	36.5	0.8	0.0	**125.4**
56	Gampaha M.C	0.0	3.0	15.8	12.0	B	0.00	7.25	28.2	17.1	36.5	1.9	0.0	**121.6**
57	Talawakele - Lindula U.C	0.0	0.0	49.0	12.0	B	9.50	0.00	26.9	12.4	2.0	1.9	0.0	**113.7**
58	Akurana P.S	0.0	1.5	20.9	12.0	B	0.00	0.00	26.5	13.3	36.5	1.5	0.0	**112.3**
59	Akkaraipattu M.C	27.0	3.0	22.0	12.0	B	9.50	0.00	25.5	10.3	2.0	0.6	0.0	**112.0**
60	Haputhale U.C	27.0	0.0	22.9	12.0	B	9.50	0.00	26.9	11.0	2.0	0.0	0.0	**111.3**
61	Nawalapitiya U.C	27.0	1.5	15.4	12.0	B	0.00	7.25	26.5	13.3	0.0	6.3	0.0	**109.4**
62	Point Pedro U.C	27.0	0.0	13.4	12.0	B	0.00	0.000	24.7	10.3	20.3	0.0	0.0	**107.7**
63	Kuliyapitiya U.C	0.0	1.5	17.1	12.0	B	0.00	0.00	27.5	12.9	36.5	0.0	0.0	**107.5**
64	Gampola U.C	0.0	3.0	30.0	12.0	B	4.75	7.25	26.5	13.3	2.0	2.0	0.0	**100.9**
65	Moneragala P.S	0.0	1.5	20.4	24.0	A	0.00	14.50	26.9	9.1	2.0	0.2	0.0	**98.6**
66	Wattegama U.C	0.0	1.5	37.7	12.0	B	4.75	0.00	26.5	13.3	2.0	0.2	0.0	**97.9**
67	Karachchi P.S	0.0	0.0	0.0	12.0	B	4.75	7.25	24.7	9.1	36.5	1.2	0.0	**95.4**
68	Mahara P.S	0.0	6.0	28.7	12.0	B	0.00	0.00	28.2	17.1	2.0	1.0	0.0	**94.9**
69	Eravur U.C	32.0	1.5	9.1	12.0	B	0.00	0.00	25.5	8.9	2.0	0.1	0.0	**91.2**
70	Vavuniya U.C	0.0	9.0	8.5	12.0	B	0.00	14.50	24.7	13.6	2.0	0.2	0.0	**84.4**
71	Valvettithurai U.C	0.0	1.5	5.6	12.0	B	0.00	0.00	24.7	10.3	20.3	0.3	0.0	**74.7**
72	Chavakachcheri U.C	0.0	0.0	2.2	12.0	B	0.00	0.00	24.7	10.3	20.3	0.1	0.0	**69.5**
73	Kalmunai M.C	0.0	3.0	11.3	12.0	B	0.00	0.00	25.5	10.3	2.0	0.8	0.0	**64.8**
74	Maritimepattu P.S	0.0	0.0	0.0	12.0	B	0.00	7.25	24.7	7.8	2.0	2.0	0.0	**55.7**

M.C : Municipal Council
U.C : Urban Council
P.S : Pradeshiya Sabha

Danish
JICA
Sweeda
AFD

5.4.3 Selection Process

Cities scoring the highest points are selected (from **Table 5.4-5**) until the 7.0% target is reached (Source: Mahinda Chintana Vision for Future, Department of National Planning, Ministry of Finance and Planning, 2010). The selection is shown in **Table 5.4-6**. These cities have relatively high population, are national growth centres or have relatively high pollution load on public water bodies.

Table 5.4-6 Cities for Sewerage System Development to 2035

Local Government Authority	Population (2012)	Water Served Population (2012)	Necessity of Sewerage System	Note
Colombo MC	561,314	561,314	Biggest Town in Sri Lanka National Growth Centre District Capital	Sewerage system has been developed.
Kandy MC	98,828	96,060	Regional Growth Centre District Capital World Famous Tourist Area Water intake located at the downstream	Sewerage system is under construction (JICA).
Sri Jayawardanapura Kotte MC	107,925	107,925	Capital of Nation Big impact of Pollution Load on Public water body	Sewerage system has been planned.
Anuradhapura MC	65,345	47,676	National Growth Centre District Capital World Famous Tourist Area Water intake located at the downstream Big impact of Pollution Load on Public water body	Sewerage system is under plan.
Badulla MC	42,237	42,237	Regional Growth Centre District Capital Water intake located at the downstream	Sewerage system has been planned.
Kelaniya PS	109,603	109,603	Regional Growth centre Famous Tourist Area Water intake for Colombo located at the downstream Big impact of Pollution Load on Public water body	Sewerage system has been planned (AFD).
Nuwara Eliya MC	23,804	23,804	District Capital World Famous Tourist Area Ground water as a water source	
Galle MC	86,333	86,333	Regional Growth Centre District Capital World Famous Tourist Area Water intake located at the downstream	Sewerage system has been planned (AFD).
Dehiwala-Mt. Lavinia MC	184,468	184,468	Large Population Adjoining City to Colombo	Sewerage system partially has been developed and has been planned.
Negombo MC	142,449	142,449	World Famous Tourist Area	Sewerage system has been planned (AFD).
Kotikawatta-Mulleriyawa PS	131,643	131,643	Water intake for Colombo located at the downstream	
Rathnapura MC	47,105	36,112	District Capital World Famous Tourist Area Water intake located at the downstream	
Hambantota MC	23,236	23,326	National Growth Centre District Capital	Sewerage system has been planned (china).

			World Famous Tourist Area	
Trincomalee UC	48,351	48,351	National Growth Centre District Capital World Famous Tourist Area	
Maharagama UC	196,423	169,902	Impact of Pollution Load on Public water body	Sewerage system has been planned (China).
Total		1,811,103		7.1% (=1,811,103*0.9/22,645,723*100)

Note: It is assumed that sewerage served population in 2035 is 90% of water served population in 2012.
Source: JET

5.4.4 Five Cities for City Sewerage Master Plan

Five cities are selected from **Table 5.4-6** based on the following criteria:

1) Colombo and other cities where sewerage systems have been developed or planned to be developed by other donors, are not selected.
2) Cities which represent strategically important areas in Sri Lanka

Sri Jayawardanapura Kotte MC as the national capital, Anuradhapura MC as a national growth centre and a world class tourist area, Badulla MC as regional growth centre, Nuwara Eliya MC as a famous world class tourist area, Dehiwala-Mt. Lavinia MC as a large city close to Colombo, are selected.

Table 5.4-7 Five Cities for City Sewerage Master Plan

Local Government Authority	Description
Sri Jayawardanapura Kotte MC	Capital of Nation Big impact of Pollution Load on Public water body
Anuradhapura MC	National Growth Centre District Capital World Famous Tourist Area Water intake located at the downstream Big impact of Pollution Load on Public water body
Badulla MC	Regional Growth Centre District Capital Water intake located at the downstream
Nuwara Eliya MC	District Capital World Famous Tourist Area Ground water as a water source
Dehiwala-Mt. Lavinia MC	Large Population Adjoining City to Colombo

Source: JET

5.5 TECHNICAL DETAILS OF SEWERAGE SYSTEMS

5.5.1 Sewerage Reticulation Systems

There are two types of sewer reticulation systems: a) Combined sewers, b) Separate sewers

a) Combined sewers:

Combined sewers are designed to carry both sanitary sewage and storm water in one system of large diameter pipes. In a congested urban area, which experiences frequent flooding, storm water and sewage can be managed together. During heavy rain, part of the combined untreated sewage and storm water is diverted to the overflow weir to reduce flows entering the treatment plant. The combined sewer overflow (CSO) is a public health and environmental concern, as it allows pathogens, nutrients, and chemicals to enter surface water bodies. Storage and treatment of CSO is very costly because of the large volume. Therefore, combined sewers are not recommended for Sri Lanka.

b) Separate sewers:

Sewage and storm water are transported separately. Existing watercourses can serve as storm sewers. Smaller pipes (thus, cheaper) can be used for sanitary sewers. Separate sewers provide the advantage of uniform wastewater characteristics. There will be no discharge of untreated wastewater to public water bodies. Separate sewer is the system of choice for Sri Lanka.

The advantages and disadvantages of combined and separate sewers are given in **Table 5.5-1**.

Table 5.5-1 Comparison of Separate and Combined Sewers

Separate Sewers	Combined Sewers
Storm water and sanitary sewage can be managed separately	Storm water and sanitary sewage can be managed together
Limited or no risk of sewage overflow	Risk of sewage overflow
Recycling of nutrients and energy becomes easier	In dry weather, problems associated with sluggish flow, longer detention time may lead to deposits & bad odour in pipelines.
Conventional uniform wastewater characteristics sewerage system is smaller and, therefore, cheaper to build.	

Source: JET

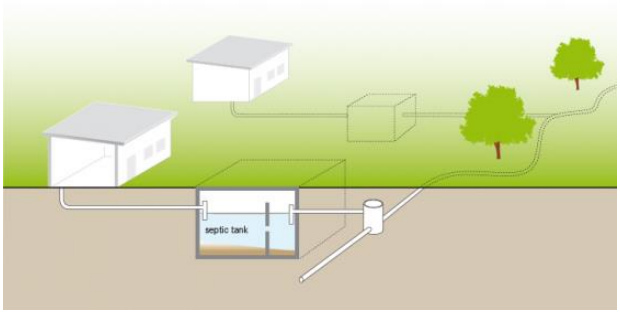
Sewer collection system and septic tank

Where a sewerage system is available, household sewage is usually conveyed directly to sewers. Some systems involve pre-treatment. With solids-free sanitary sewer systems or small-bore sanitary sewer systems, solids are removed within the premises by an interceptor such as single-chamber septic tank, before the effluent is discharged to the street sewer (**Figure 5.5-1**). Small-bore systems eliminate the risk of depositions and clogging of the sewer, and the need for regular cleaning. The small-bore sewers would require fewer inspections to maintain satisfactory performance.

"Interceptor sanitary sewer system" is like the small-bore system but the effluent from the septic tank is collected by an interceptor sewer installed along an existing water channel and conveyed to the STP.

These systems are cheaper to build, but expertise is required in the design, construction supervision, and O&M. Much responsibility is placed on the individual user to make sure that there is no poor construction and no skipping of the pre-settlement step. In addition, septage must be removed periodically and properly disposed of, to protect the local environment.

Given these considerations, household sewage should be connected directly to sewers and existing septic tanks should be abolished.



Source: TILLEY *et al.*2014

Figure 5.5-1 Solids-Free Sewer Systems

5.5.2 Wastewater Treatment Options and Recommendations

(1) Wastewater Characteristics

Wastewater from domestic and industrial sources has different characteristics. **Table 5.5-2** shows the quality of domestic wastewater treated at Moratuwa/Ratmalana STP (6,000 m^3/d), from October 2013 to February 2016. Influent wastewater concentration is relatively low, although septage is regularly put into the plant at 2% v/v of inflow amount. Organic matter (BOD_5, COD), phosphorus, nitrogen and TSS concentration are lower than the design values.

Table 5.5-2 Influent Wastewater Quality of Moratuwa/Rathmalana STP

	Influent								
	pH	BOD_5 (mg/l)	COD (mg/l)	Total P (mg/l)	Total N (mg/l)	Ortho P (mg/l)	NH_4– N (mg/l)	NO_3–N (mg/l)	TSS (mg/l)
MIN	6.6	16	90.7	0.94	14.8	0.47	3.27	0.56	24
MAX	8.5	180	925	18.6	191	13.6	23.7	1.7	856.7
Avg	–	86.9	274.3	2.8	42.4	2.4	14.2	1.0	232.4
Design	–	355	1057	12	55	–	–	–	458*

*：SS

Source: NWSDB

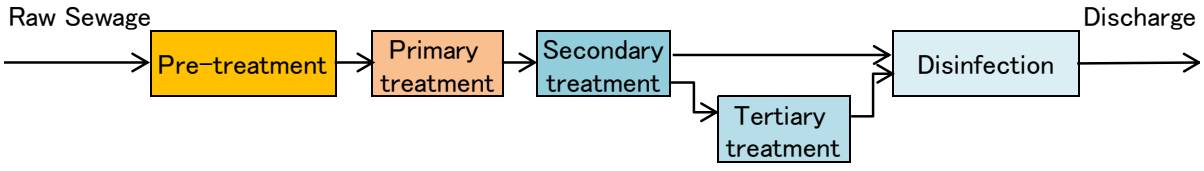
There are fewer data for Ja-Ela/Ekala STP. The average concentration of influent BOD_5 and COD measured over 1 year, are 187 mg/L and 628 mg/L, which are also lower than the design values.

There can be many reasons for low influent wastewater concentration. In warm countries organic substances decompose in the sewer. High infiltration can also lower influent concentration.

(2) Processes for Municipal Wastewater Treatment

Figure 5.5-2 shows the basic steps of a municipal wastewater treatment process. It usually starts with of pre-treatment, followed by primary and secondary treatment and disinfection. Tertiary treatment is added when necessary. Sometimes primary and secondary treatments are integrated.

Sewage can be discharged through an ocean outfall after primary treatment or simply after pre-treatment. Primary treatment is usually by gravity sedimentation. There are few variations for this type of treatment process.



Source: JET

Figure 5.5-2 Municipal Wastewater Treatment Process

Secondary treatment is more complicated and different methods can be used depending on the treatment level required and the characteristics of the wastewater. Biological treatment is commonly used for municipal wastewater since it contains significant amounts of organic substances and nutrients suitable for microbial growth.

1) Selection of appropriate process

The most suitable treatment process should only be determined after careful consideration of the following conditions specific to each wastewater treatment operation:

a) Stability and reliability

The process must be able to treat the wastewater to consistently produce an effluent that meets the allowable discharge limits, without many serious breakdowns or unforeseen emergencies.

b) Land requirement

Land available for the facilities can seriously constrain the choice of treatment method.

c) Power consumption

When power failures are common and electricity rates are relatively high, the treatment process that uses less power is preferable.

d) Ability to accept septage

Treatment plants must accept septage in the foreseeable future until septic tanks are no longer in use. Septage increases influent load and causes loading fluctuations. The treatment process has to accommodate these conditions (refer to Chapter 6).

e) Sludge generation

Treatment produces waste sludge and must be disposed of appropriately or put to beneficial use. Sludge disposal is not without challenges. The treatment process that is selected should produce the lowest possible amount of waste sludge.

f) Easy maintenance

Easy O&M is an obvious advantage. It should also be relatively simple to procure parts and consumables.

g) Minimum impact on surrounding environment

The process should have minimal negative impact on the surrounding environment. The facilities should not generate excessive noise and odour or attract unpleasant insects or pests.

h) Possibility of effluent reuse

STP effluent can be an important resource in areas with water scarcity. The appropriate advanced treatment must be selected to produce the required water quality for the purpose of the reuse. Alternatively, wastewater with hazardous substance should not be accepted. Water with harmful substance cannot be used for irrigation because the contaminants would contribute to bio-magnification along the food chain.

i) Low O&M costs

Low construction cost is only acceptable if the plant equipment is reliable and durable. Otherwise, high repair and replacement cost can become a budgetary burden for the long term.

(3) Characteristics of Wastewater Treatment Processes

The general features of commonly used wastewater treatment processes are given in **Table 5.5-3**. These are mainly secondary treatment processes. Some of these, such as the biological nutrient removal

process (BNR) or membrane bioreactor (MBR), can produce high quality effluent without adding tertiary treatment.

The qualitative evaluation given in the table can change depending on the site conditions.

Table 5.5-3 Characteristics of Typical Wastewater Treatment Processes

System	Removal efficiency (%)				Land requirements (m^2/inhab.)	Energy requirements	Sludge production	Costs		Simplicity in O&M	Environmental problems (Odors, insects)	Existing plants in Sri Lanka
	BOD_5	NH_4-N	T-P	FC (log)				Capital	O&M			
Ponds & lagoons												
Facultative pond	75–85	<50	<35	1–2	2.0–4.0	+++	+++	+++	+++	+++	++	Hikkaduwa (Facultative ponds + maturation pond) Digana Victoria Village (Pond type unknown) Monaragala Base Hospital (Pond type unknown)
Anaerobic pond– Facultative pond	75–85	<50	<35	1–2	1.2–3.0	+++	+++	+++	+++	+++	+	
Facultative aerated lagoon	75–85*	<30	<35	1–2	0.3–0.4*	++	+++	++	+++	+++	++	
Completely mixed aerated lagoon + sedimentation pond	75–85	<30	<35	1–2	0.2–0.4	+	++	++	++	+++	++	
Activated sludge process												
Conventional activated sludge process	85–92*	>80	30–45*	1–2	0.2–0.25*	++	+	+	++	+	+++	Seethawakapura EPZ and many other plants for industrial and hospital wastewater, Kandy
Extended aeration (including Oxidation ditch)	95–98*	>80	10–20*	1–2	0.15–0.2*	+	++	++	++	++	+++	
Biological nutrient removal process	85–93	>80	75–88	1–2	0.12–0.25	+	+	+	+	+	+++	Ekala–Jaela, Morutuwa/Ratmalana
Sequencing batch reactor (SBR)	90–97	>80	<35	1–2	0.12–0.25	++	+	+	++	++	+++	Wathupitiwela EPZ
Membrane Bioreactor (MBR)	90–97	>80	<35	>3	0.08–0.1	+	+	++	++	++	+++	
Anaerobic treatment												
UASB reactor	75–85*	<50	<35	1–2	0.03–0.10	+++	+++	++	+++	++	+	
UASB + submerged aerated biofilter	83–93	50–85	<35	1–2	0.05–0.15	++	+	++	++	+	+++	
Biofilm process												
Low rate trickling filter	80–90*	65–85	<35	1–2	0.2–0.3*	+++	+	+	++	++	+	Ratnapura Hospital and other five plants for hospital (Type unknown)
High rate trickling filter	70–87	65–85	<35	1–2	0.12–0.25	+++	+	+	++	++	+	
Submerged aerated biofilter	88–95	>80	<35	1–2	0.1–0.15	++	+	++	++	+	+++	

Notes: +++ favorable, ++ medium, + less favorable. The grading is only relative in each column and is not generalized for all the items.

Reference "Biological Wastewater Treatment in Warm Climate Regions" Marcos von Sperling et.al. 2006 IWA

* from "Design manual 07, Wastewater Collection, Treatment, Disposal & Reuse" 2012 NWSDB

(4) Wastewater Treatment Processes in Sri Lanka

Table 5.5-4 shows the treatment processes used at various municipal plants.

Table 5.5-4 Municipal Wastewater Treatment Plants and Treatment Processes

No	Place	Capacity (m^3/d)	Process	Notes
1	Moratuwa/Ratmalana	17,000	Activated sludge process with nutrient removal	
2	Ekala/JaEla	7,200	Activated sludge process with nutrient removal	
3	Hikkaduwa	3,000PE	Facultative pond and polishing pond	
4	Kataragama	4,500PE	Facultative stabilization pond	
5	Kandy	14,000	Oxidation ditch with nutrient removal	Under Construction
6	Kurunegela	4,500	Activated sludge process with N removal	Under Construction

Source: JET

Even though there are few operating municipal STP, many are using the activated sludge extended aeration processes, including OD . Activated sludge extended aeration process with nutrient removal is constructed at Moratuwa/Rathmalana and Ja-Ela/Ekala because there is not enough space to build a waste stabilization ponds.

The OD process combined with effluent maturation ponds is often used for industrial wastewater treatment in EPZ **(Table 4.7-1**). A wide variety of treatment processes are used in hospitals. Extended aeration is most common but some hospitals use the conventional activated sludge process or OD process. The more basic operations include septic tank with soakage pit, trickling filters and ponds.

(5) Recent Developments

Various promising wastewater treatment technologies have been developed recently. Some examples are introduced in **APPENDIX 9**.

5.5.3 Effluent Disposal in Compliance with CEA Standards

The most important concern for the treatment facility is to consistently meet effluent quality standards, prescribed in Extraordinary Gazette No. 1534/18 of 01 February, 2008, Schedule 1 of the Gazette No.1534/18. (**APPENDIX 10**)

These standards are being amended. The revised allowable discharge limits will apply to industrial and domestic wastewater discharged to inland surface waters. The revised discharge limits compared to the existing ones are shown in **Table 5.5-5**. Parameters not listed remain unchanged.

Table 5.5-5 Changes to Allowable Discharge Limits for Industrial/Domestic Effluent Discharged to Inland Surface Waters

Parameter	Unite type of limit	Tolerance limit values	
		Gazette No.1534/18	Proposed amendment
Particle size of the total suspended solids	μ m, less than	850	–
Total dissolved solids	mg/l, max	–	1,000
Biochemical oxygen demand (BOD_5 in five days at 20 ℃ or BOD_3 in three days at 27℃)	mg/l, max	30	–
Biochemical oxygen demand (BOD_5 in five days at 20 ℃)	mg/l, max	–	30
Temperature of discharge	℃, max	30 Shall not exceed 40℃ in any section of the stream within 15m down stream from the effluent outlet.	Ambient temperature ±5 or 40 whichever is lesser
Nitrates (as N)	mg/l, max	–	10
Cyanide (as CN)	mg/l, max	0.2	0.05
Total residual chloline	mg/l, max	1.0	0.5 (as Cl_2)
Chlorides (as Cl)	mg/l, max	–	400
Sulphide (as S)	mg/l, max	2.0	0.5
Arsenic (as As)	mg/l, max	0.2	0.05
Cadmium (as Cd)	mg/l, max	0.1	0.03
Chromium,total (as Cr)	mg/l, max	0.5	0.05
Chromium, Hexavalent (as Cr^{6+})	mg/l, max	0.1	0.01
Copper (as Cu)	mg/l, max	3.0	0.05
Lead (as Pb)	mg/l, max	0.1	0.05
Mercury (as Hg)	mg/l, max	0.0005	0.001
Nickel (as Ni)	mg/l, max	3.0	0.2
Silver (as Ag)	mg/l, max	–	0.035
Faecal Coliform	MPN/100ml, max	40	150
Radio Active material (a)Alpha emitters (b)Beta emitters	micro curie/ml,max	 10^{-8} 10^{-7}	–

Source: CEA

Discharge limits for organic substances will not change much. Those for heavy metals will become more rigorous. Heavy metals can be removed to a certain degree by biological treatment. But the heavy metals remain in the sludge. Heavy metal discharge should be controlled at the discharge points.

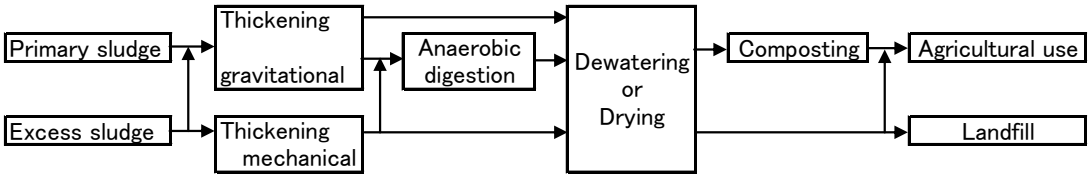
The important amendment is the introduction of discharge limits for nitrates at 15 mg/L. In activated sludge processes with long SRT, nitrification occurs naturally under warm water temperature condition like in Sri Lanka. Introduction of denitrification process is necessary if nitrate concentration exceed the allowable limits. Activated sludge processes that can denitrify, such as OD or extended aeration, must be considered.

Discharge limits for ocean disposal will also be amended. There are three types of ocean disposal: near-shore outfall, short-sea outfall and long-sea outfall. Discharge limits are determined according to the expected dilution rate (refer to 7.6). The changes are intended to exercise more stringent pollutant control for ocean disposal practice.

5.5.4 Managing Sludge, Grit and Screenings

(1) Sludge

Sludge production is inevitable in most biological treatment processes. The amount differs depending on the treatment process as shown in **Figure 5.5-3**. Extended aeration activated sludge processes produce less waste sludge, but requires longer retention time, larger tank volume and more land area.



Source: JET

Figure 5.5-3 Typical Sludge Treatment and Disposal for Activated Sludge Process

Primary sedimentation sludge and waste activated sludge are produced by the conventional activated sludge (CAS) process. The OD process, which has no primary sedimentation tank, produces only waste sludge. The characteristics of primary and waste activated sludge are considerably different. Primary sludge consists mainly of carbohydrate and is easily decomposed by anaerobic digestion. The major component of waste activated sludge is organic matter or protein in microbial cells, which is not easily decomposed anaerobically. Sludge treatment is therefore an important consideration in choosing the appropriate wastewater treatment process.

Organic matters in the sludge may contain pathogens that can pose risks to public health. Therefore stabilization is a priority in sludge treatment. Sludge is usually thickened and then dewatered. Dewatering reduces sludge volume, which facilitates disposal or composting.

Primary sludge is sometimes anaerobically digested after thickening. Anaerobic digestion stabilizes the sludge, reduces its volume and produces methane gas – a valuable energy source. Small high efficiency gas generators developed in recent years is enabling biogas power generation in mid-scale STPs.

After composting or drying, sludge can be utilized as soil conditioner. Agricultural use of sludge recycles nutrients and is therefore much preferred than disposal at landfills. Sludge containing hazardous materials such as heavy metals or radioactive substances cannot be used for agriculture. Sri Lanka has no regulations on hazardous material content in treated sludge for agricultural application. EU (directive 86/278/EEC), German and Japanese tolerance limits are used instead.

Table 5.5-6 Allowable Limits for Hazardous Materials in Sludge for Agricultural Application

Parameters	Unit	EU Directive (1986) 86/278/EEC	German Directive (1992)	Japanese Standard
Pb	mg/dryKg	750–1,200	900	0.01 (%)
Cd	mg/dryKg	20–40	5–10	0.0005 (%)
Cr	mg/dryKg	–	900	0.05 (%)
Cu	mg/dryKg	100–1,750	800	–
Ni	mg/dryKg	300–400	200	0.03 (%)
Hg	mg/dryKg	16–25	8	0.0002 (%)
Zn	mg/dryKg	2,500–4,00	2,000–2,500	–
As	mg/dryKg	–	–	0.005 (%)
PCB	mg/dryKg	–	0.2	–
PCDD/PCDF	mg/dryKg	–	100	–
AOX	mg/dryKg	–	500	–

Source: EU Directive 86/278/EEC (1986)

Besides heavy metals, sewage sludge may contain ascaris eggs and pathogens, harmful to human health. Anaerobic digestion can neutralize these health risks and should be used to treat sludge for agricultural use.

Composted sewage sludge can be used for gardening. This use is not directly related to food production, and the concern with the health risks is much lower. Sewage sludge is made up of soil particles and organic materials, like clay, and can be used as construction materials, for instance, in cement manufacturing. However, high phosphorus content in the sludge can reduce the quality of the product.

(2) Grit and Screenings

Grit and screenings generated from pre-treatment should be properly disposed of to avoid negative environmental impacts. Grit should be washed and dewatered prior to disposal. Sometimes clean grit is recycled as backfill materials for sewer laying. Screenings are disposed of as solid wastes. Grit and screening area should be enclosed for odour control. There are no regulations on disposal of grit and screenings at this time but these should be introduced as soon as possible.

5.6 BENEFITS OF SEWAGE TREATMENT

Discharging untreated sewage into water bodies pollutes the water environment, soil ecosystem and is harmful to wildlife, including fish. Sewage treatment reduces pollutants, minimizes environmental damage and contributes to public health and better quality of life. The major benefits of a sewerage system are as described below.

(1) Reduced level of disease

Wastewater treatment removes disease-causing agents and prevents citizens' exposure to harmful organisms.

(2) Preserving the natural environment

Sewage treatment will replace the use of poorly constructed septic tanks and similar facilities, which inevitably discharge pollutants to groundwater and surface water; not to mention the health hazard caused by emptying such facilities in densely populated areas in major cities. Polluted water eventually ends up in the sea, causing degradation of marine environments.

(3) Boost to tourism

The attractive and pristine natural environment is essential to tourism development.

(4) Protection of fish and wildlife

Ecological conservation, such as protecting fish and wildlife, is not only good for the environment but also improves the well-being of the local people who can enjoy recreational activities on clean rivers and sea.

(5) Standard of living and quality of life

Sewerage treatment is essential for sustainable development, which will increase the standard of living and improve quality of life.

5.7 COST ESTIMATES

Table 5.7-1 shows the construction cost estimate. Estimates are based on existing sewerage projects. A total of 3,850 million USD is required to achieve 7.0% sewerage coverage for the population of Sri Lanka. The treatment plant cost is assumed to be 2,000 USD per cubic meter and the collection network cost is assumed to be 2,000 USD per customer.

Table 5.7-1 Estimated Costs

	Local Government Authority	Construction Cost, Million USD	Water Served Population (2012)	Water Consumption (2012), m^3/d	Calculation
1	Colombo MC	950	561,314	472,086	=2,000*472,086
2	Kandy MC	240	96,060	30,443	=2,000*96.060*0.9 +2,000*30,443
3	Sri Jayawardanapura Kotte MC	270	107,925	35,000	=2,000*107,925*0.9 +2,000*35,000
4	Anuradhapura MC	130	47,676	20,556	=2,000*47,676*0.9 +2,000*20,556
5	Badulla MC	100	42,237	9,150	=2,000*42,237*0.9 +2,000*9,150
6	Kelaniya PS	250	109,603	22,626	=2,000*109,603*0.9 +2,000*22,626
7	Nuwara Eliya MC	90	23,804	19,400	=2,000*23,804*0.9 +2,000*19,400
8	Galle MC	190	86,333	16,772	=2,000*86,333*0.9 +2,000*16,772
9	Dehiwala-Mt. Lavinia MC	410	184,468	39,000	=2,000*184,468*0.9 +2,000*39,000
10	Negombo MC	330	142,449	32,234	=2,000*142,449*0.9 +2,000*32,234
11	Kotikawatta-Mulleriyawa PS	320	131,643	37,326	=2,000*131,643*0.9 +2,000*37,326
12	Rathnapura MC	80	36,112	7,200	=2,000*36,112*0.9 +2,000*7,200
13	Hambantota MC	60	23,326	6,972	=2,000*23,326*0.9 +2,000*6,972
14	Trincomalee UC	60	48,351	8,477	=2,000*48,351*0.9 +2,000*8,477
15	Maharagama UC	370	169,902	27,300	=2,000*169,902*0.9 +2,000*20,000
	Total	3,850	1,783,049	784,542	

Note: It is assumed that sewerage served population in 2035 is 90% of water served population in 2012 and sewage treatment capacity in 2035 is water consumption in 2012.
It is assumed based on existing construction cost that sewer construction cost is 2,000 USD per capita and sewage treatment plant cost is USD 2,000 per capacity.
Source: JET

CHAPTER 6 ON-SITE SANITATION MANAGEMENT AND DEVELOPMENT

6.1 ON-SITE SANITATION

One of the UN Sustainable Development Goals (SDGs) is to "ensure access to water and sanitation for all by 2030", with the following specific targets.

- By 2030, achieve access to adequate and equitable sanitation facilities.
- By 2030, improve water quality by halving the proportion with no access to sanitation facilities.

As of 2015, 89% of the population of Sri Lanka have access to improved toilets[6-1)], and all will have access to sanitation facilities by 2030. Modern sewerage systems will be the main wastewater treatment infrastructure in Sri Lanka. However, it will take a long time to reach country-wide sewerage system coverage. In the meantime, on-site treatment will continue to play an important role.

The focus on improving water quality must be directed to on-site facilities such as septic tanks.

6.1.1 Status and Problem Areas (Urban)

(1) Status

Densely populated urban areas are better served by centralized wastewater management systems. The sewerage system coverage in the country is only 2%. 83 % of the population have on-site facilities.[6-2)]

(2) Common problems associated with septic tanks

Septic tanks with soakage pit are the most widely used on-site treatment. They are not always properly installed and maintained. The following problems are often encountered.

1) Improper installation and insufficient treatment

According to the survey in Gampaha City, about 80 % of the on-site facilities are not septic tanks with soakage pits. Most are just collection or soakage pits. Such systems do not comply with SLS 745. Many (75%) are installed less than the recommended 18 m from wells (SLS 745/2009). Some septic tank capacity is too large, resulting in excessively long intervals (of over 5 years) between sludge removals, and soakage pits were installed in areas where groundwater level is high. The seasonal high GWT should be at least 2.5 m below the GL. Soak pits frequently are filled during the rainy season.

2) Improper maintenance

SLS745/2009 recommends that septage be removed when the septic tank is between one-third to half full. If this is not done often enough to save money, the effective capacity of the septic tank is reduced. The practice results in inadequate decomposition of wastewater, carryover of SS to the soil percolation system, leading to clogging of the soil. Some septic tanks are not properly designed, e.g. no opening for suction hose, and concrete wall of the tank must be broken to withdraw septage. Sometimes kerosene oil is sprayed into the septic tank after septage withdrawal to control odour. Another serious problem is discarding various objects in the toilet, causing problems in septage treatment and disposal.

3) Improper septage management

Septage is regarded as waste according to the definition of "Sri Lanka National Environment Act No.47 of 1980". The challenges of septage treatment and disposal are explained in the following section.

(3) Septage treatment and disposal

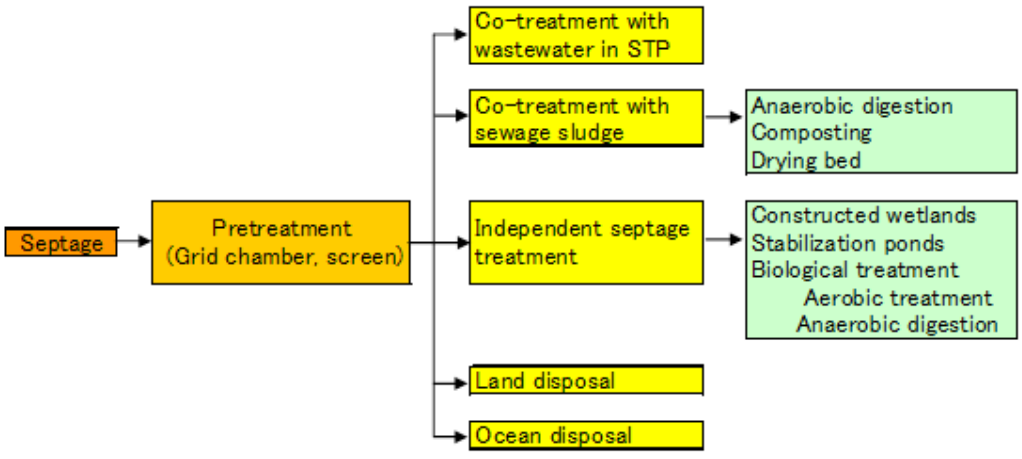
Proper septage management is essential for the protection of groundwater and the environment. There are less than 10 septage treatment facilities in Sri Lanka. **Table 6.1-1** shows septage quality compared to India. Sri Lankan septage shows relatively low suspended solids, and hence low organic matter and nitrogen concentration.

Table 6.1-1 Septage Quality

Source	Appearance	pH	Temp (℃)	COD (mg/L)	TSS (mg/L)	BOD (mg/L)	TKN (mg/L)	NH_3-N (mg/L)	TS (mg/L)	Remarks
Clean Tech Env. Service	Ash colour, odorous	9.32	28.2	1,499	2,145	–	–	–	–	Septage
Clean Town Gully Service	Ash colour, odorous	7.28	27.2	1,665	–	635	–	–	–	Septage
Pyramid Gully Service	Ash colour, Cloudy, odorous	7.35	26.8	1,906	–	320	–	–	–	Septage
Abans Clean Tec gully service	Sewage bluish, yellow odorous	4.95	29	1,066	64	–	20.3	4.4	1,140	Septage
Mulleriyawa Kotikawatta PS	sewage yellowish odorous	7.39	28.5	500	640	65	188	186.5	1,676	Sewage
Pyramid Gully Bowser Service	sewage yellowish odorous	7.23	29.5	1,157	524	185	291	236.5	1,688	Septage
Boralesgamuwa Municipal Council	sewage yellowish odorous	6.48	29.5	1,867	520	720	193	147.5	1,312	Septage
India＊＊	–	–	–	31,900	12,862	6,480	588	97	34,100	Septage (Average)

＊Data of Sri Lanka were measured in 2015.
＊＊"Septage management in Urban India (draft)" WSP, 2012
Source: JET

Septage treatment and disposal methods are summarized in **Figure 6.1-1**.



Source: JET

Figure 6.1-1 Septage Treatment and Disposal

(4) Treatment of septage in STPs

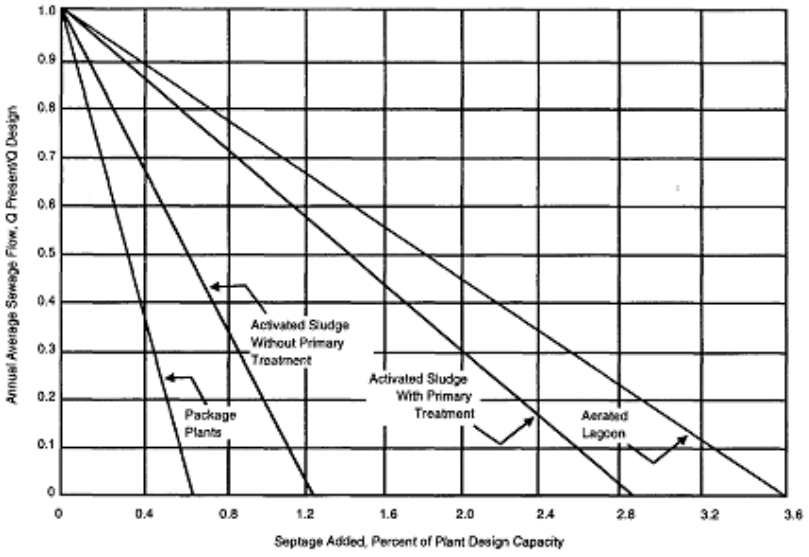
The most inexpensive method of disposal and treatment is to treat septage together with wastewater in the STP. This practice can cause the following problems for the STP operation:

- increased screenings and grit
- increased odour emission
- scum production in settling tanks
- increased organic load and SS at the biological treatment process
- possibility of foaming or odour generation in aeration tank
- increased sludge production
- increased maintenance

Pre-treatment of septage is necessary to avoid damage to STP machinery and equipment, especially when there is no primary settling tank. Solid waste or sand contained in septage should be removed as much as possible by screens (or grinders) and grit chambers. In addition, if the oil and fat content in septage is high, a grease trap should be added at the receiving station.

There is a limit to how much septage can be discharged without upsetting the STP process. The acceptable amount of septage should be determined considering the following factors:

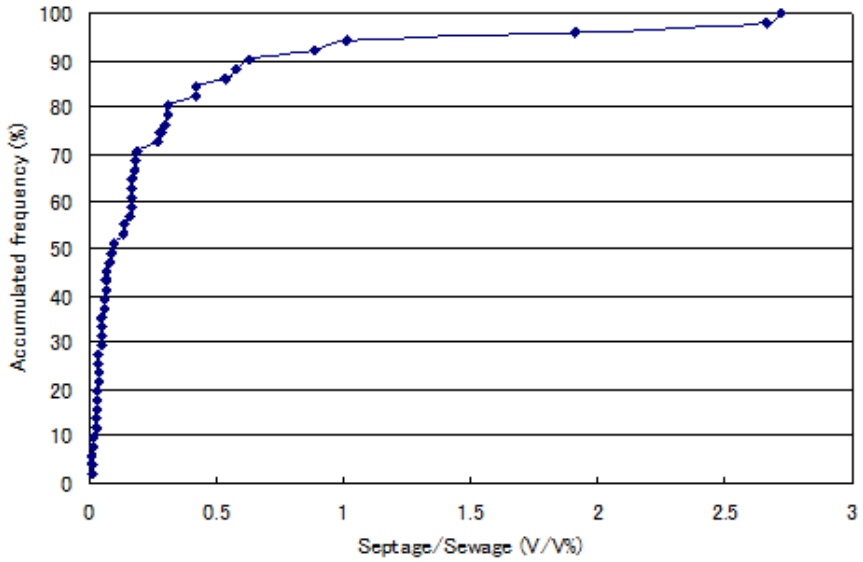
- inflow to design capacity ratio
- existence of primary settling tank
- existence of septage holding tank
- type of biological treatment



Source: US EPA

Figure 6.1-2 Allowable Septage Loadings to an STP Having Septage Holding Tanks

Figure 6.1-2 shows allowable septage loadings to an STP with a septage holding tank (US EPA). STPs with excess treatment capacity are able to accept more septage. STPs with primary settling tanks can also accept more septage.



Source: Japan Sewage Works Agency (JSWA)

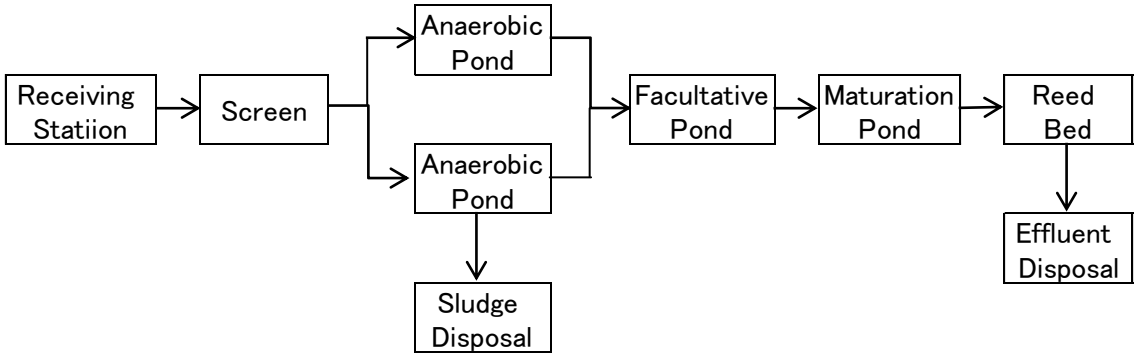
Figure 6.1-3 Septage/Sewage Ratio in Japanese STPs

Figure 6.1-3 shows the average septage/sewage ratio of 0.32%, for Japanese STPs that receive septage. The maximum is 2%. In this case, septage is from on-site treatment systems and latrine toilets.

Moratuwa/Ratmalana and Ekala-Jaela sewage treatment plants are receiving septage at about 2% of inflow volume without any serious problems. However, if a STP receives considerable amounts of industrial wastewater, the septage volume should be reduced. It is also important that septage from industrial wastewater sources should not have any toxic materials that could inhibit bacterial activity in the bioreactor/aeration tank.

1) Independent septage treatment

If there is no STP available, collected septage should be treated separately. Stabilization pond is an inexpensive choice if land is available. The Mannar septage treatment facility, which accepts 28 m^3 of septage daily, is shown in **Figure 6.1-4**. This facility consists of two anaerobic ponds - facultative pond and maturation pond. Effluent from the maturation pond flows through reed beds for polishing before discharge.



Source: ADB

Figure 6.1-4 Mannar Septage Treatment Facility[6-7)]

6.1.2 Status and Problems (Rural & Small towns)

The country has successfully achieved the millennium goal on sanitation. Nevertheless, there are still many people, especially in rural areas, who do not have access to improved toilets. In rural areas and small towns with low population density and dispersed residences, on-site system is more practical. The improvement of sanitary situation by introducing improved toilets as well as proper use of septic tank system is required.

6.1.3 Latrine and Distribution

Only 7% of the population use unimproved toilet, 1.7% with no sanitation facilities and 2.6 % of households still use pit latrines. (refer to **APPENDIX 12** for various types of latrine toilets)

Water supply and sanitation in schools is drastically improved. Schools with adequate sanitation coverage reached 80% (2012), and 85% of schools have improved drinking water sources.

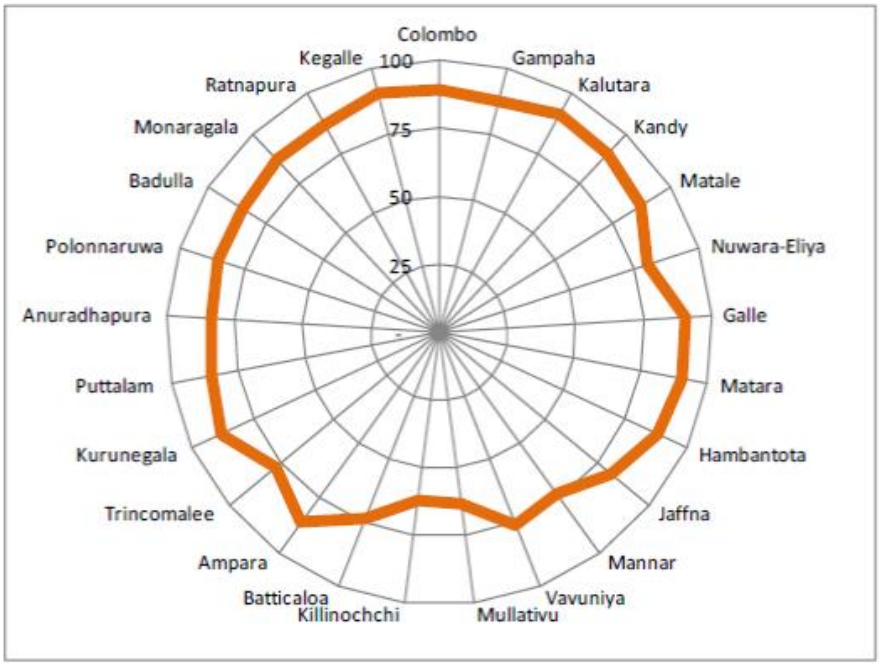
Table 6.1-2 shows that the quality of sanitation has improved tremendously. Bucket latrines are no longer used and pit latrines without slab or open pits are not reported. Ventilated improved pit latrine (VIP) is promoted in rural agricultural areas. The target of improved sanitation is 100% by 2020.

Table 6.1-2 Quality of Sanitation

Improved Sanitation Facilities	Unimproved Sanitation Facilities
Flush or pour-flush to: - piped sewer system- increasing by 2% - septic tank- first choice according to SLS Standards - pit Ventilated improved pit latrine (VIP) Promoted in rural agricultural areas. Composting toilet - promoted as ecosan Public or shared sanitation Facilities	Bucket Latrines = eradicated Flush or pour - flush to non sewer - reportedly not in use Pit latrine without slab or open pit - not reported Hanging toilet or hanging latrine - none Pit latrines with slab - discouraged No facilities or bush or field (open defecation) is 1.7%

Source: Regional Center for Sanitation

Figure 6.1-5 shows the households with own toilet - northern and eastern parts of Sri Lanka have lower ratios in this distribution.



Source: Census of Population and Housing – 2012; Department of Census & Statistics, Ministry of Policy Planning and Economic Affairs (MOPPEA)

Figure 6.1-5 Households with Own Toilet by Districts

6.2 ON-SITE SANITATION IMPROVEMENT

6.2.1 Standards for On-Site Sanitation Facilities

SLS 745 series should be followed for facility design. SLS 745 has been revised several times since 1986 and the latest version is SLS 745 PART 2: 2009, Code of Practice for the design and construction of septic tanks and associated effluent disposal systems. Part 1 (issued in 2004) deals with small systems with underground seepage. Part 2 deals with systems without underground seepage (in cases where the level of groundwater is high or the soil infiltration speed is low) as well as large systems. Part 2 also shows post-treatment options, such as anaerobic bio filters, subsurface flow constructed wetlands and gravel percolation beds.

6.2.2 Priority Areas for On-site Treatment Improvement

Groundwater may be polluted if the treated water is directly discharged to the ground. If seasonal GWT is < 2.5 m, soil bacteria cannot do the purification before the pollutants reach GWT. Ground water pollution is not monitored nationally and, problems are not identified. Therefore, on-site treatment improvements must be carried out area by area. Problems and priority for action must be identified.

Priority areas should be determined by giving considering the following:

The soakage pit allows the septic tank effluent to soak into the surrounding soil before the effluent enters the groundwater or other water bodies. SLS 745 part 2: 2009 provides the appropriate minimum depth from ground surface to the seasonal high groundwater table and the minimum soil percolation rate. Groundwater table and the percolation rates of the soil are required to determine if septic tank system in the city is functioning properly. In the absence of this data, other clues are scrutinized to help identify possible problems:

- cities adjoining lagoons
- cities with waterlogged areas
- cities not having the above conditions but are situated on hilly terrain
- cities in the wet zone which experience frequent flooding

These cities are identified and categorized into 3 groups. (**APPENDIX 13)**

1. Problem areas
   Wet and dry zone cities with adjoining lagoons, wet zone coastal cities with waterlogged areas, and wet zone cities with low height above MSL and waterlogged areas
2. Potential Problem areas
   Wet zone cities with marshy areas, and dry zone cities with waterlogged areas
3. Non- priority areas:
   Cities where above situations are not applicable

The priority areas are categorized in **Table 6.2-1**.

Table 6.2-1 Priority Areas for On-Site Sanitation Improvements

Problem Area	Sewage Volume	Potential Problem Area	Sewage Volume
Boralesgamuwa U.C	71 m^3/d	Batticaloa M.C	94 m^3/d
Chavakachcheri U.C	21 m^3/d	Beruwala U.C	53 m^3/d
Chilaw U.C	4 m^3/d	Hikkaduwa U.C	30 m^3/d
Eravur U.C	29 m^3/d	Ja - Ela U.C	35 m^3/d
Jaffna M.C	100 m^3/d	Kalmunai M.C	117 m^3/d
Kattankudy U.C	48 m^3/d	Katunayake - Seeduwa U.C	67 m^3/d
Mannar U.C	28 m^3/d	Kinniya U.C	45 m^3/d
Matara M.C	41 m^3/d	Kolonnawa U.C	71 f/d
Panadura U.C	33 m^3/d	Moratuwa M.C	184 m^3/d
Wattala Mabola U.C	31 m^3/d	Peliyagoda U.C	30 m^3/d
Colombo M.C*	62 m^3/d	Point Pedro U.C	15 m^3/d
Dehiwala - Mount Lavinia M.C*	20 m^3/d	Valvettithurai U.C	11 m^3/d
Kelaniya P.S*	20 m^3/d	Weligama U.C	26 m^3/d
Negombo M.C*	53 m^3/d	Sri Jayawardanapura - Kotte M.C*	12 m^3/d
		Galle M.C*	9 m^3/d
		Kotikawatta - Mulleriyawa P.S*	58 m^3/d
Total	406 m^3/d Except for 4 cities		770 m^3/d Except for 3 cities

Note: *marks a city that is proposed for sewerage development because of high priority.
Source: JET

14 cities are identified in problem areas Sewerage systems are going to be developed in 4 of these cities (Colombo MC, Dehiwala-Mount Lavinia MC, Kelaniya PS and Negombo MC) to reach 7.0% national coverage.

16 cities are identified in potential problem areas. Sewerage systems are going to be developed in 3 of these cities (Sri Jayawardanapura - Kotte M.C, Galle M.C, Kotikawatta - Mulleriyawa P.S) to reach 7.0% national coverage.

Therefore 10 cities in the problem areas should have improved toilets and septage treatment first, followed by another 13 cities in potential problem areas. Others should be improved with toilets and septage treatment at the last stage.

1,300 million LKR (=406 m^3/d*110 million/34) will be required for problem areas at the first stage, 2,491 million LKR (=770 m^3/d*110 million/34) for areas with potential problems at the second stage, and 8,549 million LKR (=12,340-1,300-2,491) for other cities at the final stage. **(APPENDIX 14)**

6.2.3 Institutional, Commercial and Industrial On-site Disposal

Septic systems are commonly found in rural and suburban areas where ground water is usually the source of drinking water. Septic systems that are properly located, designed, constructed, operated, and maintained, pose little threat to drinking water sources. Otherwise contamination of ground water or surface water can occur.

A large capacity septic system that receives solely sanitary waste from multiple dwellings or non-residential establishment has the capacity to serve 20 or more persons per day. It is usually used in:

- apartment buildings
- schools and religious institutions
- office, industrial, and commercial buildings
- shopping malls
- state parks and campgrounds
- recreation or vehicle parks
- train and bus stations
- hotels and restaurants

On-site sewage treatment systems are designed to treat household wastewater and do not provide adequate treatment for contaminants found in commercial and industrial facilities. Strict policies and regulations are required for on-site disposal of commercial and industrial wastewater to safeguard against any potential of serious soil and groundwater contamination. It is necessary to consider alternative means of disposal and on-site option should only be considered when nothing else is feasible. Some options are described below.

(1) Reduce and recycle wastewater

Adjust manufacturing processes to minimize generation of wastewater. Reduce use of materials that contribute to pollution loads. Recycle the wastewater as much as possible. Recycling will save water and reduce costs.

(2) Connect to municipal sewer system

The easiest and most inexpensive way is to send the wastewater to the nearest municipal STP. Sometimes industrial wastewater requires pre-treatment before discharging to a sewer to reduce strength or remove harmful substances. The discharge limits are given in **APPENDIX 15** and **APPENDIX 16.**

Small amounts of non-hazardous wastewater can be discharged in soil. Natural processes can breakdown organic substances or contaminants in the wastewater faster than in septic systems.

(3) Treat wastewater on-site

The industry can install oil/grease separators, reverse osmosis systems or waste evaporators to remove certain pollutants and reduce wastewater volume. Waste composition, volume, available capital, and operating costs may affect the type of on-site treatment technology that is chosen.

(4) Other options

Industrial wastewater that does not contain harmful substances can be used for various applications.

6.2.4 Criteria for Siting Septage Treatment Systems

SLS 745 states that collected septage should be sent to sewage treatment plants or to landfills for disposal. Septage disposal must not introduce adverse effects on groundwater and the surrounding environment. SLS 745 does not specify the criteria for treatment or disposal site selection.

Three candidate sites were considered for the Mannar septage treatment facility. The following issues were considered in choosing the Mannar site.[6)]

- sufficient land area
- no risk of groundwater contamination
- no need to resettle inhabitants
- no negative effects on surrounding environment caused by odour, noise, vectors and traffic of gully suction trucks
- easy access

The aerial photograph of the Mannar facility is shown in **Figure 6.2-1**. The 1.88 ha site treats 28 m^3/day. The treatment methodology uses 2 anaerobic ponds - facultative pond and constructed wetland. There are no houses in the neighborhood and access to the site from the trunk road is good. NWSDB also designed septage treatment plants in Baticola with funding from JICA after the tsunami disaster on 26th December 2004. This is an on-going sanitation project for IDB camps at Mevik and Vawmiya. The treatment to meet inland surface standards comprised of anaerobic ponds, facultative ponds, and maturation ponds with at least two treatment trains. The ponds provide entirely natural treatment and need very little maintenance and are ideally suited to local authority management.

Source: Google Map

Figure 6.2-1 Aerial Photo of Mannar Septage Treatment Facility[6)]

6.2.5 Approval Procedure for Buildings

(1) Rules and regulations

The Urban Development Authority Act, No 41, 1978, states that construction should be done according to rules and regulations. Municipal Council, UC or PS control and regulate all building activities in the area of its authority. Anyone engaging in building activities must obtain a building permit from the relevant local authority. A building permit is valid for one year and can be renewed for two years [Regulation 10 (06)]. Section 3(1) of the Act describes the "Urban Development Areas" which requires building permits.

(2) Application and approval

Application for building permit should be submitted with the following supporting documents:

- map showing land and roads adjoining the location where the building activity is to take place.
- if land is subdivided, approved plan for sub-division drawn in the scale of not less than 1:4000 which indicates:
  - geographical characteristics
  - buildings in the area
  - width of roads in the area
- detailed plan of the proposed building drawn in the scale of not less than 1:1000 showing:
  - existing buildings
  - street lines to be amended if any
  - boundary of the land
  - access roads
  - parking areas
- notarized deed of the land on which the building activity is to take place
- plan drawn in the scale of 1:100 for each floor of the building (depending on the complexity of the building this can be drawn in the scale of 1:200)
- plan showing the toilets and sewage pits
- if the land is a paddy field, the permit from the Agrarian Services Department to fill the land should also be submitted.

Note:

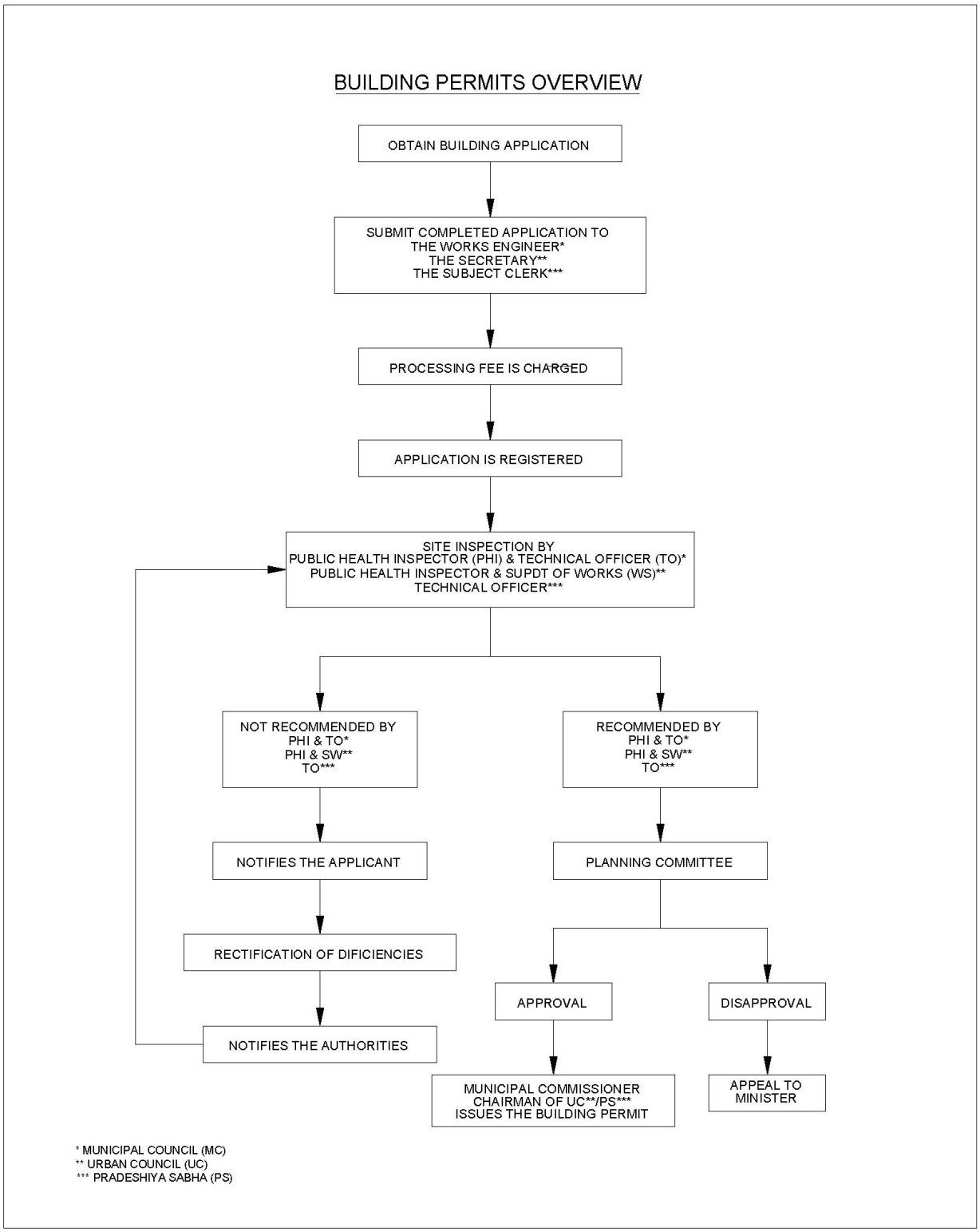
(i) If the building is to be constructed by the side of a road under the purview of the Road Development Authority, consent has to be obtained from the Road Development Authority.

(ii) Where the building is to be constructed on a river bank within 100 metres of the river, approval has to be obtained from the Mahaweli Development Authority.

(iii) If buildings are to be constructed within the limits of the coast, approval has to be obtained from the Coast Conservation Authority.

(3) Approval procedure

The procedure for approving building plans by each local authority is shown in **Figure 6.2-2**. The Technical Officer or PHI inspects the site and determines if the building project meets water supply and sanitary guidelines (such as, SLS 745 Part II, NWSDB design manual D7, PHI Manual, National Policy for Rural Water Supply & Sanitation and UDA guidelines issued for housing projects). Some important aspects of the water supply and sanitation guidelines are given below.



Source: UDA

Figure 6.2-2 Procedure for Approving Building Plans by Local Authority

1) Water Supply & Sewerage

- Every building shall have a protected water supply from an existing public water supply system.

- When it is not possible to connect to the public water supply system, connecting to a private service is permitted.
- Every building shall have water storage tanks and pumps of specified capacity, where the authority has reason to believe that the supply of water may not be continuous, because of the building location and other geographic factors of the area.
- (a) No wells for drinking water shall be located less than 15.0 m. from a cess pit or a soakage pit of a septic tank.
  (b) A well for drinking water should not be located within 10.0 m. from a cess-pit or a soakage pit of a septic tank, unless approved by a qualified geologist and the Medical Officer of Health of the area, when piped water is not available.
  (c) In areas where there is no piped water supply, the minimum lot size should be 20 perches.
  (d) The bottom level of a soakage pit, a cess pit or a septic tank should not be lower than the water table.

2) Sanitary Conveniences

- Every dwelling shall have at least one water closet, while other types of building shall be provided with an adequate number of water closets, urinals, wash basins and other sanitary conveniences. The numbers of water closets, urinals, wash basins and other sanitary conveniences to be provided in any building shall be as specified.
- All sewerage and wastewater outlets shall be connected to a public sewerage system and the authority may, in any case, require the sewerage and wastewater to be pre-treated to acceptable standards before connecting to a public sewerage system.
- (a) Where a public sewerage system does not exist, or when the authority is of the opinion that the outlets cannot be connected to the public system, sewerage shall be disposed of through a septic tank; and
  (b) Wastewater shall be appropriately disposed of through a soakage pit.

3) Drainage

Every building shall be provided with adequate drainage facilities to convey rainwater from the roof to a street drain or other approved outlet without causing dampness or damage to the walls or foundation of the building or those of adjacent buildings.

4) Waste disposal

Waste generated within any premises shall be collected and disposed of in a manner, which the authority considers appropriate to safeguard the health of the inhabitants.

6.2.6 Operation & Maintenance of Septage Treatment Systems

Matara and Negombo are two examples of septage treatment practice.

(1) Matara[4)]

Matara MC makes 77,114 LKR monthly in septage collection. Gully suckers dump collected septage into a trench in a 70-acre coconut forest. Coconut production increased by 20% without using other fertilizer. Savings on fertilizer amounted to 70,000 LKR annually.

Sri Lankan people are reluctant to use septage as fertilizer. This practice is very rare.

The septage not fully decomposed and stabilized may be a health risk to the workers and contaminate the agricultural products. Health risks include infections from roundworm eggs and hepatitis A virus. Health risks can be reduced by composting the septage before applying to the fields.

(2) Negombo[4)]

Negombo septage treatment facility was constructed to avoid environmental problems caused by gully suckers at the existing dump site. The facility, commissioned in 2005, could only operate intermittently for only six months. The treatment process is as the follows:

Grit chamber → 2 collection tanks → 4 anaerobic digestion tanks → 2 aeration tanks → primary and final settling tanks, sludge drying bed, sand filtration, disinfection tank, gas collection equipment.

The collection tank is designed for 40 m^3/day, assuming TSS of sludge is 1,500 mg/L.

The design was changed twice after the facility was constructed because of problems. The primary and final settling tanks were added later.

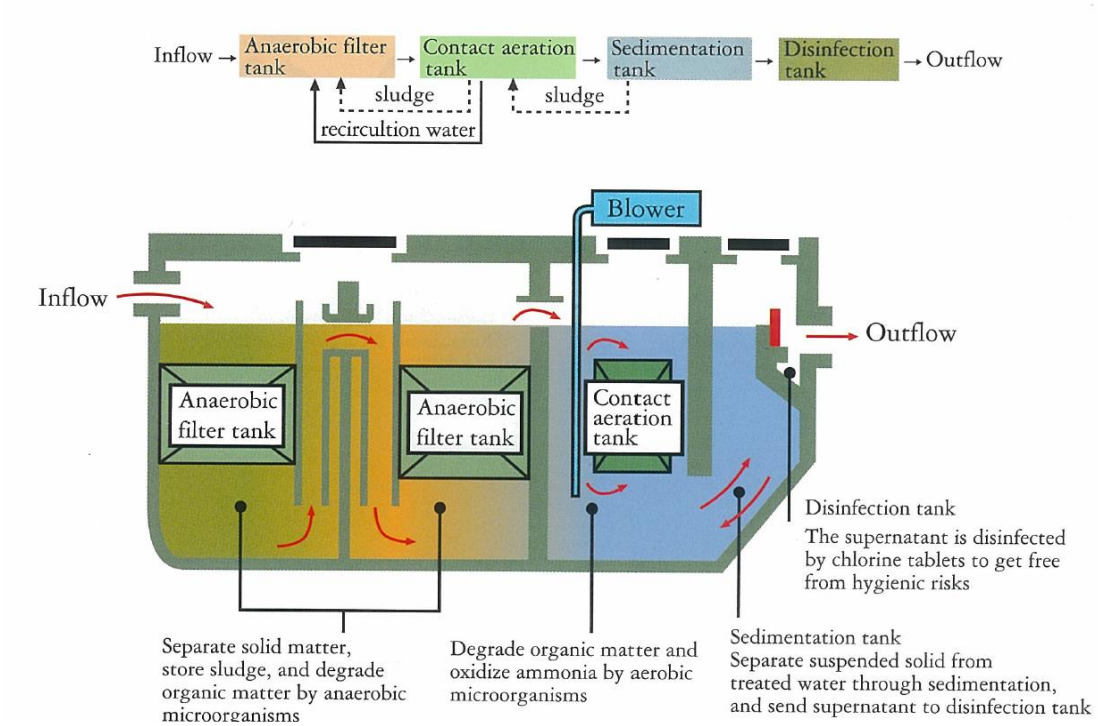
One of the problems was that the grit chamber was filled continuously with solid waste and sand because the solid waste in the septage was much more than expected. There was polyethylene shampoo containers, diapers, sanitary napkins, glass bottles and fish market wastes. The process failed with the accumulation of sediments and scum. The septage concentration was TSS 30,000 mg/L, far exceeding the design value. In addition, there was also clogging of filters and foaming, caused by kerosene dosing during sludge removal.

The pre-treatment, or screening, of collected septage is quite important for the stable operation of septage treatment facilities. Citizens need to be educated on the proper use of septic tanks, and not to throw solid wastes into septic tank.

6.2.7 Other On-Site Treatment Options

In septic tanks, only partial decomposition of organic matters occurs. The anaerobic treatment is not aided by heating or mechanical mixing. Adding aerobic process to the system can achieve much higher removal efficiency of organic matters.

Figure 6.2-3 shows an improved on-site treatment system, using anaerobic bio-filter followed by aeration. Air is supplied by a blower. Electricity cost makes this system more expensive but the treatment can consistently bring the effluent BOD_5 to less than 30 mg/L. The facility made of FRP, can be installed easily and rapidly. The capacity is sufficient for 5 to 5,000 persons, and even as a small-scale sewage treatment facility. The improved on-site system is suitable for environmental sensitive areas or in upstream areas of drinking water source intake points.



Source: Japan Education Center of Environmental Sanitation (JECES)

Figure 6.2-3 Example of Improved On-Site Treatment System

6.2.8 Capital and O&M Cost

(1) Capital and O&M Cost of Septic Tank System

Table 6.2-2 shows the costs of pour-flush toilets connected to a septic tank and soakage pit for 5 people. The costs ranges from 48,000 to 79,000 LKR, with the average cost of 60,920 LKR. These costs are low compared to 270,000 LKR (8-person system) and 480,000 LKR (15-person) listed in the 2015 NWSDB Rate Book.

Table 6.2-2 Cost of Pour-Flush Toilet Connected to Septic Tank and Soakage Pit

Location	Implementing Agency/NGO	Total Cost in LKR	Date
Kilinochi	UNICEF	55,000	Apr.06
Jaffna	UNICEF	79,000	Jun.06
Galle	UNICEF	48,761	Jul.06

Source: JET

Colombo MC provides sludge removal free of charge. In other cities, the fee is usually 2,000 to 4,000 LKR per load depending on the local authority. In Matara UC the cost is 2,400 LKR for 2 m^3 vacuum trucks and 3,200 LKR for 4 m^3 vacuum trucks. In remote places such as Deniyana, the cost is about 26,000 LKR per load. The monthly income of a gully worker is about 14,000 LKR.

Sludge removal is usually carried out at intervals of one year or longer depending on usage. Septic tanks in areas where groundwater level is high, must be emptied more frequently. Facilities in coastal areas affected by tides, such as Chilaw, can filled up in three months[8)]

(2) Capital and O&M Cost of Septage Treatment Facilities

There are many kinds of septage treatment. The most advanced in Sri Lanka is stabilization pond system used in Chilaw and Mannar, described in **Section 6.2.1 - 3**.

The Chilaw septage treatment facility has a capacity of 34 m^3/d. The facility built at a cost of 110 million LKR, was commissioned in May 2015. The construction cost of the 28 m^3/d Mannar facility was 48 million LKR. **Table 6.2-3** shows the construction cost of four septage treatment facilities, with the average cost at 2.29 million LKR/m^3/d.

Table 6.2-3 Construction Cost of Septage Treatment Facilities

Name of plant	Capacity (m^3/d)	Constructoin cost (Million LKR)	Unit Cost (Milliom LKR/m^3/d)
Chilaw	34	110	3.24
Puttlam	39	110	2.82
Mannar	28	48	1.71
Vauniya	28	39	1.39

Source: JET

Table 6.2-4 shows the O&M cost of the Mannar facility, with a capacity of 28m^3/d.

Table 6.2-4 Annual O&M Cost of Mannar Septage Treatment Facility

Cost Component	Cost (LKR Million)
Staff	1.39
Electricity	1.06
Repairs and Maintenance	0.89
Administration/Establishment	0.50
Total	3.84

Source: JET

CHAPTER 7 STRATEGIC SEWERAGE DEVELOPMENT AND IMPROVEMENT PLANS

7.1 STRATEGY TO ACHIEVE NATIONAL TARGET IN SEWERAGE SECTOR

Table 7.1-1 shows the NWSDB and national targets to be achieved by 2020 and 2035. Sewerage development will be implemented in the cities shown in **Table 7.1-2**.

Table 7.1-1 Targets for Sewerage Development

Institution	Target	Target Year	Source
NWSDB	3.3%	2020	Corporate Plan 2016-2020, Ministry of City Planning & Water Supply, NWSDB
Ministry of Finance and Planning	7.0%	2035*	Mahinda Chintana Vision for Future, Department of National Planning, Ministry of Finance and Planning, 2010

Note: * According to the Department of National Planning, Mahinda Chintana Vision targeted a pipe borne sewerage coverage of 7% in the Urban Sector by the year 2020.
Source: JET

It is assumed that 90% of the population receiving water supply service will be connected to a sewerage system. The sewage tariff calculation will use the population forecasts for 2020 (21.2 million) and 2035 (22.6 million). The population of 20.3 million in 2012 (Census and Statistics Department) is used as the base figure. (**APPENDIX 17**)

Table 7.1-2 shows the 15 cities where sewerage systems will be implemented starting with the first 4 cities on the list. By 2020, 3.4% of the population will have sewerage coverage (=731,676/21,200,000*100). When sewerage systems are developed in all 15 cities by 2035, the coverage will reach 7.1% (=1,630,076/22,645,000*100).

Table 7.1-2 Cities Targeted for Implementation of Sewerage Systems

	Local Government Authority	Population (2012)	Water Served Population (2012)	Sewerage Service Population	Cumulative Sewerage Service Population	Served Population based on year 2035, %
1	Colombo MC	561,314	561,314	505,182	505,182	2.2
2	Kandy MC	98,828	96,060	86,454	591,636	2.6
3	Sri Jayawardanapura Kotte MC	107,925	107,925	97,132	688,768	3.0
4	Anuradhapura MC	65,345	47,676	42,908	731,676	3.2
5	Badulla MC	42,237	42,237	38,013	769,689	3.3
6	Kelaniya PS	109,603	109,603	98,642	868,331	3.8
7	Nuwara Eliya MC	23,804	23,804	21,423	889,754	3.9
8	Galle MC	86,333	86,333	77,699	967,453	4.2
9	Dehiwala-Mt. Lavinia MC	184,468	184,468	166,021	1,133,474	5.0
10	Negombo MC	142,449	142,449	128,204	1,261,678	5.5
11	Kotikawatta-Mulleriyawa PS	131,643	131,643	118,478	1,380,156	6.0
12	Rathnapura MC	47,105	36,112	32,500	1,412,656	6.2
13	Hambantota MC	23,236	23,326	20,993	1,433,649	6.3
14	Trincomalee UC	48,351	48,351	43,516	1,477,165	6.5
15	Maharagama UC	196,423	169,902	152,911	1,630,076	7.1
	Total		1,783,049	1,630,076		

Note: It is assumed that sewerage served population in 2035 is 90% of water served population in 2012.
Source: JET

The construction costs of sewerage development are assumed to be USD 2,000 per capita and USD 2,000 per m^3 plant capacity. Based on these assumptions, USD 1,590 million by 2020, and USD 3,850 million by 2035 are required. For Colombo, only the cost of sewage treatment is included in the estimate.

Table 7.1-3 Estimated Cost

	Local Government Authority	Construction Cost, Million USD	Cummulative Construction Cost, Million USD	Calculation	Water Served Population (2012)	Water Consumption (2012), m^3/d
1	Colombo MC	950	950	=2,000*472,086	561,314	472,086
2	Kandy MC	240	1,190	=2,000*96.060*0.9 +2,000*30,443	96,060	30,443
3	Sri Jayawardanapura Kotte MC	270	1,460	=2,000*107,925*0.9 +2,000*35,000	107,925	35,000
4	Anuradhapura MC	130	1,590	=2,000*47,676*0.9 +2,000*20,556	47,676	20,556
5	Badulla MC	100	1,690	=2,000*42,237*0.9 +2,000*9,150	42,237	9,150
6	Kelaniya PS	250	1,940	=2,000*109,603*0.9 +2,000*22,626	109,603	22,626
7	Nuwara Eliya MC	90	2,030	=2,000*23,804*0.9 +2,000*19,400	23,804	19,400
	Galle MC	190	2,220	=2,000*86,333*0.9 +2,000*16,772	86,333	16,772
8	Dehiwala-Mt. Lavinia MC	410	2,630	=2,000*184,468*0.9 +2,000*39,000	184,468	39,000
9	Negombo MC	330	2,960	=2,000*142,449*0.9 +2,000*32,234	142,449	32,234
10	Kotikawatta-Mulleriyawa PS	320	3280	=2,000*131,643*0.9 +2,000*37,326	131,643	37,326
11	Rathnapura MC	80	3,360	=2,000*36,112*0.9 +2,000*7,200	36,112	7,200
12	Hambantota MC	60	3,420	=2,000*23,326*0.9 +2,000*6,972	23,326	6,972
	Trincomalee UC	60	3,480	=2,000*48,351*0.9 +2,000*8,477	48,351	8,477
13	Maharagama UC	370	3,850	=2,000*169,902*0.9 +2,000*20,000	169,902	27,300
	Total	3,850			1,783,049	784,542

Note: It is assumed that sewerage served population in 2035 is 90% of water served population in 2012 and sewage treatment capacity in 2035 is water consumption in 2012.
It is assumed based on existing construction cost that sewer construction cost is 2,000 USD per capita and sewage treatment plant cost is USD 2,000 per capacity.
Source: JET

The challenges in sewerage system development are as follows:

- Securing the budget for construction,
  The annual budget requirement is 202 million USD (=3,850/19). NWSDB receives 202 million USD per year for water supply development. 85% of the budget allocation from the central government to NWSDB should be secured only for sewerage development (government allocation in 2016 was 35 billion LKR which is equivalent to 241 million USD (= $35*10^9/145/10^6$)).
- Securing O&M Staff
  The target of 7.0 % sewerage coverage is three times more than present coverage. More O&M staff will be needed to manage the new sewerage facilities. (**APPENDIX 18**)
- Securing land for sewage treatment plants and pumping stations
  Land requirement depends on the treatment process. In Kandy, the 14,000 m^3/d OD occupies 16,700 m^2. This is equivalent to 1.2 $m^2/m^3/d$. In Soyzapura, the 17,000 m^3/d anaerobic-aerobic process occupies 13,000 m^2 (0.8 $m^2/m^3/d$). Land requirement for pumping stations is estimated to be 0.02 $m^2/m^3/d$ to 0.07 $m^2/m^3/d$ based on pumping stations in Mt. Lavinia [364 m^2, capacity 19,000 m^3/d (=814*24)] and Kandy (1,012 m^2, capacity 14,000 m^3/d).

- Securing the disposal sites for septage and utilization of waste sludge from treatment plants
  Waste sludge produced from sewage treatment will increase as sewerage systems are being developed. Assuming that water content of dewatered sludge is 80%, 706 m^3/d (=(200-20)* 784,542 m^3/d/1,000,000/0.2) is produced by 2035. Composting dewatered sludge can reduce its volume by half to 282 m^3/d (at water content of 50%).
  If all composted sludge is disposed of over 20 years, 21 ha (=282*365*20/10/10,000) is required (assuming height of landfill is 10 m) for the disposal site.
  The composted sludge can be used as fertilizer for coconut, rubber and tea plantations, after confirming that it is free from heavy metals and other contaminants. All the composted sludge produced to 2035, can be used, by applying 0.5 cm on 47.64 million m^2 of plantations once every 2.3 years (= 47.64 million*0.005/282/365). Therefore, it is recommended that sludge should be composted and used as fertilizer.

7.2 CAPACITY DEVELOPMENT IN SEWERAGE DIVISION OF NWSDB

7.2.1 Current Capacity

(1) Implementation Arrangement

The survey found the following areas of concern in the institutional and organizational capacity of NWSDB;

The number of planning and design staff in the sewerage section is quite small compared to that in water supply. When needed, staff from water supply are redeployed to the sewerage section. More staff must be hired in engineering, planning and design, to cope with the increasing number of sewerage projects.

At present, 5 sewerage projects are in the construction phase. As more projects come on stream, staff assigned to the construction section must also be increased. Currently, all project managers report to the DGM (Sewerage). A DGM (Construction) will be needed to manage the increasing number of projects more effectively and efficiently.

As the served area expands and the facilities age, O&M workforce must be augmented to match the increasing workload. Outsourcing to the private sector (supervised by NWSDB) can be more efficient and cost effective. When work is outsourced, engineers in the field can be transferred to the head-office. More maintenance equipment such as gully suckers, jetting machines, health and safety equipment will also be needed.

Many sewerage projects are implemented outside GCS sections in RSCs will have to be established to carry out O&M of the new facilities.

Given the above challenges, 5 options are considered for the implementation of sewerage development as shown in **Table 7.2-1**.

Table 7.2-1 Organizational Options for Implementation of Sewerage Systems

Activity	Option 1	Option 2	Option 3	Option 4	Option 5
Request for introduction of sewerage system	NWSDB	NWSDB	LA	LA	LA
Approval for implementation of sewerage works	MWSD	MWSD	MWSD through MLGPC	MWSD through MLGPC	MWSD through MLGPC
Preparation of budget	MWSD through NWSDB	MWSD through NWSDB	MLGPC through LA	MLGPC through LA	MLGPC through LA
Project Planning i.e. overall planning of the project	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA
Engineering Planning & Design of the project	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C
Construction	Private Contractor	Private Contractor	Private Contractor	Private Contractor	Private Contractor
Construction Supervision	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C	NWSDB and C/C
Ownership of facilities	NWSDB	NWSDB	LA	LA	LA
O & M of the sewerage scheme	NWSDB	Private Operator supervised by NWSDB	NWSDB	Private Operator supervised by LA	LA
Loan Settlement	MWSD through NWSDB	MWSD through NWSDB	MLGPC through LA	MLGPC through LA	MLGPC through LA
Remarks	Sewerage works bolongs to NWSDB sssisted by LA.	Sewerage works bolongs to NWSDB sssisted by LA. Private operaor conduc O&M under supervision of NWSDB	Sewerage and water works belongs to LA like solid waste. NWSDB assists for engineering, construction and O&M phase.	Sewerage and water works belongs to LA like solid waste. NWSDB assists for engineering and construction phase. Private operator conducts O&M under supervision of LA.	Sewerage and water works belongs to LA like solid waste. NWSDB assists for engineering and construction phase.

Notations
1. LA - Local Authority (Municipal Council, Urban Council, Pradeshiya Sabha
2. NWSDB - National Water Supply & Drainage Board
3. MWSD - Ministry of Water Supply & Drainage
4. MLGPC - Ministry of Local Government & Provincial Councils
5. C/C - Appointed Consultants/Contractor

Source: JET

In Options 1 and 2, the sewerage system is owned and managed by NWSDB and in one case the O&M

is outsourced to the private sector.

In Options 3 and 4, the system is owned by MC but the O&M of the STP is outsourced either to NWSDB (Option 3), or to the private sector (Option 4). In Option 5, the system is owned, operated and maintained by MC. Since local authorities do not have the capability to conduct planning, design and supervision of construction, these tasks are entrusted to the NWSDB in all options.

Table 7.2-2 shows the pros and cons of the 5 options and ranks them in terms of suitability, feasibility, and acceptability (SFA).

Table 7.2-2 SFA of 5 Options

	Suitability	Feasibility	Acceptability
Option 1	1. NWSDB is the leading organization/responsible authority in water supply and sewerage sector in the country to implement the Central Government's policy through the M/of CP&WS. 2. NWSDB's vision is "being the leading national organization, to provide and facilitate access to water supply & sanitation facilities for social and economic development" whereas its mission is " to serve the nation by providing safe water and sanitation facilities ensuring affordable tariffs and environmental quality." 3. Association with NWSDB may pave the way to obtain more synergistic benefits etc. as they have similar operations all over the country. 4. NWSDB is the authorized Government Agency under Law No. 2 of 1974 to develop, provide, operate and control an efficient, co-ordinated water supply for public, domestic or industrial purposes as well as to provide sewerage and sanitation services. 5. NWSDB is also mandated by law to take into its possession such services under the control of local authorities either compulsorily or voluntarily.	1. Under the NWSDB, this option will be technically feasible with the expertise know how they possess and the skilled staff they have within the organization. 2. They have all physical infrastructure required in place in their centralized set-up. 3. NWSDB is already managing water supply and sewerage schemes all over the country under their decentralized organization. To cater the requirements of these schemes, they have equipped their organization with centralized facilities at the highest level in addition to the infrastructure facilities made available at regional levels. 4. The following resource based analysis also strengthens this position; • Specialized technical staff including about 300 engineers and skilled grade staff including technicians, plant operators, mechanics etc. • Well-equipped central design office, central laboratory and central workshop etc. • Specialized professional staff strengthening support functions required for success of the core function. 5. This option will also be financially feasible as NWSDB has required finance facilities in place to support any project with any gaps in financing operations until the project generates cash to become self-sufficient.	1. The objective of the key stakeholders is to provide sanitary facilities to the citizens of the area. However at the moment, there are significant gaps between the level of the services offered from local authorities and the expectations of the Community. 2. Especially, the most important and the biggest sewerage scheme Colombo Sewerage Scheme operated by Colombo Municipal Council is not in a position to extend their services to the potential consumers in the municipality city limits. 3. The implementation of new projects, under the NWSDB administration will substantially close the gap indicated above. Therefore this option will be acceptable to the most important stakeholders including Central Government, Provincial Councils, and Community etc. 4. This option will be acceptable to the Provincial Council, as this will ease off their already drained budget.
Option 2	In this Option 2, except the O&M of sewerage schemes, all other activities will remain as in the Option 1. O & M of sewerage schemes is outsourced to private sector in order to reduce the management cost. When NWSDB manages small to medium scale sewerage works, their financial management will be much difficult and economic efficiency has to be pursued. 1. NWSDB is empowered to manage any new sewerage system according to the Law No. 2 of 1974 of the NWSDB Act. Accordingly, to optimize O & M cost, operation and maintenance of sewerage schemes could be outsourced to a private party similar to contracting any other services without any policy intervention. 2. NWSDB has already gained in experience in out-sourcing some services to private operators their operational activities. 3. Caretaker approach adopted in maintaining small water supply schemes in reducing O & M costs is somewhat similar to out-sourcing strategy.	1. Currently, there are some private operators performing operation and maintenance of sewerage schemes in Sri Lanka, especially serving BOI and other private companies. 2. However, when the sewerage projects are implemented nationwide and the number of sewerage schemes are on increase, the slow growth of private sector in the provincial areas may become an issue.	1.This option will be acceptable to the NWSDB, as this will reduce their O & M costs and improve its financial positions. 2. Since NWSDB will be playing the role of a regulator and monitoring the performance of the private operator, the major stakeholder of the sewerage schemes will get a service up to their expectations. Hence, customer will be the ultimate beneficiary.
Option 3	1. This option will provide a solution to the overlapping jurisdiction between the NWSDB and Local Authorities while maintaining the major stakeholder's expectations within the existing legal framework. 2. Local Authority will play the regulatory role while ensuring their obligations to their citizens. 3. NWSDB supports a part of the works which are difficult for LA to implement technically and financially. Only a part of the works which are difficult for LA to implement like planning, designing, construction and O&M are entrusted to NWSDB.	1. This option will make use of NWSDB's strengths in engineering expertise in implementation of sewerage projects and skills in operation and maintenance of sewerage schemes. 2. This will assist Local Authorities to share the NWSDB's resources in providing sewerage facilities to their community and to to reduce the gaps between Local Authority and the community.	1. Among stakeholders of O & M of sewerage schemes, the high powered highly interested stakeholder is the community due to political reasons, and the community expects to have sewerage services at an affordable price. Then efficiency and effectiveness of the services are playing a major role in delivering the services. NWSDB could do a better job than Local Authorities using their resources already available with them. 2. Since the ownership of the sewerage schemes is going to be with the local Authorities, there will not be any objection from them. 3. The major stakeholder could achieve its objectives, if NWSDB is going to handle O & M of sewerage schemes.
Option 4	The ownership of LA is much strengthened in this option and O&M which was proposed to be implemented by NWSDB in the Option 3, is to be implemented by private sector contracted with LA under supervision of LA. In this option, NWSDB is a technical authority conducting planning, designing and construction supervision entrusted from LA. When the capacity of LA is improved in the future, the option might become suitable. 1. This option is in line with the specific objectives of the services to be provided by Local Authorities. 2. Not required to have policy intervention in implementing this option.	1. This option is not going to make use of the full strength of the NWSDB. 2. Whether LAs are equipped with necessary expertise to regulate and monitor private operators in O & M of sewerage schemes are to be of concerned.	1. Level of service of the sewerage services mostly depend on the Local Authority who will be the regulator in this option. Capability and capacity of LAs to perform as a regulator is questionable. Therefore, level of service to the most important major stakeholder may not be up to expectations. 2. Introducing an affordable taiff to high powered and high interested stakeholders may be jeopordized.
Option 5	1. Under the Municipal Council Ordinance and Pradeshiya Sabha Act, local authorities within their administrative limits are responsible for the regulation, control and administration of matters relating to the public health, public utility services (including water supply, sanitation and solid waste) and public thoroughfares and generally with the protection, convenience and welfare of the people. Therefore local authorities are responsible for the welfare of the citizens of their areas. In that context, this option can be considered to be suitable for local authorities. 2. On the other hand, NWSDB is also empowered to manage any new sewerage system according to the Law No. 2 of 1974 of the NWSDB Act. 3. Provision of sewerage services is only one aspect of a number of services that come under local authorities' purview in improving the welfare of the citizens. Except Colombo Municipal Council, other Municipal Councils and Pradeshiya Sabhas never managed a sewerage scheme in the past.	1. The existing staff in the water sections of the Loacal Authorities haven't had any experience in managing a sewerage scheme. It clearly demonstrates that Local Authorities will be required to start from zero whereas NWSDB is already on the job with its resources. The following resource based analysis also highlights these weaknesses and suggests that this may not be technically feasible; • Non-availability of specialized technical staff including engineers and skilled grade staff including technicians, plant operators, mechanics etc. • Non-availability of a well-equipped design office, laboratory and workshop etc. 2. With no proper mechanisms in place their cash generation from the system will be not as good as from NWSDB. 3. Other than Colombo Municipal Council, other local authorities neither have experience nor strong relationships with key stakeholders such as CEA who is a very important stakeholder for this option, when compared with NWSDB. 4. Further, this will not provide any benefits such as synergistic benefits.	1. Local Authorities are going to take a high risk associated with finances in managing these sewerage schemes. It is highly doubtful of their ability to provide a superior quality service compared to what can be offered by NWSDB as resources they possessed is very limited compared to NWSDB. Even though, the necessary infrastructure would be in place, these resources will play a significant difference when it comes to management of schemes. 2. Taking-over of the management of sewerage schemes to local authorities will be a burden on Provincial Councils and it is a clear indicator that this will not be acceptable to Main Stakeholder. 3. Managing of sewerage scheme will not be financially viable with the local authorities at the beginning as sufficient cash will not be generated from its operations to cover the recurring expenses. Then it will be a burden on the local authorities' budgets and in turn will have to be borne by the Province Councils. Even the NWSDB has started billing for sewerage services in the recent past and it is slowly moving forward towards recovering its operation and maintenance cost. They have achieved that progress after investing their resources through awareness campaigns and it is unlikely that Local authorities will be able to do that with the limited resources available.

Option 1 is like existing arrangements, with the exception of the CMC area. As the sewerage coverage expands, more staff will be needed and the cost effectiveness of this mode of operation may be questionable. In Options 4 and 5, the lack of capability of local authorities for implementing sewerage works is of concern except for major MCs.

In Option 2, NWSDB can outsource O&M to the private sector to achieve better economic efficiency. Local authorities are more directly involved in Option 3. Being at the front line of enhancing public health and good community living, understandably they would have the interest to manage water, sewage and solid waste.

Table 7.2-3 shows how the options can be introduced in 2 stages.

At the start, all projects should adopt Option 2 with simple tasks outsourced to the private sector. Later on, small local authorities can extend the outsourcing to all O&M tasks, but retain the supervisory responsibility. When medium size cities improve their capabilities in sewerage system management, they can adopt Option 3. Major cities would have the capability to operate under Option 4 from the start.

Table 7.2-3 Introduction of Implementation Arrangements

Stage	Option 1	Option 2	Option 3	Option 4
Present condition	✔ In the existing schemes			✔ In Kandy
1st Stage		✔ In all sewerage projects Outsource simple O&M works		✔ In major cities
2nd Stage		✔ In small cities Outsource O&M works except supervision	✔ In medium size cities	✔ In major cities

Source: JET

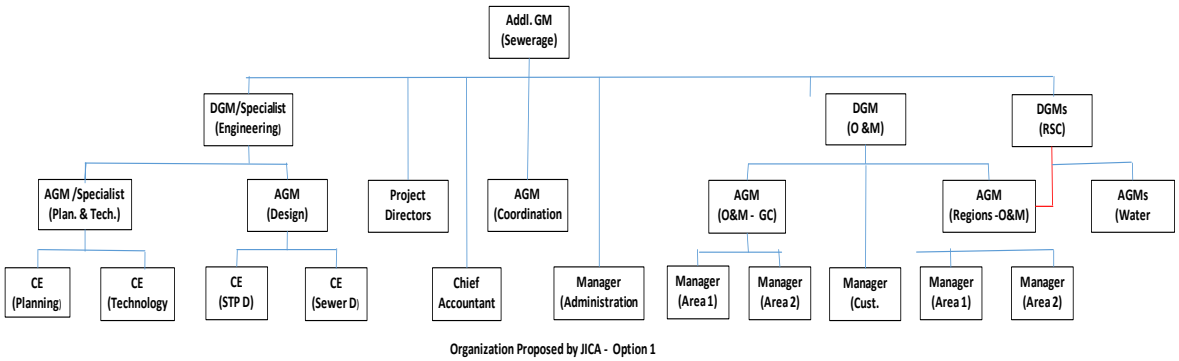
(2) Sewerage Division in NWSDB

The sewerage division is facing the following challenges:

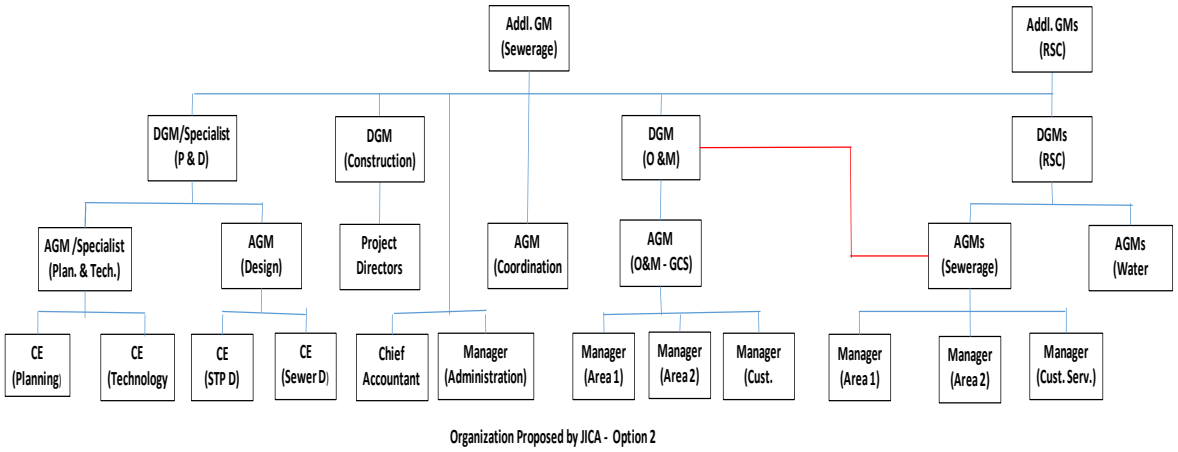
- The DGM (Sewerage) manages all the tasks from planning to O&M. At the moment, 5 project directors (for Kandy, Kurunagara, Kataragama, GCWWP and WB projects) report to the DGM. The number of sewerage project is increasing. Jaffna project is now in the design stage. Galle, Negombo and Kelaniya-Peliyagoda projects are about to start. One DGM alone would not be able to manage such a large number of projects in the prescribed time frame.
- O&M responsibilities will increase with the commissioning of every new STP. As facilities and equipment age, more and more maintenance and repair is expected. The organization must be prepared to consider hiring more staff and/or outsourcing some of the work to the private sector.
- Sewerage coverage will expand to the regional areas. Not all RSCs have the resources to implement sewerage system O&M.

Two adjustments to the sewerage division, shown in (**Figure 7.2-1**), would help the organization cope with the challenges.

Adjustment 1



Adjustment 2



Source: JET

Figure 7.2-1 Proposed Adjustments to Sewerage Division

2 new DGM positions, one for planning and design and another for O&M, should be established to ease the workload of the current single DGM (Sewerage). Sewerage sections should be established in the relevant RSCs. They will have technical guidance from the Addl. GM (Sewerage). This is particularly urgent as sewerage development progresses and facilities begin to operate.

Another useful adjustment is to add a new DGM (Construction) to deal with the increasing number of projects under implementation.

7.2.2 Other Issues

(1) Planning and Design

Currently, there are no mechanical/electrical engineers or engineering assistants in the planning and design section for sewerage. The work is handled by water supply teams. As sewerage projects are being implemented, it is important to have mechanical/electrical engineers and engineering assistants dedicated to this sector.

(2) Operation & Maintenance

1) Outsourcing

NWSDB staff is handling all sewerage tasks from planning to O&M. In future it is more cost effective to outsource the simple sewer network and STP maintenance activities to the private sector

2) Equipment

More equipment will be needed for the new facilities. In addition, as these facilities age, breakdowns will be on the rise, as well as complaints from citizens. It is necessary to ensure that there is adequate equipment for maintenance, such as high pressure washing vehicles, CCTV equipment, health and safety equipment and gully suckers, to cope with the new realities.

3) Preventive Maintenance

As well prepared as one can be for increasing maintenance as facilities age, it is very useful to emphasize preventive maintenance from the start, to conscientiously and consistently keep cost low. Preventive maintenance is more cost effective than corrective maintenance. Budget for human resources and equipment required for preventive maintenance has to be identified every year.

(3) Human Resources

There are many technical training programs for staff in water supply at NWSDB. Training programs exclusively on sewerage systems are not adequate. As the number of staff in this sector increases, the need for training will continue to rise. More training programs on sewerage systems have to be offered not only for NWSDB staff but also for MC and private sector workers. Private sector workers can be charged a fee for the training.

7.3 STRENGTHENING FINANCIAL CONDITION IN SEWERAGE SECTION OF NWSDB

7.3.1 Sewerage tariff Plan

(1) Basic Principle of Sewerage tariff Plan

As explained in **Section 4.5.2,** before 2014, Budget Speech, NWSDB received 100% grant for construction cost for sewerage projects and used its own budget (from sewerage tariff and other revenues) to cover O&M and replacement costs, sewerage tariff By the 2014 Budget Speech, the central government decided that NWSDB would arrange its own financing for sewerage projects. With the change in government, grants for water supply and sewerage projects were re-instated in January 2016. The Treasury will bear 100% of the debt service for the construction of sewerage projects.

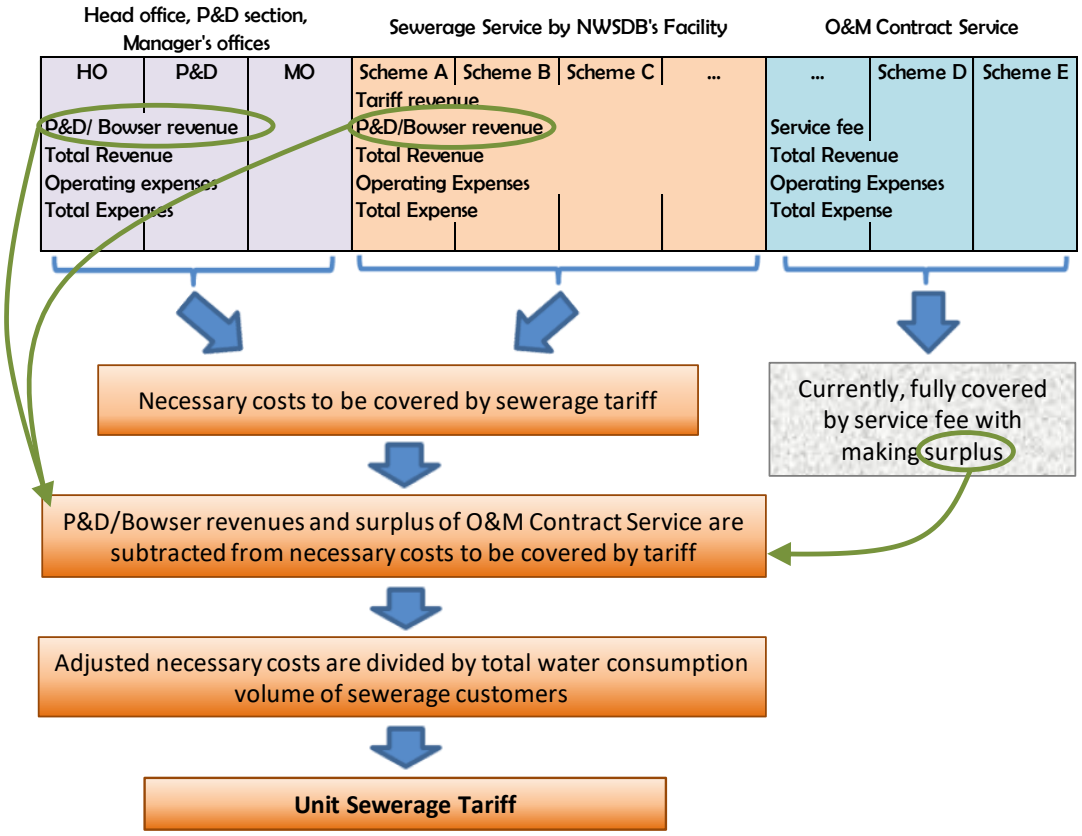
As in most countries including Japan, the sewerage tariff does not cover the full cost of construction, O&M, and future replacement. In many developing countries, such as Malaysia, Thailand and Vietnam, it is difficult for sewerage tariff to cover even just the O&M costs because of the low willingness to pay (WTP). Therefore, for Sri Lanka, it is recommended that:

- central government would cover 100% of the construction cost, as grants to NWSDB.
- O&M costs shall be covered by a sewerage tariff which will be implemented gradually
- small-scale replacements would be covered by NWSDB budget, but large-scale ones would be implemented as projects funded by the central government.

(2) Calculating Sewerage tariff

The sewerage tariff must generate enough income to recover the O&M costs of the sewerage facilities for the future. Methodology of calculation is as follows (refer to **Figure 7.3-1**);

i. Operating revenue, expenses and billed water consumption volume are tabulated and totalled for all sewerage schemes managed by NWSDB's
ii. The expenses for support from head office, planning & design section, manager's offices (branch offices), are added to the total operating expenses. Expenses for these sections are not covered by other revenues and must be covered by the sewerage tariff.
iii. Expenses from O&M contract services are excluded from the calculation because the costs are fully recovered from fees that are not related to water consumption.
iv. Expenses that are recorded under "P&D/Bowser" are excluded from the calculation because the costs are fully recovered from user fees. These amounts are related to consultancy services, septic tank cleaning, and charges for receiving septage at sewerage facilities.
v. Contract services and other services under P&D/Bowser have consistently generated a net revenue surplus. This surplus is used to offset some of the operating costs thereby reducing the sewerage tariff.
vi. The volumetric sewerage tariff is calculated by dividing the operating expenses (less surplus from contract services and P&D/bowser) by the total water consumption volume of the customers located in the sewer service area.



Source: JET

Figure 7.3-1 Calculating Sewerage tariff

(3) Assumptions for Calculating Sewerage tariff

Following assumptions are made in calculating sewerage tariff:

- O&M expense is assumed to remain unchanged for the next fifteen to twenty years. The factors that will reduce the O&M costs are (1) as sewerage coverage expands O&M cost would go down because of the economy of scale; (2) new technologies (for pumps and other equipment) would save energy and reduce electricity cost. These cost reductions would be balanced off by the increase in O&M cost with the lower average population density of served areas when more areas outside of major cities are covered.
- Contract services and P&D/bowser will continue to generate a surplus.
- Customers are charged for connecting to the sewage collection system (as is the present practice). Connection charge can be paid by installment or be included in the monthly charge.
- Costs of gully bowser owned by NWSDB (5 units as of December 2015) are fully covered by service fees (4,000 LKR/service).
- Metered water consumption by consumer class for sewerage customers is currently 51% domestic, 36% commercial, and 13% industrial (**Table 4.5-11**). As the sewerage coverage area expands, the number of domestic consumers will increase and the percentages will change. It is assumed that the percentage of domestic, commercial, and industrial water consumption shall be close to those of water supply in the future.
- Sewerage tariff would cover the sewerage section head office costs for the planning & design, manager's office, even though they not directly serving sewerage customers.
- The surplus (3-year average 2013-2015) from "P&D/Bowser" and contract services, shall be used to offset total operating expenses.
- Sewerage tariff should more than cover O&M costs. Some profit should be made to pay for future replacements, unexpected disasters, or sudden price hikes. Profit is set at 5% of total operating expenses.

(4) Result of Sewerage tariff Calculation

Table 7.3-1 shows the calculation of the net O&M expenses for the last 3 years including head office (HO), planning & design section (P&D), and manager's offices (MO).

Operating expenses have stayed at about the same level. However, when the surplus generated by fees for services (contract services and P&D/Bowser) is subtracted from the operating expenses, quite a bit of fluctuation is indicated. Therefore, for the 2016 estimate, the 3-year average for surplus should be used.

Table 7.3-1 Calculation of Sewerage O&M Expense

Item Description	Unit	Items	2013	2014	2015
Operating Expense	LKR.	Salary	140,822,444	150,290,564	235,483,393
	LKR.	Utility	37,978,502	35,943,949	51,030,301
	LKR.	Chemical	114,130	1,886,416	1,198,744
	LKR.	Connection Material	-	-	-
	LKR.	Maintenance Cost	10,257,630	12,996,351	20,247,304
	LKR.	Establishment cost	13,725,733	13,718,518	17,906,224
	LKR.	Security & Rent	11,893,128	9,975,336	18,999,938
	LKR.	**Total**	214,791,567	224,811,134	344,865,905
less surplus generated by fee for services	LKR.	Contract services	33,431,159	48,017,011	44,192,853
	LKR.	P&D/Bowser	47,034,867	88,196,798	71,567,497
	LKR.	**Total**	80,466,026	136,213,809	115,760,350
Net Operating Expense	LKR.		**134,325,541**	**88,597,325**	**229,105,555**
Water Consumption	m^3		4,260,526	4,825,306	6,193,400
Unit Sewerage Expense (including HO, P&D, MO)	LKR./m^3		50.41	46.59	55.68
Unit Sewerage Expense	LKR./m^3		**31.53**	**18.36**	**36.99**

Note: *; The expenses include income and expenditure of sewerage section (Head office, P&D, GCS) and any sewerage schemes other than contract services. Connection material expense is not included in cost items to be covered by sewerage tariff, as it is covered by connection charge income.
Source: prepared by JET, based on the data from NWSDB

Table 7.3-2 shows the plan for implementing sewerage tariff gradually and the extent to which sewerage O&M expenses are covered by tariff revenue.

In 2015, the Weighted Average Sewerage tariff (WAST) based on current tariffs is calculated to be 28.75 LKR/m^3. This is relatively low (52%) when compared with unit sewerage expense including the expenses of Head Office, P&D, Manager's Offices at 55.68 LKR/m^3. The unit operating expense can be reduced to 36.99 LKR/m^3 if the operating costs are offset by the surplus generated by P&D/Bowser and contract services.

WAST based on current tariffs will decrease slightly over time as the number of domestic sewerage customers is assumed to increase along with sewerage coverage expansion.

Table 7.3-2 Unit Sewerage Expense, Tariff Raise Plan, and Coverage Ratio with the Plan

Year	Unit	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Unit Sewerage Tariff (Current)																	
Share of water consumption volume *1																	
Domestic	%	51.5%	52.5%	53.6%	54.6%	55.6%	56.7%	57.7%	58.7%	59.8%	60.8%	61.8%	62.8%	63.9%	64.9%	65.9%	67.0%
Commercial	%	36.3%	35.6%	34.9%	34.2%	33.5%	32.8%	32.1%	31.4%	30.7%	29.9%	29.2%	28.5%	27.8%	27.1%	26.4%	25.7%
Industrial	%	12.2%	11.9%	11.5%	11.2%	10.9%	10.6%	10.2%	9.9%	9.6%	9.3%	8.9%	8.6%	8.3%	8.0%	7.6%	7.3%
Sub-total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Current unit sewerage tariff																	
Domestic	Rs./m^3	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96	11.96
Commercial	Rs./m^3	40.13	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00	40.00
Industrial	Rs./m^3	65.73	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00	65.00
Weighted Averaged Sewerage Tariff	Rs./m^3	**28.75**	**28.24**	**27.87**	**27.50**	**27.13**	**26.76**	**26.39**	**26.02**	**25.65**	**25.27**	**24.90**	**24.53**	**24.16**	**23.79**	**23.42**	**23.05**
Unit Sewerage Operating Expense per water consumption																	
Sewerage schemes excluding contract service, head office, P&D section, and manager's offices	Rs./m^3	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**	**33.50**
Sewerage schemes including head office, P&D section, and manager's offices, excluding contract service	Rs./m^3	**55.68**	**55.68**														
Adjusted Unit Operating Expense*2 (above expenses minus P&D/Bowser revenues and contract service surplus)	Rs./m^3	**36.99**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**	**37.79**
Necessary Unit Sewerage Tariff to cover Expenses																	
To cover Adjusted Unit Operating Expenses (sewerage schemes excluding contract services including head office, P&D section, manager's offices, minus P&D/Bowser revenue and contract service surplus)	Rs./m^3	36.99	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79	37.79
Tariff Raise Plan and Coverage Ratio																	
Unit sewerage tariff raise ratio (%)*3	%		**0.0%**			**23.5%**			**23.5%**			**5.0%**			**5.0%**		
Raised Unit Sewerage Tariff	Rs./m^3	28.75	28.24	27.87	27.50	33.50	33.05	32.59	39.68	39.11	38.55	39.88	39.29	38.70	40.01	39.38	38.76
Coverage ratio of adjusted operating expenses by sewerage tariff	**%**	**77.7%**	**74.7%**	**73.7%**	**72.8%**	**88.7%**	**87.4%**	**86.2%**	**105.0%**	**103.5%**	**102.0%**	**105.5%**	**104.0%**	**102.4%**	**105.9%**	**104.2%**	**102.6%**

Notes: *1; Share of water consumption volume for sewerage customers of each domestic, commercial, and industry is assumed to be the same as the present share of each domestic, commercial, and industry of entire water supply customers for the year 2050.

*2; Adjusted operating expenses cover O&M costs of all sewerage schemes (other than contract services) and expenses for head office, planning & design, and manager's offices all of sewerage section. Then, subtracted the average P&D/Bowser revenue other than contract services and the average surplus of contract service. Kataragama Scheme and Hanthana Scheme have sewerage customers but they don't record sewerage operating expenses. This is because they have small number of sewerage customers and water supply staff operates and maintains sewerage facilities and records expenses as water supply expenses. Therefore, water consumption volume of sewerage customers does not include the water consumptions of these scehmes.

*:3; Tariff raised ratio is the real term, without including inflation adjustment. Tariff raise ratio is the ratio to be multiplied to the tariff of the previous year.

Source: prepared by JET, based on the data from NWSDB and "Sri Lanka Socio- Economic Data 2015", Central Bank of Sri Lanka, June 2015

Sewerage tariff raises will be implemented incrementally over 3 years. The initial tariff would go up by 23.5% in 2019 and again in 2022 (not factoring in inflation). After the final increment, sewerage tariff will more than cover all the sewerage expenses (105%), i.e. there will be a 5% surplus (**Table 7.3-3**, **Figure 7.3-2**).

Table 7.3-3 Proposed Incremental Implementation of Sewerage tariff

Year	2019	2022
Increment (%)*1	23.5%	23.5%
Sewerage tariff (real term)*2	33.5 LKR/m^3	39.68 LKR/m^3
Expenses covered by tariff	88.7%	105.0%
Target Coverage (example)	85%	100%

Note:
*1; Minor tariff raises will be conducted at 5% in 2025 and in 2028 to recover the reduction of WAST by increasing share of domestic water consumption.
*2; In actual, inflation adjustment is required. Raised unit tariff is average unit sewerage tariff for 3 categories; domestic, commercial, and industry.
Source: prepared by JET

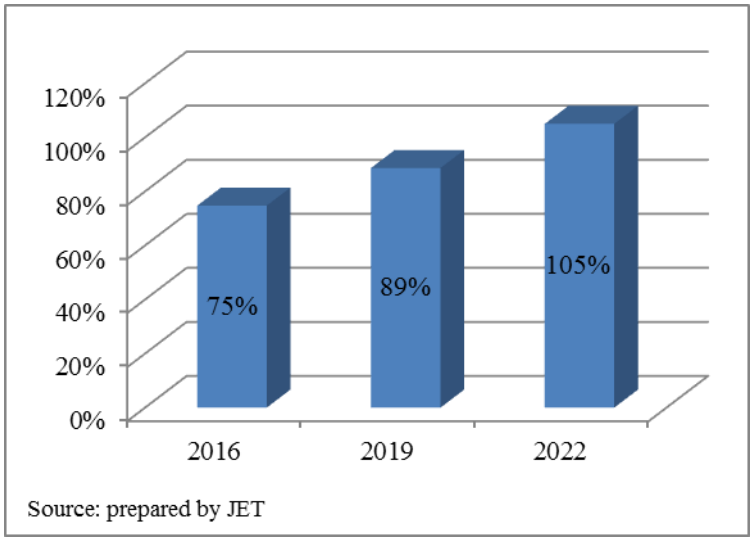


Figure 7.3-2 Net Operating Expenses Covered by Sewerage tariff

(5) Ability To Pay

The WB International Bank for Reconstruction and Development (IBRD) estimates the household ability to pay (ATP) for sewerage services to be 1% of average monthly household income. Figure 7.3-3 shows the monthly domestic sewerage charge proposed in this tariff implementation scheme, falls well below (50-60%) of the ATP for the average household. This indicates that most households would be able to afford the sewage fee.

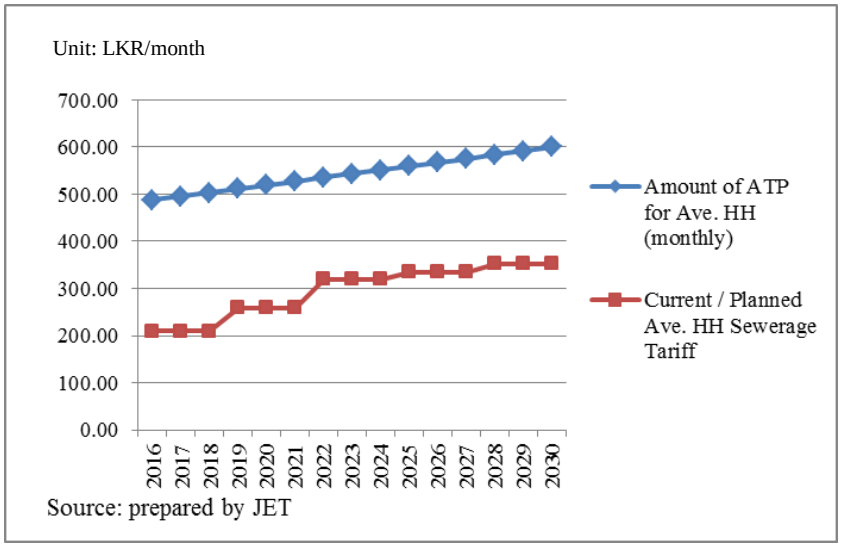


Figure 7.3-3 Proposed Sewerage tariff and Ability to Pay

(6) Example of Revised Sewerage tariff Table

In the above calculation, the proposed sewerage tariff is a weighted average unit price of all customer categories. **Table 7.3-4** and **Table 7.3-5** are examples of sewerage tariff tables, prepared based on water supply tariff. Sewerage tariff will change with the revision of water supply tariff. It is important that water supply and sewerage sections coordinate their tariff revisions to ensure that the sewerage charge remains reasonable vis-à-vis water supply charges.

Table 7.3-4 Example of Revised Sewerage tariff: Domestic (in 2019)

Sewerage tariff: Domestic; 40% of the following water supply tariff

No. of units	Domestic - Samurdhi Recipient		Domestic - Non Samurdhi Tenement Garden		Other than for Samurdhi Recipient and Tenement Garden	
	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)	Usage charge (LKR/Unit)	Monthly Service Charge (LKR)
00 - 05	5	50	8	50	12	50
06 - 10	10	50	11	65	16	65
11 - 15	15	50	20	70	20	70
16 - 20	40	80	40	80	40	80
21 - 25	58	100	58	100	58	100
26 - 30	88	200	88	200	88	200
31 - 40	105	400	105	400	105	400
41 - 50	120	650	120	650	120	650
51 - 75	130	1,000	130	1,000	130	1,000
Over 75	140	1,600	140	1,600	140	1,600

Source: JET

Table 7.3-5 Example of Revised Sewerage tariff: Non-Domestic (in 2019)

Sewerage tariff: Commercial; 50% of the following water supply tariff
Government hospital; 50% of the following water supply tariff
Industries (SME); 120% of the following water supply tariff
Industries (non SME & Govt. Institution); 120% of the following water supply tariff

No. of units	Commercial	Government Hospital	Industries under SME*	Industries other than SME & Government

							Institution	
	Usage charge (LKR/ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR./ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR./ Unit)	Monthly Service Charge (LKR)	Usage charge (LKR./ Unit)	Monthly Service Charge (LKR)
00 - 25	75	290	53	250	56	265	58	275
26 - 50	75	575	53	500	56	525	58	550
51 - 75	75	1,150	53	1,000	56	1,050	58	1,100
76 - 100	75	1,150	53	1,000	56	1,050	58	1,100
101 - 200	75	1,840	53	1,600	56	1,680	58	1,760
201 - 500	75	2,875	53	2,500	56	2,625	58	2,750
501-1,000	75	4,600	53	4,000	56	4,200	58	4,400
1,001-2,000	75	8,625	53	7,500	56	7,875	58	8,250
2,001-4,000	75	14,375	53	12,500	56	13,125	58	13,750
4,001-10,000	75	28,750	53	25,000	56	26,250	58	27,500
10,001-20,000	75	57,500	53	50,000	56	52,500	58	55,000
Over 20,000	75	115,000	53	100,000	56	105,000	58	110,000

Note: *; Small and Medium Enterprises
Source: JET

An Example of revised sewerage tariff table (**Table 7.3-4** and **Table 7.3-5**) is based on the current water supply tariff table. Therefore, it does not happen that sewerage charge becomes higher than water supply charge in any monthly water consumptions. Furthermore, it is easier for the NWSDB commercial staff to calculate the monthly sewerage charge.

7.3.2 Private Sector Financing

Table 7.3-6 shows the types of public private partnership (PPP).

Table 7.3-6 Types of Public Private Partnerships (PPP)

No.	Type	How It Works	Contract Period
1	Outsourcing	Part of tasks is separately outsourced to private entity. (Accounting, IT, meter reading, billing & collection, maintenance of STP, sewer)	2 to 3 years
2	O&M contract	Part of O&M tasks of facilities is outsourced to private entity.	5 to 10 years
3	Lease	Sewerage infrastructures are leased to private entity to be maintained as a whole. Owner responsible for capital investment.	10 to 15 years
4	Concession	Ownership of sewerage infrastructures is transferred to be maintained as a whole. Private entity collects sewerage charge directly and also provides capital investment.	25 to 50 years
5	DBO	Design, construction, and O&M are outsourced to private entity as an all-in contract, to achieve efficiency and to save costs. Public prepares the fund for investment.	2 to 10 years
6	BOT	Private responsible for fund procurement, design, construction, O&M, as an all-in contract. Investment cost is recovered by annual contract fee. The infrastructures are transferred to public after contract period.	15 to 35 years
7	BOO	Private responsible for fund procurement, design, construction, O&M, as an all-in contract. Investment cost is recovered by annual contract fee. Private keeps owning the infrastructures.	Unlimited duration
8	Privatization	The ownership of a sewerage entity (public) as a whole is transferred to private side entirely.	Unlimited duration

Source: Prepared by JET, referring "The New Century of Water Business" by Mr. Yasushi Ujioka, and "Public Private Partnership for Urban Water Utilities: A Review of Experiences in Developing Countries" by WB.

There are several types of PPP for water supply and sewerage utilities. Those with private financing for facility construction are concession, BOT, and BOO.

Regarding the other PPP schemes, public entity responsible for the initial capital investment and no

private finance is provided for the facility expansion. Privatization is a change of ownership from public to private and requires fundamental change of management policy. Therefore, it is excluded from the analysis in this study.

Concession, BOT and BOO will save initial investment costs by the government and should improve management efficiency. A private entity procures the funds for construction through capital investment (such as; joint capital, stock issue), a bank loan or bond issue. If the sewerage development pursues the capital investment route, the dividend pay-out to investors must be high enough to match the investment risks. This can be costly and unprofitable for the project. The market interest rate offered by private banks or corporate bonds is generally higher than that of ODA loans. The interest rate of ODA loans is set at concessional rate rather than to make a profit. ODA loans also set longer repayment and grace periods than that of private sector loans.

Concession, BOT, and BOO can improve management efficiency and save costs. However, they must obtain more surpluses from the project to repay higher interest than that of ODA or government loan and to distribute enough dividends to the investors.

Equity Internal Rate of Return (IRR) is the rate of return for capital investment, which is the annual profit for the project. It indicates the financial feasibility of the privately financed project. Equity IRR is calculated using the following formula:

$$Cap = \sum \frac{Cen}{(1+re)^n}$$

Cap : Amount of investment
Cen : Net profit after tax + depreciation costs – loan principal paid amount, of "n" years later
re : Discount rate of Equity IRR

Equity IRR of a sewerage project must be higher than 15 or 20% to be attractive to investors. This standard of financial viability is much more stringent than that of ODA loans. Then, sewerage tariff must be raised higher than to recover O&M costs, replacement cost, and initial investment costs (loan principal and interest), in order to make enough profit to distribute dividend to investors. Or in otherwise, public entity, for this project, NWSDB or central government, must provide service fee every year to private entity to supplement the shortage of revenue by sewerage tariff, so as to make profit for private.

In the previous section, sewerage tariff raise plan is proposed only to cover the O&M costs of sewerage sector. The present unit sewerage tariff for domestic is still not high enough (11.82 LKR/m^3, Table 4.5-11). In reality, in Sri Lanka, it is possible for sewerage tariff to raise only to cover the O&M costs of sewerage sector. If targeting mainly for domestic customer, the introduction of private financing for sewerage project is still difficult in Sri Lanka. However, targeting mainly for commercial or industrial customer, the introduction of private finance for sewerage project may have the possibility to realize, considering present higher sewerage tariff for them (40 LKR/m^3 for commercial, and 65 LKR/m^3 for industrial customer). The financial viability of privately financed projects must be carefully studied case by case.

The Energy, Transport, and Water department (ETWWA) of the WB, in partnership with the Public-Private Infrastructure Advisory Facility (PPIAF) reviewed the experience of more than 65 large PPP projects for water supply in developing countries. These projects continued 5 years or longer (for management contracts, 3 years or longer) between 1990 and 2007. Some observations from this review include:

"In the 1990s, the main attraction of PPPs in the sector was their supposed ability to supply private finance. Experience has shown that this was largely the wrong focus. The review of the cases that worked shows that the biggest contribution that private operators can make is improving operational efficiency and service quality." (p.7)

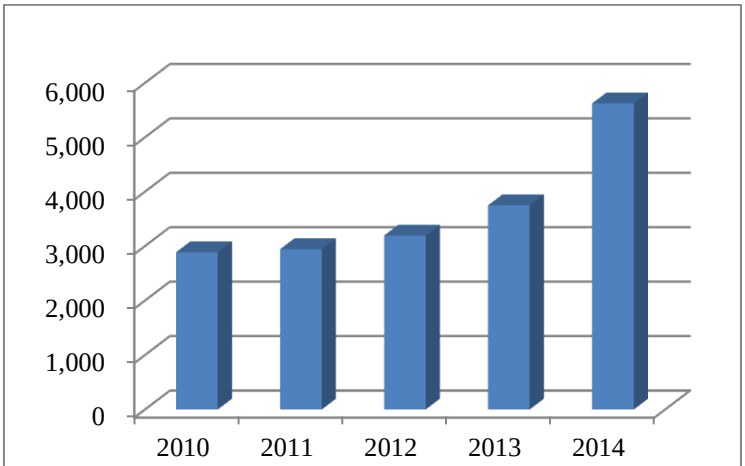
"A large proportion of the PPPs that were awarded during the 1990s, particularly in Latin America, focused on attracting private funding and therefore adopted the concession scheme. The early termination of many of these concessions demonstrated the inherent vulnerability of this approach in the volatile economic environment of developing countries." (p.8)

"The focus of PPP should be on using private operators to improve operational efficiency and quality of service, instead of primarily trying to attract private financing." (p.8)

For considering the introduction of concession to attract private finance for sewerage sector in Sri Lanka, it should be noted that the past experiences in developing countries in water supply sector showed some undesirable results.

7.3.3 Asset Management and Financial Improvement

Figure 7.3-4 shows the changes from 2010 to 2014 in NWSDB inventory levels for water supply and sewerage materials and equipment for replacement and repair of pipes, meters and manholes, etc.



Source: prepared by JET, based on financial statements of NWSDB

Figure 7.3-4 NWSDB Inventory Levels, 2010-2014

The high inventory in recent years reflects the need to maintain a supply of spare parts and materials after a project is completed and facilities are up and running.

Projects funded by different aid agencies may use different suppliers for parts and materials. The cost of stocking non-standardized supplies and building warehouses to store them can be a serious issue.

It is recommended that NWSDB shall keep records of the inventories to control it at head office and utilize them at any places where the spare parts and materials are necessary. Types and specifications of spare parts and materials, equipment had better be standardized to limited sorts.

NWSDB keeps records of its assets and their values, and reports depreciation costs of major facilities

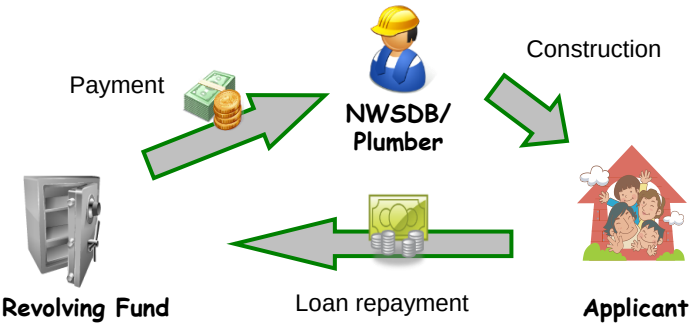
in its financial statements. On the other hand, typical asset management of water and sewerage sectors establishes database of detailed facilities and equipment, pipelines, checks and diagnoses the conditions (e.g., high risk, medium risk, normal, relatively safe, safe) of all these facilities and equipment to prioritize the order of preventive maintenance before breakdown. By this asset management, total future costs to repair the broken facilities, usually generated at one time, would be levelled to some extent for several years, reduce total costs for repair by earlier maintenance, and reduce the life-cycle cost. Furthermore, transparency of investment for rehabilitation or replacement shall be improved and service stability or continuity shall be raised by decreasing the possibility of a sudden stoppage of the system. From the financial view point, reduction of life-cycle cost is highly appreciated. Introduction of asset management requires additional costs such as:

a) personnel to investigate and register the condition of all the facilities including underground old sewers,
b) Costs of PC
c) Database and software with maintenance to establish the asset management database
d) consultant fees to prepare facility maintenance and asset management plan.

It is recommended that NWSDB shall discuss and decide a basic orientation whether to introduce an asset management system or not as it costs much and takes long period for the establishment. For the cost estimation of an establishment of asset management system, it is recommended to ask the specialized consultant team for asset management to do it in detail as it requires the experiences of an establishment of the system and some periods for the study.

7.3.4 House Connection Promotion Measures

In Sri Lanka, low connection rate is one of the serious problems for NWSDB. The home owner must cover the two connection costs. NWSDB installs the connection from the public sewer to the interceptor manhole that must be built. This costs from 60,000 to 100,000 LKR, about 1.3 to 2.2 times of the average monthly household income (45,878 LKR, 2012/2013). If the house has a septic tank, the owner must, at his own expense, install plumbing to take greywater from the shower, toilet, and kitchen to the interceptor manhole. Financial burden is a major obstacle to connecting to the public sewer system. The central government can require residents to connect to the public sewer system and provide subsidies for low income households. Subsidies may not bring in all the residents. It is preferable to establish payment by installment for the connection fees. Installment payment system shall be realized by NWSDB borrowing a certain amount of money from private bank or public lending organization. NWSDB utilizes the fund, called revolving fund, from borrowed money and stimulate to construct the connections to the public sewer for applicants. New customers can pay the connecting fees (plus interest), by installment every month, in addition to the sewerage tariff.



Source: JET

Figure 7.3-5 Revolving Fund System

NWSDB can introduce the payment by installment system on a trial basis, involving a limited number of households. Then depending on the trial outcomes, a decision can be made on whether to roll out a full-scale program. The process for the implementation of payment by installment using revolving fund is shown in **Figure 7.3-6**.

Order	Steps
1	Detailed planning
2	Official decision on revolving fund and public announcement
3	Accepting applications and screening applicants
4	Loan agreement with lending organization
5	Secure enough funds for the number of applications approved
6	Agreement with each applicant
7	House connection construction using borrowed funds
8	Payment by installment from customers and repayment to lending organization

Source: JET

Figure 7.3-6 Implementation of Payment by Installment

7.3.5 Future Tasks regarding Sewerage Finance

Tasks to be accomplished in financing sewerage developments in Sri Lanka are:

- decide and implement a sewerage tariff revision proposed in 7.3.1 Sewerage tariff Plan,
- consider carefully and study in detail the introduction of private financing in sewerage facility construction, since sewerage service is not a profitable business,
- establish separate accounting systems for water supply and sewerage in NWSDB; or prepare the segment information for water supply and sewerage, with detailed income and expenditure reports for both,
- improve inventory control and decide on whether to introduce asset management,
- implement payment by instalment for connection charges, using a revolving fund, on a trial basis,
- approve how sewerage projects would be funded as proposed by this survey: construction of sewerage facilities to be covered by central government (current status), O&M costs to be covered by sewerage tariff revenue, large-scale replacement cost to be covered by central government, small-scale replacement from tariff revenue.

7.4 IMPROVING ON-SITE SEWAGE TREATMENT

7.4.1 Costs for Improvements

Based on the Millennium Development Goals, all septic tanks meeting Sri Lanka Standards (SLSs) shall be installed to achieve the target by 2020, and all septage sludge shall be treated in septage treatment plants by 2035 (**Table 7.4-1**).

Table 7.4-1 Target for On-site Sewage Treatment

Target	Target Year
100 % septic tanks meeting SLSss is installed.	2020
100 % septage sludge is treated in Septatge Treatment Plant.	2035

Source: JET

The costs to achieve the above targets are presented in **Table 7.4-2**, with details in **APPENDIX 14**.

Table 7.4-2 Funding Required to Achieve On-site Sewage Treatment Targets

Target	Cost by 2035	Annual Cost
100 % septic tanks meeting Sri Lanka Standards is installed by 2020.	45,738 million LKR	2,407 million LKR/year (=45,738/12)
100 % septage sludge is treated in Septatge Treatment Plant by 2035.	74,590 million LKR	3,925 million LKR/year (=74,590/12)
100 % septage sludge is treated in Septatge Treatment Plant by 2035 with co-sludge treatment in Sewage Treatment Plant.	73,960 million LKR	3,892 million LKR/year (=73,960/12)
For 74 cities, 100 % septage sludge is treated in Septatge Treatment Plant by 2035.	13,490 million LKR	710 million LKR/year (=13,490/12)
For 74 Cities, 100 % septage sludge is treated in Septatge Treatment Plant by 2035 with co-sludge treatment in Sewage Treatment Plant.	12,340 million LKR	64 million LKR/year (=12,340/12)

Source: JET

The cost of a septic tank meeting SLSss is 45,738 million LKR. The cost of septage treatment plant is 74,590 million LKR for the entire country and 13,490 million LKR for 74 local government authorities. If septage can be treated in sewage treatment plants, septage treatment plant cost would be reduced to 73,960 million LKR for the entire country and 12,340 million LKR for 74 local government authorities.

7.4.2 Improving On-Site System

(1) Approval and installation of septic tanks

Septic tank installation requires approval by local authority. Careful examination of each application and meticulous site inspection is necessary to prevent improper installation. Officials must possess adequate expertise in septic tank systems and wastewater management, if not, training programs must be launched to build the required capability.

In addition, the establishment of a "Septic Tank Association" would help promote proper septic tank installation and use. The association, composed of septic tank manufacturers and installers and related businesses, could conduct voluntary training, standardization of septic tank products, and public outreach.

(2) Proper usage

1) Educating users

Not all solid wastes should be thrown into septic tanks, hence the saying “do not put anything in the toilet unless you have eaten it first (with exception of toilet paper)!” Inappropriate solid wastes not only increase septage volume but can also damage the treatment facility. Putting large quantities of oils or grease will have negative effects on performance. It is essential to educate homeowners about the proper use of septic tanks. The “Handbook for Water Consumers”[7-1)] is an easy to understand educational tool. Education of children is very effective as well. They bring the knowledge home and are usually very energetic in making sure that their parents are doing the right thing.

2) Training in septage collection

As more on-site facilities are installed, more private companies are carrying out septage removal. The training of workers on the proper procedures is very importance; for example, how much kerosene oil to use for odour control during sludge removal, and to leave 100-200 L of septage, containing methane

fermentation bacteria, as seed sludge[7-3)]. It is necessary to introduce qualification or licensing examination for these workers to ensure proper septage management.

(3) Budget for construction of septage treatment plants, annual 27million USD (3.9 billion LKR/year) (APPENDIX 14)

10% of the budget for Ministry of Local Government should be reserved for the construction of septage treatment plants. (Ministry of Provincial Councils and Local Government in 2016 is 279 Billion LKR which equivalent to 1.9 billion USD (= 279*109/145/106).

(4) Securing O & M Staff and gully suckers

Local government authorities rely on NWSDB for septage treatment and sludge removal. 810 gully suckers working everyday are estimated to be required for 74 cities (**Table 7.4-3**). Some of this work can be outsourced to private companies.

(5) Septage treatment at STPs

Treating septage in STPs saves construction costs for septage treatment plants. STPs can treat septage up to about 2% of inflow sewage volume. At this rate, in 2035, all septage produced in cities with sewerage systems can be treated in STPs (**Table 7.4-3**). For example, in 2035, if 10% of the population (56,131 people) in Colombo who does not use sewerage system, produces 62 m^3 of septage per day, this volume of septage can be treated at the 9,000 m^3/d capacity STP, without exceeding the 2% limit.

Table 7.4-3 Septage Volume, No. of Gully Suckers and Volume Acceptable at STP

Sl No	Local Government Authority	Water Consumption【Domestic+ Commercial+ Industrial】	Water Served Population	Population【2012】	Population【2035】	Individual Treatment Population	Septage Volume	No of Gully Sucker, 5m3	STP Acceptable Volume
		①	②	③	④	⑤=④-②×0.9 ⑤=④	⑥=⑤×0.4/365	⑦=⑥/5	⑧=①×0.02
		【m^3/day】	【pers.】	【pers.】	【pers.】	【pers.】	【m^3/d】	【No】	【m^3/d】
1	Colombo M.C	472,086	561,314	561,314	561,314	56,131	62	13	9,442
2	Kandy M.C	30,443	96,060	98,828	98,828	12,374	14	3	609
3	Sri Jayawardanapura Kotte M.C	35,000	107,925	107,925	107,925	10,793	12	3	700
4	Anuradhapura M.C	20,556	47,676	50,595	50,595	7,687	8	2	411
5	Badulla M.C	9,150	42,237	42,498	43,798	5,785	6	2	183
6	Kelaniya P.S	22,626	109,603	110,751	116,844	18,202	20	4	453
7	Nuwara Eliya M.C	19,400	23,804	23,804	23,804	2,380	3	1	388
8	Galle M.C	16,772	86,333	86,333	86,333	8,633	9	2	335
9	Dehiwala - Mount Lavinia M.C	39,000	184,468	184,468	184,468	18,447	20	5	780
10	Negombo M.C	32,234	142,449	147,484	176,349	48,144	53	11	645
11	Kotikawatta - Mulleriyawa P.S	37,326	131,643	137,789	171,137	52,658	58	12	747
12	Ratnapura M.C	7,200	36,112	47,308	48,350	15,849	17	4	144
13	Hambantota M.C	6,972	23,326	24,039	30,210	9,217	10	3	139
14	Trincomalee U.C	8,477	48,351	48,351	48,351	48,351	53	11	170
15	Maharagama U.C	27,300	169,902	198,751	210,172	57,260	63	13	546
16	Chilaw U.C	3,360	20,197	21,441	21,441	3,264	4	1	
17	Puttalam U.C	6,500	30,678	46,339	50,637	50,637	55	12	
18	Matara M.C	20,475	74,193	36,550	37,049	37,049	41	9	
19	Hatton - Dik Oya U.C	2,262	12,184	14,659	15,000	15,000	16	4	
20	Peliyagoda U.C	5,778	27,736	27,736	27,736	27,736	30	7	
21	Boralesgamuwa U.C	9,560	58,784	60,889	64,727	64,727	71	15	
22	Kolonnawa U.C	61,628	60,044	60,802	64,529	64,529	71	15	
23	Beruwala U.C	25,808	37,793	39,137	48,794	48,794	53	11	
24	Biyagama P.S	29,705	186,585	192,678	227,314	227,314	249	50	
25	Panadura U.C	9,175	30,069	30,069	30,069	30,069	33	7	
26	Dambulla M.C	4,000	23,814	24,917	32,212	32,212	35	8	
27	Kalutara U.C	20,973	32,417	32,417	32,417	32,417	36	8	
28	Kattankudy U.C	3,200	23,000	40,847	43,574	43,574	48	10	
29	Kegalle U.C	15,000	11,187	15,993	15,993	15,993	18	4	
30	Balangoda U.C	4,744	16,510	17,679	25,034	25,034	27	6	
31	Weligama U.C	5,832	22,377	22,541	23,473	23,473	26	6	
32	Batticaloa M.C	23,594	21,051	86,227	86,227	86,227	94	19	
33	Moratuwa M.C	23,626	168,280	168,280	168,280	168,280	184	37	
34	Tangalle U.C	5,932	8,473	8,473	8,473	8,473	9	2	
35	Wattala Mabola U.C	4,000	26,136	28,031	28,031	28,031	31	7	
36	Kesbewa U.C	21,757	167,365	192,265	230,132	230,132	252	51	
37	Kinniya U.C	18,000	36,772	37,442	41,233	41,233	45	10	
38	Ampara U.C	6,660	22,511	23,614	29,930	29,930	33	7	
39	Kadugannawa U.C	2,435	12,654	12,850	13,948	13,948	15	4	
40	Kaduwela M.C	55,000	124,367	261,617	312,293	312,293	342	69	
41	Matale M.C	8,948	36,462	36,550	37,049	37,049	41	9	
42	Thamankaduwa P.S	25,929	27,444	84,460	96,388	96,388	106	22	
43	Bandarawela M.C	2,812	20,250	24,366	25,360	25,360	28	6	
44	Ja - Ela U.C	8,924	31,232	31,330	31,839	31,839	35	7	
45	Horana U.C	4,845	5,661	9,665	10,420	10,420	11	3	
46	Jaffna M.C	2,798	19,503	82,083	90,957	90,957	100	20	
47	Ambalangoda U.C	4,300	19,990	20,069	20,496	20,496	22	5	
48	Mannar U.C	6,500	17,928	24,564	25,565	25,565	28	6	
49	Hikkaduwa U.C	9,840	27,075	27,075	27,075	27,075	30	6	
50	Katana P.S	6,274	26,460	176,891	192,173	192,173	211	43	
51	Embilipitiya U.C	7,200	26,843	151,305	172,520	172,520	189	38	
52	Minuwangoda U.C	1,368	7,523	7,523	7,523	7,523	8	2	
53	Seethawakapura U.C	8,050	25,187	32,441	44,824	44,824	49	10	
54	Katunayake Seeduwa U.C	6,800	12,650	60,915	60,915	60,915	67	14	
55	Kurunegala M.C	4,500	7,600	24,833	24,833	24,833	27	6	
56	Gampaha M.C	7,000	20,038	63,835	72,140	72,140	79	16	
57	Talawakele - Lindula U.C	710	4,691	4,966	6,446	6,446	7	2	
58	Akurana P.S	5,550	27,081	65,290	76,358	76,358	84	17	
59	Akkaraipattu M.C	6,691	13,882	31,807	36,509	36,509	40	9	
60	Haputhale U.C	450	2,475	5,331	5,549	5,549	6	2	
61	Nawalapitiya U.C	2,333	4,200	13,338	13,338	13,338	15	3	
62	Point Pedro U.C	458	3,375	12,504	13,698	13,698	15	4	
63	Kuliyapitiya U.C	1,350	1,920	5,509	5,509	5,509	6	2	
64	Gampola U.C	7,563	23,154	38,459	41,745	41,745	46	10	
65	Moneragala P.S	3,900	20,583	51,297	61,911	61,911	68	14	
66	Wattegama U.C	3,000	6,270	8,248	8,750	8,750	10	2	
67	Karachchi P.S	-	-	62,236	66,413	66,413	73	15	
68	Mahara P.S	18,948	121,500	215,079	256,875	256,875	282	57	
69	Eravur U.C	1,188	4,590	24,900	26,322	26,322	29	6	
70	Vavuniya U.C	880	6,026	36,598	47,804	47,804	52	11	
71	Valvettithurai U.C	2,756	954	8,490	10,005	10,005	11	3	
72	Chavakachcheri U.C	1,924	725	16,533	19,495	19,495	21	5	
73	Kalmunai M.C	6,757	22,942	101,053	106,995	106,995	117	24	
74	Maritimepattu P.S	-	-	29,334	31,339	31,339	34	7	
Total						3,807,417	4,173	874	
Total (except for top 15 Cities)						3,541,117	3,881	809	

Note: It is assumed that septage sludge production is 0.4m3/capita/year.
Source: JET

7.5 IMPROVING INDUSTRIAL WASTEWATER MANAGEMENT

Environmental Protection License (EPL for carrying out business operations. At present, most are unable to comply with wastewater disposal regulations due to lack of appropriate disposal environment. It is a problem to find water bodies having adequate dilution or assimilation capacity for discharging treated wastewater[7-3)].

Some of the problems for water environment management in Sri Lanka are as follows[7-4)]:

- lack of affordable pollution control technologies for small and medium size enterprises.
- poor regulatory enforcement and compliance monitoring.
- lack of awareness for environment concerns among industries, hence failures in self-reporting. inadequate law enforcement by local government authorities, no proper zoning plans at all levels of government.
- lack of systematic data collection and analysis of issues such as quality and availability with respect to access.
- poor inter-agency coordination.
- lack capacity building programs.

The plan for Management of Environmental Sensitive Areas is presented in **APPENDIX 19**.

7.5.1 Specific Challenges

(1) Capacity building in CEA

Development of water environment standards and monitoring capacity building are currently carried out mainly by CEA with technical support from JICA. Establishment of rules and penalties for water environment has just started. The development of a comprehensive legal framework will take a long time. EPL has been developed for wastewater control and wastewater regulations are implemented for industrial complexes developed by the government. These efforts have not been extended to industrial complexes developed by municipalities and factories of small and medium-sized enterprises. Strengthening CEA operation with capacity building will be needed so that it can fully fulfil its mandate.

Examples of capacity building for EPL:

- systematic and automatic data collection and establishment of a monitoring system using the latest ICT
- establishment of a training plan and building compliance monitoring capacity
- strengthening collaboration with relevant organizations

(2) Awareness building for companies discharging wastewater

The management of the company must be aware of the rules and regulations on discharging wastewater, so that they can comply with them effectively.

(3) Support for small and medium-sized enterprises

It is difficult for small and medium-sized enterprises to have appropriate sewage facilities due to the lack of funds. Therefore, a support framework for the introduction of such facilities is required. They need simple and inexpensive treatment systems. If land is available, a settling reservoir is not expensive and easy to implement. If land is limited, the adoption of small facilities for advanced treatment may

need some financial support.

7.6 IMPROVING WATER QUALITY IN SURFACE WATER BODIES

Sewerage system development is estimated to reduce the pollution load in 79 cities by about 40%. If BOD of a river in a city is 10 mg/L, it will be improved to about 3 mg/L. (See **APPENDIX 20**)

Water quality improvement is important to public health. The WHO report (Water, sanitation and hygiene in health care facilities, Status in low-and middle-income countries and way forward, WASH in Health Care Facilities for better Health Care Services, WHO, UNICEF 2015) says, "The health consequences of poor water, sanitation and hygiene services are enormous. I can think of no other environmental determinant that causes such profound, debilitating, and dehumanizing misery…. Speaking as a health professional, I am deeply concerned that many health care facilities still lack access to even basic water, sanitation, and hand-washing facilities, and I have committed WHO to support partners to overcome this problem." [7-5)]

In "Water, Sanitation & Hygiene, December 2003", the WB says, "Water supply, sanitation and health are closely related. Poor hygiene, inadequate quantities and quality of drinking water, and lack of sanitation facilities cause millions of the world's poorest people to die from preventable diseases each year. Women and children are the main victims.[7-6)]"

Wastewater treatment reduces pollution, preserves water quality and contributes to improvement of health and sanitation for the residents.

7.6.1 Compliance and Enforcement of Effluent Disposal Standards

Effluent disposal standards play a key role in controlling pollution discharges. Strict regulations of wastewater disposal limit conventional water pollution problems. There are two discharge standards and periodic monitoring is required to ensure compliance to these standards.

- wastewater discharge standards in "Gazette Extraordinary No. 1534/18 of 01 February, 2008" (under revision).
- Sri Lankan wastewater standard 722, which regulates allowable values for inland surface water used as raw water for public water services. (See **APPENDIX 10**)

7.6.2 Water Quality Monitoring

Regular monitoring of source water quality is carried-out by NWSDB in water bodies where WTP intakes are located. In addition, CEA conducts water quality monitoring on several water bodies. Monitoring of water quality is also carried-out in selected sites in Kelani river by NWSDB and CEA. CEA regulates and monitors industrial and other hazardous wastewater discharges to water bodies.

CEA developed a Water Quality Index (WQI). The WQI indicates the status and trend of water quality in water bodies. Regular comprehensive water quality monitoring is important for the improvement of water quality:

- monitoring data can be analysed to detect changes in water quality over time.
- track pollution events and determine source of pollution so that corrective action can be taken.
- sound basis for designing pollution prevention and management strategies.

APPENDICES

APPENDICES

APPENDIX 1 Salaries and Benefits

Table A shows the salaries and benefits of engineer, supervisor, skilled labourer and un-skilled labourer positions in the NWSDB and similar positions of a private company in the sewerage sector business. The salaries and benefits of NWSDB is much higher than those of similar positions in the private company at every level. Therefore, out-sourcing some O & M activities to the private sector will be more economical to the NWSDB while keeping the few higher level positions with experience and expertise in the sewerage sector for supervision and regulatory measures.

Table A Comparison of Salaries and Benefits Between NWSDB and Private Sector

Grade		Staff of NWSDB		Staff of a private sector	
		Salary (SLR)	Benefits (in SLR)	Salary (SLR)	Benefits in (SLR)
1	Engineer	125,000	39,500	105,000	21,000
2	Supervisor	75,000	30,500	37,500	6,000
3	Skilled Laborer	50,000	28,500	27,500	8,000
4	Un-skilled Laborer	40,000	28,000	19,000	5,000

Source: JET Team

(1) Promotion System

Table B shows the promotion scheme available for employees at each grade of the NWSDB. This scheme indicates any one can get promoted to a higher level grade after being in the current grade after a certain period of time and it is effective to keep the employees motivated.

When the STPs and sewer system starts deteriorating due to ageing, O&M of them becomes difficult gradually and then the experiences and knowledge of O&M staff will be required. Then, securing of excellent staff with sufficient experience will become quite important for NWSDB. Solid promotion system as well as high salary and benefits will be indispensable for keep those staff in NWSDB.

Table B Promotion Scheme of the NWSDB

1. Engineer Level		
Position	NWSDB Grade	Promotion Scheme
Engineer	6	BSc.Degree in Engineering or equivalent
Senior Engineer	5	Chartered Engineer with 5 years experience in the NWSDB
Chief Engineer	4	Chartered Engineer with 8 years experience in the NWSDB
Assistant general Manager	3	Chartered Engineer with 3 years experience as a Chief Engineer in the NWSDB
Deputy General Manager	2	Chartered Engineer with 4 years experience as an Assistant General Manager in the NWSDB
Additional General Manager	1A	Chartered Engineer with 3 years experience as a Deputy General Manager in the NWSDB
General Manager	1	Chartered Engineer with 15 years experience as an Engineer and 1 year as Addl. GM in the NWSDB
2. Supervisory Level		
Position	NWSDB Grade	Promotion Scheme
Engineering Assistant Class Ⅲ	10	NDT/HNDE/NDES/Diploma in Technology of Open University or equivalent
Engineering Assistant Class Ⅱ	9	Above qualifications and 2 years experience as an Engineering Assistant in ClassⅢ
Engineering Assistant Class Ⅰ	8	Above qualifications and 2 years experience as an Engineering Assistant in ClassⅡ

Engineering Assistant - Sp. Class	7	Above qualifications and 12 years experience as an Engineering Assistant out of which 3 years experience
Senior Eng. Assistant - Supra	6	
3. Skilled Labor Level		
Position	NWSDB Grade	Promotion Scheme
Skilled Labor - Class Ⅱ	13	GCE(O.L) in 6 subjects with Sinhala/Tamil and Math within 2 sittings and a pass in a trade test conducted by NWSDB
Skilled Labor - Class Ⅰ	12	Trade Apprenticeship of NAB or 3 years experience in Class Ⅱ and a pass in a trade test conducted by NWSDB
Skilled Labor Special Class Ⅱ	11	5 Years experience in Class Ⅰ and a pass in a trade test conducted by NWSDB
Skilled Labor Special Class Ⅰ	10	7 Years experience in Special Class Ⅱ and a pass in a trade test conducted by NWSDB
4. Un-skilled Labor Level		
Position	NWSDB Grade	Promotion Scheme
Un-skilled Labor – Class Ⅲ	15	5th Standard education and should be physically and mentally fit
General Labor	14	Above qualifications and 5 years in Labor – Class Ⅲ or GCE(O.L.) in 6 subjects with 1 year in Class Ⅲ

Source: NWSDB

(2) Securing of Human Resources

Besides 13 national universities, mostly with faculties of civil, mechanical, electrical, chemistry and environment which are necessary to gain knowledge in sewerage works, there are 8 technical colleges/high-schools as shown in **Table C**, and many graduates are passed-out from these universities, collages and high-schools every year. Therefore, it may not be difficult to secure the technical staff required for sewerage works in the near future.

Table C Faculties in the National Universities and Colleges/Technical High Schools

University	Civil Works	Electrical	Mechanical	Chemistry	Environment
Colombo				✓	
Peradeniya	✓	✓	✓	✓	
Sri Jayewardenepura				✓	
Kelaniya				✓	
Moratuwa	✓	✓	✓	✓	
Jaffna	✓	✓	✓	✓	
Ruhuna	✓	✓	✓	✓	✓
Open University	✓	✓	✓	✓	✓
Eastern				✓	
South Eastern	✓	✓	✓		
Rajarata				✓	✓
Sabaragamuwa					
Wayamba		✓			
Uva Wellassa					
Visual & Performing Arts					
Collage/High school	Civil Works	Electrical	Mechanical	Chemistry	Environment
Construction Industry Development Authority	✓	✓	✓		
Ceylon-German Technical Training Institute		✓	✓		
National Apprentice & Industrial Training Authority	✓	✓	✓		
National Vocational Training Authority	✓	✓	✓		

Industrial Technical Institute				✓	✓
National Building Research Organization	✓				✓
Institute of Chemistry				✓	✓

Source: JET Team

APPENDIX 2 Sewerage tariff Revision Proposal: NWSDB

Tariff Structure Proposed for Sewerage

		Consumption Slabs	
			2015
Domestic Tariff (Slab Wise)	Unit rate (Rs.)	0 - 10	20
		1 - 15	20
		1 - 20	20
		1 - 25	20
		1 - 30	20
		1 - 40	20
		1 - 50	30
		> 50	30
	Fixed charge (Rs.)	0 - 10	300
		1 - 15	300
		1 - 20	300
		1 - 25	300
		1 - 30	300
		1 - 40	300
		1 - 50	300
		> 50	300
Commercial Tariff			2015
	Unit rate (Rs.)	> 0	65
	Fixed charge (Rs.)	> 0	2000
Industrial Tariff	Unit rate (Rs.)	> 0	65
	Fixed charge (Rs.)	> 0	4000

Note: Samurdhi Recipients would be charged 50% domestic tariff

Source: NWSDB

APPENDIX 3 Gazette (The Prescribed Activities for which a License is Required)

No. 1533/16 - FRIDAY, JANUARY 25, 2008

The Gazette of the Democratic Socialist Republic of Sri Lanka

EXTRA ORDINARY
(Published by Authority)

PART I: SECTION (I) — GENERAL

Government Notifications

THE NATIONAL ENVIRONMENTAL ACT, No. 47 of 1980

Order under Section 23A

BY virtue of the powers vested in me by section 23A of the National Environmental Act, No. 47 of 1980 as amended by Act, Nos. 56 of 1988 and 53 of 2000. I, Patali Champika Ranawaka, Minister of Environment and Natural Resources, do by this Order, determine the activities set out in the Schedule hereto as activities for which a License is required under the aforesaid section being activities which involves or results in discharging, depositing or emitting waste into the environment causing pollution.

Colombo,
14th January, 2008.

PATALI CHAMPIKA RANAWAKA,
Minister of Environment and Natural Resources.

THE SCHEDULE

THE PRESCRIBED ACTIVITIES FOR WHICH A LICENSE IS REQUIRED

PART A

1. Chemicals manufacturing or formulating or repacking industries.
2. Soaps, detergents, softener or any other cleansing preparations manufacturing industries having a production capacity of 1,000 kilograms per day or more.
3. Bulk petroleum liquid or liquefied petroleum gas storage or filling facilities having a total capacity of 150 or more metric tons excluding vehicle fuel filling stations.
4. Industries involved in the use of fibreglass as a raw material where 10 or more workers are employed.
5. Synthetic rubber, natural rubber manufacturing or processing or rubber based industries excluding industries which manufacture less than 100 kilograms of ribbed smoke rubber sheets per day.
6. Activated carbon or carbon black manufacturing industries or charcoal manufacturing industries having a production capacity one or more metric ton per batch.
7. Industries involved in manufacturing extracting or formulating Ayurvedic, Indigenous medicinal products where 25 or more workers are employed.
8. Chemical fertilizer manufacturing, formulating, processing or repacking Industries.
9. Pesticides, insecticides, fungicides and herbicides manufacturing, formulating or repacking industries.
10. Oil (mineral oil or petroleum) refineries.
11. Dye and dye intermediate manufacturing or formulating industries.
12. Paints (emulsion or enamel), inks, pigments, varnish, polish manufacturing or formulating industries.
13. Petrochemical (basic or intermediates) manufacturing or formulating industries.
14. Industrial gas manufacturing, processing or refilling industries.
15. Asphalt processing plants.

16. Industries involved in the manufacture of polymers or polymer based products (i.e. polyethylene, polyvinyl chloride (PVC), polyurethane, polypropylene, polyester, nylon, polystyrene, resins, fibreglass or other manmade fibres etc.) or polymer or polymer based products, recycling industries.
17. All types of tyres, tubes manufacturing or tyre re-treading industries.
18. Industries involved in manufacturing or reconditioning of batteries.
19. Any industry involved in the use of asbestos fibres as a raw material.
20. Industries involved in manufacturing, extracting or formulating pharmaceuticals or cosmetic products including intermediates.
21. Adhesives manufacturing industries excluding natural gums.
22. Match sticks manufacturing industries and explosives manufacturing or formulating industries.
23. Batik industries where 10 or more workers are employed.
24. Textile processing (i.e. bleaching, dyeing, printing) industries or garment washing industries or textile sand blasting industries or commercial laundries where 10 or more workers are employed.
25. Tanneries.
26. Lather finishing industries having effluent generating operations.
27. Jute processing industries.
28. Industries involved in bleaching or dyeing of natural fibre or natural fibre based industries where 25 or more workers are employed.
29. Power looms having 25 or more machines or power looms with sizing activities.
30. Sugar manufacturing industries or sugar refineries.
31. Fermentation industries (Distilleries, Breweries) or alcoholic beverages bottling plants or bottling plants having bottle washing operations.
32. Food manufacturing and processing industries including bakery products and confectioneries where 25 or more workers are employed.
33. Abattoirs.
34. Coconut oil or cinnamon oil extraction industries where 25 or more workers are employed.
35. Plants or animal oil/fats extraction industries having production capacity of 10 litres or more per day excluding coconut oil and cinnamon oil extraction industries.
36. Instant tea or coffee processing industries.
37. Non-alcoholic beverages manufacturing industries where 25 or more workers are employed.
38. Desiccated coconut mills or coconut processing industries where 10 or more workers are employed.
39. Rice mills having wet process and having a production capacity of 5,000 kilograms or more per day.
40. All hatcheries or poultry farms having 2,500 or more birds or piggery, cattle, goats farms having animals 50 or more or having rating* for mixed farming 2,500 or more.

*Rating for Mixed Farming = No. of Birds + 50 x (No. of Pigs + No. of Cattle + No. of Goats)

41. Animal feed manufacturing industries having a capacity of 25 or more metric tons per day.
42. Cigarettes or other tobacco products manufacturing industries where 50 or more workers are employed.
43. Industries involved in surface treatment of metal or plastic including electroplating, galvanizing and powder coating industries.
44. Iron and steel mills.
45. Foundries with any type of furnaces.
46. Non-ferrous metal processing industries including secondary process, smelting and recovery of metals.
47. Metal fabricating industries or machinery, machinery parts or hardware items or electrical and electronic goods and equipment manufacturing or assembling industries where 24 or more workers are employed. (Including lathe workshops, welding shops, spray painting industries).
48. Cement industries (clinker grinding, manufacturing or repacking).
49. Concrete batching plants having a production capacity of 50 or more cubic meters per day.
50. Glass or glass based product manufacturing industries.
51. Lime kilns having a production capacity of 20 or more metric tons per day.
52. Ceramic industries where more than 25 or more workers are employed.
53. Mechanized mining activities with multi bore hole blasting or single bore hole blasting activities with production capacity having 600 or more cubic meters per month.

54. Crushing or processing of non-metallic minerals (i.e. limestone, dolomite, apatite, rock phosphate, sand stone, feldspar, quartz, ilmenite, rutile, zircon, mica, graphite, kaolin, etc) excluding lime shell and granite crushing activities.
55. Granite boulders making or processing industries (extracting, blasting, slicing, polishing).
56. Granite crushing (Metal crushing) industries having a total production capacity of 25 or more cubic meters per day.
57. Common wastewater (industrial or sewage) treatment plants.
58. Incinerators having a feeding capacity of 5 or more metric tons per day.
59. Water treatment plants having a treatment capacity of 10,000 or more cubic meters per day.
60. Municipal solid waste and other solid waste composting plants having a capacity or 10 or more metric tons per day.
61. Solid waste recovery/recycling or processing plants having a capacity of 10 or more metric tons per day.
62. Solid waste disposal facility having a disposal capacity of 10 or more metric tons per day.
63. All toxic and hazardous waste treatment facility or disposal facilities or recycling/recovering or storage facilities.
64. Industries involved in chemical treatment and preservation of wood excluding Boron treatment.
65. Saw mills having a milling capacity of 50 or more cubic meters per day or wood based industries where 25 or more workers are employed.
66. Hotels, guest houses, rest houses having 20 or more rooms.
67. Hostels and similar dwelling places where occupancy level is exceeding 200 or more.
68. Health care service centres generating infectious wastes, including medical laboratories and research centres.
69. Automobile or bicycle manufacturing or assembling industries.
70. Vehicles service stations or container yards having vehicle service activities excluding three wheeler and motor cycles services and interior cleaning.
71. Railway workshops or all bus depots having vehicle servicing activities.
72. All vehicle emission testing centres.
73. Electrical power generating utilities excluding standby generators and hydro or solar or wind power generation.
74. Printing presses with lead smelting o newspaper printing or printing process which generates wastewater or colour photographs processing centres.
75. Paper and Pulp Industries or corrugated cartons manufacturing industries.
76. Any industry where 200 or more workers per shift are employed.
77. Industrial Estates approved under the part IVC of the National environmental Act including Katunayake and Biyagama Export processing Zones.
78. Zoological gardens.
79. Transmission towers providing facilities for telecommunication and broadcasting.
80. Any industry not included above which discharges 10 or more cubic meters of wastewater per day or using toxic chemicals in its process.

PART B

1. Soaps, detergents, softener or any other cleansing preparations manufacturing industries having a production capacity less than 1,000 kilograms per day.
2. Bulk petroleum liquid storage facilities excluding filling stations or liquefied petroleum gas (LP Gas) storage or filling facilities having a total capacity less than 150 metric tons.
3. Industries involved in the use of fibre glass as a raw material where less than 10 workers are employed.
4. Ribbed smoke rubber sheet manufacturing industries having a production capacity of more than 50 kilograms and less than 100 kilograms per day.
5. Activated carbon or carbon black manufacturing industries or charcoal manufacturing industries having a production capacity less than one metric ton per batch.
6. Industries involved in manufacturing, extracting or formulating Ayurvedic, indigenous medicinal products where more than 10 workers and less than 25 workers are employed.

7. Batik industries where less than 10 workers are employed.
8. Commercial laundries where less than 10 workers are employed.
9. Leather finishing industries having dry process operations.
10. Natural fibre based industries where less than 25 workers are employed excluding industries involved in bleaching or dyeing of natural fibre.
11. Power looms having less than 25 machines.
12. Hand Looms or knitting or embroidery industry having more than 10 looms.
13. Garment industries where 25 or more workers and less than 200 workers per shift are employed.
14. Sugar cane based industries excluding sugar factories of sugar refineries.
15. Food manufacturing and processing industries including bakery products and confectioneries where 5 or more workers and less than 25 workers are employed.
16. Cinnamon oil extracting industry where less than 25 workers are employed.
17. Rice mills having wet process with a production capacity of less than 5,000 kilograms per day.
18. Grinding mills having production capacity of more than 1,000 kilograms per month.
19. Poultry farms have 250 or more and less than 2,500 birds or piggery, cattle, goats farms having animals 5 or more and less than 50 or having rating * for mixed farming 250 and less than 2,500.

Rating for Mixed Farming = No. of Birds + 50 x (No. of Pigs + No. of Cattle + No. Goats)

20. Animals feed manufacturing industries, having a capacity of less than 25 metric tons per day.
21. All ice manufacturing industries.
22. Metal fabricating industries or machinery, machinery parts or hardware items or electrical and electronic goods and equipment manufacturing or assembling industries where less than 25 workers are employed. (Including lathe workshop, welding shops, spray painting industries).
23. Concrete batching plants having a capacity less than 50 cubic meters per day.
24. Single borehole blasting with industrial mining activities using explosives, having a production capacity of less than 600 cubic meters per month.
25. Granite crushing (Metal crushing) industries having a total production capacity of less than 25 cubic meters per day excluding manual crushing operations using hand tools.
26. Municipal solid waste and other solid waste composting plants (excluding household composting) having a capacity of less than 10 metric tons per day.
27. Solid waste recovery/recycling or processing plants having a capacity of less than 10 metric tons per day.
28. Solid waste disposal facilities a disposal capacity of less than 10 metric tons per day.
29. Hostels and similar dwelling places where occupancy level or 25 or more boarders and less than 200 borders.
30. Vehicle repairing and maintaining garages including spray painting or mobile air-conditioning activities.
31. Recycling or recovering centres of refrigerants form air-conditioners or refrigerators.
32. Three wheeler or motor cycle servicing activities or vehicle interior cleaning activities.
33. Any industry not included above which discharges 3 or more and less than 10 cubic meters of industrial processing wastewater per day.

PART C

1. All vehicle filling stations (liquid petroleum and liquefied petroleum gas).
2. Manufacturing of candles where 10 or more workers are employed.
3. Coconut oil extraction industries where 10 or more workers and less than 25 workers are employed.
4. Non-alcoholic beverages manufacturing industries where 10 or more workers and less than 25 workers are employed.
5. Rice mills having dry process operations.
6. Grinding mills having production capacity of less than 1,000 kilograms per month.
7. Tobacco barns.
8. Cinnamon fumigating industries with sulphur fumigation having capacity of 500 or more kilograms per batch.
9. Edible salt packing and processing industries.
10. Tea factories excluding instant tea processing.

11. Concrete pre-cast industries.
12. Mechanized cement blocks manufacturing industries.
13. Lime kilns having a production capacity of less than 20 metric tons per day.
14. Plaster of Paris industries where less than 25 workers are employed.
15. Lime shell crushing industries.
16. Tile and brick kilns.
17. Single borehole blasting with artisanary mining activities using explosives, having capacity of less than 600 cubic meters per month.
18. Saw mills having a milling capacity of less than 50 cubic meters per day or industries involved in Boron treatment of wood or timber seasoning.
19. Carpentry workshops which use multipurpose carpentry machine or wood based industries where more than 5 workers and less than 25 workers are employed.
20. Residential hotels, guest houses, rest houses with 05 or more and less than 20 rooms.
21. Vehicle repairing or maintaining garages excluding spray-painting or mobile air-conditioning activities.
22. Repairing, maintaining or installation centres of refrigerators and air-conditioners.
23. Container yards excluding where vehicle servicing activities are carried out.
24. All electrical and electronic goods repairing centre where more than 10 workers are employed.
25. Printing presses and later press machines excluding lead smelting.

Source: GOSL

APPENDIX 4 Proposed Waste Disposal Fee (WDF) for New Pollution Control System

Industries discharging waste water into the environment must meet the relevant concentration based on standards established by the CEA. But there are several disadvantages could be identified in present EPL system.

- No regulations to restrict the quantity / amount of pollutants discharged into the environment. As a result, pollution load into the environment cannot be controlled adequately
- EPL System is not equitable to all, since high as well as low polluters are subject to the same license fee irrespective of the pollutant load discharged.

The WDF system is an example of a market-based instrument. This is a more equitable system in the sense that the larger the amount of pollutant discharged, the payment will be more. On the other hand, the smaller the amount payment will be less.

The WDF system encourages industries to;

- Establish of more efficient waste water treatment systems with better process control;
- Reduce costs by better housekeeping;
- Reduce use of water consumption;
- Reduce/recycling of treated waste water etc.

The WDF system also encourages third party involvement to provide high quality environmental services for industries through;

- Establishing accredited laboratories for analytical services;
- Environmental consultancy firms to provide effective technological solutions.

It is planning to establish a separate fund from the charges collected which will be used for environmental management activities in Sri Lanka, including:

- Provision of soft loans for waste water treatment systems
- Adoption of cleaner production technologies;
- Environmental clean-up programs

It is necessary to amend the National Environmental Act and regulations giving legal effect to the WDF program and to develop institutional capacity of the CEA for WDF program implementation.

As the implementation strategy, it was suggested to implement the WDF scheme using sectorial focus (Initially applied to textile, tanning sector, chemical, and sectors)

- In first phase, COD is the priority pollution parameter, later to be extended to toxics
- Industry awareness/ capacity development will be given high priority
- Share experience with other countries in Asia

WDF Work Plan consists creation of Technical Support Committee convened by the Chairman CEA to make technical decisions with the representatives from

- The Ministry of City Planning and Water Supply,
- The Ministry of Industries,
- The Ministry of Mahaweli Development and Environment,
- The NWSDB

At present legal counselling is in progress to incorporate necessary provision to existing law. Proposed provisions will cover;

- Implementing the WDF Program
- Determining the wastewater discharge fee
- Collection of wastewater discharge fee
- Discontinuance of water supply upon default
- Regulations
- Maintenance of the resulting revenues
- Provision enabling the utilization of such funds

APPENDIX 5 Status of Treatment & Disposal of Hospital Wastewater

Hospital	Bed Capacity	District/ Local Authority	Estimated Sewage Flow (m^3/d)	Treatment Process	Status of Operation & Disposal Option
1. Ampara, District General Hospital	578	Ampara/ Ampara UC	400	Flow through process include Screening, Extended aeration, Secondary clarifier with sludge recirculation & disinfection	Wastewater from Nursing School also connected, Sludge treatment is required. Treated effluent disposal option need to be assessed
2. Anuradhapura Teaching Hospital	1861	Anuradhapura/ Anuradhapura MC	800 (Grey water not connected)	Flow through process consists collection tank, Aeration tank, secondary clarifier and disinfection	Ayurvedic Hospital effluent also connected Screening, Grit channel & Sludge recirculation & sludge treatment are required Treated effluent disposal option need to be assessed
3. Badulla General Hospital	1453	Badulla/ Badulla MC	670	Grit chamber, Primary settling, Trickling filter, secondary clarifier, disinfection, & anaerobic sludge digester	Treated effluent disposal option need to be assessed
4. Batticaloa Teaching Hospital	931	Batticaloa/ Batticaloa MC	450	Screening, extended aeration, Secondary clarifier with sludge recirculation, disinfection & anaerobic sludge digester	Sewage from the Prison also connected. Treated effluent discharged on Leaching field
5. Dambulla Base Hospital	278	Matale/ Dambulla MC	185	Flow through process consists collection tank, Grit settler, Aeration tank, secondary clarifier, disinfection & Anaerobic sludge digester	Sludge recirculation is required. Treated effluent was black in colour and suitable disposal options to be identified
6. Elpitiya Base Hospital	309	Galle/ Elpitiya PS	125	Collection well, Extended aeration tank, Secondary clarifier with sludge recirculation, disinfection, Anaerobic sludge digester	STP operation is outsourced, Treated effluent was black in colour and suitable disposal options to be identified
7. Horana Base Hospital	501	Kaluthra/ Horana UC	270	Grit chamber, Extended aeration tank, Secondary clarifier with sludge recirculation & disinfection	Treated effluent disposal option need to be assessed
8. Kalmunai South Base Hospital	320	Ampara/ Kalmunai MC	135	Combine treatment using equalization tank, anaerobic tank, aeration tank & trickling filter followed by disinfection	Treated effluent disposal option need to be assessed
9. Kalmunai North Base Hospital	413	Ampara/ Kalmunai MC	180	Septic tank & soakage pit	Onsite disposal
10. Kaluthra District General Hospital	803	Kaluthara/ Kaluthara UC	330	Collection tank, Primary settling, extended aeration Secondary clarifier with sludge recirculation, disinfection and anaerobic sludge digester	Treated effluent disposal option need to be assessed

Hospital	Bed Capacity	District/ Local Authority	Estimated Sewage Flow (m^3/d)	Treatment Process	Status of Operation & Disposal Option
11. Kegalle District General Hospital	746	Kegalle/ Kegalle UC	370	Grit chamber, Primary settling, trickling filter followed by disinfection and anaerobic sludge digester	Treated effluent disposal option need to be assessed
12. Kuliyapitiya Base Hospital	590	Kurunegala/ Kuliyapitiya UC	220	Collection tank, extended aeration Secondary clarifier with sludge recirculation & disinfection	Treated effluent disposal option need to be assessed
13. Mahiyangana Base Hospital	280	Badulla/ Mahiyangana PS	200 (Grey water not connected)	Grit chamber, Primary settling, trickling filter, Secondary clarifier and anaerobic sludge digester (no disinfection)	Plant capacity is inadequate, treated effluent disinfection is required and disposal option need to be assessed
14. Matale District General Hospital	760	Matale/ Matale MC	270	Flow through process including screening, grit chamber, inlet chamber, Extended aeration, secondary clarifier, disinfection and anaerobic sludge digester	Sludge recirculation shall be introduced. Treated effluent disposal option need to be assessed
15. Nawalapitiya District General Hospital	447	Kandy/ Nawalapitiya UC	170	Screening, inlet chamber, Primary settling, trickling filter secondary clarifier and anaerobic sludge digester (no disinfection)	Treated effluent disposal option need to be assessed
16. Nuwara Eliya District General Hospital	417	Nuwara Eliya/ Nuwara Eliya MC	380	Flow through process including screening, grit chamber, primary settling, Extended aeration, secondary clarifier, & disinfection	Digester is required for primary sludge. Treated effluent disposal option need to be assessed
17. Panadura Base Hospital	247	Kaluthara/ Panadura UC	175	Flow through process including collection tank, aeration tank, secondary clarifier, & disinfection	Police station wastewater also connected. Sludge recirculation is required. Treated effluent was black and disposal option need to be assessed
18. Polonnaruwa District General Hospital	854	Polonnaruwa/ Thamankaduwa PS	410	Flow through process including grit channel, aeration tank, secondary clarifier, & disinfection	Sludge recirculation is required. Treated effluent was black and disposal option need to be assessed
19. Rathnapura General Hospital	1057	Ratnapura/ Ratnapura MC	475	Grit chamber, Primary settling, trickling filter, disinfection and anaerobic sludge digester	Treated effluent was black, disposal option need to be assessed
20. Tangalla Base Hospital	264	Hambantota/ Tangalla UC	100	Flow through process including Screening, Grit Chamber, aeration tank, secondary clarifier, & disinfection	New treatment plant, no sludge recirculation provided. Treated effluent disposal option need to be assessed
21. Diyatalawa Base Hospital	368	Badulla/ Haputale PS	150	Septic tank & soakage pit	Onsite disposal (new treatment plant is required)
22. Trincomalee General Hospital	653	Trincomalee/ Trincomalee UC	310	Screening, collection tank, trickling filter (new	Treated effluent disposal option need to be assessed

Hospital	Bed Capacity	District/ Local Authority	Estimated Sewage Flow (m^3/d)	Treatment Process	Status of Operation & Disposal Option
				treatment plant seems to be under capacity)	
23. Homagama Base Hospital	426	Colombo/ Homagama PS	165	Septic tank & soakage pit at present (new plant with equalization tank, anaerobic tank, aeration tank, secondary clarifier with sludge recirculation, disinfection and anaerobic sludge digestion under construction)	Treated effluent will be disposed on land considering percolation rate
24. Mannar District General Hospital	330	Mannar/ Mannar UC	140	Septic tank & soakage pit, Septic tank emptied weekly by gully sucker	Soaking capacity is inadequate. New STP is necessary
25. Mulativu District General Hospital	200	Mulativu/ Maritimepattu PS	130	Septic tank & soakage pit, Septic tank emptied every other week by gully sucker	Soaking capacity is inadequate. New STP is necessary
26. Hatton-Dickoya Base Hospital	100	Nuwara Eliya/ Hatton-Dickoya UC	Not estimated	Septic tank & soakage pit at present. New treatment plant construction in progress	Treated effluent disposal option need to be assessed
27. Avissawella Base Hospital	495	Colombo/ Seethawakapura PS	Not estimated	Oxidation ditch	Treated effluent disposal option need to be assessed
28. Karawanella Base Hospital	308	Kegalla/ Yatiyantota PS	Not estimated	Oxidation ditch (abounded)	Treated effluent disposal option need to be assessed
29. Monaragala Base Hospital	370	Monaragala/ Monaragala PS	Not estimated	Waste stabilization pond	Treated effluent disposal option need to be assessed
30. Maharagama, National Cancer Institute	886	Colombo/ Maharagama UC	Not estimated	Oxidation ditch (Plant improvement is done)	Treated effluent discharge to the Rathmalana Moratuwa Central Treatment plant
31. Kalutara, National Institute of Health service	801	Kaluthara/ Kaluthara UC	Not estimated	Oxidation ditch	Sludge recirculation is required Treated effluent disposal option need to be assessed
32. Kilinochchi General Hospital	235	Kilinochchi/ Karachchi PS	Not estimated	Septic Tank	Onsite disposal
33. Vavuniya Distric General Hospital	561	Vauniya/ Vavuniya UC	Not estimated	Septic tank, soakage pit with bio filter	Onsite disposal
34. Point Pedro Base Hospital	264	Jaffna/ Point Pedro UC	Not estimated	Activated sludge system	Treated effluent disposal option need to be assessed
35. Thelippalai Base Hospital	102	Jaffna/ Valikamam North	Not estimated	Activated sludge system	Treated effluent disposal option need to be assessed
36. Sirima Bandaranayaka Teaching Hospital	115	Kandy/ Kandy Four Gravets & Gangawata Korale PS	Not estimated	Rotating Biological contactors (RBC)	Will be connected to the Kandy Central Wastewater Management Plant
37. Peradeniya Teaching Hospital	896	Kandy/ Kandy Four Gravets & Gangawata Korale P	Not estimated	Activated sludge system	Will be connected to the Kandy Central wastewater Management Plant
38. Sri Jawardanapura Nurses Training School		Colombo/ Sri Jayawardanapura MC	Not estimated	Pump to Sri Jayawardanapura Hospital Sewer system	End up in Sea outfall Colombo

Hospital	Bed Capacity	District/ Local Authority	Estimated Sewage Flow (m^3/d)	Treatment Process	Status of Operation & Disposal Option
39. Balapitiya Base Hospital	365	Galle/ Balapitiya PS	Not estimated	Activated sludge system	Treated effluent disposal option need to be assessed
40. Embilipitiya Base Hospital	361	Rathnapura/ Embilipitiya UC	Not estimated	No data	Treated effluent disposal option need to be assessed
41. Mawanella Base Hospital	249	Kegalle/ Mawanella PS	Not estimated	No data	Treated effluent disposal option need to be assessed

Source: NWSDB Survey Report for Improving Wastewater Disposal Systems of Government Hospitals(February 2014)

APPENDIX 6 Definition of Parameters

According to the AHP concept agreed upon at a previous JCC meeting, parameters and scoring method are set eventually. All these parameters are explained below.

(1) Urbanization

1) Population Density

Population density is calculated adopting the following formula. Unit is persons per hectare.

$$P_d = \frac{Population【2012】}{\mathrm{Re}sidentialArea【2012】} \cdots (1)$$

Population corresponds to the population living in relevant residential area.

2) Population (Equivalent Population)

In addition to the population resides permanently in a particular area, there will be a floating population coming in to the area for economic activities such as commercial, tourism etc. It is difficult to assess this floating population by activities wise.

In order to assess the potential floating population and activity intensity, equivalent population is defined in this study. Equivalent population is calculated adopting the following formula. Unit is persons.

$$E_p = \frac{WaterConsumption【\mathrm{Domestic}+\mathrm{Commercial}+\mathrm{Industrial}】}{\mathrm{WaterConpumption\ per\ Capita}} \cdots (2)$$

(2) Sanitation

1) Water Supply Coverage Ratio

Number of people connected to the water supply service leads to the extent of impact on the sanitary environment.

Water supply coverage ratio is calculated adopting the following formula. Unit is percent.

$$W.S.C.R = \frac{WaterServedPopulation}{Population} \cdots (3)$$

2) Diseases

Number of water-borne diseases is one of the indicators that shows how a province could ensure a desirable hygienic environment. This indicator is assessed by the figures shown below. Unit is persons per ten thousand residential population.

$$RateofWaterboneDiseases = \frac{NumberofWaterboneDiseases【2015】}{Population} \times 10{,}000 \cdots (4)$$

(3) Development

1) Places of Attraction (How attractive to tourists)

A council with places of attraction is to be developed much faster than councils which don't have places of attraction. Attractive Places could be classified under three (3) categories as shown below.

2) Growth Center and Industrial Zone

Presence of Growth Centers and Industrial Zones is expected to represent future development and growth. Growth Centers are classified under three (3) categories as shown below.

(4) Sustainability

1) Recovery of Water Tariff Ratio

Recovery of water tariff ratio indicates the tendency for fulfillment of payment obligations. This indicator is calculated adopting the formula given below. Unit is percent.

$$\text{R.W.T.R} = \frac{Water\ Tariff\ Paid}{Water\ Tariff\ Billed} \cdot \cdot \cdot (5)$$

2) Median of Household Income

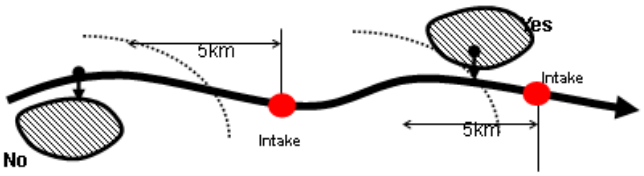
Household income indicates the affordability of each council on its sewerage scheme.

(5) Water Environment

1) Influence for Water Source

For rivers or lakes with a water intake point, potential impact to the waters are studied.

As shown in **Figure A.9-1**, intake points are set along the river. If a province is located within 5 km. upstream of the intake point then it is considered that there is an impact and marked as "Yes". Moreover, councils which use groundwater as their water source, groundwater contamination will be prevented by sewerage installation, and these councils are also evaluated in this study.



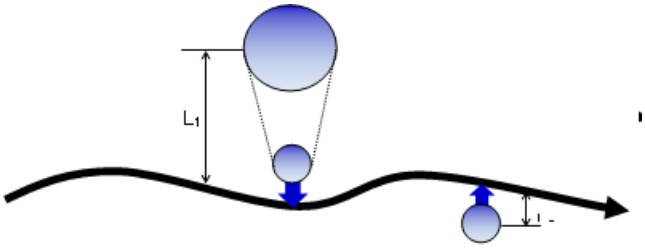
Source: JET

Figure A.9-1 Basic Idea on Influence for Water Source

2) Potential Pollution Impact for Water Environment

Potential pollution impact on water environment from each council is assessed along with the idea as shown in **Figure A.9-2**.

Pollution load generated in each council is calculated by the following formula as shown below. Unit of pollution load generated is kilogram per day.



Source: JET

Figure A.9-2 Basic Idea of Pollution Impact

Pollution Impact is calculated by the following formula as shown below. This value is proportional to pollution load, inversely proportional to the distance from center of the province to waters.

$$\text{【Pollution Impact】} = \frac{\text{Pollution Load}}{L} \cdots (7)$$

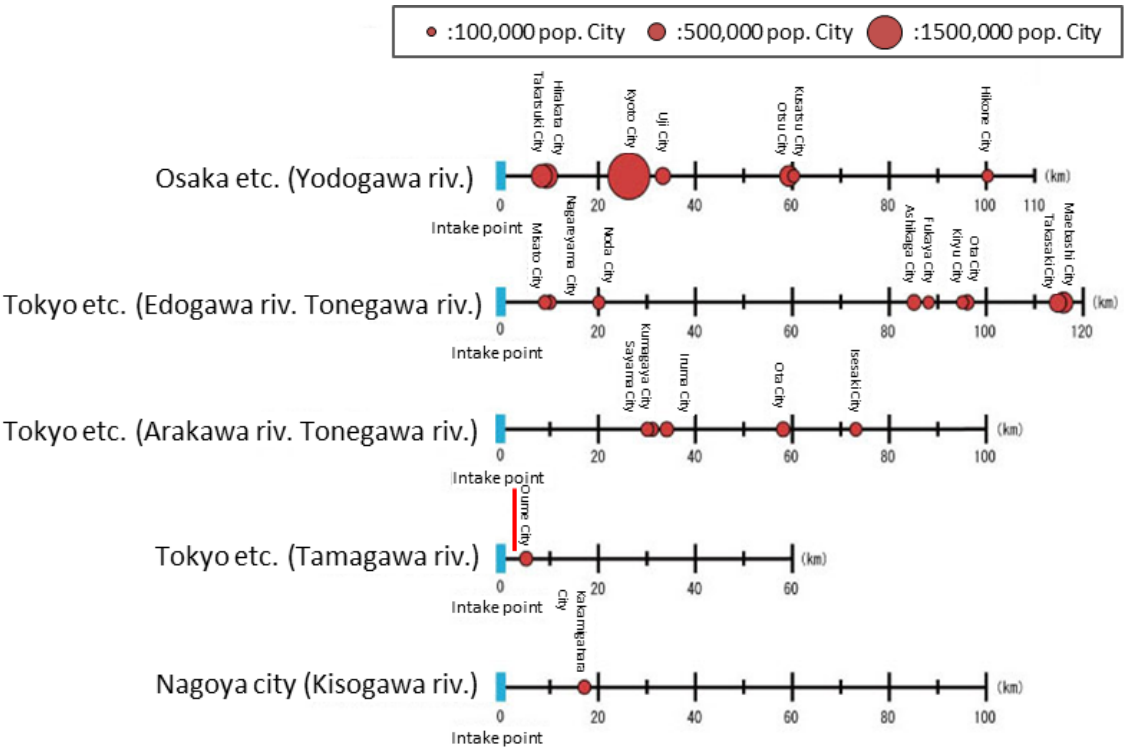
(6) Maturation

1) Feasibility Study and Approval Process

Maturation for sewerage system installation in each province is assessed from the information relates to feasibility study and approval process.

Maturation of councils for sewerage system are classified under two (2) categories as shown below.

APPENDIX 7 Intake points of a part of Big Cities in Japan.



Source: prepared by JET, based on the data from the HP of Yodogawa River Office.
URL of the HP http://www.yodogawa.kkr.mlit.go.jp/know/data/problem/01/a.html

Figure A-11-1: Relationship between main intake points of big city in Japan and upper cities.

It is considered reasonable that the minimum distance from intake point to the city is 5km, referring from the case of Oume city - there is red under line - .

APPENDIX 8 Environmental and Social Considerations

(1) 1 Master Plan for Environmental and Social Considerations

1) Strategic Environmental Assessment (SEA)

a) SEA Internationally

The Strategic Environmental Assessment (SEA) as defined in the current Project is administered during the project implementation stage. However, general interpretations of SEAs allow it to be performed in earlier stages of development projects. SEA takes into account Policy, Planning, and Programs (PPPs) to evaluate the impacts (environmental, social, economic, and others) of future projects prior to the decision making stage.

b) SEA at the World Bank

The World Bank uses the SEA as a tool to help improve outcomes of investment projects by integrating environmental protection into the planning and decision making processes. "The World Bank Strategic Environmental Assessment is an approach which uses a range of analytical and participatory approaches to integrate environmental considerations into Policies, Plans, and Programs (PPPs)".

c) SEA at the Asian Development Bank

According to the ADB, "The term 'Strategic Environmental Assessment' is used exclusively for assessments of policies, plans and programs. The term 'environmental assessment' is used for assessments of specific projects".

SEAs are advantageous in that:

- They allow environmental assessments to take place prior to decision making on projects
- They allow consideration of cumulative effects of multiple policies and projects on the environment
- They allow "tiering" of assessments related to the environment, resulting in optimal implementation of assessment activities, at the right time, in the right scale.

d) SEA at the OECD

The OECD iterates the importance of SEAs for the "integration of the principles of sustainable development into country policies and programs".

e) SEA in Sri Lanka

The SEA policy in Sri Lanka is similar to the above. In a booklet published by the Central Environmental Authority (CEA) titled, A SIMPLE GUIDE TO STRATEGIC ENVIRONMENTAL ASSESSMENT, the role of SEA is given as follows:

In Sri Lanka, project level Environmental Impact Assessment has been effectively implemented since 1993. Although project level EIA is effective in addressing environmental impacts at the project level, it often fails to take into account cumulative impacts of projects. Strategic Environmental Assessment could prove to be a more effective tool in this regard, as SEA is applied at a higher strategic level, thereby ensuring that possible environmental impacts of a Policy, Plan or Programme are addressed at the strategic level.

In an interview with the CEA conducted by the survey team, SEAs in Sri Lanka "are performed at higher planning and policy stages, involving a broad range of sectors".

According to the CEA, "since the current Project is already defined as a sewerage project, an SEA is neither required nor effective at this stage".

(2) Environmental and Social Considerations for the Project

1) Strategic Sewerage Master Plan

Although the current phase of the Project is not suitable for SEA, aspects of it can be reviewed and verified. Recalling the fundamental principle behind the SEA, the PPPs of Sri Lanka will be reviewed, and the consistency and rationality of the current Project will be analysed in this context. Intelligence regarding the environmental and sewerage sectors will also be collected and consolidated.

2) City Master Plan

Initial Environmental Evaluations (IEE) and Environmental Impact Assessments (EIA) are valuable in mitigating environmental impacts directly related to construction activities of development projects. Therefore, they are most often implemented during the Feasibility Study (F/S) stage. The Cities Master Plan stage (or the Pre-F/S stage) will be defined as the preparatory stage for the IEE/EIA. This stage will be used to collect background information, and analyse the results. Detailed surveys (such as fauna and flora surveys, and socio-economic surveys) will be excluded at this stage. The data gathered during this stage will be used for the selection of the two cities for F/S implementation.

Furthermore, the CEA has agreed to the provisional creation of the Terms of Reference (TOR) of the IEE/EIA, ahead of the F/S. The background information required in the TOR will be collected during this M/P stage.

(3) Feasibility Study

IEE or EIA, as required by CEA, will be performed for the two selected cities.

(4) Survey Schedule

With consideration of the above, the Environmental Survey (and Natural Conditions Survey) is scheduled as shown in **Table -A**.

Table -A Environmental and Social Considerations Survey Schedule

Stage	Period	Experts Assignment	Target		Environmental Study	Remark
			Original	Selected		
Strategic MP	Jan		335 local authorities (79)	(Approx.) 5 local authorities	Primary study	➢ Environmental policies, plans and programs ➢ National level research
	Feb	■				
	Mar					
	Apr					
Cities MP (Pre-F/S)	May	■	5 local authorities	2 local authorities	Preparation study for IEE/EIA	➢ Literature search ➢ Simple site survey
	Jun					
	Jul	■				
	Aug	■				
In case MP was agreed between the both Sri Lanka and Japanese sides						
Feasibility Study	December, 2016 to June, 2017		2 local authorities		EIA study	➢ EMP(draft) ➢ Monitoring Plan(draft)

				➢ EIA Report ➢ Resettlement Action Plan

Source: JET

(5) Results of Primary Study

1) Sewerage Sector – Policy

a) Millennium Development Goals

The Millennium Development Goals (MDGs) are the eight international development goals that were established following the Millennium Summit of the United Nations in 2000, following the adoption of the United Nations Millennium Declaration. The Millennium Development Goal 7C (MDG7) Target 10 is *"to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation"*. Although progress has been made, studies have revealed that the world remains off track to meet this sanitation target by more than half a billion people, as shown in **Table-B**. Unless the pace of change in the sanitation sector can be accelerated, the MDG target may not be reached until 2026.

Table -B Population with Sanitation Service

2000	2015	
	Target	Actual
3 billion (50% of global population)	5.5 billion (75% of global population)	4.9 billion (67% of global population)

Source: http://www.un.org/millenniumgoals/environ.shtml

2) National Policy

Sri Lanka's Millennium Development Goal with respect to sanitation included providing access to adequate sanitation for 93% of its population by 2015, and for 100% of its population by 2025. The goals also included provision of pipe-borne sewers in selected growth centres and major urban areas (**Table -E**), and acceptable on-site sanitation to those not connected to sewer systems. The Government of Sri Lanka has set an ambitious goal for sanitation development. It anticipates that 7% of the Sri Lankan population will be connected to a collective wastewater management system by 2020. The targets are summarized in **Table -C**.

Table -C Sri Lanka Government Targets for Reticular Systems of Sewerage

Year	2005	2009	2015	2020
Sewer reticular system coverage (%)	2	2.5	3	7

Source: Mahinda Chinthanaya 2010 (Page 61,62)

In the context of increased environmental pollution, systematic sewerage facilities will be promoted along with the water supply as these two sectors are mutually inclusive. The provision of adequate water supply and sanitation services not only serves to promote national development but also reduces government spending on medical and preventive health care for the people (especially children) who are easily susceptible to waterborne diseases by protecting natural environment.

Water supply and sewerage service provision island-wide are expected to be streamlined and delivered through the implementation of a strategic framework incorporating larger cities, townships, and rural areas. The policy is specifically stated as:

"In the context of increased environmental pollution, systematic sewerage facilities will be promoted along with the water supply as these two sectors are mutually inclusive. Highly populated and industrialized towns and areas such as Galle, Hambantota, Trincomalee, Jaffna, kandy, Kurunegala, Sri JayawardanapuraKotte, Kataragama sacred city, and Kaththankuddy will be facilitated through centralized wastewater purification systems on a priority basis"

Source: Mahinda Chinthanaya 2010 (page 65)

By 2020, all the emerging metro cities such as Kandy, Hambantota, Trincomalee, Dambulla, Jaffna, Galle, Gampaha, Kurunegala and Nuwara-Eliya, as well as large townships such as Vavuniya, Badulla, Matara, Anuradhapura and Ratnapura, which attract a substantial portion of the population and are predicted to increase economic activities in coming years, will have centralized sewerage systems, which in turn will contribute to environmental sustainability.

Table -D City and Town Development Strategy Framework

City Order	Development Strategy	Cities
Large cities	Global business city	Colombo / Hambantota / Trincomalee
	Diversified city	Jaffna
Strategic cities	Heritage city	Kandy / Galle
	Ancient city/ historical	Anuradhapura / Polonnaruwa
	Logistical corridors	Dambulla / Kurunegala / Ratnapura
	Tourism corridors	Nuwara Eliya / Batticaloa
Secondary cities	Emerging cities	Municipal and urban councils except above
Urban service centers	Community Development (Pura Neguma)	Small towns under PSs (local authority other than urban and municipal councils)

Source: Government of Sri Lanka, Public Investment Strategy 2014–2016. Colombo

(6) Sewerage Sector – Implementation

The sanitation sector is almost wholly owned and managed by the governmental institutions. The main organizations active in the sector include the Government of Sri Lanka through relevant ministries, provincial councils, local authorities, National Water Supply and Drainage Board (NWSDB) etc. Other parties such as Non-Governmental Organizations (NGOs), community based organizations (CBOs), the private sector, and plantation companies are also involved in the sanitation sector.

1) National Level

The principle government ministry is the Ministry of City Planning & Water Supply while, the agency principally responsible for the development, operation, and maintenance of water supply and sanitation schemes is the NWSDB, which reports to the ministry. Established in 1975, the NWSDB supports sector development through provision of technical expertise, develops macro-level development and investment plans, undertakes design, construction, and operation of small, medium, and major pipe-borne sanitation systems for smaller towns and cities, builds partnerships in operational areas to enhance service levels, and provides support through rural water and sanitation units to CBOs and local authorities to ensure proper operation and maintenance.

Some of the ongoing and proposed projects under NWS&DB are listed in the **Table -E** below.

Table -E Select Ongoing and Proposed Projects under NWSDB

Project Name	District
Identified priority water supply & sewerage projects	
Central Province	
Water Sector Development Project 1 Sub Project 1 Sewage disposal system for Kandy Municipal area (JICA)	Kandy
Southern Province	
Galle Sewerage (AFD)	Galle
Kataragama Sacred City Waste Water Disposal (Austria)	Monaragala
Western Province	
Greater Colombo Waste Water Rehabilitation (ADB)	Colombo
GPOBA funded project for increasing Household Access to Sewerage Services (World Bank)	Colombo
Maharagama Boralesgamuwa (China)	
Hospital Sewerage System Improvement (China)	
North Western Province	

Greater Kurunegala Water Supply & Sanitation (China)	

Source: http://www.waterboard.lk/web/index.php?option=com_content&view=article&id=74&Itemid=272&lang=en

2) Provincial and Local Level

Provincial councils and local authorities, such as municipal and urban councils as well as PSs have been delegated responsibility for the delivery of water and sanitation services in certain areas.

The role of the provincial councils is to ensure adequate allocation of resources, and the quality and standards of services to local authorities. Local authority managed sanitation utilities vary in size. Most are small except for the Colombo Municipal Council, which is responsible for managing the Greater Colombo sewerage system, including the operation and maintenance of piped sewers serving 80% of the city area, collection of septage from individual and community septic tanks, and disposal of large volumes of wastewater transferred to Colombo for this purpose by a number of industries.

3) Rural Level

Non-Governmental Organizations are registered with a relevant authority and engaged in providing services to rural communities. Their scope extends to a variety of functions including provision of sanitation facilities and hygiene education. Community Based Organizations are rural groups or community organizations engaged in their beneficiary communities for the provision and sustainable management of water supply and sanitation facilities.

Tea plantations were established in the hill country nearly 150 years ago and are one of the major sources of foreign exchange for the country. The terrain and land availability in plantation areas do not favour large-scale development of common sanitation facilities. Sanitation facilities consist of latrines with on-site disposal, and resulting watercourse pollution from these is common.

In the sanitation sector, private firms are providing de-sludging services to customers with septic tanks.

(7) Acts and Regulations Relevant to the Implementation of Sewerage Sector Projects

In Sri Lanka, various environmental legislations and standards are in force pertaining to wastewater collection, treatment, and disposal practices in order to safeguard the environment. It should be noted that many number of statutes exist which deal with this subject directly or indirectly. The most important legislations and standards are;

- National Environmental Act No. 47 of 1980 and No. 56 of 1988 and its amendments
- Tolerance limits for the discharge of industrial waste in to inland surface waters
- Tolerance limits for industrial effluents discharged on land for irrigation purpose
- Tolerance limits for industrial and domestic effluents discharged into marine coastal areas
- Tolerance limits for discharge of effluents into public sewers with central treatment plants
- Hazardous Waste Disposal
- Air Quality and Offensive Odor
- Noise & Vibration
- Marine Pollution Prevention Act no 59 of 1981
- Coast Conservation Act No. 57 of 1981 amended by Act No 64 of 1988 and its amendments
- Flood Protection Ordinance No 4 of 1924
- Land development Ordinance of 1935
- Nuisance Ordinance No. 15 of 1862 as amended by act No 57 of 1946
- State Land Ordinance No 8 of 1947
- Soil Conservation Act No 25 of 1951
- Urban Development Authority Law No 41 of 1978

- Mahaweli Authority of Sri Lanka Act No 23 of 1979
- Municipal Councils Ordinance No 29 of 1947 amended by act no 61 of 1981
- Fauna and Flora Protection Ordinance No 2 of 1987
- Agrarian Services Act No 58 of 1979 amended by Act No. 4 of 1991
- Irrigation Ordinance No 32 of 1946, amended by No 48 of 1968 and by No 13 of 1994
- Forest Ordinance No 16 of 1907 as amended by Act No 23 of 1995

(8) Approvals Required for a Sewerage Project

The proposed Project and each of its subprojects will be in full concurrence with legal requirements of the relevant Government Ministries and agencies.

1) Central Environmental Authority (CEA)

Approval of CEA under EIA regulations is required for the implementation of any "Prescribed Project" and valid Environmental Protection License (EPL) is required to discharge effluents in to the environment.

2) Coast Conservation and Coastal Resources Management Department (CC&CRMD - Commonly known as CCD)

Approval of the Director General of CC&CRMD is required for any development activity to be carried out within the Coastal Zone as defined under Coast Conservation Act.

3) Local Authority (LA) (Municipal Councils, Urban Councils or Pradeshiya Sabha)

To carryout construction activities of the project, the approval of relevant Local Authority must be obtained.

4) Mahaweli Authority of Sri Lanka (MASL)

As the responsible agency for Mahaweli River, the Mahaweli Authority in Sri Lanka (MASL) has been vested with the authority of granting permission for development works in the Mahaweli River and its reservation. Moreover, MASL is also a Project Approving Agency Gazette under the NEA.

5) Road Development Authority (RDA), Provincial Road Development Authority (PRDA)

If the project activities require to lay pipelines along provincial or national roads, the approval of PRDA or RDA is required.

6) Department of Archaeology

It is the state agency responsible for conservation of archaeological artifacts and structures of historical interest whether lying or hidden beneath the surface of the ground or in any water / lake. Any development project on such land will have to be permitted by the Director General of Archaeology.

7) The Forest Department

The Forest Department in its role as statutory custodian of state forests and lands and the plantation of new forests, has been vested with powers so as to not granting permission for any development activity within any land declared, proposed or defined under the Forest Ordinance.

8) The Department of Wild Life Conservation

The Department of Wild Life Conservation has been vested with the powers as to not grant permission for development projects which are proposed to be located within, or within a 1 mile radius of National Reserves declared under the Fauna and Flora Protection Ordinance without carrying out EIA.

9) Department of Agrarian Development

Filling of any paddy cultivation land is envisaged for the construction of sewerage treatment plants, laying of pipelines or related structures, approval of the Department, of Agrarian Development is required.

10) Urban Development Authority (UDA)

If the development activities of the proposed project are within an area declared under UDA law, approval of UDA is required.

(9) The Strategic Sewerage Master Plan in Context: Rationale, and Conformity to SEA Principles

The previous sections described the fundamental principles of SEA analyses and PPPs in relation to Government of Sri Lanka's international goals, national goals and policies, and national and local policies and plans in the sewerage sector.

The objective of the current Project is to mitigate water environment pollution through the development of a sewerage M/P (which involving all major urban communities of the country), and implementation of the policies developed.

This M/P includes selection of the five highest priority cities for sewerage infrastructure development based on the analysis of i) urbanization, ii) hygiene, iii) urban development, iv) environmental factors, v) sustainability of sewerage service, and vi) maturation for sewerage projects of all major urban communities.

From the above, it is clear that the pollution mitigation considerations are consistent with higher level international and national policies regarding environmental protection.

Further analysis verifies that, in addition to the "policy" considerations, the consistency to "plan and program" considerations are ensured since:

i) and iii) are applicable to the aforementioned "city and town development strategy framework" (**Table -E**)
ii) and v) are applicable to MDG, governmental and sewerage sector goals,
iv) and vi) are applicable to sewerage development projects planned and implemented by NWSDB.
in the selection process of the five priority cities.
In the implementation of the M/P, the previously mentioned laws, regulations, and approvals will be strictly adhered to, to ensure consistent and efficient progress of the project.

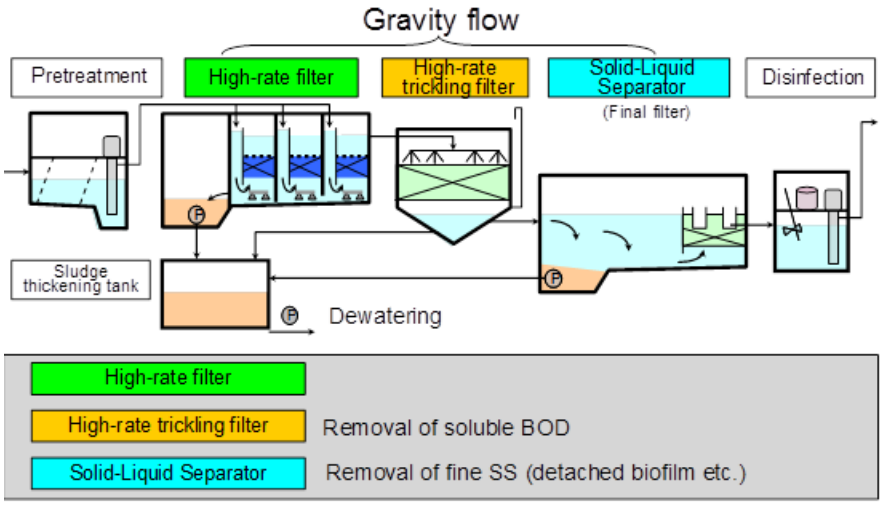
In this section, higher level national and international policies were compared with the objectives of the current Project. The rationality of the Project was verified, and found to be consistent with national and international policies.

APPENDIX 9 Introduction of Innovative Wastewater Treatment Technologies

(1) Improved trickling filter.

This technology is a improved trickling filter developed by Metawater Co.Ltd.. After removing suspended solids by a high rate solid-liquid separation device, influent is supplied to trickling filter. The trickling filter is filled with plastic carrier. While influent passes through the filter bed, organic matters will be captured and decomposed by biofilm on the carrier.

In conventional trickling filter method, the occurrence of odor and filter flies have been a problem, but in this process, regularly soaking of the trickling filter enables to suppress the generation of filter flies. Furthermore, power consumption is as small as 0.05kWh / m^3, and operation is easy. It is expected that the process will be introduced soon in Vietnam.

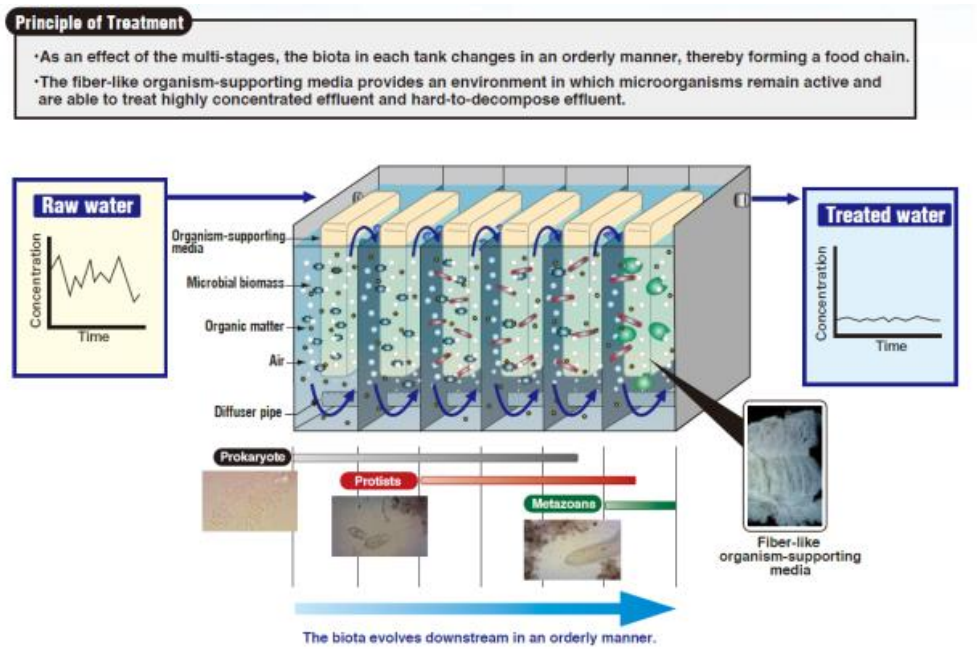


Source: Metawater Co., Ltd.

Figure A Flow scheme of improved trickling filter

(2) MSABP（Multi-stage activated biological process）

This technology is a new contact oxidation process developed by Teijin Limited. Special fiber carriers are arranged in multiple stages in the reactor. Pretreated influent passes through the aerated fibrous carrier. Organic matter in the influent water will be captured by the microorganisms attached to the fiber carrier, and undergoes biodegradation. On the carrier, not only bacteria, but protozoa and metazoan also appear in the downstream of the reactor, forming the food chain and thus reducing sludge generation to 70% less than Oxidation Ditch. This method is easy to operate and has advantage of much reduced sludge production. Five MSABP plants have been introduced in China.

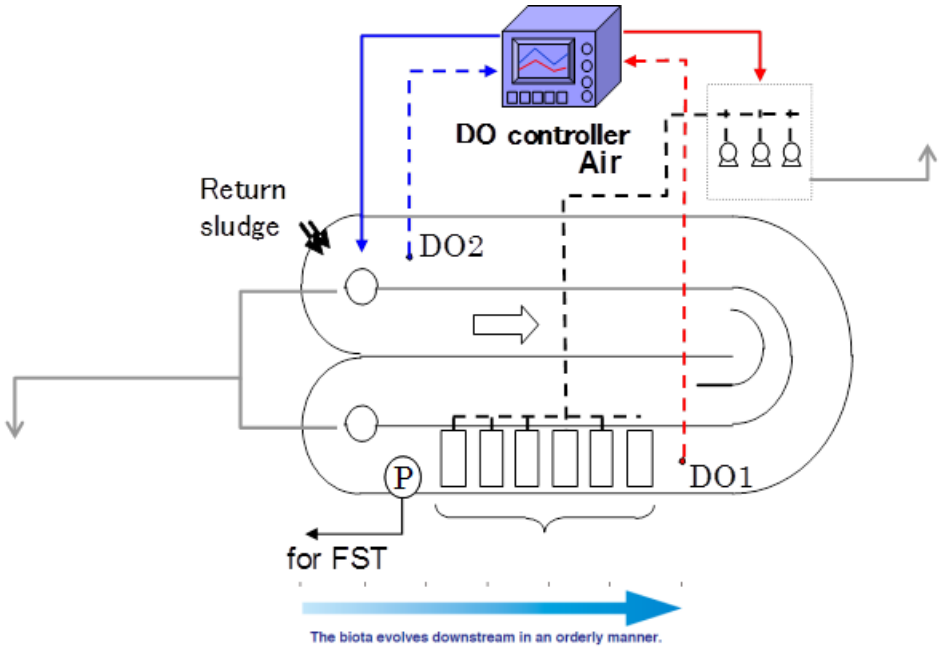


Source: Teijin Limited.

Figure B Flow scheme of MSABP

(3) Dual DO control of oxidation ditch

This is a new control technology for oxidation ditch (OD) process developed by Maezawa Industries, Inc.. DO level is measured at two different points, which are just the downstream point of the aerator and just the upstream point of the mixing device in the endless waterways of the OD process. Based on the measured DO levels, aeration amount and mixing speed are controlled independently so as to maintain a decreasing gradient of DO constant. Such control enables to form stable aerobic zone and anoxic zone, thus high nitrogen removal rate can be obtained. By applying this technology, required HRT of OD can be shortened to less than 24 hours, which results in the increase of the capacity of existing facility.



Source: Maezawa Industries. Inc.

Figure C Flow scheme of dual DO control oxidation ditch

APPENDIX 10 Gazette (Tolerance Limits for the Discharge of Industrial Waste in to Inland Surface Waters)

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PART I : SEC. (I) - GAZETTE EXTRAORDINARY OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA - 01.02.2008

SCHEDULE I

TOLERANCE LIMITS FOR THE DISCHARGE OF INDUSTRIAL WASTE IN TO INLAND SURFACE WATERS

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
01.	Total suspended solids	mg/1, max.	50
02.	Particle siz of the total suspended solids	µm, less than	850
03.	pH at ambient temperature	-	6.0 - 8.5
04.	Biochemical oxygen demand (BOD_5 in five days at 20^0c or BOD_3 in three days at 27^0c)	mg/1, max.	30
05.	Temperature of discharge	^{0}C, max.	Shall no exceed 40^0 C in any section of the stream within 15 m down stream from the effluent outlet.
06.	Oils and greases	mg/1, max.	10
07.	Phenolic compounds (as C_6H_5OH)	mg/1, max.	1
08.	Chemical oxygen demand (COD)	mg/1, max.	250
09.	Colour	Wavelength Range	Maximum spectral absorption coefficient
		436 nm (Yellow range)	$7m^{-1}$
		525 nm (Red range)	$5m^{-1}$
		620 nm (Blue range)	$3m^{-1}$
10.	Dissolved phosphates (as P)	mg/1, max.	5
11.	Total Kjeldahl nitrogen (as N)	mg/1, max.	150
12.	Ammoniacal nitrogen (as N)	mg/1, max.	50
13.	Cyanide (as CN)	mg/1, max.	0.2
14.	Total residual chlorine	mg/1, max.	1.0
15.	Flourides (as F)	mg/1, max.	2.0
16.	Sulphide (as S)	mg/1, max.	2.0
17.	Arsenic (as As)	mg/1, max.	0.2
18.	Cadmium (as Cd)	mg/1, max.	0.1
19.	Chromium, total (as Cr)	mg/1, max.	0.5
20.	Chromium, Hexavalent (as Cr^{6+})	mg/1, max.	0.1
21.	Copper (as Cu)	mg/1, max.	3.0
22.	Iron (as Fe)	mg/1, max.	3.0
23.	Lead (as Pb)	mg/1, max.	0.1
24.	Mercury (as Hg)	mg/1, max.	0.0005
25.	Nickel (as Ni)	mg/1, max.	3.0
26.	Selenium (as Se)	mg/1, max.	0.05

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PART I : SEC. (I) - GAZETTE EXTRAORDINARY OF THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA - 01.02.2008

SCHEDULE I *(Contd.)*

TOLERANCE LIMITS FOR THE DISCHARGE OF INDUSTRIAL WASTE IN TO INLAND SURFACE WATERS

No.	*Parameter*	*Unit type of limit*	*Tolerance Limit values*
27.	Zinc (as Zn)	mg/1, max.	2.0
28.	Pesticides	mg/1, max.	0.005
29.	Detergents/surfactants	mg/1, max.	5
30.	Faecal Coliform	MPN/100 ml, max	40
	Radio Active Material :		
31.	(*a*) Alpha emitters	micro curie/ml, max	10^{-8}
	(*b*) Beta emitters	micro curie/ml, max	10^{-7}

Note 1 : All efforts should be made to remove unpleasant odour as far as possible.

Note 2 : These values are based on dilution of effluents by at least 8 volumes of clean receiving water. If the dilution is below 8 times, the permissible limits are multiplied by the 1/8 of the actual dilution.

Note 3 : The above mentioned general standards shall cease to apply with regard to a particular industry when industry specific standards are notified for that industry.

Note 4 : Pesticides as per World Health Organization (WHO) and Food and Agriculture Organization (FAO) requirements.

Source: CEA

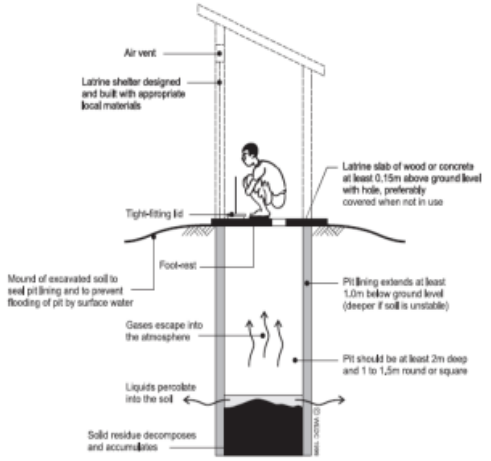
APPENDIX 11 Tolerance limits (into the marine waters)

Tolerance limits for the discharge of wastewaters or effluents (industrial and/ or domestic) from a prescribed activity into the marine waters

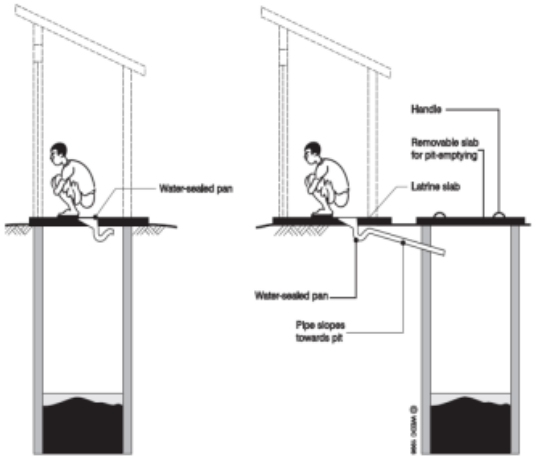
No.	Parameter	Unit, type of limit	Tolerance limit values for an outfall leading up to near shore water	Tolerance limit values for a short sea outfall	Tolerance limit values for a long sea outfall
1.	Total suspended solids	mg/1, max.	30	50	250
2.	Total dissolved solids	mg/1, max.	1000	-	-
3.	pH at ambient temperature	-	6.0 – 8.5	5.5 – 9.0	5.5 – 9.0
4.	Biochemical oxygen demand (BOD_5 in five days at 200C)	mg/1,max.	15	75	400
5.	Temperature at the measurement point	0C, max	Ambient water temperature +/- 5 or 35 whichever is lesser	40	40
6.	Oil and grease	mg/1,max.	5	12	20
7.	Phenols	mg/1,max.	1	1	5
8.	Chemical oxygen demand (COD)	mg/1,max.	50	400	800
9.	Colour (Spectral absorption coefficient - Wavelength range) 436 nm - (Yellow range) 525 nm - (Red range) 620 nm - (blue range)	 m-1, max. m-1, max. m-1, max.	 7 5 3		
10.	Dissolved phosphates (as P)	mg/1,max.	1	5	5
11.	Ammonia nitrogen (as N)	mg/1,max.	15	50	150
12.	Cyanide (as CN)	mg/1,max.	0.1	0.2	0.4
13.	Total residual chlorine(as OCl-)	mg/1,max.	0.2	0.5	1.0
14.	Fluorides (as F)	mg/1,max.	2	2	5
15.	Sulphides (as S)	mg/1,max.	2	2	5
16.	Arsenic (as As)	mg/1,max.	0.08	0.1	0.2
17.	Cadmium (as Cd)	mg/1,max.	0.02	0.05	0.10
18.	Chromium, total (as Cr)	mg/1,max.	0.05	0.05	0.10
19.	Chromium, hexavalent (as Cr6+)	mg/1,max.	0.01	0.01	0.05
20.	Copper (as Cu)	mg/1,max.	1.0	1.0	1.0
21.	Lead (as Pb)	mg/1,max.	0.10	0.10	0.10
22.	Mercury (as Hg)	mg/1,max.	0.001	0.002	0.01
23.	Nickel (as Ni)	mg/1,max.	0.1	0.2	1.0
24.	Selenium (as Se)	mg/1,max.	0.01	0.05	0.10
25.	Zinc (as Zn)	mg/1,max.	3	3	5
26.	Silver (as Ag)	mg/1,max.	0.005	0.035	0.35
27.	Pesticides (Total)	mg/1,max.	0.005	0.005	0.05
28.	Surfactants (Total)	mg/l, max.	1	5	10
29.	Faecal Coliform level	MPN/100ml, max.	150	1500	10^7
30.	Radio Active Material: (a) Alpha emitters (b) Beta emitters	microcurie/ml, max. microcurie/ml, max.	10^{-9} 10^{-9}	10^{-8} 10^{-7}	10^{-8} 10^{-7}

Note 1: All efforts should be made to remove unpleasant odour as practicable as possible.
Note 2: These limits are based on the premise that for an outfall leading up to near shore water the dilution factor may be zero, for short sea outfalls 1:10 and for long sea outfalls 1:100 respectively. In an event where the dilution factor for a respective category mentioned above is found to be less, the limits given in the Schedule should be adjusted on a proportional basis so as to give rise to more stringent limits.
Note 3: The limits given in the Schedule should be measured at the entrance of the outfall preferably at the pumping station or a manhole.
Note 4: In the case of application of this Schedule, the design incorporating bathymetry, dilution based on actual meteorological and current data at the place of construction, construction details such as pipe details, anchoring details and diffuser descriptions etc. should be approved by the Coast Conservation and Coastal Resource Management Department, the Marine Environment Protection Authority, and any other relevant authorities as the case may be, and the letter/s of approval should be submitted to the Authority along with the application for a new Environmental Protection License or a renewal of the license.
Source: CEA

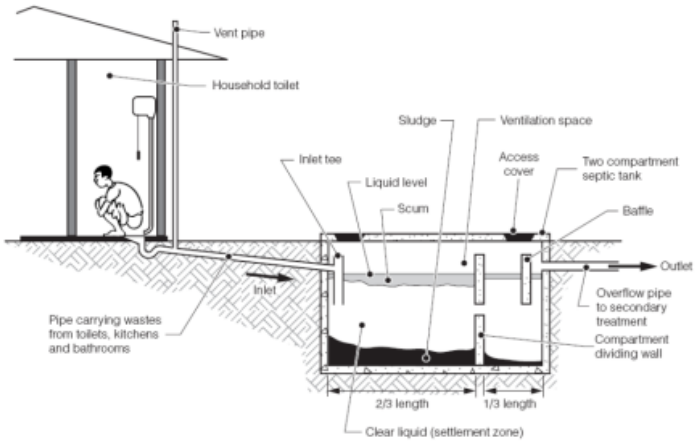
APPENDIX 12 Type of toilets



Simple latrine



Pour-flush latrines



Septic tank toilet

Source: "Types of Toilets and their suitability" by Practical Action

APPENDIX 13 Conditions of Local Municipalities for On-Site Treatment

	Local Authority		Zone	Comments
M-13	**Akkaraipattu M.C**	Non-priority area	Dry zone	Coastal
P-06	**Akurana P.S**	Non-priority area	Intermediate zone	Hill country
M-34	**Ambalangoda U.C**	Non-priority area	Wet zone	Coastal
M-61	**Ampara U.C**	Non-priority area	Dry zone	
M-58	**Anuradhapura M.C**	Non-priority area	Dry zone	
M-23	**Badulla M.C**	Non-priority area	Intermediate zone	Hill country
M-59	**Balangoda U.C**	Non-priority area	Wet/Intermediate zone	Hill country
M-36	**Bandarawela M.C**	Non-priority area	Intermediate zone	Hill country
M-45	**Batticaloa M.C**	Problem area	Dry zone	Coastal, lagoon
M-06	**Beruwala U.C**	Non-priority area	Wet zone	Coastal
P-04	**Biyagama P.S**	Non-priority area	Wet zone	
M-10	**Boralesgamuwa U.C**	Problem area	Wet zone	Waterlogged areas, Low height above MSL
M-60	***Chavakachcheri U.C***	Problem area	Dry zone	Coastal, lagoon
M-20	**Chilaw U.C**	Problem area	Intermediate zone	Coastal, septage treatment is in operation
M-01	**Colombo M.C**	Problem area	Wet zone	Coastal, Some waterlogged areas
M-63	**Dambulla M.C**	Non-priority area	Dry zone	
M-04	**Dehiwala - Mount Lavinia M.C**	Problem area	Wet zone	Coastal, some waterlogged areas
M-62	**Embilipitiya U.C**	Non-priority area	Dry zone	
M-08	***Eravur U.C***	Problem area	Dry zone	Coastal, lagoon
M-18	**Galle M.C**	Problem area	Wet zone	Coastal, some waterlogged areas
M-40	**Gampaha M.C**	Non-priority area	Wet zone	
M-43	**Gampola U.C**	Non-priority area	Wet zone	Hill country
M-64	**Hambantota M.C**	Non-priority area	Dry zone	Coastal
M-37	**Haputhale U.C**	Non-priority area	Intermediate zone	Hill country
M-11	**Hatton - Dik Oya U.C**	Non-priority area	Intermediate zone	Hill country
M-29	**Hikkaduwa U.C**	Non-priority area	Wet zone	Coastal
M-50	**Horana U.C**	Non-priority area	Wet zone	
M-25	**Ja - Ela U.C**	Potential problem area	Wet zone	Near coast, marsh areas filled up
M-19	**Jaffna M.C**	Problem area	Dry zone	Peninsula, close to lagoon
M-38	**Kadugannawa U.C**	Non-priority area	Intermediate zone	Hill country
M-35	**Kaduwela M.C**	Non-priority area	Wet zone	
M-26	***Kalmunai M.C***	Problem area	Dry zone	Coastal, lagoon
M-22	**Kalutara U.C**	Non-priority area	Wet zone	Wet zone, coastal
M-27	**Kandy M.C**	Non-priority area	Intermediate zone	Hill country
P-07	***Karachchi P.S***	Non-priority area	Dry zone	
P-01	**Katana P.S**	Non-priority area	Wet zone	
M-03	**Kattankudy U.C**	Problem area	Dry zone	Coastal, lagoon
M-39	**Katunayake Seeduwa U.C**	Non-priority area	Wet zone	Coastal
M-44	**Kegalle U.C**	Non-priority area	Wet zone	Hill country
P-03	**Kelaniya P.S**	Problem area	Wet zone	Waterlogged areas, Low height above MSL
M-30	**Kesbewa U.C**	Non-priority area	Wet zone	
M-47	**Kinniya U.C**	Non-priority area	Dry zone	Coastal
M-02	**Kolonnawa U.C**	Non-priority area	Wet zone	
P-02	**Kotikawatta - Mulleriyawa P.S**	Problem area	Wet zone	Some waterlogged areas, Low height above MSL
M-56	**Kuliyapitiya U.C**	Non-priority area	Intermediate zone	
M-41	**Kurunegala M.C**	Non-priority area	Intermediate zone	Hill country
P-05	**Mahara P.S**	Non-priority area	Wet zone	
M-15	**Maharagama U.C**	Non-priority area	Wet zone	
M-51	**Mannar U.C**	Problem area	Dry zone	Island, waterlogged areas
P-10	***Maritimepattu P.S***	Non-priority area	Dry zone	Coastal
M-31	**Matale M.C**	Non-priority area	Intermediate zone	Hill country
M-28	**Matara M.C**	Problem area	Wet zone	Coastal, waterlogged areas
M-42	**Minuwangoda U.C**	Non-priority area	Wet zone	
P-08	**Moneragala P.S**	Non-priority area	Intermediate zone	
M-05	**Moratuwa M.C**	Problem area	Wet zone	Coastal, some waterlogged areas
M-14	**Nawalapitiya U.C**	Non-priority area	Wet zone	Hill country
M-16	**Negombo M.C**	Problem area	Wet/Intermediate zone	coastal, lagoon
M-48	**Nuwara Eliya M.C**	Non-priority area	Wet/Intermediate zone	Hill country
M-17	**Panadura U.C**	Problem area	Wet zone	Coastal, waterlogged areas
M-07	**Peliyagoda U.C**	Potential problem area	Wet zone	Marsh areas filled up
M-33	**Point Pedro U.C**	Non-priority area	Dry zone	Coastal
M-46	**Puttalam U.C**	Problem area	Dry zone	Coastal, lagoon
M-49	**Ratnapura M.C**	Non-priority area	Wet zone	Hill country
M-57	**Seethawakapura U.C**	Non-priority area	Wet zone	
M-12	**Sri Jayawardanapura Kotte M.C**	Problem area	Wet zone	Waterlogged areas, Low height above MSL
M-52	**Talawakele - Lindula U.C**	Non-priority area	Wet zone	Hill country
M-32	**Tangalle U.C**	Non-priority area	Dry zone	Coastal
P-09	**Thamankaduwa P.S**	Non-priority area	Dry zone	
M-24	**Trincomalee U.C**	Non-priority area	Dry zone	Coastal
M-55	***Valvettithurai U.C***	Non-priority area	Dry zone	Coastal
M-54	***Vavuniya U.C***	Non-priority area	Dry zone	
M-09	**Wattala Mabola U.C**	Problem area	Wet zone	Coastal, some waterlogged areas
M-53	***Wattegama U.C***	Non-priority area	Intermediate zone	Hill country
M-21	**Weligama U.C**	Problem area	Wet zone	Coastal, some waterlogged areas

Source: JET

APPENDIX 14 Toilet Improving Cost

In sanitary facilities, it could be observed that the use of water sealed toilet has become very popular in recent times. During the period from 1981 to 2012 the use of water sealed toilets has increased from 22.1% to 93.6%. According to census 2012, 86.7% of the dwelling units in Sri Lanka have a toilet for its own exclusive use while 10.9% of the units have shared toilets. Occupants of 0.7% of the dwelling units use public toilets.

During census 1981 dwelling units with no toilet facilities whatsoever were recorded as 33.5% while at census 2012 it is recorded as only 1.7%. Nevertheless, this should mean that numerically 88,280 dwelling units in the country have no toilet facilities. 68% of these dwelling units with no toilet facilities are located in the Northern, Eastern and North- central provinces.

When this position is considered district wise, it could be observed that in the districts of Mullaitivu (20.6%) and Kilinochchi (21.9%) one in every five dwelling units have no toilet facility while in Batticaloa district one in every eight dwelling units or 12.5% have no toilet facilities.

According to the 2012 census district wise distribution of toilet facility for household units are given in table below.

Toilet Facility for Household units

District	Total	Water seal and connected to a piped sewer system	Water seal and connected to a septic tank	Pour flush toilet (Not water seal)	Direct pit	Other	Not using a toilet
Colombo	572,475	457,919	95,894	8,172	8,631	1,534	325
Gampaha	604,009	561,768	24,117	10,277	6,551	536	760
Kalutara	305,737	292,195	6,638	3,284	2,710	123	787
Kandy	348,019	314,317	16,196	5,830	9,768	200	1,708
Matale	129,710	110,095	4,106	4,509	10,218	91	691
Nuwara Eliya	181,182	144,673	9,252	9,593	10,456	148	7,060
Galle	273,140	257,657	5,917	4,296	4,123	108	1,039
Matara	206,790	196,953	4,565	1,788	2,991	56	437
Hambantota	156,476	145,252	1,904	1,736	6,836	120	628
Jaffna	140,323	123,978	2,939	4,929	1,157	70	7,250
Mannar	23,975	19,382	713	1,014	353	8	2,505
Vavuniya	41,908	34,118	1,564	2,432	756	21	3,017
Mullaitivu	24,896	16,118	744	1,488	1,326	80	5,140
Kilinochchi	28,369	18,396	1,217	1,571	937	42	6,206
Batticaloa	134,966	111,166	1,697	4,297	817	64	16,925
Ampara	165,166	140,376	7,892	6,073	6,397	85	4,343
Trincomalee	96,951	83,647	2,656	4,406	2,526	75	3,641
Kurunegala	443,349	416,194	8,159	5,963	8,313	156	4,564
Puttalam	202,796	185,401	4,646	3,410	2,737	77	6,525
Anuradhapura	231,356	204,734	6,891	5,688	8,734	99	5,210
Polonnaruwa	111,010	97,262	2,817	2,404	6,333	60	2,134
Badulla	214,900	189,711	8,077	6,264	8,524	118	2,206
Moneragala	120,137	102,560	4,331	2,248	8,610	72	2,316
Ratnapura	285,893	255,586	12,250	4,775	11,490	142	1,650
Kegalle	220,749	203,790	5,140	5,285	5,250	69	1,215
Sri Lanka	5,264,282	4,683,248 88.96%	240,322 4.57%	111,732 2.12%	136,544 2.59%	4,154 0.08%	88,282 1.68%

Source: 2012 Census

According to the types of toilet considered in the 2012 census, all sealed types toilets can be taken as improved toilets. Hence, total improved toilets in the country is 4,923,570 (4,683,248 + 240,322)

according to the 2012 census. Only non-sealed type toilets can be improved converting to the sealed type toilets while rest of the household required new toilet facilities. According to the 2012 census toilet improvement required for 111,732 households while new water sealed type toilet required for 228,980 (136,544 + 4,154 + 88,282) households. It was planned for 100% improved sanitation facilities by 2020 according to the Sri Lanka country paper presented in SACOSAN VI – 2016. The toilet facilities that need improvement calculated based on 2012 census was prorated using predicted population growth are given in the table below.

Number of Households where improvement and new toilet are required

	2012	2015	2020	2025	2030	2035
Growth rate	0.60%	0.58%	0.53%	0.48%	0.44%	0.41%
Population	20,277,597	20,633,623	21,189,946	21,706,994	22,190,707	22,645,723
Household units	5,264,282	5,356,710	5,501,138			
Household with improved toilet (water sealed) facilities	4,923,570	5,010,016	5,145,096			
Households with non-water sealed toilet facilities where improvements required	111,732	113,694	116,759			
Households where new toilet facilities are required	228,980	233,000	239,283			

Source: JET

Investment plan calculated for improvement of sanitation facilities based on the Rs 150,000/- per construction of new toilet (including water sealed squatting pan, precast septic tank (1.8m^3), soaking pit & brickwork building) & Rs 75,000/- for improvement of existing facilities (only water sealed squatting pan & precast septic tank) are given in the table below,

Cost of Onsite Facility

Year	No of toilets to be improved	Cost for improvement (Million Rs)	No of new toilet to be constructed	Cost for new units (Million Rs)	Total investment for onsite facility in million RS
2017	29,189	2,189.22	59,820	8,973.11	11,162.33
2018	29,190	2,189.22	59,821	8,973.11	11,162.33
2019	29,190	2,189.22	59,821	8,973.11	11,162.33
2020	29,190	2,189.22	59,821	8,973.11	11,162.33
Total	116,759	8,756.9	239,283	35,892.45	44,649.35

Source: JET

With the improvement of sanitation facilities need for the septage treatment also arose to empty the septic tank at least once in five years. According to the literature septatge generation rate is 0.23m^3 per capita per year. Based on this, assuming 0.4m^3 per capita per year as septage sludge is produced. It is proposed to complete the establishment of septatge treatment facilities for the country by 2035. Hence, total volume of septage to be treated in 2035 would be 23,058 m^3 per day (=(22,645,723-160,737)*0.4/365) for the predicted population of 22,645,723 and sewerage served population of 1,604,737.

Based on Chilaw Septage treatment plant of Rs 110million SLR with 34 m^3/d, 74.59 billion Rs (=23,058*110 million/34) is required for all island. If co-sludge treatment with septage in 15 cities, 73.96 billion Rs(=(22,645,723-1,783,049)*0.4/365*110 million/34) for septage treatment plant is required.

For only 74cities, 13.49 billion Rs(=3,807,417*0.4/365*110million/34) is required. If co-sludge treatment in 15 cities, 12.34 billion Rs(=3,480,593*0.4/365*110million/34) is required.

Cost of Septage Treatment Plant

Septage Treatment Plant	Septage User Population	Costs by 2035	Annual Cost
For all island	22,484,986 (=22,645,723-160,737	74.59 Billion Rs	3.92 Billion Rs/year (=74.59/19)
For all island except for co-sludge treatment	20,862,674 (=22,645,723-1,783,049	73.96 Billion Rs	3.89 Billion Rs/year (=73.96/19)
For 74 cities	3,807,417	13.49 Billion Rs	0.71 Billion Rs/year (=13.49/19)
For 74 cities except for co-sludge treatment	3,480,593	12.34 Billion Rs	0.64 Billion Rs/year (=12.34/19)

Source: JET

APPENDIX 15 Tolerance limits (into sea outfall etc.)

Tolerance limits for the discharge of wastewaters or effluents from a prescribed activity into the public sewer network, connected either to a common treatment plant or a sea outfall or a combination of both

No.	Parameter	Unit, type of limit	Tolerance limit values
1.	Total suspended solids	mg/1, max.	500
2.	Total dissolved solids	mg/1, max.	3000
3.	pH at the ambient temperature	-	5.5 – 9.0
4.	Biochemical oxygen demand (BOD_5 in five daysat 200 C)	mg/1,max.	400
5.	Temperature at the measurement point	0C, max	45
6.	Oils and greases	mg/1, max.	20
7.	Phenols (Total)	mg/1, max.	5.0
8.	Chemical oxygen demand (COD)	mg/1, max.	800
9.	Colour Maximum spectral absorption co efficient - Wave length range 436 nm, (Yellow range) 525 nm, (Red range) 620 nm, (blue range)	 m-1, max. m-1, max. m-1, max.	 7 5 3
10.	Total Phosphorous(as P)	mg/1, max.	3.5
11.	Total Kjeldhal nitrogen (as N)	mg/1, max.	350
12.	Free Ammonia (as N)	mg/1, max.	50
13.	Ammonical nitrogen (as N)	mg/1, max.	50
14.	Total Cyanide (as CN)	mg/1, max.	2.0
15.	Total residual chlorine (as OCl-)	mg/1, max.	2.0
16.	Chlorides (as Cl)	mg/1, max.	1200
17.	Fluorides (as F)	mg/1, max.	10
18.	Sulphides (asS)	mg/1, max.	2.0
19.	Arsenic, total (as As)	mg/1, max.	0.1
20.	Cadmium, total (as Cd)	mg/1, max.	0.1
21.	Chromium, total (as Cr)	mg/1, max.	2.0
22.	Chromium, hexavalent (as Cr6+)	mg/1, max.	0.5
23.	Copper, total (as Cu)	mg/1, max.	3.0
24.	Lead (as Pb)	mg/1, max.	0.1
25.	Mercury, total (as Hg)	mg/1, max.	0.005
26.	Nickel, total (as Ni)	mg/1,max.	3.0
27.	Selenium (as Se)	mg/1,max.	0.1
28.	Zinc, total (as Zn)	mg/1,max.	5.0
29.	Pesticides (Total)	mg/1,max.	0.005
30.	Surfactants (Total)	mg/l, max.	50
31.	Sulphates (as SO_4^{2-})	mg/l, max.	1000
32.	Radio Active Material: (a) Alpha emitters (b) Beta emitters	 μ curie/ml, max μ curie/ml, max	 10^{-8} 10^{-7}

Note: The following materials should not include in the waste:

- Discharge of highly viscous material
- Sludge including Calcium Carbide
- Substances producing inflammable vapours
- Oil based substances

Source: CEA

APPENDIX 16 Tolerance limits (irrigation purposes)

Tolerance limits for the discharge of wastewaters or effluents (industrial / domestic) from a prescribed activity on land for irrigation purposes

No.	Parameter	Unit, type of limit	Tolerance limit values for on land disposal
1.	Total dissolved solids	mg/1, max.	2000
2.	pH at ambient temperature	-	6.5 – 8.5
3.	Biochemical oxygen demand (BOD_5 in five days at 200 C)	mg/1,max.	250
4.	Oils and greases	mg/1,max.	10
5.	Chemical oxygen demand (COD)	mg/1,max.	400
6.	Chlorides (as Cl)	mg/1,max.	300
7.	Sulphates (as SO_4)	mg/1,max.	1000
8.	Boron (as B)	mg/1,max.	2.0
9.	Arsenic (as As)	mg/1,max.	0.1
10.	Cadmium (as Cd)	mg/1,max.	0.01
11.	Chromium, total (as Cr)	mg/1,max.	0.1
12.	Lead (as Pb)	mg/1,max.	5.0
13.	Mercury (as Hg)	mg/1,max.	0.001
14.	Sodium adsorption ratio (SAR)	-	Less than 10
15.	Residual Sodium carbonate (RSC)	mili-equivalant /L, max.	1.25
16.	Nitrate (as NO_3)	mg/1,max.	45
17.	Electrical conductivity	ds/m, max.	<1000
18.	Faecal coliform levels	MPN/100ml, max.	1000
19.	Copper (as Cu)	mg/1,max.	0.2
20.	Cyanide (as CN)	mg/1,max.	0.2
21.	Radioactive material (a) Alpha emitters (b) Beta emitters	 micro curie/ml, max. micro curie/ml, max.	 10^{-9} 10^{-8}
22.	Discharge rate	m^3/hectare. day	as decided in accordance with the notes given herein below

Note 1: The effluent discharge on land should only be allowed under the following conditions;
a)The highest seasonal groundwater table usually envisaged during rainy season should be at least 0.5metres below the existing ground surface.
b)The natural slope of the existing ground surface should not be steeper than 30 Percent (or 16.7 degrees).
Note 2:The in-situ infiltration rate of the land to which the effluents be discharged should be measured in accordance with the standard test method for infiltration rate of soils in the field using double- ring infiltrometer as stipulated in ASTM D3385-09 by a competent authority and the test report should be forwarded to the Authority for the approval.
Note 3:The number of in-situ tests to be carried out for the land to which the effluents discharge is planned should be decided as follows;
(i)For a land having an extent less than 0.1 hectares ($1000m^2$) - 1 test
(ii)For a land having an extent less than 1.0 hectare ($10,000m^2$) - 2 tests and greater than 0.1 hectares ($1000m^2$)
(iii)For a land having an extent greater than 1.0 hectares ($10,000m^2$) -2 tests +1 test for every additional hectare in order to account for factor of safety
Note 4:The design infiltration rate should be taken as one third of the average infiltration rate obtained from the number of field tests carried out for the given land and be expressed in terms of cubic meters per hectare per day. The maximum allowable effluent discharge rate for the given land should be the rate at which the effluent discharge on to the land is allowed and it should be taken as the design infiltration rate expressed in terms of cubic meters per hectare per day.
Note 5:A report encompassing method of delivery of effluents to the land, method of irrigation over the land, number of hours of application, its storage facilities and the type of crops to be irrigated should be submitted to the Authority for the approval.
Source: CEA

APPENDIX 17 Population Projection

Area	Population				Average Annua Average Growth Rate				Year		Projection				
	1981	2001	2007	2012	81 - 01	01 - 12	81 - 12	07 - 12		2012	2015	2020	2025	2030	2035
Sri Lanka	**14,846,274**	**18,797,257**		**20,277,597**	**1.19%**	**0.69%**			**Growth Rate**	**0.60%**	**0.58%**	**0.53%**	**0.48%**	**0.44%**	**0.41%**
									Population	20,277,597	20,633,623	21,189,946	21,706,994	22,190,707	22,645,723
Western Province															
Colombo	**1,675,847**	**2,251,274**		**2,323,826**	**1.49%**	**0.29%**			**Growth Rate**	**0.22%**	**0.21%**	**0.18%**	**0.16%**	**0.14%**	**0.12%**
1 Colombo MC						-1.28%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		647,100		561,314					Population	561,314	561,314	561,314	561,314	561,314	561,314
2 Kolonnawa UC						0.57%			Growth Rate	0.44%	0.42%	0.36%	0.31%	0.27%	0.24%
		56,396		60,044					Population	60,044	60,802	61,915	62,887	63,751	64,529
3 Dehiwala - Mount Lavinia MC						-1.19%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		210,546		184,468					Population	184,468	184,468	184,468	184,468	184,468	184,468
4 Moratuwa MC						-0.49%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		177,563		168,280					Population	168,280	168,280	168,280	168,280	168,280	168,280
5 Sri Jayawardanapura Kotte MC						-0.68%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		116,366		107,925					Population	107,925	107,925	107,925	107,925	107,925	107,925
6 Boralesgamuwa UC						0.59%			Growth Rate	0.46%	0.43%	0.37%	0.32%	0.28%	0.25%
		56,362		60,110					Population	60,110	60,889	62,035	63,035	63,925	64,727
7 Maharagama UC						0.54%			Growth Rate	0.42%	0.39%	0.34%	0.29%	0.26%	0.23%
		185,193		196,423					Population	196,423	198,751	202,167	205,145	207,790	210,172
8 Kesbewa UC						1.73%			Growth Rate	1.35%	1.27%	1.10%	0.95%	0.83%	0.74%
		153,257		185,122					Population	185,122	192,265	203,094	212,880	221,841	230,132
9 Kaduwela MC						1.71%			Growth Rate	1.33%	1.25%	1.09%	0.93%	0.82%	0.73%
		209,251		252,041					Population	252,041	261,617	276,124	289,222	301,209	312,293
10 Seethawakapura UC						3.13%			Growth Rate	2.43%	2.29%	1.99%	1.71%	1.49%	1.33%
		21,601		30,308					Population	30,308	32,441	35,798	38,959	41,960	44,824
Kotikawatta - Mulleriyawa PS						2.09%			Growth Rate	1.63%	1.53%	1.33%	1.14%	1.00%	0.89%
		104,851		131,643					Population	131,643	137,789	147,197	155,789	163,730	171,137
Ganpaha	**1,367,813**	**2,063,684**		**2,298,588**	**2.08%**	**0.98%**			**Growth Rate**	**0.83%**	**0.80%**	**0.72%**	**0.64%**	**0.58%**	**0.52%**
11 Peliyagoda UC						-0.66%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		29,820		27,736					Population	27,736	27,736	27,736	27,736	27,736	27,736
12 Wattala Mabola UC						-0.23%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		28,740		28,031					Population	28,031	28,031	28,031	28,031	28,031	28,031
13 Negombo MC						1.44%			Growth Rate	1.21%	1.16%	1.05%	0.93%	0.84%	0.77%
		121,701		142,449					Population	142,449	147,484	155,388	162,783	169,749	176,349
14 Ja - Ela UC						0.13%			Growth Rate	0.11%	0.10%	0.09%	0.08%	0.08%	0.07%
		30,791		31,232					Population	31,232	31,330	31,478	31,610	31,730	31,839
15 Katunayake Seeduwa UC						-1.64%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		73,030		60,915					Population	60,915	60,915	60,915	60,915	60,915	60,915
16 Gampaha MC						18.90%			Growth Rate	0.83%	0.80%	0.72%	0.64%	0.58%	0.52%
		9,284		62,335					Population	62,335	63,835	66,157	68,296	70,282	72,140
17 Minuwangoda UC						-0.05%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		7,567		7,523					Population	7,523	7,523	7,523	7,523	7,523	7,523
Kelaniya PS						0.43%			Growth Rate	0.36%	0.35%	0.31%	0.28%	0.25%	0.23%
		104,544		109,603					Population	109,603	110,751	112,498	114,076	115,517	116,844
Ja - Ela PS						0.93%			Growth Rate	0.78%	0.75%	0.67%	0.60%	0.54%	0.49%
		153,875		170,289					Population	170,289	174,139	180,088	185,555	190,624	195,358
Biyagama PS						1.33%			Growth Rate	1.12%	1.08%	0.97%	0.86%	0.78%	0.71%
		161,300		186,585					Population	186,585	192,678	202,210	211,094	219,436	227,314
Wattala PS						1.06%			Growth Rate	0.89%	0.85%	0.77%	0.68%	0.62%	0.56%
		131,387		147,494					Population	147,494	151,305	157,217	162,676	167,757	172,520
Mahara PS						1.43%			Growth Rate	1.21%	1.16%	1.04%	0.93%	0.84%	0.76%
		177,698		207,782					Population	207,782	215,079	226,529	237,238	247,323	256,875
Katana PS						0.67%			Growth Rate	0.56%	0.54%	0.49%	0.43%	0.39%	0.35%
		161,796		174,063					Population	174,063	176,891	181,226	185,174	188,806	192,173
Gampaha PS						1.61%			Growth Rate	1.35%	1.30%	1.17%	1.04%	0.94%	0.85%
		113,579		135,332					Population	135,332	140,669	149,087	157,008	164,508	171,646
Kalutara	**823,964**	**1,066,239**		**1,214,880**	**1.30%**	**1.19%**			**Growth Rate**	**1.16%**	**1.15%**	**1.13%**	**1.10%**	**1.08%**	**1.05%**
18 Beruwala UC						1.21%			Growth Rate	1.18%	1.17%	1.15%	1.12%	1.10%	1.07%
		33,096		37,793					Population	37,793	39,137	41,437	43,813	46,265	48,794
19 Panadura UC						-0.98%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		33,514		30,069					Population	30,069	30,069	30,069	30,069	30,069	30,069
20 Kalutara UC						-1.30%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		37,451		32,417					Population	32,417	32,417	32,417	32,417	32,417	32,417
21 Horana UC						0.41%			Growth Rate	0.40%	0.40%	0.39%	0.38%	0.37%	0.36%
		9,127		9,550					Population	9,550	9,665	9,855	10,044	10,232	10,420
Panadura PS						NA			Growth Rate	1.16%	1.15%	1.13%	1.10%	1.08%	1.05%
		NA		152,216					Population	152,216	157,537	166,637	176,028	185,712	195,692
Central Province															
Kandy	**1,032,335**	**1,279,028**		**1,368,216**	**1.08%**	**0.61%**			**Growth Rate**	**0.53%**	**0.51%**	**0.47%**	**0.43%**	**0.39%**	**0.36%**
22 Nawalapitiya UC						-0.13%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		13,532		13,338					Population	13,338	13,338	13,338	13,338	13,338	13,338
23 Kandy MC						-0.91%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		109,343		98,828					Population	98,828	98,828	98,828	98,828	98,828	98,828
24 Kadugannawa UC						23.64%			Growth Rate	0.53%	0.51%	0.47%	0.43%	0.39%	0.36%
		1,226		12,654					Population	12,654	12,850	13,156	13,439	13,702	13,948
25 Gampola UC						4.19%			Growth Rate	0.53%	0.51%	0.47%	0.43%	0.39%	0.36%
		24,116		37,871					Population	37,871	38,459	39,373	40,219	41,007	41,745
26 Wattegama UC						0.44%			Growth Rate	0.38%	0.37%	0.34%	0.31%	0.28%	0.26%
		7,770		8,157					Population	8,157	8,248	8,389	8,519	8,638	8,750
Akurana PS						1.18%			Growth Rate	1.02%	0.99%	0.90%	0.82%	0.74%	0.68%
		55,744		63,397					Population	63,397	65,290	68,287	71,115	73,800	76,358
Kandy Four Gravets & Gangawata Korale PS						1.06%			Growth Rate	0.92%	0.89%	0.82%	0.74%	0.67%	0.62%
		57,864		65,015					Population	65,015	66,770	69,540	72,144	74,606	76,944
Matale	**352,860**	**441,328**		**482,348**	**1.12%**	**0.81%**			**Growth Rate**	**0.74%**	**0.72%**	**0.68%**	**0.63%**	**0.59%**	**0.55%**
27 Matale MC						0.09%			Growth Rate	0.08%	0.08%	0.08%	0.07%	0.07%	0.06%
		36,103		36,462					Population	36,462	36,550	36,687	36,815	36,936	37,049
28 Dambulla MC						1.71%			Growth Rate	1.56%	1.52%	1.43%	1.33%	1.24%	1.17%
		19,757		23,814					Population	23,814	24,917	26,750	28,576	30,397	32,212
NuwaraEliya	**583,716**	**703,610**		**706,210**	**0.94%**	**0.03%**			**Growth Rate**	**0.02%**	**0.02%**	**0.02%**	**0.02%**	**0.01%**	**0.01%**
29 Hatton - Dikoya UC						0.24%			Growth Rate	0.18%	0.17%	0.14%	0.12%	0.10%	0.09%
		14,204		14,585					Population	14,585	14,659	14,764	14,853	14,931	15,000
30 NuwaraEliya MC						-0.58%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		25,388		23,804					Population	23,804	23,804	23,804	23,804	23,804	23,804
31 Talawakele - Lindula UC						2.75%			Growth Rate	2.05%	1.92%	1.63%	1.38%	1.19%	1.05%
		3,481		4,691					Population	4,691	4,966	5,384	5,766	6,118	6,446

Southern Province																
Galle	**805,403**	**990,487**		**1,059,046**	**1.04%**	**0.61%**			**Growth Rate**	**0.53%**	**0.51%**	**0.47%**	**0.43%**	**0.39%**	**0.36%**
32 Galle MC						-0.40%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		90,270		86,333					Population	86,333	86,333	86,333	86,333	86,333	86,333
33 Ambalangoda UC						0.16%			Growth Rate	0.14%	0.13%	0.12%	0.11%	0.10%	0.09%
		19,651		19,990					Population	19,990	20,069	20,190	20,300	20,402	20,496
34 Hikkaduwa UC						-0.28%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		27,932		27,075					Population	27,075	27,075	27,075	27,075	27,075	27,075
Matara	**642,235**	**761,370**		**810,703**	**0.85%**	**0.57%**			**Growth Rate**	**0.51%**	**0.50%**	**0.46%**	**0.43%**	**0.40%**	**0.37%**
35 Weligama UC						0.28%			Growth Rate	0.25%	0.24%	0.23%	0.21%	0.19%	0.18%
		21,698		22,377					Population	22,377	22,541	22,799	23,038	23,262	23,473
36 Matara MC						5.16%			Growth Rate	0.51%	0.50%	0.46%	0.43%	0.40%	0.37%
		42,663		74,193					Population	74,193	75,307	77,070	78,729	80,298	81,788
Hnbantota	**421,277**	**526,414**		**595,877**	**1.12%**	**1.13%**			**Growth Rate**	**1.14%**	**1.14%**	**1.14%**	**1.15%**	**1.15%**	**1.16%**
37 Tangalle UC						-1.88%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		10,437		8,473					Population	8,473	8,473	8,473	8,473	8,473	8,473
38 Hambantota MC						6.92%			Growth Rate	1.14%	1.14%	1.14%	1.15%	1.15%	1.16%
		11,134		23,236					Population	23,236	24,039	25,444	26,937	28,524	30,210
Northern Province																
Jaffna	**734,474**		**559,619**	**583,071**		NA	**-0.74%**	**0.82%**	**Growth Rate**	**0.82%**	**0.82%**	**0.82%**	**0.82%**	**0.82%**	**0.82%**
39 Jaffna MC						NA		0.51%	Growth Rate	0.51%	0.51%	0.51%	0.51%	0.51%	0.51%
		NA	78,781	80,829					Population	80,829	82,083	84,217	86,406	88,653	90,957
40 Point Pedro UC						NA		0.46%	Growth Rate	0.46%	0.46%	0.46%	0.46%	0.46%	0.46%
		NA	12,056	12,334					Population	12,334	12,504	12,792	13,087	13,389	13,698
41 Valvettithurai UC						NA		4.59%	Growth Rate	0.82%	0.82%	0.82%	0.82%	0.82%	0.82%
		NA	6,617	8,283					Population	8,283	8,490	8,845	9,216	9,602	10,005
42 Chavakachcheri UC						NA		0.83%	Growth Rate	0.83%	0.83%	0.83%	0.83%	0.83%	0.83%
		NA	15,478	16,129					Population	16,129	16,533	17,228	17,953	18,708	19,495
Mannar	**105,276**			**99,063**			**-0.20%**		**Growth Rate**	**0.20%**	**0.20%**	**0.20%**	**0.20%**	**0.20%**	**0.20%**
43 Mannar UC						NA			Growth Rate	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%
		NA		24,417					Population	24,417	24,564	24,810	25,060	25,311	25,565
Vacuniya	**93,694**	NA		**172,789**			**1.99%**		**Growth Rate**	**1.19%**	**1.15%**	**1.05%**	**0.95%**	**0.87%**	**0.80%**
44 Vavuniya UC						NA			Growth Rate	1.19%	1.68%	1.54%	1.39%	1.27%	1.17%
		NA		34,816					Population	34,816	36,598	39,501	42,331	45,097	47,804
Mullaitivu	**73,886**			**92,228**			**0.72%**		**Growth Rate**	**0.43%**	**0.41%**	**0.38%**	**0.34%**	**0.31%**	**0.29%**
Maritimepattu PS									Growth Rate	0.43%	0.41%	0.38%	0.34%	0.31%	0.29%
		NA		28,973		NA			Population	28,973	29,334	29,894	30,410	30,890	31,339
Kilinochchi	**90,778**			**112,872**			**0.71%**		**Growth Rate**	**0.42%**	**0.41%**	**0.37%**	**0.34%**	**0.31%**	**0.28%**
Karachchi PS						NA			Growth Rate	0.42%	0.41%	0.37%	0.34%	0.31%	0.28%
		NA		61,484					Population	61,484	62,236	63,403	64,479	65,479	66,413
Eastern Province																
Batticaloa	**329,343**		**515,857**	**525,186**			**1.52%**	**0.36%**	**Growth Rate**	**0.36%**	**0.35%**	**0.32%**	**0.29%**	**0.26%**	**0.24%**
45 Kattankudy UC						NA		0.42%	Growth Rate	0.42%	0.40%	0.37%	0.34%	0.31%	0.28%
		NA	39,523	40,356					Population	40,356	40,847	41,609	42,311	42,964	43,574
46 Eravur UC						NA			Growth Rate	0.36%	0.35%	0.32%	0.29%	0.26%	0.24%
		NA		24,643					Population	24,643	24,900	25,299	25,665	26,005	26,322
47 Batticaloa MC						NA		**-0.51%**	Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		NA	88,459	86,227					Population	86,227	86,227	86,227	86,227	86,227	86,227
Ampara	**383,275**	**592,997**		**645,825**	**2.21%**	**0.78%**			**Growth Rate**	**0.63%**	**0.60%**	**0.53%**	**0.47%**	**0.42%**	**0.37%**
48 Akkaraipattu MC						1.20%			Growth Rate	0.98%	0.93%	0.83%	0.72%	0.64%	0.58%
		27,117		30,934					Population	30,934	31,807	33,142	34,356	35,472	36,509
49 Kalmunai MC						0.50%			Growth Rate	0.41%	0.39%	0.34%	0.30%	0.27%	0.24%
		94,579		99,893					Population	99,893	101,053	102,790	104,334	105,726	106,995
50 Ampara UC						2.08%			Growth Rate	1.69%	1.61%	1.42%	1.24%	1.11%	1.00%
		17,957		22,511					Population	22,511	23,614	25,342	26,959	28,483	29,930
Trinconalee	**250,771**		**334,363**	**376,366**				**2.39%**	**Growth Rate**	**2.39%**	**2.31%**	**2.12%**	**1.92%**	**1.76%**	**1.62%**
51 Trincomalee UC						NA		-1.26%	Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		NA	51,524	48,351					Population	48,351	48,351	48,351	48,351	48,351	48,351
52 Kinniya UC						NA		0.62%	Growth Rate	0.62%	0.60%	0.55%	0.50%	0.46%	0.42%
		NA	35,645	36,772					Population	36,772	37,442	38,489	39,463	40,375	41,233
North-Western Province																
Kurunegala	**1,198,795**	**1,460,215**		**1,611,407**	**0.99%**	**0.90%**			**Growth Rate**	**0.87%**	**0.86%**	**0.84%**	**0.82%**	**0.80%**	**0.78%**
53 Kurunegala MC						-1.21%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		28,401		24,833					Population	24,833	24,833	24,833	24,833	24,833	24,833
54 Kuliyapitiya UC						-1.20%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		6,290		5,509					Population	5,509	5,509	5,509	5,509	5,509	5,509
Puttalam	**485,619**	**709,677**		**760,778**	**1.92%**	**0.63%**			**Growth Rate**	**0.51%**	**0.49%**	**0.43%**	**0.38%**	**0.33%**	**0.30%**
55 Chilaw UC						-0.84%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		23,533		21,441					Population	21,441	21,441	21,441	21,441	21,441	21,441
56 Puttalam UC						0.78%			Growth Rate	0.63%	0.60%	0.53%	0.46%	0.41%	0.37%
		41,761		45,511					Population	45,511	46,339	47,585	48,700	49,711	50,637
North-Central Province																
Anuradhapura	**575,546**	**745,693**		**855,562**	**1.30%**	**1.26%**			**Growth Rate**	**1.24%**	**1.24%**	**1.23%**	**1.21%**	**1.20%**	**1.19%**
57 Anuradhapura MC						-0.45%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		53,151		50,595					Population	50,595	50,595	50,595	50,595	50,595	50,595
Polonnarua	**253,411**	**358,804**		**403,859**	**1.75%**	**1.08%**			**Growth Rate**	**0.95%**	**0.92%**	**0.85%**	**0.77%**	**0.71%**	**0.66%**
Thamankaduwa PS						0.96%			Growth Rate	0.84%	0.82%	0.75%	0.69%	0.63%	0.58%
		74,224		82,426					Population	82,426	84,460	87,687	90,735	93,629	96,388
Uva Province																
Budulla	**620,839**	**779,983**		**811,225**	**1.15%**	**0.36%**			**Growth Rate**	**0.29%**	**0.27%**	**0.24%**	**0.21%**	**0.19%**	**0.17%**
58 Badulla MC						0.27%			Growth Rate	0.22%	0.21%	0.18%	0.16%	0.14%	0.13%
		41,005		42,237					Population	42,237	42,498	42,884	43,223	43,525	43,798
59 Bandarawela MC						11.50%			Growth Rate	0.29%	0.27%	0.24%	0.21%	0.19%	0.17%
		7,296		24,168					Population	24,168	24,366	24,661	24,919	25,151	25,360
60 Haputhale UC						4.57%			Growth Rate	0.29%	0.27%	0.24%	0.21%	0.19%	0.17%
		3,235		5,288					Population	5,288	5,331	5,396	5,452	5,503	5,549
Monaragala	**269,684**	**396,521**		**448,194**	**1.95%**	**1.12%**			**Growth Rate**	**0.97%**	**0.94%**	**0.86%**	**0.78%**	**0.71%**	**0.65%**
Moneragala Ps						1.41%			Growth Rate	1.22%	1.18%	1.08%	0.98%	0.89%	0.82%
		42,457		49,520					Population	49,520	51,297	54,134	56,838	59,426	61,911
Sabaragamuwa Province																
Ratnapura	**779,927**	**1,015,807**		**1,082,299**	**1.33%**	**0.58%**			**Growth Rate**	**0.48%**	**0.46%**	**0.41%**	**0.37%**	**0.33%**	**0.30%**
61 Ratnapura MC						0.18%			Growth Rate	0.15%	0.14%	0.13%	0.11%	0.10%	0.09%
		46,183		47,105					Population	47,105	47,308	47,612	47,883	48,128	48,350
62 Balangoda UC						2.89%			Growth Rate	2.41%	2.31%	2.07%	1.83%	1.64%	1.49%
		12,062		16,510					Population	16,510	17,679	19,582	21,438	23,254	25,034
63 Embilipitiya UC						1.03%			Growth Rate	0.86%	0.82%	0.74%	0.65%	0.58%	0.53%
		32,797		36,712					Population	36,712	37,623	39,027	40,314	41,504	42,613
Kegalle	**678,456**	**785,524**		**837,179**	**0.74%**	**0.58%**			**Growth Rate**	**0.54%**	**0.53%**	**0.51%**	**0.48%**	**0.45%**	**0.43%**
64 Kegalle UC						-0.63%			Growth Rate	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		17,139		15,993					Population	15,993	15,993	15,993	15,993	15,993	15,993

2001 Census Data: obtained from Census and statistic Department in March, 2016
2001 Census Data: obtained from Census and statistic Department in April, 2016

Source: JET, based on 2001 Census Data

APPENDIX 18 O&M costs

O&M of sewerage system is calculated on the existing costs of Morayuwa/ Ratmalana.

The table shows the O&M costs for 11 months.

The estimated annual costs is 47,607,000 LKR (=43,640,008 / 11 *12).

Since the present sewage flow is 5,000 m^3/d, O&M cost as sewage flow is 26.1 LKR/m^3/d (=47,607,000/365/5,000).

Since sewage volume of 15 cities is 784,542 m^3/d, the estimated annual O&M cost is 7,474,000,000 LKR (=26.1*784,542*365).

Moratuwa Ratmalana – 8119

Type of Expenditure	Moratuwa Ratmalana WWTP	Moratuwa Ratmalana Distribution Network	Moratuwa (Soysapura)	Total
Salary			21,586,000.00	21,586,000.00
Utility Cost	9,460,008.00	3,300,000.00	103,000.00	12,863,008.00
Chemical Cost	383,000.00	–		383,000.00
Repair and Maintanance Cost	810,050.00	142,950.00	1,271,000.00	2,224,000.00
Establishment Cost	862,000.00	–	1,115,000.00	1,977,000.00
Security and Rent Cost	1,162,000.00	2,324,000.00	1,121,000.00	4,607,000.00
Total	**12,677,058.00**	**5,766,950.00**	**25,196,000.00**	**43,640,008.00**

APPENDIX 19 Plan for Management of Environmental Sensitive Areas

(1) Environmental Sensitive Areas

According to the Gazette Extraordinary No 777/22 of 24th June, 1993, following areas were declared as environmentally sensitive for the purpose of permitting development activities.

Within 100 m from the boundaries of or within any area declared under;

- National Heritage Wilderness Act No. 3 of 1988, the Forest Ordinance [Chapter 451]
- whether or not such areas are wholly or partly within the Coastal Zone as defined in the Coast Conservation Act, No. 57 of 1981.

Within the following areas whether or not the areas are wholly or partly within the Coastal Zone:

- any erodible area declared under the Soil Conservation Act (Chapter 450).
- any Flood Area declared under the Flood Protection Ordinance (Chapter 449) and any flood protection area declared under the Sri Lanka Land Reclamation and Development Corporation Act, No.15 of 1968 as amended by Act, No. 52 of 1982.
- 60 meters from the bank of a public stream as defined in the Crown Lands Ordinance (Chapter 454) and having a width of more than 25 meters at any point of its course.
- any reservation beyond the full supply level of a reservoir.
- any archaeological reserve, ancient or protected monument as defined or declared under the Antiquities Ordinance (Chapter 188).
- any area declared under the Botanic Gardens Ordinance (Chapter 446).
- "within 100 meters from the boundaries of, or within, any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (Chapter 469)".
- "within 100 meters from the high flood level contour of, or within, a public lake as defined in the Crown Lands Ordinance (Chapter 454) including those declared under section 71 of the said ordinance.".

For siting of any projects or undertakings wholly or partly within the above areas shall submit comprehensive EIA or IEE report irrespective to its magnitude in consideration for granting approval. In case of establishing STP, final disposal point shall be a priority concern than the other issues not only for declared environmental sensitive areas

(2) Assimilation Capacity

Assimilative Capacity is the ability of a body of water to cleanse itself; its capacity to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water.

Assimilative capacity is the relationship between water quality and quantity, land use, and the capability of the watercourse or lake, to resist the effects of landscape disturbance without impairment of water quality. An assimilative capacity study (ACS) develops specific scientific modelling to support and assist municipalities and other legislative authorities in predicting the impacts of land use. The ACS aims to conserve the natural resources of Lake and River in a cooperative, integrated manner that balances human needs with those of a sustainable natural environment. Combined efforts will ensure a safe drinking water supply, a healthy aquatic ecosystem and stream, increased recreational opportunities, sustainable agricultural operations, and a vibrant economy.
(Source:http://www.lsrca.on.ca/reports/acs.php#sthash.StVjW1kV.dpuf)

(3) Expected New Disposal Options

According to the prevailing environmental legislation of the country, effluent discharge standards were published in the Extraordinary Gazette No. 1534/18 of 01 February 2008. However, these norms currently being amended and will be enforced soon. More disposal options available under the new regulation as described below.

a) Tolerance limits for the discharge of wastewaters or effluents (industrial and/ or domestic) from a prescribed activity into the marine waters through;

* an outfall leading up to near shore water ("Near-Shore water" means the water in the area bounded by the mean low water line and a line drawn parallel to wave breaking with an elevation of minus 2.0 metres from the mean sea level)
* a short sea outfall ("Short sea outfall" means a pipeline or a tunnel that discharges wastewater or effluent from a prescribed activity and is laid underneath the marine water with a mechanism to achieve intended dilution in such a manner that there should be a minimum dilution factor of 1:10 at a distance of 10 metres from the point of exit of the pipeline or tunnel)
* a long sea outfall ("Long sea outfall" means a pipeline or a tunnel that discharges wastewater or effluent from a prescribed activity and is laid underneath the marine water with a mechanism to achieve intended dilution in such a manner that there should be a minimum dilution factor of 1:100 at a distance of 500 metres from the point of exit of the pipeline or tunnel)

b) Tolerance limits for the discharge of wastewaters or effluents (industrial/ domestic) from a prescribed activity into coastal waters

c) Tolerance limits for the discharge of wastewaters or effluents (industrial/ domestic) from a prescribed activity into the inland surface waters where dilution factor not less than 1:8.

d) Tolerance limits for the discharge of wastewaters or effluents (industrial/ domestic) from a prescribed activity on land for irrigation purposes

e) Tolerance limits for the discharge of wastewaters or effluents from a prescribed activity into the public sewer network, connected either to a common treatment plant or a sea outfall or a combination of both

Even though the number of disposal locations specified under the new regulation discharge of treated wastewater still have a problem especially in inland areas due to several reason.

* Seasonal variation of stream flow; most of the inland streams running dry during dry weather period. Hence, required dilution cannot be arrived to comply with the regulation even with the extensive treatment since dilution factor for many stream become zero.
* Lowest assimilation capacity of nearby stagnant water bodies is not known, hence, regulating authorities will not permit for discharge into such water bodies. Unlike flowing water, stagnant water takes longer recovery period in case of contamination.
* Dispose on land for irrigation also not feasible due to difficulty for finding suitable land in urban areas. However, this onsite disposal option shall be looked in carefully to avoid groundwater contamination.

  Note: In case of commercial/ industrial wastewater is added to the sewage treatment plant both land disposal and stagnant water body options shall be further looked in considering the possibility for accumulation of non-degradable pollutants such as heavy metals, inorganic salts (TDS), refractory organics etc, if significant plant uptake cannot be ensured.
* Transport and discharge into marine water through sea outfall or common treatment plant already in operation also not feasible option due to heavy transport cost, accident potential etc.

Since, there are many stagnant water bodies and flowing water bodies available in the country in close proximity to the urban areas determination of lowest assimilation capacity may be useful for disposal of treated effluent.

(4) Ocean Disposal of Sewage

1) Situation of Ocean Disposal of Sewage

Ocean disposal of sewage or sewage sludge used to be a wide spreads sewage disposal method in the past. But in recent years the number of ocean disposal practices is continuing to decrease globally due to the perception of possible marine environment contamination problems. **Table -A** shows the ocean outfall installations of the world. (Source: "Functional Appraisal of Marine Outfall For Domestic Waste Disposal through Tracer Technoque" Dr.Shivani Dhage et.al, International conference on desalination, environment and marine outfall systems, April 2014.)

Table -A Ocean Outfall Installations of the World

Continents	Country	Place
Africa	Morocco	Casablanca
Asia	Philippines	Manila Bay
	India	Mumbai
	Sri Lanka	Mutwall, Wellawaththa, Lunawa
Australia	Australia	Sydney
Europe	Spain	Barcelona, San Sebastian
	Portugal	Costa do Estoril
	Turkey	The Marmara Sea near Istanbul
	Croatia	Split
	UK	Edinburgh,The Thamed estuary down stream of London
North America	USA	Honolulu, the New York Bight, Southern California Bight
	Canada	Victoria
Latin America and the Carribbean	Colombia	Cartagena
	Brazil	Ipanema beach of Rio de Janeiro
	Dominican Republic	Sosua

Source: Dhage et al, 2014

In Sri Lanka, during 1983-1987, Greater Colombo constructed two 1,500mm diameter ocean outfalls at Mutwal and Wellawatte with the assistance of World Bank and Saudi.At these outfalls sewage is taken into the sea up to a distance of approximately 1.5 km before discharging. However, even preliminary treatment is not being done purely due to the cost factor. (Source: "Design of Sewerage System in Kirulapone for Colombo Municipality" Shahina M Mysan and Ananda Ranasinghe, Engineer-Vol.XLVII, No.4, 2014.) Sri Lank is ranked as fifth of the word countries in the amount of plastic waste discharged into the ocean in 2010. Sufficient care should be payed to pre-treatment in ocean disposal.

2) Advantages and Disadvantages of Ocean Disposal

Table -B Summarizes the advantages and disadvantages of ocean outfall of sewage or sewage sludge. (Source: "Functional Appraisal of Marine Outfall For Domestic Waste Disposal through Tracer Technoque" Dr.Shivani Dhage et.al, International conference on desalination, environment and marine outfall systems, April 2014, and "Biological Wastewater Treatment in Warm Climate Regions" Marcos von Sperling et.al, IWA publishing, 2005)

Table -B Advantages and Disadvantages of Ocean Disposal

Advantages	Disadvantages
Use of natural dilution & disperson of pollutants	Potential negative influence on environment
Low cost	− Water and sediment pollution
− Small energy consumption	− Alternation of the marine flora and fauna community
− Preliminary treatment is suffucient	− Contamination of elements of the food chain

Source: JET

Ocean disposal of sewage utilizes the natural dilution, dispersion and assimilation capacity of water bodies, thus it is a very simple and inexpensive way. Preliminary treatment to remove solid wastes and grit is sufficient, demanding far smaller energy than other conventional sewage treatment methods.

On the other hand, various possible negative influences on marine environment are pointed out as disadvantage of ocean disposal. Those are; water and sediment pollution, alternation of marine flora and fauna community and contamination of elements of the food chain. In installation of ocean outfall, those negative influences should be carefully surveyed and evaluated, but difficulties in evaluation are pointed out as the followings;

- Once the ocean outfall is operational, it is cumbersome to find its functional and operational behaviour in coastal region.
- Evaluation of extent of dilution achieved is complicated due to many reasons like, variation in direction and buoyancy of upward flow, density, currents, tidal effects and also the submergence of the physical components of the diffuser.
- Accurate information on compliance of the coastal water standards is not readily computable.

(Source: "Functional Appraisal of Marine Outfall For Domestic Waste Disposal through Tracer Technoque" Dr.Shivani Dhage et.al, International conference on desalination, environment and marine outfall systems, April 2014.)

3) Ocean outfall design

NWSDB Design Manual D7 "Wastewater collection, Treatment, Disposal and Re-use" (2012) describes the design of ocean outfall. According to the manual, "ocean disposal" is an accepted means and disposal provided that the assimilative capacity of the ocean at the discharge location is not exceeded and provided that the discharge does not give unacceptable pollution levels in recreation areas or in shellfish harvesting areas. NWSDB design manual D7 states that substances which bring about the following phenomena should not be contained in the receiving marine coastal waters.

- Rise of floating or suspended matter, oil, grease and foam;
- Production of sludge banks or slime infestation;
- Rise of heavy growth of attached plants or animals or blooms of plankton;
- Rise of discolouration or turbidity or the evolution of gases and odour;
- Being injurious or toxic to the natural ecology of the disposal area or which can be concentrated in food chains.

Regarding the health risk, there are no coliform criteria for marine waters in Sri Lanka standards. But the design manual recommends that a guideline faecal coliform value of 1,000/100mL not being exceeded in 80% of samples be adopted. The most important design factor of ocean outfall is principally based on dilution effect. The design manual describes the design procedure of ocean outfall in detail.

4) Ocean outfall modifications

As introduced in 7.6.3, there will be more options of wastewater disposal in the coming amendment of regulation according to the coming amendment of the regulation. There will be two types of sea outfalls; long sea outfall & short sea outfall were introduced under the new regulation for ocean disposal of effluent with the relevant tolerance limits for each (Refer **APPENDIX 10** for tolerance limits).

Sea outfall shall be established with the approval of relevant authorities including the environmental authority, in which scientific evident are required to ensure the existence of minimum dilution factor specified for each outfall with the support of bathymetric modelling study.

APPENDIX 20 Effect of Sewerage

Effect of introducing sewerage system is estimated by the reduction of pollution loads. The assumptions of estimation are as follows;

- BOD of law sewage is 130 mg/L (Source: NWSDB Design Manual D7).
- BOD removal rate of on-site treatment facility is 20%
- BOD removal rate of sewage treatment plant is 80%.
- BOD removal rate of sewage treatment is not considered.

The estimation is carried out by comparing pollution loads after 15 city's sewerage system with before sewerage system.

(1) Before sewerage system

Water consumption volume of 79 cities: 1,463,202 m^3/d
Water consumption volume of 74 cities: 1,354,093 m^3/d
Pollution loads from 79 cities: 152,172 kg as BOD/day (=130*1,463,202*0.8*10-3)
Pollution loads from 74 cities: 140,825 kgas BOD/day (=130*1,354,093*0.8*10-3)

(2) After sewerage system

Water consumption volume of 15 cities where sewerage system is developed: 779,425 m^3/d
Water consumption volume of 64 cities (=79-15): 683,777 m^3/d (=1,463,202-779,425)
Water consumption volume of 59 cities (=74-15): 574,668 m^3/d (=1,354,093-779,425)
Pollution loads from 15 cities: 20,265 kg as BOD/day (=130*779,425*0.2*10-3)
Pollution loads from 64ities: 71,113 kg as BOD/day (=130*683,779*0.8*10-3)
Pollution loads from 5 cities: 59,765 kg as BOD/day (=130*574,668*0.8*10-3)

(3) Reduced Pollution Load By Sewerage System

Reduced pollution load = Pollution load before sewerage system – pollution load after sewerage system:

For 79 cities, 60,794kg as BOD/day (=152,172-20,265-71,113)
For 74 cities, 60,795kg as BOD/day (=140,825-20,265-59,765)

Based on above calculation, about 40 % (=60,795/152,172*100) of pollution reduction is estimated by introducing sewerage system into 15 cities.

Quantitative improvement of water quality in surface water body after treated effluent is discharged into Public Water body

Consider a city with a population of 100,000 persons, presently discharging its untreated effluents into a receiving water stream like a river/tributary. It has been planned to provide a sewerage project to this city. Waste water will be treated so that the BOD is reduced to 30mg/l, the tolerance limit as per the regulations for the discharge into inland surface waters.

Purpose of the calculations:

It is necessary to get a quantitative idea, about the status of the quality of the water in stream after discharge, in terms of BOD, when the effluent is discharged, 1) without treatment and, 2) with treatment.

Following assumptions are made in this regard.

- Flow in the stream is sufficient to provide 1:8 dilution as per the regulations(to ensure this, minimum dry weather flow is considered).
- Existing BOD of the stream is 0 mg/l
- BOD of the sewage to be treated is 130mg/l
- Consumption of water is 130lpcd
- 80% of the consumed water is released to the environment as wastewater. For simplicity of calculations, no infiltration etc. into the collection system is considered

Calculations:
Total wastewater released = 100,000x130x0.8 l/day = 10400 m^3/day
With a 1:8 dilution, the minimum dry weather flow in the stream = 10400x8 = 83,200 m^3/day

1. Discharge of effluent without treatment :
   Total BOD of the effluent = 100,000x130x0.8x130 mg/day = 1352 kg/day
   Total flow, after discharge of the effluent, = 10400+ 83200 = 93,600 m^3/day
   &, BOD of the water at the discharge point = 3120/93600 kg/ m^3 = 14.4 mg/l
   (assuming that the effluent is evenly diffused in the stream flow)
   Note: The BOD value of 14.4mg/l is too high and above the BOD tolerance limit of 5mg/l prescribed under SL 722 Standard.

2. Discharge of effluent with treatment :
   Total BOD of the effluent = 100,000x130x0.8x30 mg/day = 312 kg/day
   Total flow, after discharge of the effluent = 10400+ 83200 = 93,600 m^3/day
   &, BOD of the water at the discharge point = 312/93600 kg/ m^3 = 3.3 mg/l
   (assuming that the effluent is evenly diffused in the stream flow)
   Note: The BOD value of 3.3mg/l is within the BOD tolerance limit of 5mg/l prescribed under SL 722 Standard.

Based on above calculation, water quality of a tributary as a discharging river with about 14 mg/L as BOD improves to about 3 mg/L as BOD by sewerage system.

APPENDIX 21 List of Joint Coordinating Committee and Technical Committee Members

(1) Joint Coordinating Committee (JCC) Members

Name	Position	Department/Organization
Mr. N D Hettiarachchi	Secretary	Ministry of City Planning and Water Supply
Ms. L Mangalika	Additional Secretary (Technical)	Ministry of City Planning and Water Supply
Ms. K A H K Perera	Assistant Director	Department of National Planning, Ministry of Policy Planning and Economic Affairs
Mr. Dhanushka Perera	Assistant Director	Department of External Resources, Ministry of Policy Planning and Economic Affairs
Ms. KG Samarasinghe	Project Director of GCWMP	Ministry of Provincial Council and Local Government
Mr. K A Ansar	Chairman	NWSDB
Mr. G A Kumararathna	Add.GM (Sewerage)	NWSDB
Mr. S G Jayawardena	DGM (Sewerage)	NWSDB
Mr. G D Neville	AGM (P&D-Sewerage)	NWSDB
Mr. D N Danesh Gunatilleke	Specialist (Sewerage)	NWSDB
Mr. M.M Umarlebbe	Assistant General Manager (Japanese Projects Unit)	NWSDB
JICA Sri Lanka Office		
JICA Exper Team		

Source: JET

(2) Technical Committee Members

Name	Position	Department/Organization
Mr. G A Kumararathna	Add.GM (Sewerage)	NWSDB
Mr. S G Jayawardena	DGM (Sewerage)	NWSDB
Mr. G D Neville	AGM (P&D-Sewerage)	NWSDB
Mr. D N Danesh Gunatilleke	Specialist (Sewerage)	NWSDB
Ms. K P P Dharmasena	CE (P&D-Sewerage)	NWSDB
Mr. G G Suthesen	CE (P&D-Sewerage)	NWSDB
JICA Exper Team		

Source: JET

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