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)

SECTION II STRATEGIC SEWERAGE MASTER PLAN ②ANURADHAPURA

MAY 2017

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIHON SUIDO CONSULTANTS CO., LTD.

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1USD = 111.313 JPY

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ABBREVIATIONS AND TERMINOLOGY

ADB	Asian Development Bank
ADWF	Average Dry Weather Flow
AFD	Agence Française de Development
Addl. GM	Additional General Manager
ASRT	Aerobic Solids Retention Time
AGM	Assistant General Manager
ATP	Ability to Pay
BOD	Biochemical Oxygen Demand
BOI	Board of Investment
CBO	Community Based Organization
CP	Counterpart
CEA	Central Environmental Authority
CMC	Colombo Municipal Council
CODCr	Chemical Oxygen Demand
DCS	Department of Census and Statistics
DGM	Deputy General Manager
DMMC	Dehiwala – Mt. Lavinia Municipal Council
DNB	Department of National Budget
DNP	Department of National Planning
DO	Dissolved Oxygen
DS	Divisional Secretariats
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMoP	Environmental Monitoring Plan
EPL	Environmental Protection License
EPZ	Export Processing Zone
ERD	Department of External Resource
ETWWA	En Feasibility Study ergy, 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
JBIC	Japan Bank for International Cooperation
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JECES	Japan Education Centre 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
MTPS	Manhole Type Pumping Station
NH3-N	Ammonia Nitrogen
NWSDB	National Water Supply & Drainage Board
O&M	Operation and Maintenance
OD	Oxidation Ditch
PDWF	Peak Dry Weather Flow
PMU	Project Management Units
PO	Plan of Operations
PPIAF	Public-Private Infrastructure Advisory Facility
PS	Pradeshiya Sabha
ROA	Return on Asset
ROE	Return on Equity
RSC	Regional Support Centre
R/D	Record of Discussion
SIDA	Swedish International Development Cooperation Agency
SJKMC	Sri Jayawardenapura Kotte Municipal Council
SLS	Sri Lanka Standard
SRT	Solids Retention Time
STP	Sewage Treatment Plant
PPTA	Project Preparatory Technical Assistance
T-N	Total Nitrogen
TOR	Terms of Reference
T-P	Total Phosphorus
TKN	Total Kjeldahl Nitrogen
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 Sewage Tariff
WB	World Bank
WDF	Wastewater Discharge Fee
WHO	World Health Organization
WQI	Water Quality Index
WTP	Water Treatment Plant

EXECUTIVE SUMMARY

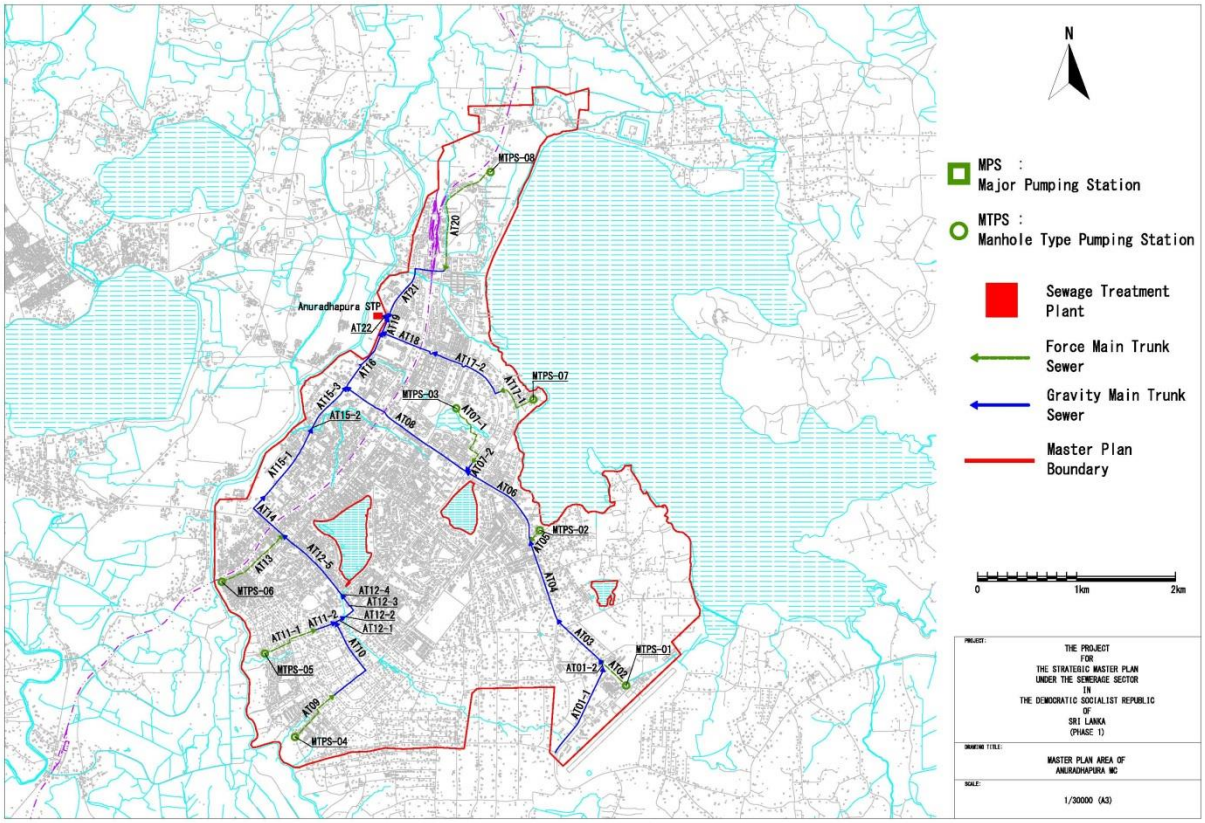
Chapter 1 describes the background and objectives of the Project and as well as the Strategic Sewerage Master Plan for the entire country. The Strategic Sewerage Master Plan identifies 15 priority cities and explains the process used to select the following five cities to be covered by the City Sewerage Master Plan.

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

Chapter 2 examines the environmental and socio-economic conditions of Anuradhapura MC and the need for a sewerage system. Increasing levels of ammonia and coliform bacteria originating from sewage are detected in the Malwathu Oya River, indicating the deterioration of water quality due to human activities. The average household income in Anuradhapura District is 23% below the national average This means that the service area of the sewerage system needs to be limited to locations where sewage can be collected and treated more cost effectively than other options.

Chapter 3 sets out the basic conditions for the preparation of the sewerage plan. The plan is to be achieved by 2046 to serve an area of 1,618 ha. The collection area will cover the new urban district on the east side of Anuradhapura MC and the adjacent area. The served population is estimated to be 54,900 and the maximum daily wastewater flow will be 13,600 m^3.

Chapter 4 describes the sewerage facility plan and design. The sewer route and the locations of pumping stations and the sewage treatment facilities are shown in **Figure 1** Treatment will be achieved by the oxidation ditch (OD) process similar to the one in Kandy MC, with low maintenance requirements and high capability to perform advanced treatment such as nitrogen removal. Sludge generated will be dewatered with a screw press machines and then composted.



Source: JET

Figure 1 Sewer System Plan for Anuradhapura

Chapter 5 proposes that the sewerage system should be operated and maintained by NWSDB. because it is already providing water supply services thereby enabling cost reductions on bill collection. Another advantage is that NWSDB staff can be utilized to manage the planning and construction. Personnel development and OJT can be provided through improved training programs at NWSDB Training Centres.

Chapter 6 estimates the project costs required at approximately 13.8 billion Japanese Yen (JPY) (excluding tax), and the annual maintenance cost at 0.15 billion JPY, as shown in **Table 1**.

Table 1 Estimated Project Cost

			Amount		Total Amount	Total Amount
			L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost					
	A	Anuradhapura STP (Q=13,600m3/day)	1,899,054,545	2,193,408,000	4,747,636,364	3,655,680,000
	B	Trunk Sewer & Pump Station	500,994,000	665,224,000	1,364,919,000	1,050,992,000
	C	Branch Sewer & Pump Station	3,295,595,000	1,116,360,000	4,745,413,000	3,653,969,000
	D	House Connection	1,372,500,000	0	1,372,500,000	1,056,825,000
	Sub-total of 1(A-D)		7,068,143,545	3,974,992,000	12,230,468,364	9,417,466,000
2	Administration cost		847,000,000	0	847,000,000	652,190,000
3	Consulting cost		465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost		438,000,000	218,000,000	721,117,000	555,260,000
5	Price escalation for construction cost		1,697,000,000	380,000,000	2,190,506,000	1,686,690,000
6	Land acquisition and compensation		-	-	-	-
7	Interest during construction		0	114,000,000	148,052,000	114,000,000
8	Front-end Fee		0	26,000,000	33,766,000	26,000,000
9	Tax and duty		3,049,000,000	0	3,049,000,000	2,347,730,000
	Sub-total of (2-9)		6,496,000,000	1,760,000,000	8,781,714,000	6,761,920,000
	Total including Tax and Duty		13,564,143,545	5,734,992,000	21,012,185,000	16,179,383,000
	Total excluding Tax and Duty		10,515,143,545	5,734,992,000	17,963,185,000	13,831,653,000
	Eligible Portion (1, 3, 4, 5 and 7)		9,668,143,545	5,708,992,000	17,082,419,000	13,153,463,000
	Non-Eligible Portion (2, 6, 8 and 9)		3,896,000,000	26,000,000	3,929,766,000	3,025,920,000

Source: JET

Chapter 7 proposes two sewage tariff schemes to recover the maintenance cost. Type 1 tariff is calculated to cover the maintenance cost for the sewerage system in Nuwara Eliya, while Type 2 is calculated based on the sewerage systems operated by NWSDB. Type 1 is calculated to be 46.39 LKR/m^3, and Type 2, 40.53 LKR/m^3, both are within the affordability estimated by the World Bank (WB). The construction cost will be borne by the central government.

Chapter 8 describes the factors that are likely to affect the local natural or social environment and proposes the parameters to be appraised in an Environmental and Social Considerations Study in the F/S phase.

Chapter 9 concludes that the Anuradhapura sewerage project will make a significant positive impact on the preservation and improvement of Malwathu Oya, which flows through the World Heritage Site area and thus has a very high priority.

Since this Project will be implemented as part of Agence Française de Development (AFD)'s Strategic City Development Project of Anuradhapura City, it will not be subject to financial assistance from JICA. Nevertheless, it is necessary to obtain EIA approval and incorporating other socio-environmental considerations by confirming the location of the proposed sewerage facilities in relation to the ruins of the nearby World Heritage Site. The F/S should include geotechnical and other basic investigations so that construction cost can be estimated accurately and to avoid cost over-run.

CHAPTER 1 BACKGROUND AND OBJECTIVES

1.1 BACKGROUND

The Democratic Socialist Republic of Sri Lanka had a per capita income of 3,162 US dollars in 2013, and an economic growth rate of 7.3% (source: JETRO website, Basic economic indicators of Sri Lanka). Steady economic growth increased the per capita income to 4,000 USD by 2016, and most Sri Lankans are approaching upper-middle income. The robust economic growth has spurred urbanization and increased water usage, and the volume of domestic and industrial wastewater has increased sharply.

In 2014, only 2.4% of the country had urban sewerage infrastructure coverage. A considerable amount of untreated wastewater is discharged into the ocean, rivers, and streams, causing problems related to hygiene and environmental degradation.

The national policy formulated in 2010 (Source: Department of National Planning (DNP), Mahinda Chintana Vision for the Future), highlights the importance of potable water supply and sewerage services as an integral element of sustainable development. The Government announced its intention to achieve 100% sanitation coverage by 2025 through the provision of on and off-site sanitation facilities. NWSDB sets forth the objective to achieve 7.0% sewerage coverage by 2020.

The Government committed to developing the Strategic Master Plan for the sewerage sector in the effort to achieve the 2025 target as well as meet the stringent environmental standards introduced by the Central Environmental Authority (CEA) to mitigate pollution of water environment. The Government sought assistance from Japan. The Japanese government accepted the request and subsequently JICA signed the Record of Discussions (R/Ds)on this project with the Sri Lankan side in August 2015 and was assigned to carry-out a study and formulate the Strategic Master Plan.

As agreed upon with the Sri Lankan side, the outline of the project is as follows:

(1) Purpose

To develop the Strategic Master Plan (M/P) to address sewerage issues in the major cities of Sri Lanka, to mitigate to some extent the pollution of rivers and ocean.

(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 at the National Water Supply and Drainage Board (NWSDB) and cities selected for F/S

The Strategic Sewerage M/P was formulated in 2016 (from January to June) and can be found in Section I of this Report. The M/P aims to improve the overall water environment through the development of sewerage systems and improvement of on-site sanitation facilities. 79 major cities in the country were evaluated using the following six criteria. An approach to the sewerage system development was proposed.

- Urbanization
- Sanitation
- Urban development
- Sustainability of sewerage service

- Water environment
- Maturity of sewerage project plan

15 cities are designated as priorities for the implementation of sewerage systems to achieve the target of 7.0% coverage by 2035. These are: Colombo MC, Kandy MC, Sri Jayawardenapura Kotte MC, Anuradhapura MC, Badulla MC, Kelaniya PS, Nuwara Eliya MC, Galle MC, Dehiwala-Mount Lavinia MC, Negombo MC, Koticawatta-Mulleriyawa PS, Ratnapura MC, Hambantota MC, Trincomalee UC, and Maharagam UC.

Septic tanks are commonly used for domestic wastewater treatment. It is important to de-sludge and treat septage to maintain proper operation. The M/P outlines the approach to improve on-site sanitation with septage treatment facility. 11 cities are identified as urgently requiring septage treatment facilities, and another 13 cities will be targeted in the next phase.

Five of the 15 priority cities are selected for the development of sewerage master plans based on the following criteria.

- Colombo MC and cities that have sewerage projects with funding assistance from other countries and international donors.
- Cities that are targeted for local development but have no sewerage services.

The five cities selected are:

- Sri Jayawardenapura Kotte MC
- Anuradhapura MC
- Badulla MC
- Nuwara Eliya MC
- Dehiwala-Mount Lavinia MC

The Report (Section II-(2)) presents a part of Output (2) regarding the City Sewerage M/P.

1.2 OBJECTIVES AND SCOPE

This Report describes the sewerage development plan to improve the water environment in Anuradhapura MC. The sewerage service area and the conditions for implementing the project are identified.

CHAPTER 2 EXISTING CONDITIONS

2.1 ENVIRONMENTAL AND NATURAL CONDITIONS

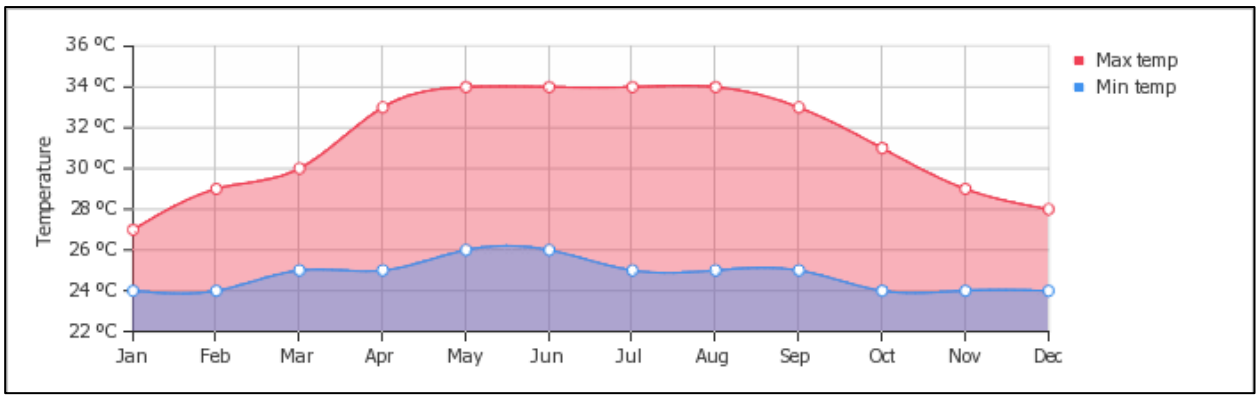
2.1.1 Climate

(1) General

Situated in the North Central part of Sri Lanka, Anuradhapura is located in the DL1b agro-ecological zone which is in the low-country dry zone, characterized by an annual rainfall of >900 mm. The District has both wet and dry seasons, and is usually hot and humid throughout the year, with average temperatures between 20°C and 30°C.

(2) Temperature

May is the warmest month, with temperatures rising to 34°C. The coldest month is January when the average temperature is 25°C, and lows can drop to 21°C. The average monthly maximum and minimum temperatures are shown in **Figure 2.1-1**.

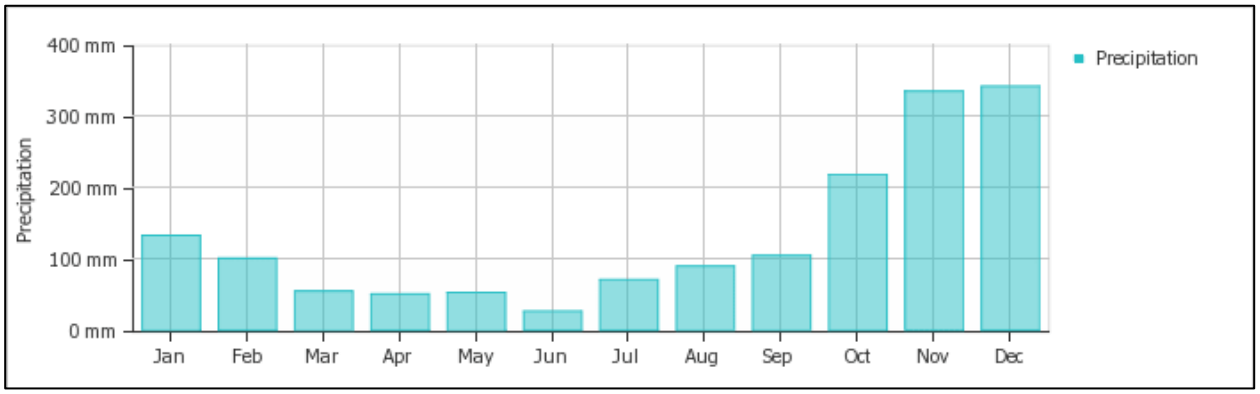


Source: JET, using Department of Meteorology data

Figure 2.1-1 Average Monthly Maximum and Minimum Temperatures

(3) Precipitation

The rain in the district comes in three forms: monsoonal convectional and cyclonic. The northeast monsoon brings rain in September to March, making a major contribution to the district's rainfall. Southwestern monsoons reach the district as dry wind only, bringing little rain in May through June. Average monthly precipitation is shown in **Figure 2.1-2**.

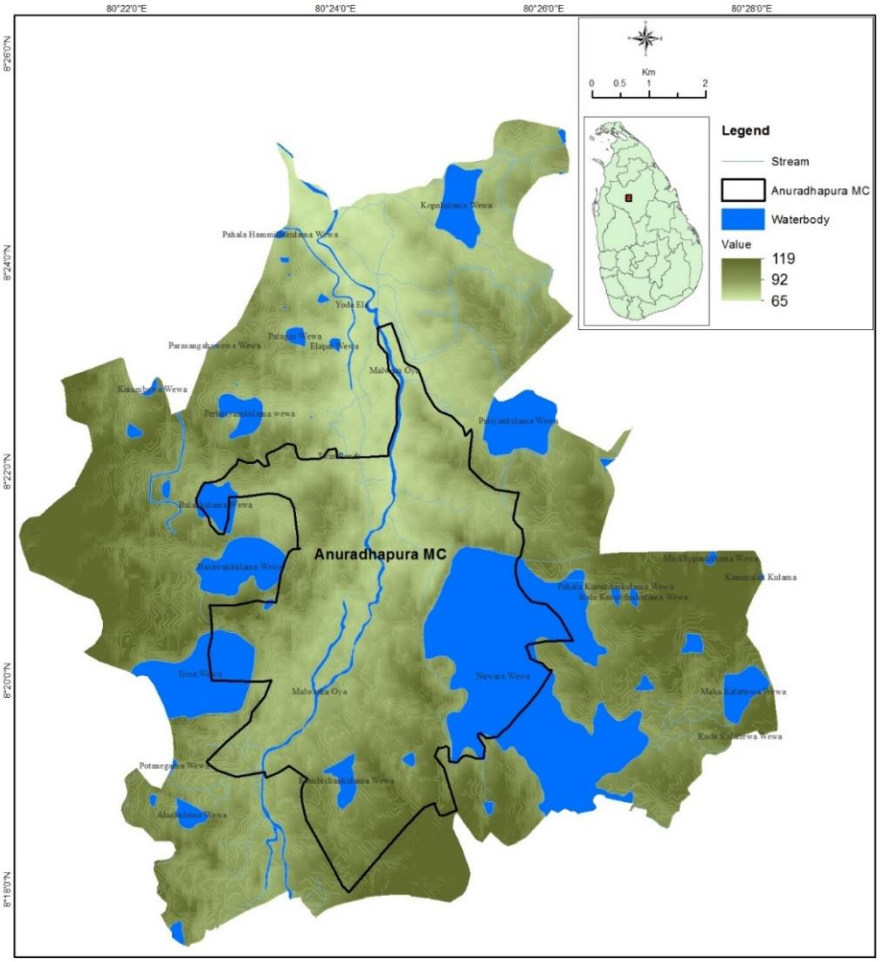


Source: JET, using Department of Meteorology data

Figure 2.1-2 Average Monthly Precipitation

2.1.2 Topography

Figure 2.1-3 shows the topography of the Anuradhapura MC and surrounding area. Anuradhapura lies 205 km north of Colombo in Sri Lanka's North Central Province, on the banks of the Malwathu Oya River. The topography of the area is generally flat, with gently rolling plains and some isolated hills. To the east of Anuradhapura, the Malwathu Oya River flows in a northerly direction.

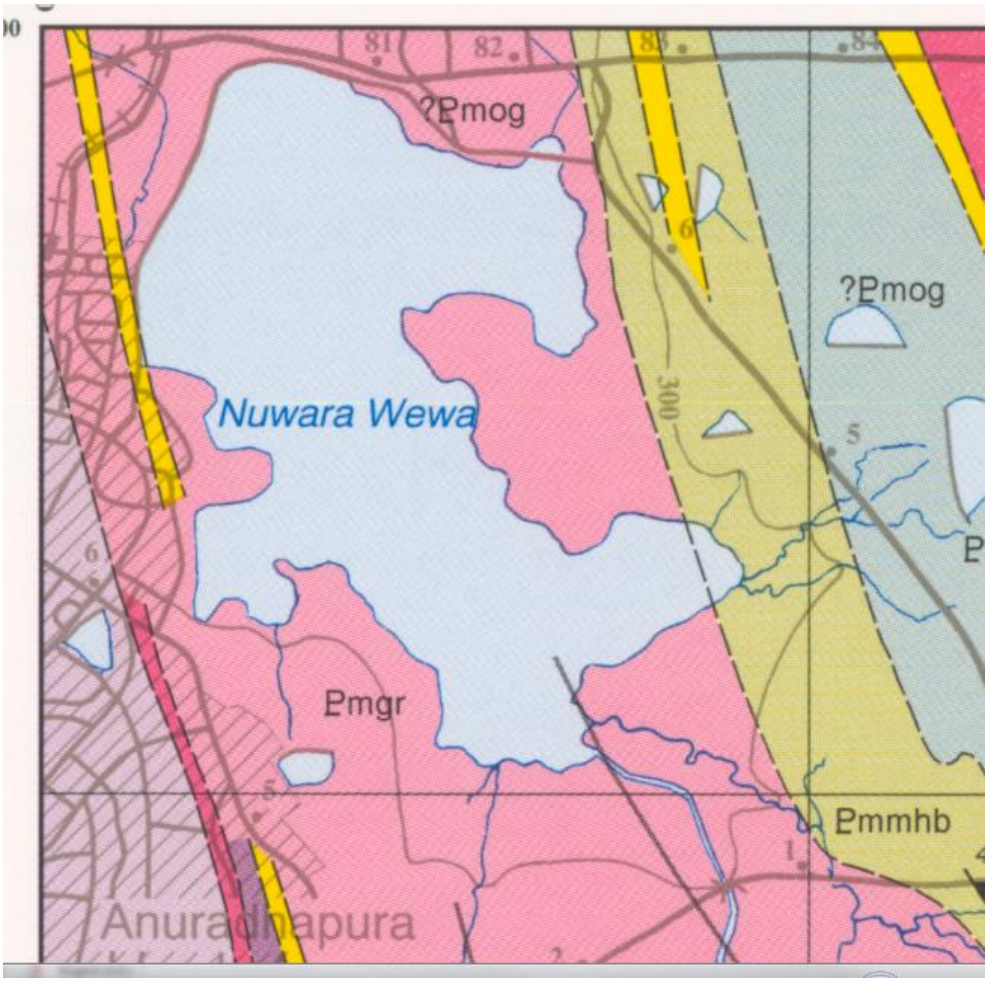


Source: Survey Department of Sri Lanka

Figure 2.1-3 Elevation Map of the Anuradhapura MC Area

2.1.3 Geology

The Anuradhapura area belongs to the litho tectonic Wanni Complex. The dominant rock types in the Wanni Complex are Hornblende baring gneisses and Pink Gneisses. The geology of the area is dominated by granitic, migmatitic, and chanockitic gneisses of the Precambrian age. **Figure 2.1-4** shows the major geologic characteristics of the area.

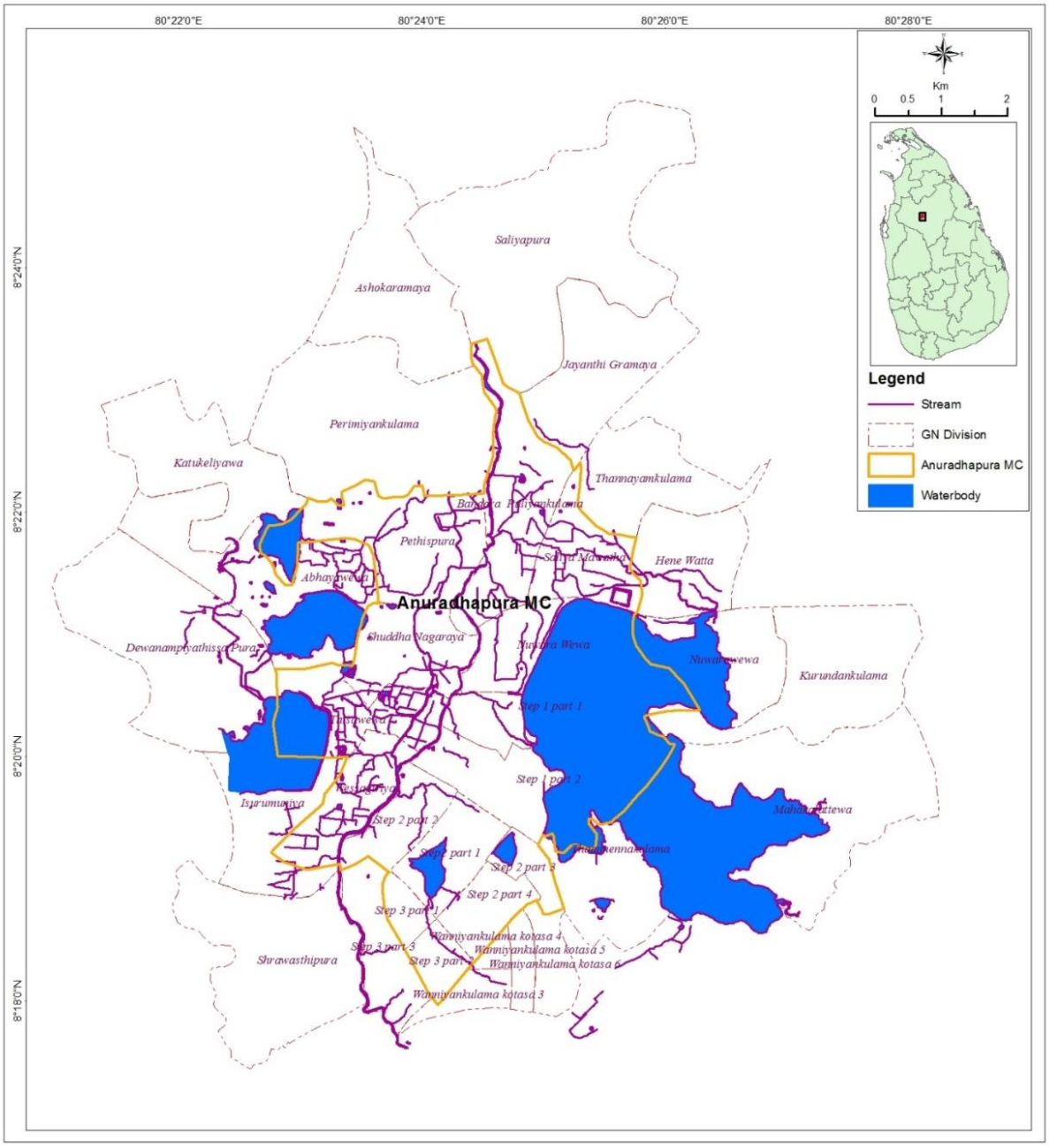


Pmog - undifferentiated felsic orthogneisses
Pmmhb - biotite Hornblende migmatites
Pmgr - Granitic Gneiss
Source: Geological Survey and Mines Bureau

Figure 2.1-4 Regional Geology

2.1.4 Hydrology

Drainage networks and surface water bodies in the area are shown in Figure 2.1-5 All the storm water canals in the city are discharged to the Malwathu Oya River. The Malwathu Oya River is the second longest river in Sri Lanka, and it flows through the Anuradhapura MC area in a south-north direction, connecting to the sea at Mannar. The Kumbichchankulama, Nuwara Wewa, and Pulyankuluma Tanks, are located on the right bank of the river. The Alankuluma, Thissa Wewa, and Basawakkuluma Tanks are located on the left.



Source: Survey Department of Sri Lanka

Figure 2.1-5 Drainage Network and Surface Water Bodies in the Project Area

2.1.5 Surface Water Quality and Quantity

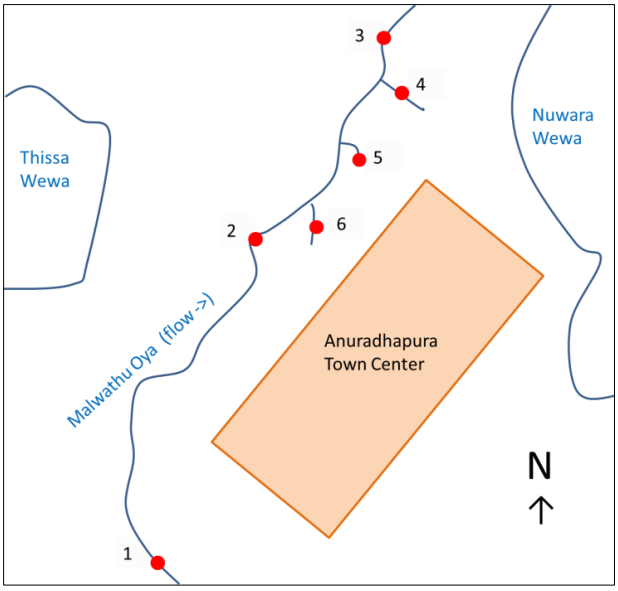
(1) Surface Water Quality

Water quality at sampling stations (1-6) in Anuradhapura is shown in the **Table 2.1-1** The locations of sampling stations are shown in the **Figure 2.1-6**.

Table 2.1-1 Surface Water Quality (Anuradhapura)

Anuradhapura		1	2			3	4	5	6	Criteria
			Surface	Middle	Bottom					
pH	-	7.8	8	7.9	8.1	7.7	7.7	7.4	8.2	-
Temperature	°C	31.4	32.4	31.8	32.4	29.3	28.9	29.4	33.7	-
Odour	-	Acceptable					Objectionable			ND
Colour	mg Pt/L	<15	<15	<15	52	17	36	<15	44	100
EC	uS/cm	841	875	879	850	50	27	79	1013	700
Turbidity	NTU	6	5	6	6	8	12	18	9	-
Total Suspended Solids (TSS)	mg/l	139	270	167	113	108	162	76	138	40
TDS	mg/l	590	570	590	590	560	570	410	720	-
DO	mg/l	7.8	5.4	6.5	5.5	5.7	2.1	3.9	5.1	5
Biochemical Oxygen Demand (BOD)	mg/l	<4	<4	<4	<4	<4	<4	<4	<4	4
COD	mg/l	74	48	63	63	44	55	22	74	15
Nitrate	mg/l	0.95	0.79	0.83	0.61	0.84	0.47	0.22	0.48	10
Ammonia	mg/l	0.16	0.52	0.08	0.25	0.26	1.54	0.31	3.2	0.59
Total Phosphorus (T-P)	mg/l	0.27	0.13	0.12	0.22	0.1	0.5	0.27	0.79	-
PO_4^{3-} - P	mg/l	0.15	0.07	0.07	0.14	0.05	0.3	0.16	0.43	0.4
Cl	mg/l	138.7	127.5	122.5	124.9	111.2	118.7	92.5	128.7	600
Total Nitrogen (T-N)	mg/l	1.15	1.66	1.55	1.05	1.17	2.07	0.56	3.88	-
Faecal Coliform	/100ml	72	214	428	$6x10^2$	200	1400	$72x10^4$	$11x10^2$	$1x10^3$
Total Coliform	/100ml	$11x10^4$	$20x10^2$	$16x10^2$	$12x10^2$	700	$208x10^2$	$76x10^4$	$18x10^2$	$1x10^4$

*) Over the criteria
Source: JET



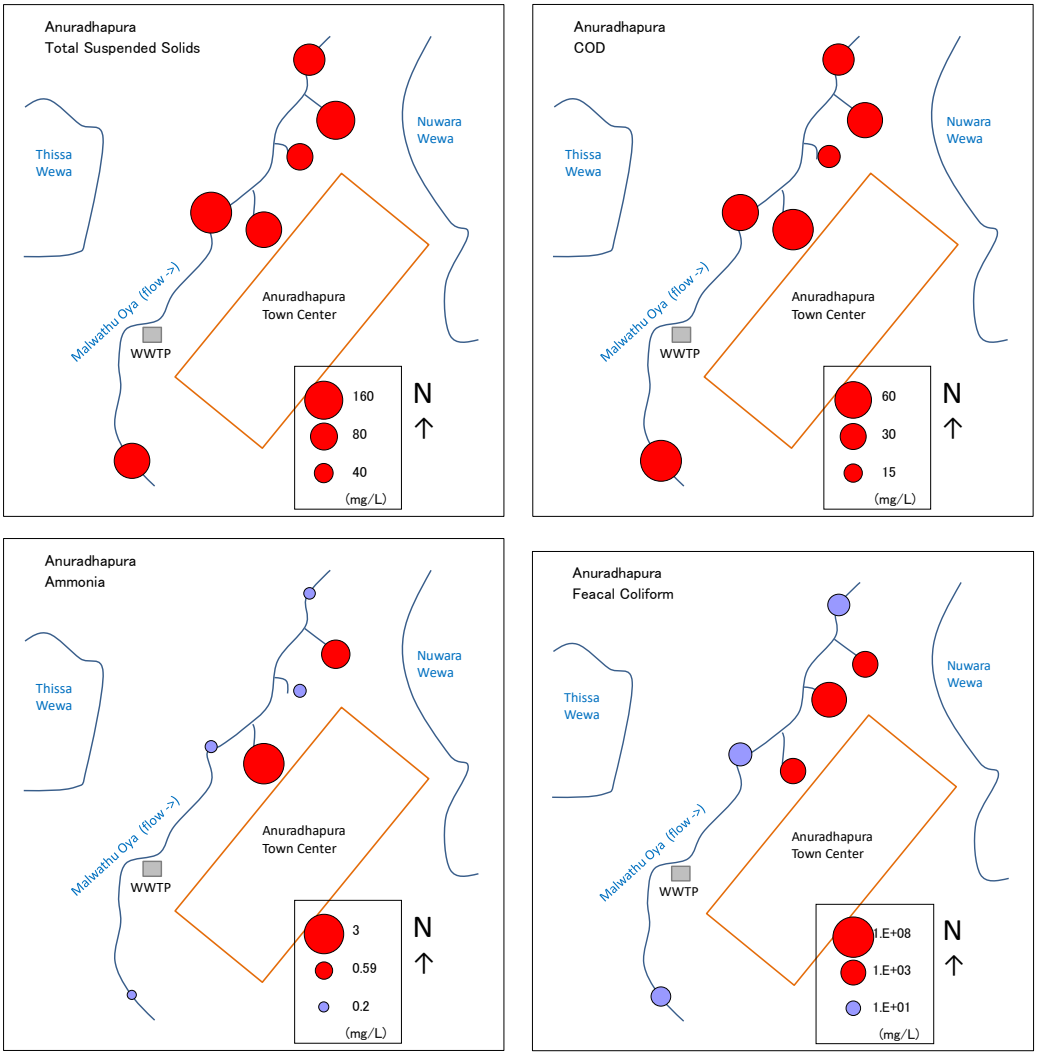
Source: JET

Figure 2.1-6 Water Sampling Locations

The criteria for evaluating water quality are based on parameters identified in "National Environmental Regulations, No.1 of 2014" and "Draft Revised Ambient Water Quality Standards (2016)". The values are chosen from Category C (Fish and Aquatic Life Water) for normal environmental standards. When values are not available from Category C, the lowest values from Categories D, E and F are used.

EC, TSS, DO, COD, ammonia, phosphate, faecal coliform and total coliform exceed the standard values at most locations. All sampling locations show some level of pollution (Figure 2.1-7).

Water pollution is widespread as indicated by high levels of TSS and COD at all sampling locations. High levels of faecal coliform and ammonia were measured at sampling stations 4, 5 and 6 (town drains). These values are higher than those measured in the main stream indicating contamination by wastewater discharged in the town centre.



*) Red indicators shows the values are over the criteria
Source: JET

Figure 2.1-7 Water Pollution in Anuradhapura

(2) Potential Impact of a Sewerage System

As shown in the above Figures, high levels of TSS, COD, ammonia and faecal coliform are observed in Anuradhapura, indicating pollution by wastewater. The TSS values are much higher than 40 mg/L set in the standards. The target effluent discharge for the proposed STP is set at 35 mg/L, therefore it is expected that TSS in the receiving water body will be reduced significantly by sewage treatment.

The proposed treatment process will improve DO values by providing aeration in the reactor tank at the sewage treatment plant (STP) and significantly reducing the oxygen demand caused by organic pollutants (BOD and COD). The aerobic treatment process can be operated to convert ammonia to nitrates (nitrification).

Total coliform will be reduced by disinfecting with chlorine. Thus, the introduction of a sewerage system will improve the water environment in Anuradhapura.

(3) Water Quantity

The flow rates at sampling stations 1, 2 and 3, measured on 17th August 2016, are shown below.

Table 2.1-2 Water Quantity (Anuradhapura)

Station	Flow Rate (m^3/s)	Incremental Flow (%)	Date
1	0.524	-	17-08-2016
2	0.517	-1.43	
3	0.571	10.59	

Source: JET

2.1.6 Environmental Quality

(1) Air Quality

No recent records on air quality measurements in Anuradhapura area are available.

Heavy traffic along A12 highway and side roads, and train movements contribute to high levels of air pollutants, such as dust, particulates, smoke, CO, CO2, NOX, SOX, especially during peak hours. Sewage and solid wastes thrown in the canals produce foul odours, especially during dry weather when water level is low.

(2) Noise and Vibration

No records on noise level/vibration measurements in Anuradhapura area are available.

Ambient noise and vibration levels are as expected for urban areas with light industries, businesses, hotels, and restaurants. There is also traffic noise from A12 highway, which carries heavy traffic during peak hours, as well as at night. The city is a major railway hub. Intermittent high noise and vibration levels are observed due to railway traffic. All these urban activities contribute to high noise levels in the project area.

2.1.7 Protected Areas

The Wildlife Department has declared Anuradhapura a Natural Sanctuary (Natural Sanctuary 05.27.1938) under the Flora & Fauna Protection ordinance. The protected lands are located outside of

the MC area.

2.1.8 Fauna and Flora

Fauna and flora of the general area as documented in literature and site surveys are summarized in Table 2.1-3 and Table 2.1-4 Further investigation is necessary to determine the fauna and flora specific to the project site.

Table 2.1-3 Survey of Fauna in the Project Area

Class	Type	Taxa		Significant Species (common name)	Conservation Status (IUCN 3.1)
		Family	Species		
Insects	Butterflies	Pieridae	5 species	*Catopsila Pomona* (Common emigrant)	LC
				Appias galena (Lessor albatros)	LC
		Papiliondae	15 species	*Papilio polymnestor* (Blue mormon)	LC
				Troides darsisus (Sri Lankan birdwing)	LC
		Lycaenidae	Many		LC
Gastropods	Snails/slugs		8 species		LC
Amphibians	Frogs	Rhacophoridae	18 species	*Pseudophilautus reguis*	Def
		Ranidae		*Hylarana gracilis* (Gravenhorsts frog)	LC
		etc			
Reptiles	Crocodiles			*Crocodylus palustris* (Marsh crocodile)	VU
	Tortoises		3 species		???
	Lizards		7 species	*Chamaeleo zelanicus* (Indian chameleon)	LC
	Geckos		10 species	Geckoella yakhuna (Northern sri Lanka gecko)	VU
				Cnemaspis podihuna (Deraniyagala day gecko)	VU
	Skinks		8 species	Eutropis madaraszi (Spotted skink)	VU
	Monitor Lizards	Varanadae	2 species	*Varanus bengalensis* (Bengal monitor)	LC
				Varanus salvator (Asian water monitor)	LC
	Snakes		40 species		???
Birds				*Pavo cristatus* (Indian peacock)	LC
				Gallus lafayettii (Sri Lankan Jungle fowl)	LC
				Galloperdix bicalcarata (Sri Lanka spurfowl)	LC
	Horn bills				
	Woodpeckers				
	Kingfishers				
	Bee eaters				
	Fly catchers				
	Pigeons				
				Pelecanus philippensis (Spot-billed pelican)	NT
				Anhinga melanogaster (Oriental dater)	NT
				Phalacrocorax fuscicollis (Indian cormorant)	LC
				Haliaeetus leucogaster (White-bellied sea eagle)	LC
Mammals	Primates	Cercopithecidae		*Macaca sinica* (Toque macaque)	EN
				Semnopithecus vetulus (Purple-faced langur)	EN
				Paradoxurus zeylonensis (Golden palm civet)	VU
				Lutra lutra (Eurasian otter)	NT
				Herpestes vitticollis (Stripe-necked mongoose)	LC
				Prionailurus viverrinus (Fishing cat)	VU
		Tragulidae		*Moschiola kathygre* (Yellow-striped chevrotain)	LC
Fish				*Oreochromis mossambicus* (Mozambique tilapia)	NT
				Oreochromis niloticus (Nile tilapia)	NA
				Labeo rohita (Rohu)	LC
				Carassius auratus (Goldfish)	Dom
				Hypothalmichthys molitrix (Silver carp)	NT
				Cirrhinus mrigala (Mrigal carp)	VU
				Catla catla (Indian carp)	LC
				Arishichthys nobilis (Bighead carp)	Def.
				Clarias brachysoma (Walking catfish)	NT
				Channa striata (Snakehead murrel)	LC
		Puntius		*Puntius singhala*	NA

		Rasbora			
				Garra ceylonensis (Ceylon longsucker)	NA

Sources:
Manamendraarachchi and Adikari (2014)
IUCN Redlist
JET

: Legend: IUCN 3.1 scale

Dom: Domesticated
Def: Data deficient
NA: Data not available

Table 2.1-4 Survey of Flora in the Project area

Taxa		Significant Species (common name)	Conservation Status (IUCN 3.1)
Family	Species		
Moraceae		*Ficus religiosa* (Bodhi tree)	LC
Putranjivaceae		*Drypete sepiaria* (Weera)	LC
Sapotacceae		*Manilkara hexandra* (Palu)	LC
Rutaceae		*Chloroxylon swietenia* (Ceylon stainwood)	VU
Malvaceae		*Berrya cordifolia* (Trinomalee wood)	VU
Meliaceae		*Azadirachta indica* (Neem wood)	LC
Moraceae		*Artocarpus heterophyllus* (Jackfruit)	LC
Anacardiaceae		*Mangifera indica* (Mango)	LC
Anacardiaceae		*Anchardium occidentale* (Cashew)	LC
Anacardiaceae		*Mangifera zeylanica* (Eth amba)	VU
Arecaceae		*Cocus nucefera* (Coconut)	LC
Lamiaceae		*Tectona grandis* (Teak)	LC
Fabaceae		*Gliricidia sepium*	LC
Fabaceae		*Leucaena leucocephala* (White leadtree)	LC
Ebenaceae		*Diospyros ebenum* (Ceylon ebony)	LC
		Felicium leucocephala	
Lamiaceae		*Vitex altissima*	LC
Rubiaceae		*Canthium dicoccum*	
Ochnaceae		*Ochna obtusata*	LC
Alangiaceae		*Alangium salviifolium*	LC
		Mixeomwlum minurum	
		Drypetes lanceolate	
Celastra		*Gymnosporia emarginata*	
Salviniaceae		*Salvinia molesta* (Kariba weed)	LC
Pontederiaceae		*Eichhrnia crassipes* (Water hyacinth)	LC
Typhaceae		*Typha anguistifolia* (Narrowleaf cattail)	LC
Araceae		*Pistia stratiotes*	LC
Anisophyleaceae		*Anisophyllea cinnamomoides* (Weli piyanna)	VU
Asteraceae		*Vernonia zeylanica* (Ironweed)	LC
Apocynaceae		*Willughbeia cirrhifera*	VU

Source:
Egodawatta and Warnasooriya (2014)
Manamendraarachchi and Adikari (2014)
Munashingha et al., (2009)
Dharmasena, (1993)
Wijerathna and Baladurage
IUCN Redlist
JET

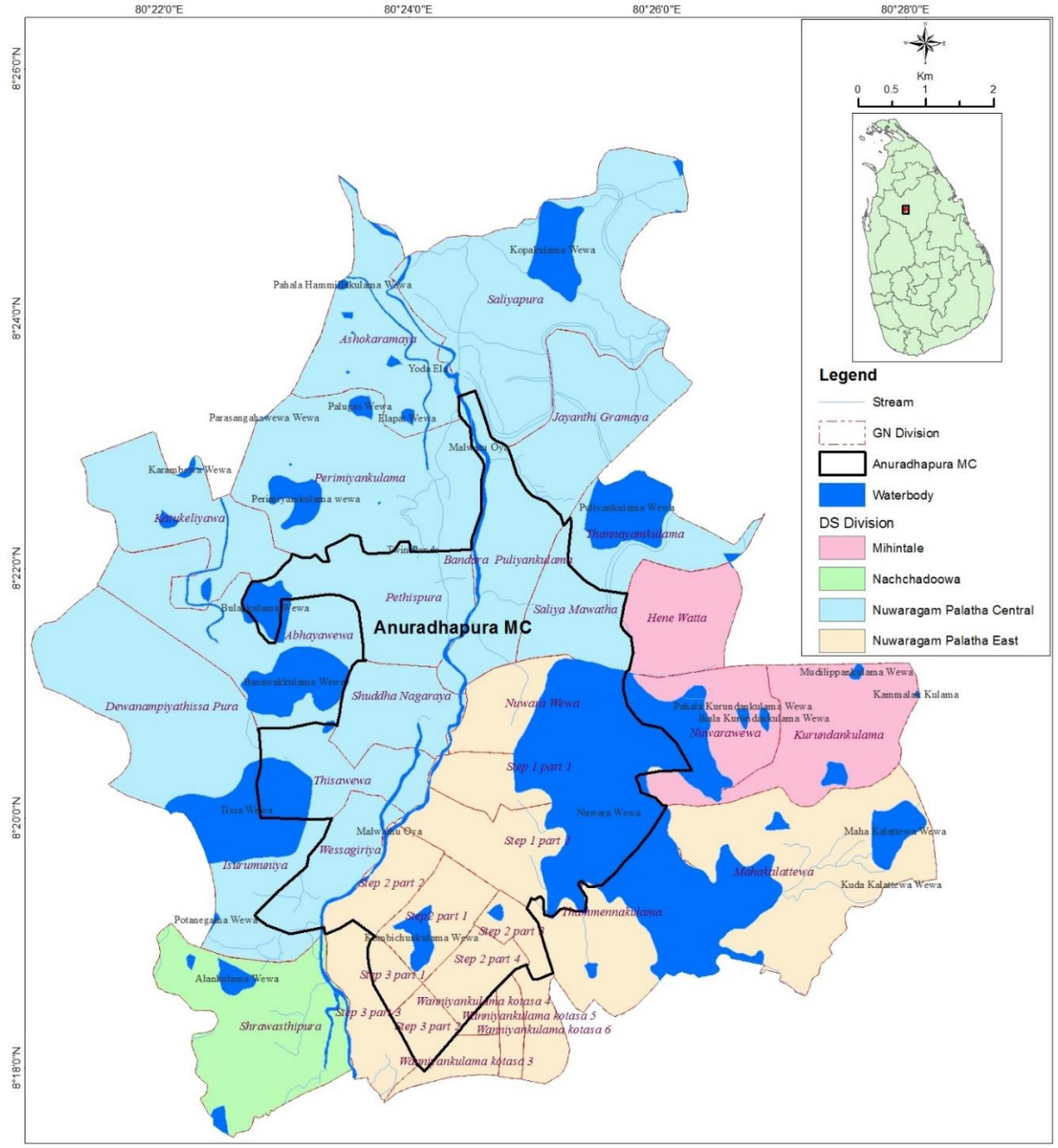
Legend: IUCN 3.1 scale

Dom: Domesticated
Def: Data deficient
NA: Data not available

2.2 EXISTING SOCIAL CONDITIONS

2.2.1 Administration

Anuradhapura City is the capital city of North Central Province, and the capital of Anuradhapura District. The MC covers parts of 3 Divisional Secretariat Divisions (DSD): Nuwaragampalatha Central (NPC), Nuwaragampalatha East (NPE), and Mihinthale. The total area is covered by 29 Grama Niladhari Divisions (GNDs). The administrative areas covered by the Anuradhapura MC are shown in **Figure 2.2-1**.



Source: Survey Department of Sri Lanka

Figure 2.2-1 Administrative Areas of Anuradhapura MC

2.2.2 Population and Demography

Anuradhapura MC is a combination of Nuwaragampalatha Central (20,888 people), Nuwaragampalatha East (45,428 people), and Mihinthale (3,594 people) DSDs, with a total population of 69,910. According to the Census and Statistics Figures of 2012, this is about 8% of the total Anuradhapura District population of 856,200. The population density is 131 persons/km^2 at the provincial level and 130 persons/km^2 at the district level.

Table 2.2-1 shows the population distribution by DSD and gender.

Table 2.2-1 Population by DSD and Gender

DS Division	Male	Female	Total
Nuwaragampalatha Central	10,304	10,584	20,888
Mihinthale	1,707	1,887	3,594
Nuwaragampalatha East	22,135	23,293	45,428
Total for Anuradhapura Municipality Council	34,146	35,764	69,910

Source: Census of Population and Housing 2012, Department of Census and Statistics (DCS)

2.2.3 Health & Diseases

The prevalence of chronic illnesses in the Anuradhapura District is slightly higher than the national average as shown in **Table 2.2-2** and **Table 2.2-3**.

Table 2.2-2 Chronic Illnesses by Age Group

	Less than 15 years	15-24 years	25-59 years	60 and above
Anuradhapura District	2.9%	4.6%	18.6%	58.3%
Sri Lanka	2.8%	3.3%	18.5%	55.2%

Source: National Survey on Self-reported Health in Sri Lanka 2014, D CS

Table 2.2-3 Diabetes and Hypertension

	Diabetes	**Hypertension**
Anuradhapura District	4.8%	7.1%
Sri Lanka	7.2%	9.2%

Source: National Survey on Self-reported Health in Sri Lanka 2014, D C S

2.2.4 Religion/Ethnicity

The majority of the population is Buddhist (Table 2.2-4).Table 2.2-4 Population by Religion

Religion	Population	% of Total Population
Buddhist	772,292	90.20%
Hindu	3,425	0.40%
Islam	71,065	8.30%
Roman Catholic	5,993	0.70%
Other Christian	3,425	0.40%
Other	-	-
Total District	856,200	

Source: Economic and Social Statistics of Sri Lanka -2014, Central Bank of Sri Lanka, April 2014

Sinhala is the dominant ethnic group (Table 2.2-5).

Table 2.2-5 Population by Ethnic Group

Ethnicity	Population	% of Total Population
Sinhala	778,286	90.90%
Sri Lanka Tamil	5,137	0.60%
Indian Tamil	856	0.10%
Sri Lanka Moor	70,209	8.20%
Other	1,712	0.20%
Total District	856,200	

Source: Economic and Social Statistics of Sri Lanka -2014, Central Bank of Sri Lanka, April 2014

2.2.5 Poverty Rate

The household income and expenditure survey (HIES) was carried out by the Census and Statistics Department of Sri Lanka. Poverty rates at the district, province, and national levels are shown in **Table 2.2-6** The data indicates that poverty levels in the district are about the same as the provincial and national averages.

Table 2.2-6 Poverty Rates

	Poor HH %		
	2006/07	2009/10	2012/13
National	12.6	7.0	5.3
North Central Province	11.8	4.6	6.1
Anuradhapura District	12.7	4.6	6.3

Source: Census and Statistics Department

2.2.6 History and Culture (Heritage)

Anuradhapura's "Sacred City" area is a UNESCO World Heritage City. Anuradhapura is regarded as Sri Lanka's first kingdom and was the capital of the island for many centuries. Pagodas, water tanks, art, and architecture attract many national and international visitors because of their cultural, religious, and architectural importance. The area under UNESCO protection is limited to the Sacred City (Old City) area. The Project will take place outside of the protected area.

2.2.7 Economy

(1) General

Anuradhapura City is in the flat and easy-to-access northern centre of the country. It is the focal point for the north, west, south and east regions. Agriculture is the main source of income. The main produce is rice, grown by irrigation networks and harvested twice a year. **Table 2.2-7** shows GDP of North Central Province which includes Anuradhapura City.

Table 2.2-7 GDP by Sector for North Central Province (Current Prices)

Unit: Million Sri Lanka Rupee (LKR)

No	Sector	2010		2011		2012		2013	
1	Agriculture	77,301	29.0%	70,248	23.0%	74,009	19.5%	85,589	19.5%
2	Industry	54,924	20.6%	74,013	24.2%	98,046	25.9%	118,149	26.9%
3	Services	134,729	50.5%	161,714	52.9%	207,188	54.6%	238,157	54.3%
	GDP	266,954	100.0%	305,975	100.0%	379,243	100.0%	438,896	100.0%
	GDP Share Percentage	4.8		4.7		5.0		5.1	

Source: CBSL Annual Report 2014

North Central Province contributes to around 5% of the national GDP. Service sector, the largest sector, contributes 50-55% (national average: 56.8%) of the total provincial GDP. The agricultural sector contributes around 20 to 30% (national average: 10.8%).

(2) Tourism

Anuradhapura is the ancient capital city of Sri Lanka and has a lot of historical monuments and temples, such as the Brazen Palace, Maha Bodhi Tree, Ruwanweli Seya Dagoba, Samadhi Buddha Statue. It is one of the major tourist destinations in Sri Lanka. **Table 2.2-8 Figure 2.2-2** and 2.2-3 show the tourist arrival numbers and tourism revenue from admission fees for the past 4 years.

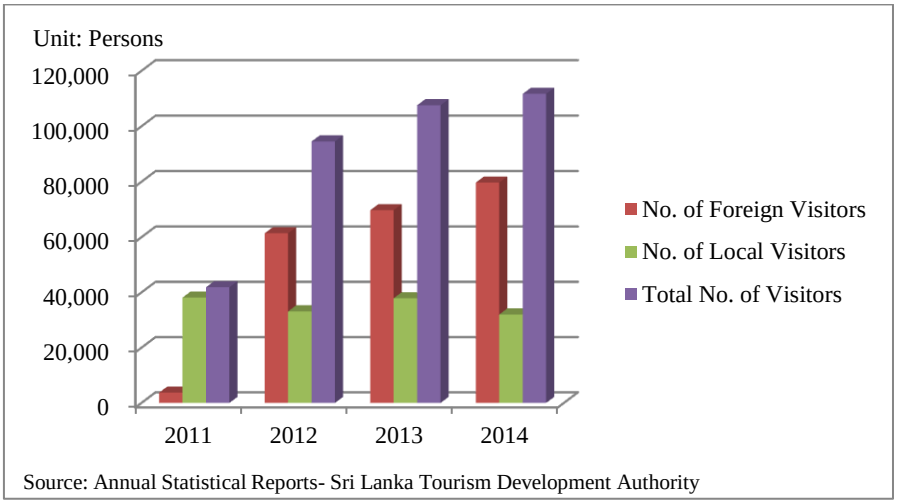
Table 2.2-8 Anuradhapura Tourist Arrival and Revenue from Ticket Sales*1

Year	2011	2012	2013	2014
No. of Foreign Visitors	3,706	61,392	69,705	79,685
No. of Local Visitors	38,149	33,138	37,894	32,016
Total No. of Visitors	41,855	94,530	107,599	111,701
Revenue: Foreign Visitors (LKR)	107,813,363	158,814,806	223,573,474	251,708,838
Revenue: Local Visitors (LKR)	668,020	593,680	680,320	550,120
Total Revenue (LKR)	108,481,383	159,408,486	224,253,794	252,258,958

Note: *1; Ticket sales is the revenue from selling ticket to visit the historical place.
Source: Annual Statistical Reports- Sri Lanka Tourism Development Authority (Annual Reports of 2011,2012,2013,2014)

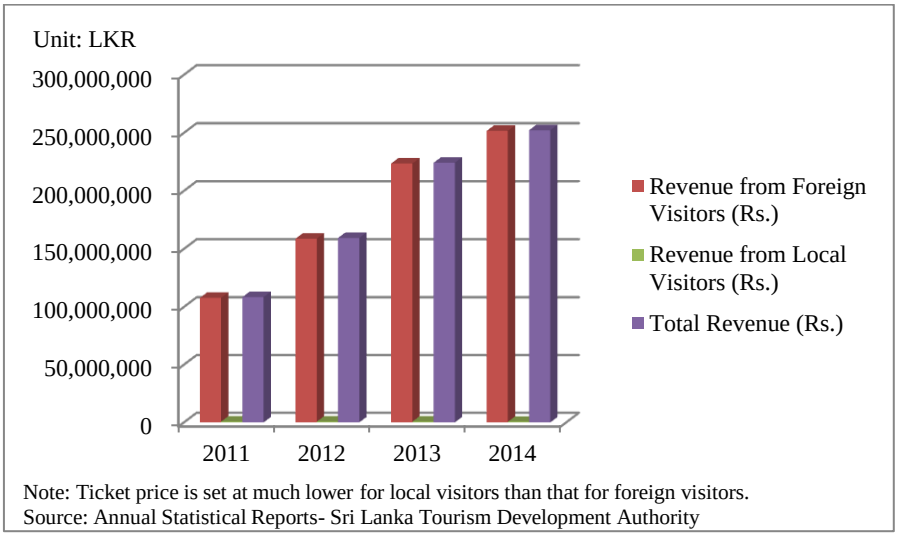
Tourist numbers and revenue have been increasing steadily. Most visitors are local however revenues from foreign tourists are 100 to 500 times higher because foreigners pay a much higher entry fee. Apart from admission fees, tourists also contribute to revenues of hotels, restaurants, transportations, souvenir shops, and related businesses. Tourism revenues are rapidly increasing and can be quite substantial.

The establishment of a sewerage system will preserve the water environment of the lake and river and contribute to the sustainable growth of the tourism industry and the economy.



Source: Annual Statistical Reports- Sri Lanka Tourism Development Authority

Figure 2.2-2 Anuradhapura Tourist Arrivals



Note: Ticket price is set at much lower for local visitors than that for foreign visitors.
Source: Annual Statistical Reports- Sri Lanka Tourism Development Authority

Figure 2.2-3 Anuradhapura Tourism Revenue from Ticket Sales

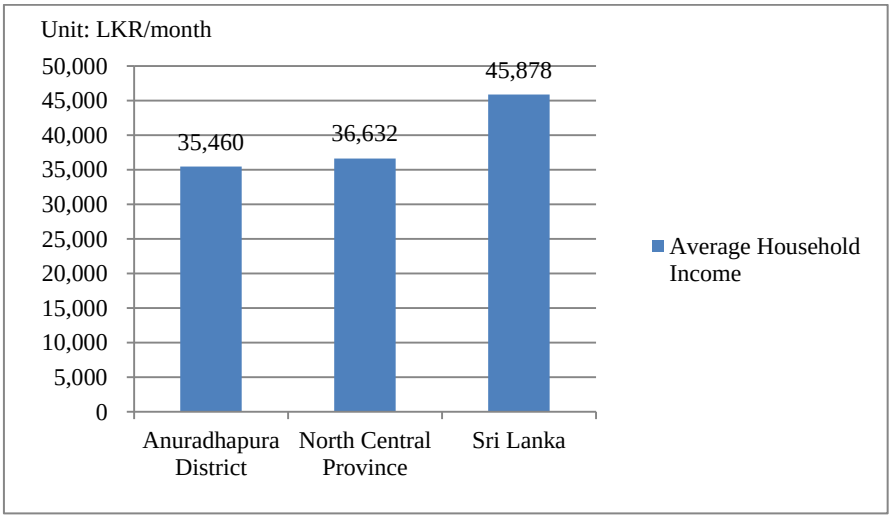
(3) Household Income

Average household income data is available from "Household Income and Expenditure Survey 2012/2013", some of which are presented in **Table 2.2-9** and **Figure 2.2-4**. The average monthly household income in Anuradhapura District was LKR 35,460 in 2012/13. Most of the household income came from "wage/salaries" (28.5%), "agricultural activities" and "other cash income" are the next large income sources (16% each). Household income in Anuradhapura District is 23% lower than the national average) and slightly lower than that in North Central Province. In Anuradhapura, the design of a sewage tariff should carefully consider the residents' ability to pay (ATP).

Table 2.2-9 Breakdown of Monthly Household Income for Anuradhapura District (2012/2013)

No.	Sector	Anuradhapura District	%
1	Average Household	35,460	
2	Per capita	9673	
3	Ave. No. of Income Receivers	1.6	
4	Wage/Salaries	10,801	28.5%
5	Agricultural Activities	5,856	15.5%
6	Non-Agricultural Activities	3,520	9.3%
7	Other Cash Income	6,008	15.9%
8	Income by Adhoc Gain	4,081	10.8%
9	Non-Monetary Income	5,194	13.7%
10	Income in Kind	2,421	6.4%

Source: Household Income and Expenditure Survey 2012/2013, DCS, Ministry of Policy Planning Economic Affairs



Source: Household Income and Expenditure Survey 2012/2013, DCS, Ministry of Policy Planning Economic Affairs

Figure 2.2-4 Comparison of Monthly Household Income

2.2.8 Land Use

Land use in Anuradhapura District and the MC are shown in **Table 2.2-10** and

Table 2.2-11 and **Figure 2.2-5**.

The ancient holy city, Anuradhapura, a UNESCO World Heritage Site, is situated on the west side of the river whereas the new urban district is located on the east side. Residential neighbourhoods are occupying 35% of the area. Irrigation ponds, rice paddies and other croplands, and the World Heritage Site occupy 24%, 22%, and 1.5%, of the area.

Table 2.2-10 Land Use in Anuradhapura District

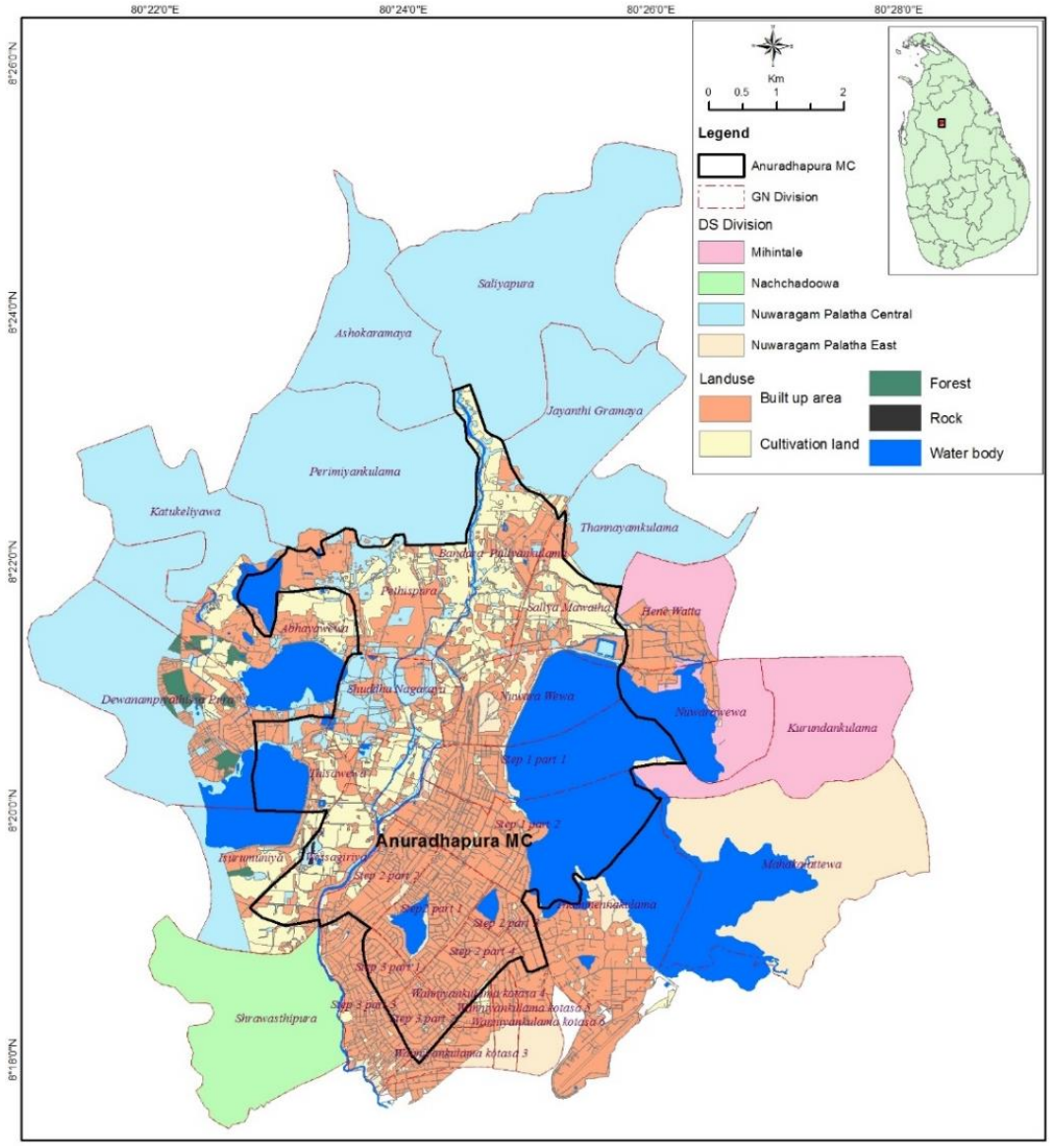
ඉඩම් ස්වභාවය Nature of land	භූමි ප්‍රමාණය (හෙක්ටයාර) Area (Hec)	ප්‍රතිශතය Percentage (%)
01.අස්වද්දන ලද කුඹුරු - Asweddumized paddy land		
1. වාරිමාර්ග - Irrigated	113841.0	15.86
11.අහස්දියෙන් - Rainfed	17381.0	2.42
02.තේ - Tea		0.00
03. රබර් - Rubber		0.00
04. පොල් - Coconut	1865.0	0.26
05. කුරුඳු- Cinnamon		0.00
06. වෙනත් වගාවන් - Other crops	8577.0	1.19
07.වනාන්තර- Forests		
1. ඝන වනාන්තර - Dense forests	199428.0	27.78
11. විවෘත වනාන්තර - Open forests	15922.0	2.22
111. වගා කරන ලද වනාන්තර - Planted forests	5477.0	0.76
08.ලදු කැළෑ හා හේන - Grass lands/Chena	191365.0	26.66
09. වගුරු හා කඩොලාන කැළෑ - Marshes and Mangroves	2542.0	0.35
10.ගෙවතු - Home gardens	96424.0	13.43
11.ජලාශ - Reservoirs	55241.0	7.69
12.ගොඩනැගිලි- Building	1320.0	0.18
13වැලි හා ගල් පර - Sand and Mountain	2949.0	0.41
14. මුඩු බිම් හා අත්හරින ලද ඉඩම් - Abandoned land	82.0	0.01
15.වෙනත් (පූජා භූමි, මාර්ග,සුසාන භූමි ආදිය)	5486.0	0.76
Other (sacred places, roads,cemetery etc)		
එකතුව - Total	717900.0	100.00

මූලාශ්‍රය - දිස්ත්‍රික් ඉඩම් පරිහරන සැලසුම් කාර්යාලය
Source - District Land use Planning Office

Table 2.2-11 Land Use in Anuradhapura MC

Land use Type	Area (Ha)
Agricultural Farm	15.40
Archaeological Area	46.96
Built-up Area	76.94
Barren Land	4.18
Car Park	1.09
Coconut	9.80
Cemetery	12.60
Homesteads	1122.63
Mixed Crop	104.99
Marshy	1.16
Other Cultivation	16.49
Park	3.64
Paddy	532.77
Playground	35.81
Palmyrah (Palms)	0.33
Railway	3.47
Road	100.59
Rock	1.38
Scrubs	320.98
Waterbody	758.78

Source: Survey Department of Sri Lanka



Source: Survey Department of Sri Lanka

Figure 2.2-5 Land Use in Anuradhapura MC

2.2.9 Water Supply and Sanitation

(1) Water Supply

Table 2.2-12 shows 94% of the households have access to piped water supply in Anuradhapura MC.

Table 2.2-12 Access to Drinking Water Sources in Anuradhapura MC

No.	Name of GND	GN Code	Total	Protected Well Within Premises	Protected Well Out Side Premises	Un Protected Well	Tap Within Unit (Main Line)	Tap Within Premises (Out Side Main Line)	Tap Outside Premises (Main Line)	Rural Water Project	Tube Well	Bourses	River , Tank, Stream	Rain Water	Bottle Water	Other
1	Devanampiyatissapura	295 A	1507	23	2	0	1025	333	25	56	1	0	0	0	42	0
2	Abayawewa	294	511	8	1	0	261	174	47	0	2	1	0	0	5	12
3	Pathispura	298	508	36	20	0	186	132	117	0	0	0	0	0	17	0
4	Bandara Puliyankulama	319	396	140	31	0	184	8	29	0	0	0	0	0	4	0
5	Jayanthi Gramaya	315	555	21	4	2	273	186	64	0	1	0	0	0	3	1
6	Thannayam Kulama	317	292	19	11	1	104	119	38	0	0	0	0	0	0	0
7	Saliya Mawatha	318	522	63	10	8	259	148	23	1	1	0	2	1	5	1
8	Shudda Nagaraya	299	177	14	14	0	46	34	62	0	3	0	0	0	0	4
9	Tissawewa	295	25	2	0	1	17	0	3	0	0	0	0	0	2	0
10	Wessagiriya	297	291	23	9	0	87	109	44	0	2	0	3	0	14	0
11	Isurumuniya	296	385	54	24	1	227	48	16	0	0	0	0	0	12	3
12	Henawatta	572	559	32	6	0	404	102	11	0	0	0	0	0	3	1
13	Nuwarawewa 571	571	395	42	4	4	258	67	16	0	1	0	0	0	3	0
14	Nuwarawewa 250	250	483	36	9	0	326	56	38	0	0	0	0	0	18	0
15	Step 1 Part 1	248	463	4	9	2	384	29	0	2		0	0	0	33	0
16	Wanni Thmmannawa	239	447	10	1	1	226	187	16	0	0	0	0	6	0	0
17	Thammanna Kulama	240	1152	37	3	0	1005	61	21	7	1	0	0	0	15	2
18	Step 1 Part 2	249	481	12	6	0	297	70	1	5	1	0	0	0	88	1
19	Step 2 Part 3	253	642	10	0	0	517	26	1	1	0	0	0	0	87	0
20	Step 2 Part 2	252	827	10	0	0	729	18	30	1	0	0	0	0	39	0
21	Step 3 Part 3	257	762	19	11	2	510	155	59	1	0	0	0	0	3	2
22	Step 2 Part 1	251	1075	15	0	0	948	2	0	5	0	0	1	0	103	1
23	Step 2 Part 4	254	821	4	0	0	687	14	0	1	0	0	0	0	114	1
24	Wanniyakulama Kotasa 4	245	437	1	0	0	341	78	5	0	0	0	0	0	12	0
25	Wanniyakulama Kotasa 5	246	533	3	0	0	417	90	3	0	0	0	0	0	19	1
26	Wanniyakulama Kotasa 6	247	471	1	0	0	353	74	1	1	0	0	1	0	40	0
27	Step 3 Part 1	255	821	6	1	0	671	107	13	0	0	0	0	0	23	0
28	Step 3 Part 2	256	833	1	0	0	701	17	1	0	0	0	0	0	113	0
29	Wanniyakulama Kotasa 3	244	350	1	0	0	262	84	3	0	0	0	0	0	0	0
	Total		16721	647	176	22	11705	2528	687	81	13	1	7	7	817	30

Source: Census of Population and Housing 2012, DCS

The city's water system consists of three water supply schemes (Table 2.2-13), operated by NWSDB.

Table 2.2-13 Water Supply Schemes in and around Anuradhapura MC

Water Supply Scheme	Water Source	Capacity (m^3/day)	Estimated Supply to MC (m^3/day)	Coverage Area
New Town WSS	Nuwara Wewa	13,500	8,000	Stage I
Anuradhapura East WSS	Thuruwila irrigation tank	21,000	8,500	Stage II & III, Wijaya Pura
Thisa Wewa WSS	Thisa Wewa	45,00	2,100	Sacred City

Source: NWSDB, date??

Water consumption by customer category is shown in Table 2.2-14 for the New Town WSS and the Anuradhapura East WSS. These systems serve mainly customers within the city. Household (domestic)

consumption accounts for 60–70% of the total consumption, while commercial/industrial and institutional customers each accounts for about 20% with slight variance depending on the service area.

Table 2.2-14 Water Consumption by Consumer Class

	New Town WSS; m^3/year			Anuradhapura East WSS; m^3/year		
Year / Type of Consumption	2013	2014	2015	2013	2014	1015
Household	1,925,011	2,005,896	2,078,426	1,114,922	1,111,720	1,100,493
Commercial and Industrial	488,244	543,488	630,272	78,374	24,498	31,763
Institutional	597,119	668,023	669,213	356,999	359,720	363,904
Others	223,848	224,463	181, 487	18,705	28,6151	33,048
Total	3,234,222	3,441,871	3,559,398	1,569,000	1,524,553	1,529,208

Source: National water Supply & Drainage Board (NWSDB)

(2) Sanitation

Table 2.2-15 shows the distribution of sanitation facilities in Anuradhapura MC. About 93% of households (16,883) have water sealed toilets (i.e. with traps to block odour) connected to septic tanks.

Table 2.2-15 Access to Sanitary Facilities in Anuradhapura MC

No.	Name of GND	Total	Water Seal Toilet	Pour Flush Toilet (Not Water Trap)	Direct Pit	Other	Not Using Toilet
1	Devanampiyatissapura	1,507	1,412	10	82	0	3
2	Abayawewa	511	472	5	11	0	23
3	Pathispura	508	487	10	8	0	3
4	Bandara Puliyankulama	396	393	1	1	0	1
5	Jayanthi Gramaya	555	530	6	19	0	0
6	Thannayam Kulama	292	288	0	3	0	1
7	Saliya Mawatha	522	517	1	2	0	2
8	Shudda Nagaraya	177	160	2	12	0	3
9	Tissawewa	25	23	0	1	0	1
10	Wessagiriya	291	277	0	10	0	4
11	Isurumuniya	385	380	0	0	0	5
12	Henawatta	559	557	0	2	0	0
13	Nuwarawewa 571	395	379	5	10	0	1
14	Nuwarawewa 250	483	480	1	2	0	0
15	Step 1 Part 1	463	460	0	3	0	0
16	Wanni Thmmannawa	447	441	2	4	0	0
17	Thammanna Kulama	1,152	1,147	3	2	0	0
18	Step 1 Part 2	481	469	3	9	0	0
19	Step 2 Part 3	642	638	0	4	0	0
20	Step 2 Part 2	827	827	0	0	0	0
21	Step 3 Part 3	762	1,217	6	5	0	2
22	Step 2 Part 1	1,222	1,074	4	1	0	0
23	Step 2 Part 4	1,075	820	0	0	0	0
24	Wanniyakulama Kotasa 4	821	433	0	1	0	0

25	Wanniyakulama Kotasa 5	437	530	3	1	0	0
26	Wanniyakulama Kotasa 6	533	471	1	0	0	2
27	Step 3 Part 1	821	819	2	0	0	0
28	Step 3 Part 2	833	833	0	0	0	0
29	Wanniyakulama Kotasa 3	350	349	0	0	0	1
	Total	17,472	16,883	65	193	0	52

Source：Census of Population and Housing 2012, Department of Census, and Statistics

Anuradhapura MC has no sewerage system. There is one small facility that partially treats wastewater from about 200 commercial stores. The facility consists of inlet pipes, two septic tanks, and an infiltration tank (**Figure 2.2-6**).

This facility has a daily capacity of 25 m^3. A vacuum truck collects sludge from the septic tanks at the request of the owner/users. However, overload and poor maintenance is causing pollution in the surrounding areas. Water from the septic tanks is discharged into a nearby canal leading to Malwathu Oya. Water flowing into the drainage canal had a black colour at the time of the field survey (Figure 2.2-7).

Source: JET

Figure 2.2-6 Wastewater Treatment Facility for Commercial Stores

Source: JET

Figure 2.2-7 Drainage Canal

Sludge from household septic tanks is transported to Anuradhapura MC's solid waste disposal area. Greywater from kitchens and bathrooms of regular households are discharged untreated into public sewer lines and then to public water areas.

Wastewater overflows from the septic and infiltration tanks during the rainy reason polluting the surrounding areas. There is an increasing concern that it could also pollute Malwathu Oya and nearby water reservoirs.

According to the Pre-Feasibility Report for the Anuradhapura Wastewater Treatment and Disposal System, prepared in 2015 by NWSDB at its own expense, the following institutions are equipped with their own sewage treatment systems.

1) Anuradhapura Teaching Hospital (1,972 beds)
   The hospital uses the OD process to treat wastewater, as well as a rotating biological contactor process for the newly constructed ward. Treated water from both systems is discharged into Ponnarankulama wewa nearby, and greywater is discharged directly to a canal.

2) Anuradhapura Army Camp
The service population is about 1,350 which is approximately 25% of the camp's population. Wastewater is treated primarily by a stabilization pond and discharged to Nuwara wewa. The Camp plans to construct another pond to increase the treatment capacity in the future.

3) Anuradhapura Air Force Camp
The service population is about 1,500 which is approximately 25% of the camp's population. Wastewater is treated by the OD process, and treated water is used to irrigate rice paddies and container plants within the Camp.

2.2.10 Solid Waste Collection and Disposal

In Anuradhapura MC, garbage is separated before collection and disposal. Organic waste is composted at the disposal site built in 2009 in Nuwaragampalatha East Pradesiya Sabah (PS). The daily collection volume in Anuradhapura MC and the PS is estimated at 40 tons. Pictures of the disposal site and compost facility are shown in **Figure 2.2-8**.

UDA is faced with a heavy daily garbage load and the problem of open dumping in the sacred site (especially during the crowded Poson Poya season in June). Construction of an additional disposal site is being planned under the "Pilisaru" (recycling resources) Project and the Integrated Sustainable Waste Management Programme (ISWMP) with the assistance of KOICA.

Sauce: JET

Figure 2.2-8 Waste Disposal Site (left) and Compost Facility (right)

2.3 NEED FOR THE PROJECT

In its national policy enacted in 2010, Sri Lanka aims to achieve 100% access to sanitation through on and off-site sanitary facilities by 2025. NWSDB plans to achieve 7.0% piped sewer coverage by 2020.

The United Nations sets Sustainable Development Goals (SDGs) as the next development agenda for the Millennium Development Goals (MDGs). The goal related to sanitation and hygiene is to ensure universal access to safely and sustainably managed water and sanitation by 2030, and some of the specific targets include:

- By 2030, achieve access to adequate sanitation and hygiene facilities for all
- By 2030, improve water quality by halving the proportion of untreated wastewater

As of 2012, sewerage system coverage is only at 2.4% in Sri Lanka. Anuradhapura has no STP, and relies on septic tanks and other on-site facilities, which do not function adequately. Increasing levels of ammonia and coliform bacteria are being detected in Malwathu Oya that flows through the World Heritage Site area (See 2.1.5).

AFD, under its Strategic City Development Project for Anuradhapura City, plans to construct and improve roads and other transportation infrastructure. The project will include improved drainage facilities for mitigating flood damage caused by urban development and the lack of drainage capacity (source: website of the French Embassy in Sri Lanka https://lk.ambafrance.org/FrenchAgencyforDevelopmentSupportsitsFirstIntegratedUrbanDevelopment). Construction of roads and drainage facilities will increase the movement of people and the number of drainage spots, which could lead to increase and concentration of wastewater volume and load.

To improve water quality, it is necessary to construct a sewerage system that can collect and treat increasing volumes of wastewater.

CHAPTER 3 PLANNING BASIS FOR SEWERAGE SYSTEM

3.1 SANITATION PROVISION

In September 2015, NWSDB prepared the Pre-Feasibility Report for the Anuradhapura Wastewater Treatment and Disposal System at its own expense. Targeting populations for 2048, the plan identifies 70 km of gravity sewers, 7.5 km of force mains and a 7,100 m^3/day activated sludge treatment plant. The population projections are based on the 2012 Census data.

The City M/P will be based on this study and considers the population for a larger collection area.

3.1.1 Target Year

According to "NWSDB Design Manual D7 Wastewater Collection, Treatment, Disposal & Re-Use 2012", design period for collection network, pumping stations, STP, and effluent disposal and utilization is 30 years. Therefore, 2046 is selected as the target year for this Master Plan.

3.1.2 Planning and Design Criteria

(1) Sewage Flow Estimate

Table 3.1-1 Design Basis for Estimating Sewage Flow

Item	Value	Remarks
Per capita water consumption	120 lpcd	
Domestic flow	80%	of water consumption
Non-domestic flow	75%	of Domestic Flow
Average dry weather flow (ADWF)	Domestic + Non-domestic flow	
Daily maximum dry weather flow	1.1 times	of ADWF
Hourly maximum dry weather Flow	1.6 times	of ADWF
Peak dry weather flow (PDWF)	3 times	of ADWF
Infiltration	20%	of ADWF

Planning of Sewer Pipe System: Peak Dry Weather Flow (PDWF) + Infiltration
Planning of Pumping Station: Hourly Maximum Dry Weather Flow + Infiltration
Source: JET

(2) Trunk Sewers

a. Hydraulic Calculations of Trunk Sewers

Manning formula is used for hydraulic calculation of gravity sewers, and Hazen William formula is used for force mains (pressure flow) as follows:

Manning Formula
$Q = A \times V$, $V = 1/n \times R2/3 \times S1/2$
where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),
n: Roughness Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)

Hazen William Formula
$Q = A \times V$, $V = 0.84935 \times C \times R0.63 \times S0.54$
where, Q: Flow (m^3/sec), V: Velocity of Flow (m/sec),
C: Flow Velocity Coefficient, R: Hydraulic Radius (m),
S: Hydraulic Gradient, A: Cross Section Area (m^2)

Table 3.1-2 Coefficients for Sewer Design

Type of Pipe	n (Roughness Coefficient)	C (Flow Velocity Coefficient)
PVC Pipe	0.013	120
HDPE Pipe	0.013	120
GRP Pipe	0.013	120
DI Pipe (Ductile Cast Iron Pipe)	0.013	120

The design slopes of gravity sewers are checked based on tractive force required to flush the sand particles expected in sewage flow.
Source: JET

b. Flow Velocities

Minimum velocity: 0.65 m/s
Maximum velocity: 3.0 m/s

c. Sewer Capacities

Diameter of 600 mm or less: capacity exceeds the estimated flow by at least 200%
Diameter greater than 600 mm: capacity exceeds the estimated flow by at least 150%

d. Minimum Earth Cover

1.0 m

e. Minimum Sewer Diameters

Trunk sewer: 225 mm, rider sewer & branch sewer: 160 mm, lateral sewer: 110 mm

f. Pipe Materials

Table 3.1-3 Pipe Materials

Diameter	Purpose	Pipe Material
200 mm or less	Gravity	PVC Pipe
225 to 355 mm	Gravity	HDPE Pipe
400 mm or above	Gravity	GRP
100 to 400 mm	Force Main	HDEP
Above 400 mm	Force Main	DI Pipe

Source: JET

(3) Pumping Stations

Table 3.1-4 shows the types of pumping station: manhole type pumping station (MTPS) or major pumping station (MPS). The Ceylon Electricity Board (CEB) requires the electrical demand of a pumping facility to be 42 kVA or less, where a transformer is not provided. Where the electrical demand exceeds 42 kVA, a transformer will be necessary in which case an MPS is more suitable. It should be noted that MTPS entails site acquisition, depending on the surrounding environment and location.

Table 3.1-4 Types of Pumping Stations

Type of Pumping Station	Site	Electricity
MTPS: Manhole Type Pumping Station	Under Road	Less than 42 kVA
MPS: Major Pumping Station	Property Required	42 kVA and above

Source: JET

(4) Treatment Facilities

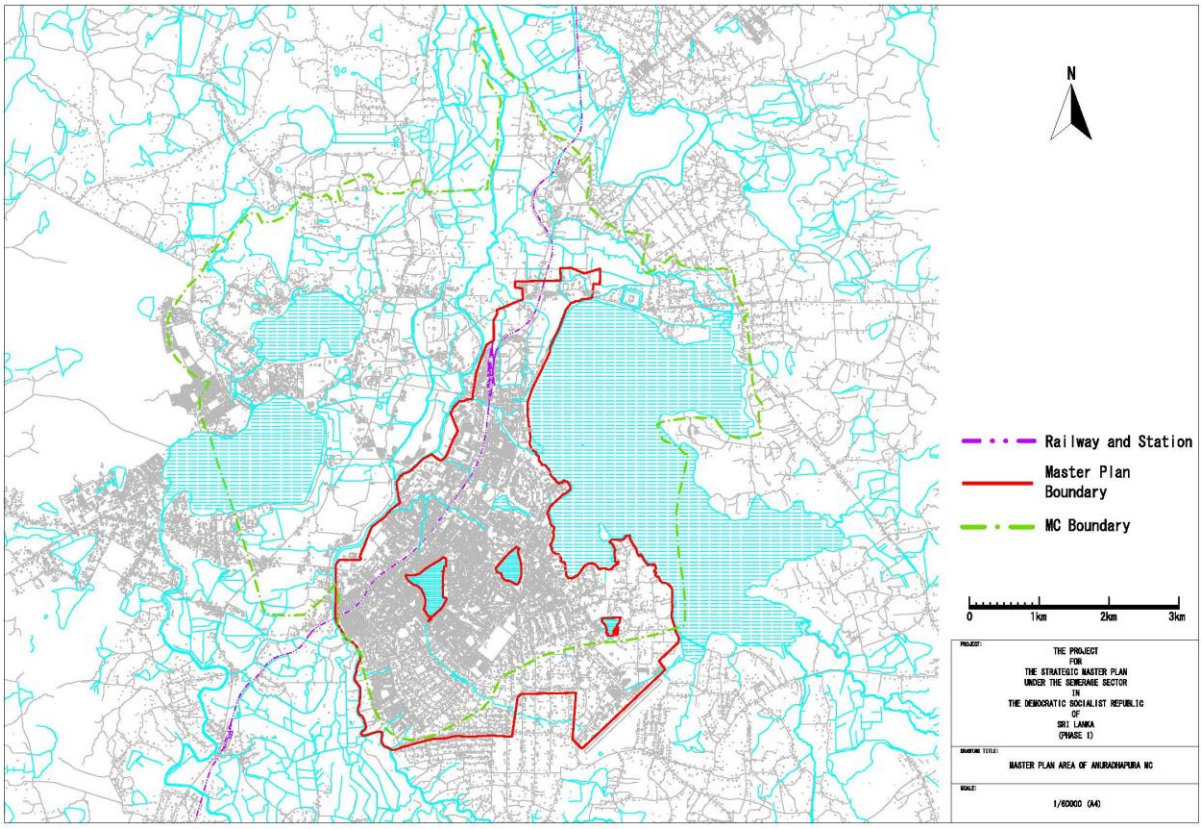
The sewage treatment process is selected by considering the following factors:

- influent sewage quality and effluent discharge standards
- land availability
- construction and O&M cost
- ease of operation and maintenance (O&M)

3.1.3 Service Area

The sewage collection service area selected for the Master Plan is shown in **Figure 3.1-1** and includes:

- developed and populated areas that will be almost saturated by the target year of 2046.
- city centre including large-scale commercial areas and facilities, such as schools, hotels, housing estate, religious and institutional buildings.
- high density residential areas
- areas suitable for applying centralized sewerage system.
- areas adjacent to the city where it is cost effective.



Source: JET based on data of Survey Department of Sri Lanka

Figure 3.1-1 Proposed Sewage Collection Area for Anuradhapura

Table 3.1-5 shows Divisional Secretary Divisions (DSDs) and Grama Niladhari Divisions (GNDs) included in the target area.

Table 3.1-5 DSDs and GNDs included in the M/P Area

S/No.	GND No.	GND
Anuradhapura DSD		
1.1	250	Nuwarawewa
1.2	248	Stage 1 Part 1
1.3	239	Wannithammennawa
1.4	240	Thammennakulama
1.5	249	Stage 1 Part 2
1.6	253	Stage 2 Part 3
1.7	252	Stage 2 Part 2
1.8	257	Stage 3 Part 3
1.9	251	Stage 2 Part 1
2.0	254	Stage 2 Part 4
2.1	245	Wanniyakulama Kotasa 4
2.2	246	Wanniyakulama Kotasa 5
2.3	247	Wanniyakulama Kotasa 6
2.4	255	Stage 3 Part 1
2.5	256	Stage 3 Part 2
2.6	244	Wanniyakulama Kotasa 3

Source: JET based on data of DCS

3.1.4 Sewage Flow

Rate of population increase in the project area and planned population is calculated as shown in Section 1 **APPENDIX 12**. Sewage flow to be treated is calculated as shown in Table 3.1-6 Detailed calculations can be found in **APPENDIX 1**.

Table 3.1-6 Estimated Sewage Flow

M/P Area (ha)	Item	2046	Remarks	
1618	a Population	54,900		
	b Water Consumption (l/d/cap)	120		
	c Return Factor (%)	80		
	d Domestic Flow (m^3/d)	5,270	d = a x b x c	
	e Non-Domestic Flow (m^3/d)	3,953	e = d x 75%	
	f Point Source (m^3/d)	1,169	(Army camp: 1,200 per.+ Air force camp: 1,500 per.) x b x c + Visitor: 26,000 persons x 35L/d	
	g Infiltration (m^3/d)	2,078	g = (d + e + f) x 20%	
	h Daily Average Flow (m^3/d)	12,470	h= d + e + f + g	
	i Daily Maximum Flow (m^3/d)	13,509	i = (d + e + f) x 1.1 + g	For STP design
	j Hourly Maximum Flow (m^3/d)	18,705	j = (d + e + f) x 1. 6+ g	For PS design
	k Peak Flow (m^3/d)	33,254	k= (d + e + f) x 3.0+ g	For Sewer design

Source: JET

3.1.5 Influent Sewage Quality

The design influent wastewater quality, based on sampling and analysis, and in consultation with NWSDB, is shown in Table 3.1-7. Details of the design influent wastewater quality are shown in **APPENDIX 2**.

Table 3.1-7 Design Influent Sewage Quality

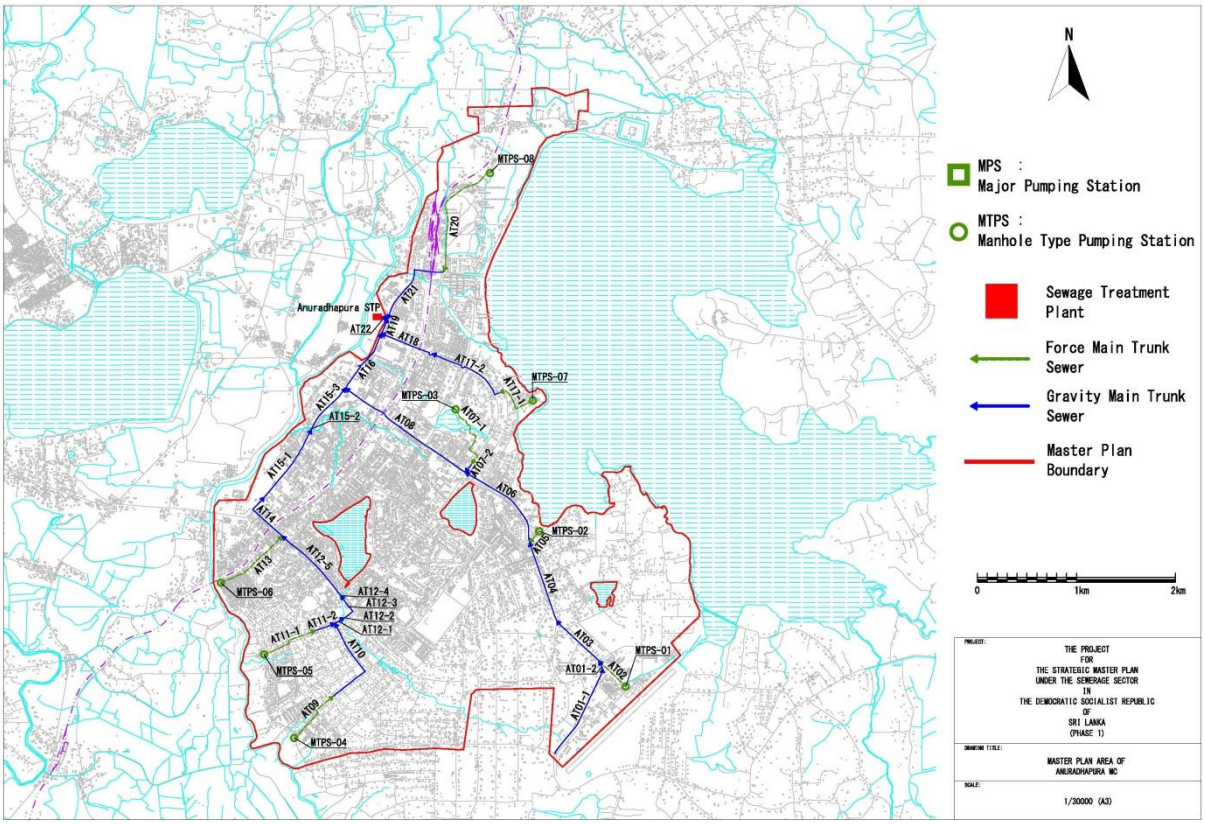
	Influent Sewage
	Design
BOD_5	240
COD	600
TSS	160
T-N	45
T-P	6

Unit: mg/L
Source: JET

CHAPTER 4 PRELIMINARY PLAN AND DESIGN OF THE SEWARAGE SYSTEM

4.1 GENERAL LAYOUT

The proposed sewerage development plan for Anuradhapura MC is shown in Figure 4.1-1 An enlarged map, flow calculations, and a longitudinal sectional view are attached in **APPENDIX 3**.



Source: JET

Figure 4.1-1 Sewerage Development Plan for Anuradhapura MC

4.2 SEWAGE COLLECTION FACILITIES

The design of the STP and location of major pumping stations depends on the layout of the trunk sewers. The length of branch sewers will be like those in other similar projects. The length of lateral sewers to the houses and buildings is estimated based on the projected population.

4.2.1 Sewer Network

The trunk sewer mains are listed in Table 4.2-1.

Table 4.2-1 Major Sewer Mains

Item	Diameter	Material	Length	Remarks
Branch Sewer	225mm	HDPE Pipe	242,700m	Including Force Main
	Sub-Total (Branch Sewer)		242,700m	
Trunk Sewer	225mm	HDPE Pipe	2,047m	
	280mm	HDPE Pipe	213m	
	315mm	HDPE Pipe	24m	
	355mm	HDPE Pipe	579m	
	400mm	GRP Pipe	1,034m	
	450mm	GRP Pipe	986m	
	500mm	GRP Pipe	1,429m	
	600mm	GRP Pipe	1,758m	Pipe Jacking (301m)
	700mm	GRP Pipe	4,453m	Pipe Jacking (348m)
	900mm	GRP Pipe	861m	
	1000mm	GRP Pipe	40m	
	110mm	HDPE Pipe	1,822m	Force Main
	125mm	HDPE Pipe	793m	Force Main
	140mm	HDPE Pipe	597m	Force Main
	200mm	HDPE Pipe	1,252m	Force Main
	225mm	HDPE Pipe	150m	Force Main
	250mm	HDPE Pipe	375m	Force Main
	Sub-Total (Trunk Sewer)		18,413m	Sub-Total (Pipe Jacking) 649m
Total	Branch Sewer + Trunk Sewer		261,113m	
	Crossing: Railway Crossing (4 locations), River Crossing (1 location)			

*Pipe Jacking of HDPE Pipe & GRP Pipe is installed by the slip lining method.
Source: JET

4.2.2 Sewage Pumping Stations

The main pumping stations are shown in Table 4.2-2.

Table 4.2-2 Main Pumping Stations

Item No.	Design Flow	Total Pump Head	Unit	Remarks
MTPS-01	Approximately 3.3 m^3/min	15 m	1+(1)	
MTPS-02	Approximately 2.3 m^3/min	10 m	1+(1)	
MTPS-03	Approximately 0.6 m^3/min	30 m	1+(1)	
MTPS-04	Approximately 0.7 m^3/min	35 m	1+(1)	
MTPS-05	Approximately 1.0 m^3/min	25 m	1+(1)	
MTPS-06	Approximately 0.8 m^3/min	30 m	1+(1)	
MTPS-07	Approximately 0.4 m^3/min	15 m	1+(1)	
MTPS-08	Approximately 2.0 m^3/min	30 m	1+(1)	

Notes: MPS: Major Pumping Station MTPS: Manhole Type Pumping Station (1): One pump unit for stand-by
Source: JET

4.2.3 Service /House Connections

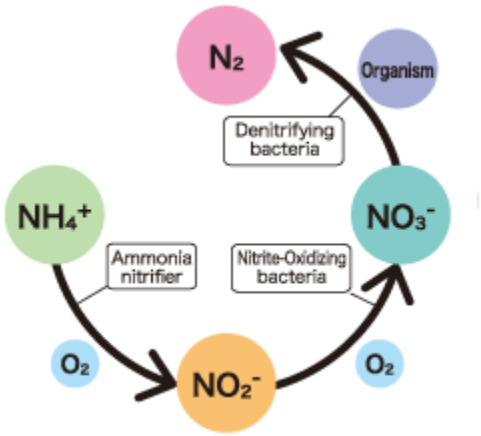
Based on the projected population of 54,900 people and an average family size of four people, in 2046, there will be approximately 4,800 households (Household Income and Expenditure Survey 2012/13 issued by the DCS).

4.3 SEWAGE TREATMENT FACILITY

4.3.1 Treatment Method

(1) Compliance with the Allowable Discharge Limits

The allowable discharge limits (shown in **APPENDIX 4**) are being amended and a draft is available to the public, although it has not yet been gazetted. The effluent quality from the proposed treatment plant will comply with the amended discharge limits. The allowable limits for organic substances in the amended version are not expected to change much. Limits for heavy metals will be stricter. The amendment introduces an allowable discharge limit for nitrates, set at 10 mg/l as NO3-N. This new requirement will have a significant impact on the selection of treatment method.



Source:http://www.zeolite-anammox.com/#!faq/c12z9

Figure 4.3-1Figure 4.3-1: Nitrogen Cycle

Figure 4.3-1 shows the reaction cycle of nitrogen during biological wastewater treatment. Ammonia nitrogen (NH3-N) and a portion of organic nitrogen is converted to nitrite and nitrate through nitrification carried out by ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB). Nitrate produced by the nitrification process should be reduced through denitrification to less than 10 mg/L to meet the amended allowable discharge limit. Nitrification occurs naturally in small scale STP which are usually operated with long solids retention time (SRT). High wastewater temperature promotes nitrification. Suppression of nitrification in any biological process is therefore not easy and is not a realistic option. Therefore, the treatment process must have the ability to denitrify. Denitrification is relatively easy to achieve with activated sludge processes but is more difficult for biofilm processes and stabilization ponds.

(2) Selection of Treatment Process for Estimating Land Requirements

The projected daily maximum sewage inflow for Anuradhapura is 13,600 m^3/d. The most commonly used process for small-scale treatment plant is OD process. The process can be slightly modified to conduct denitrification. Kandy STP, (Figure 4.3-2) under construction, is adopting the OD process with nitrogen removal ability. The capacity of Kandy STP is 14,000 m^3/d, almost the same as Anuradhapura STP. The reactor is equipped with air diffusers and mixers which can be modulated to create anoxic or aerobic conditions by switching the aeration system on and off. The duration of anoxic and aerobic conditions is designed to be 1 to 1.

Source: JFE

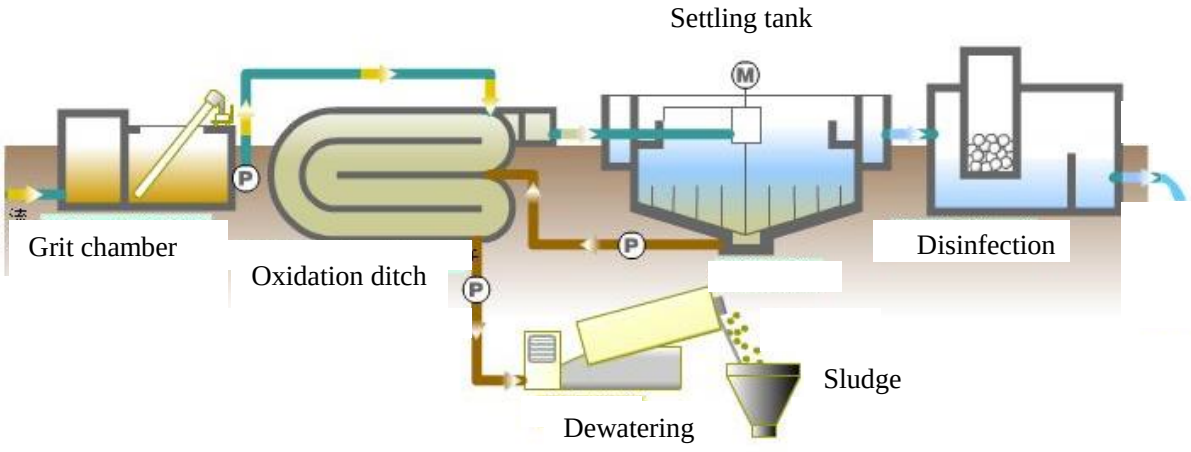
Figure 4.3-2 Kandy Sewage Treatment Plant
(14,000 m^3/day, OD Process with Nitrogen removal)

It is assumed that the treatment process for Anuradhapura STP would be OD process with nitrogen removal.

More information on the site condition is necessary for the final determination of the treatment process. Specific treatment technology cannot be discussed until a treatment plant site is determined. The discussion on treatment process at this point would be in general terms only.

(3) Characteristics of the Oxidation Ditch Process

The OD process is shown in **Figure 4.3-3**.



Source: JET

Figure 4.3-3 Schematic of Oxidation Ditch Process

OD process, used mainly in small-scale STPs have the following characteristics:

- simple configuration, limited number of equipment and easy operation
- bioreactor is oval or horseshoe shape
- no primary settling tank
- large reactor can adapt to inflow load fluctuation and assure long HRT
- tolerance to minor problems due to redundancy of the process
- nitrogen is removed by introducing anoxic condition in the reactor
- low excess sludge production

The OD process is not suitable for large scale STPs because of the large area requirement.

4.3.2 STP Site and General Layout of Unit Processes

(1) STP Site

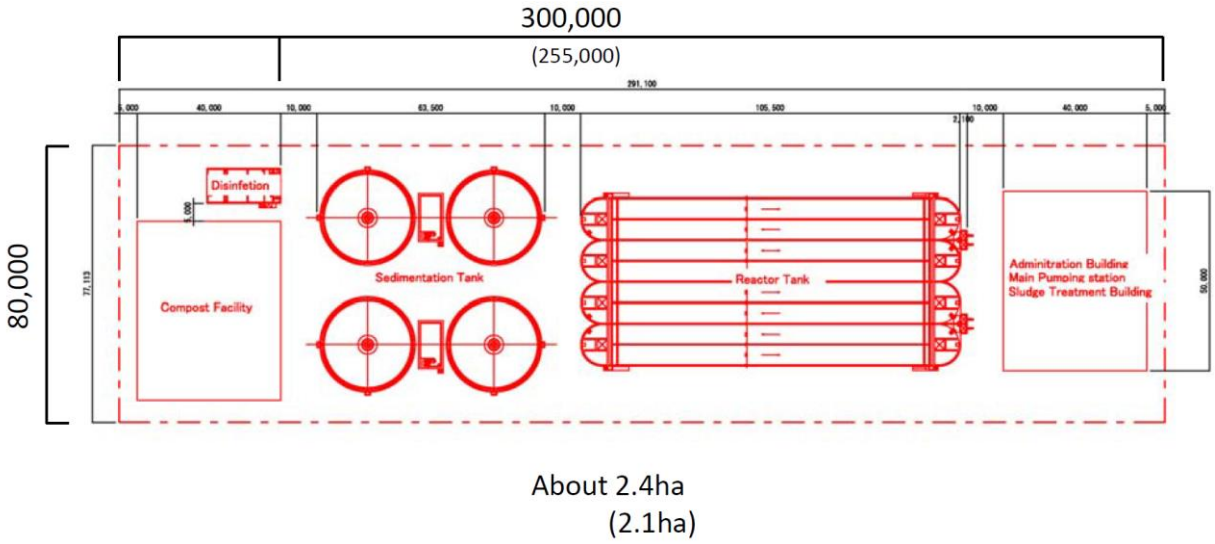
The candidate STP site is owned by the city and is located along the Maruwatu River. The City has confirmed in writing that the site can be used for STP (**APPENDIX 5**). The flow of Maruwatu river decreases during the dry season but the City's irrigation department has confirmed that the minimum 8 times dilution ratio can be met.

Source: JET

Figure 4.3-4 Candidate site

(2) General Layout

The land required for the OD process with nitrogen removal is calculated to be 2.4 ha including a composting facility. Figure 4.3-5 shows the layout arranged on a rectangular site.



Notes: Figure in the bracket denotes land area excluding composting facility
Source: JET

Figure 4.3-5: Treatment Plant Layout

4.3.3 Odour Control

Possible odour emission points of OD process are:

- septage receiving facility
- grit chamber
- OD
- sludge treatment

The septage receiving, grit chamber and sludge treatment processes are the main odour emission points. Odour from the OD is usually not very offensive.

The necessity for odour control depends on the environmental condition near the STP.

Odour control options are as follows:

- activated carbon adsorption
- biological deodorization in combination with above
- supply of odour containing air to reactor
- soil bio-filter

Soil bio-filter is a simple method but periodical soil turnover is required for more efficient odour reduction. Activated carbon is necessary if intensive odour control is required.

4.3.4 Sewage Treatment Process

The treatment plant will accept septage from the areas that will not be connected to the sewage collection network in the foreseeable future. Since there is no primary settling tank, the maximum amount of septage that can be accepted should be 0.5% of inflow wastewater volume.

(1) Required Treatment Level

The assumed quality of sewage influent and effluent treated by OD are shown in **Table** 4.3-1. The assumed quality of sewage was determined in consultation with MWSDB taking into consideration the wastewater quality of Moratuwa/Ratmalana STP, Ja-Ela/Ekala STP and other STPs that are in the neighbourhood of Colombo City. The target effluent quality is set to meet the allowable discharge limits. The dilution ratio of the effluent will vary depending on the flow rate in the stream at the discharge point.

Table 4.3-1 Assumed Quality of Sewage Influent and Effluent

Unit: mg/L	Inflow	Effluent
	Design Raw Water Quality	Tolerance limit
BOD5	240	30
COD	600	250
TSS	160	50
T-N	45	-
TKN	-	150
NH4-N	-	50
NO3-N	-	10
T-P	6	-
Soluble-P	-	5

Source: JET

(2) Main Unit Processes

1) Screen and Grit Chamber

Wastewater first flows through the screens and grit chamber where grit and solid wastes are removed to prevent damage to machines and equipment.

2) Oxidation Ditch

After the grit chamber, wastewater flows into the OD, the bioreactor of the process. Wastewater is mixed with activated sludge and retained in the tank for about 24 hours. The mixed liquor is continuously agitated either by rotor or propeller. Rotor movement supplies oxygen. When propellers are used, a diffuser supplies oxygen. Organic substances are biologically decomposed and ammoniac nitrogen is converted to nitrate. By introducing anoxic condition in the OD, denitrification occurs and nitrate is reduced to nitrogen gas. Anoxic condition can be introduced in some sections of the tank either by intermittent aeration or by adjusting aeration intensity.

3) Settling Tank

The mixed liquor flows into the circular settling tanks and is retained for about 6 hours while solid-liquid separation takes place. The clarified supernatant flows over the effluent weir of the settling tank. The activated sludge in the tank is collected in the sludge hopper. Some of the activated sludge is returned to the OD to keep the process going and the excess is sent to thickening and dewatering.

4) Disinfection Tank

Treated wastewater is disinfected before discharge to minimize the health risks associated with pathogens. Disinfection will be with chlorine in the form of sodium hypochlorite (NaOCl), added to the effluent after the final settling tank. If the receiving water is found to be sensitive to chlorine by-products (e.g. fish), UV radiation will be considered as an alternative.

4.3.5 Sludge Treatment and Disposal

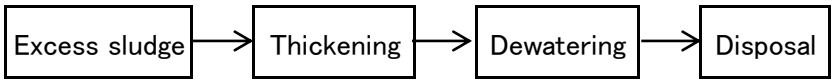
(1) Characteristics of Produced Sludge

Since the OD process has no primary settling tank, only waste activated sludge (WAS) is produced.

WAS contains mostly protein which is the main constituent of the biomass. WAS from the OD process is aerobically stabilized because of the long solids retention time (SRT). Odour emission therefore is generally much less than primary sludge.

(2) Sludge Treatment

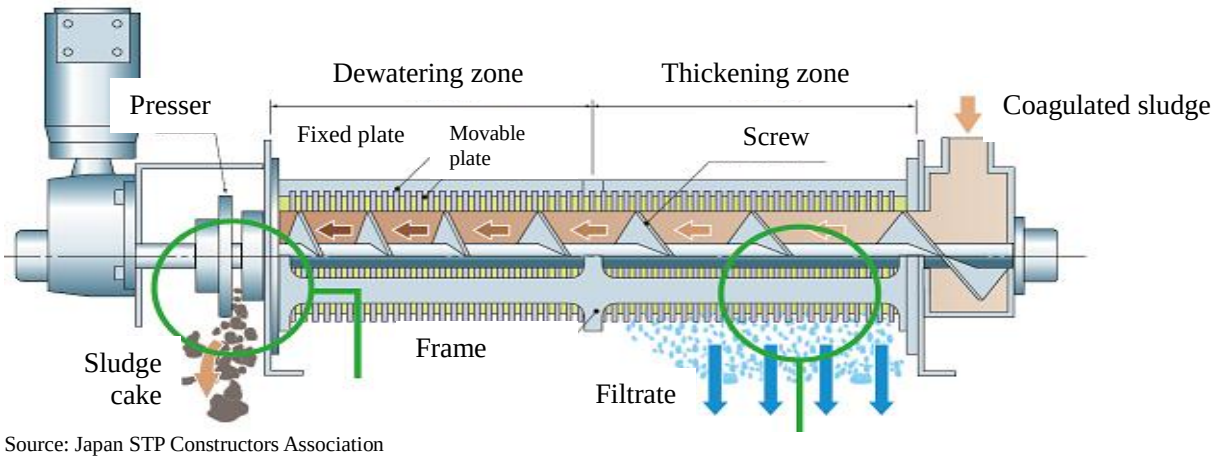
A typical sludge treatment process is shown in Figure 4.3-6 Excess sludge is thickened then dewatered. Thickening is carried out by gravity. Depending on the type of dewatering machine, thickening is sometimes omitted and excess sludge is dewatered directly. Anaerobic digestion is usually not used since WAS is not easily decomposed anaerobically.



Source: JET

Figure 4.3-6 Schematic for Sludge Treatment

Filter belt press or screw press type dewatering machines are commonly used. Both types of machine require sludge conditioning by polymer coagulant prior to dewatering. Screw press type dewatering machines are becoming popular for the following reasons: 1) compact size supplied as a unit containing dewatering and coagulation equipment, and control panel; 2) easy to operate, unmanned operation is possible; 3) direct dewatering of excess sludge without thickening is possible.



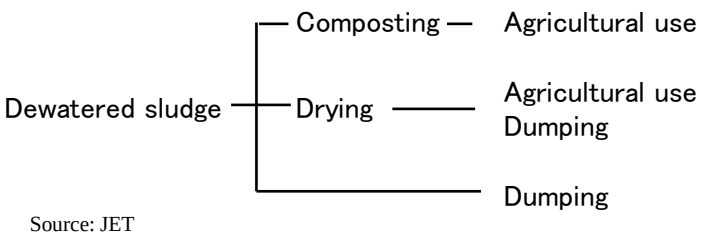
Source: Japan STP Constructors Association

Figure 4.3-7 Pressurized Screw Press

(3) Sludge Disposal

The quantity of waste sludge can be calculated by multiplying the amount of suspended solids removed by 0.75. In general, SS removal efficiency of the OD process is 95%. Therefore, in the case of Anuradhapura, sludge produced at the daily maximum flow rate is 1.6 DSt/d (13,600 × (160-8) × 0.75 × 10-6). Assuming the moisture content of dewatered sludge is 80%, the amount of the dewatered sludge will be 7.8 tons/day.

(4) The options for the disposal of dewatered sludge are listed in Figure 4.3-8.



Source: JET

Figure 4.3-8 Sludge Disposal Options

Nitrogen and phosphorus in sewage sludge are essential nutrients for plant growth. The composting process breaks down the organic substances and matured compost has no offensive odour. During composting, fermentation temperature will rise to 80-90℃, destroying pathogenic bacteria in the process. Composting is preferable to drying and dumping because it recycles the nutrients and is also hygienic. Composted sludge can be used as fertilizer for tea plantations, since it has high nitrogen content. However, strict quality control and education of users are essential.

There are various sludge composting processes. The simplest is pile composting, shown in Figure 4.3-9 Sludge is dewatered to a moisture content of around 60% by adding organic materials such as sawdust, rice hull, straw, bark, or composted sludge. The dewatered sludge is piled on a flat concrete bed. Air is supplied through a pipe or by periodic turnover using a shovel or tractor. It usually takes 10-14 days for the first stage fermentation. The second stage will take 1 to 3 months to produce matured compost.

Source: JET

Figure 4.3-9Figure 4.3-9: Pile Composting

Sludge compost contains nitrogen and phosphorus but only a small amount of potassium. Composting with other organic wastes such as cow dung can increase the potassium content and thus the value of compost products.

If there are no agricultural activities in the area to use the composted sludge, dumping may be the only option. Some dump sites do not accept materials with more than 60% moisture content. Dewatered sludge usually at around 80% moisture content must be dried before dumping.

Figure 4.3-10 shows Anuradhapura's solid waste the pile composting facility and the resulting product.

Source: JET

Figure 4.3-10 Solid Waste Composting Facility (Left) and Compost Product (Right, LKR 400/50 kg)

4.4 ON-SITE FACILITIES AND SEPTAGE MANAGEMENT

4.4.1 On-site Facilities

The west side of Anuradhapura MC is sparsely populated therefore on-site septic tanks can provide effective wastewater treatment. Design, construction, and maintenance of septic tanks should comply with the national standard (Sri Lanka Standard (SLS) 745 Part 2: 2009) so that their proper functioning can be maintained.

4.4.2 Septic Tanks

Septic tanks retain wastewater, allowing the solids to separate from the suspension and facilitate partial decomposition to reduce pollution load. A septic tank must be adequately sized to perform these functions properly.

The schematic of a typical septic tank is shown in **APPENDIX 6**. The tank should be waterproof and durable enough to withstand external soil load as well as internal water pressure. When the tank is placed under a driveway or parking area, the specifications must ensure the ability to withstand reasonable vehicle loads.

4.4.3 Septic Tank Operation & Maintenance

Periodic maintenance is important for the facility to function sustainably. Therefore, users and owners should be aware of the following precautions:

(i) Sludge Removal

A septic tank requires removal of sludge at regular intervals. In general, when filled with sludge and scum, the tank should be cleaned, leaving about one-third to half of the sludge as a 100 to 150 mm layer of "seed sludge" to restart the treatment process. The sludge pumped from the tank is disposed of at a STP to be constructed.

(ii) Access Cover

An access cover is kept shut tightly to prevent other waste from entering the tank. When damaged, it should be repaired or replaced immediately.

(iii) Mosquitoes

To prevent mosquito breeding, make sure that the septic tank is kept tightly closed. Vents must be provided with mosquito mesh and checked periodically. The mesh must be replaced, as required.

(iv) Blockage

Blockage is typically caused by solids clogging the inlet of the septic tank. Preventive measures should be taken. Solid matter should be cleared from the access cover, using a long and flexible stick.

CHAPTER 5 INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

The implementation of sewerage systems requires planning, design, construction, and eventually operation and maintenance. Capacity development of staff from NWSDB, relevant regional support centres (RSCs), and MCs is needed to ensure required tasks are satisfactorily conducted at each level.

5.1 PROJECT IMPLEMENTATION AND MANAGEMENT

5.1.1 Examples of Project Implementation Structures in Sri Lanka

Table 5.1-1 shows the implementation structure of water and sewerage works in 6 municipalities. Some sewerage works are under implementation or at the planning stage.

Table 5.1-1 Organization of Water and Sewerage Works in 6 Municipalities

Area	Water works			Sewerage works			
	Ownership	Management	O&M	Ownership	Management	O&M	
						STP	Pipe
CMC	N	N	N	MC	MC	---	MC
Kandy	MC	MC	MC	MC	MC (unfixed)	N (unfixed)	MC (unfixed)
Ratmalana-Moratuwa	N	N	N	N	N	N	N
Ja-ela/Ekala	N	N	N	N	N	N	N
Hikkaduwa	N	N	N	N	N	N	N
Kataragama	N	N	N	N	N	N	N

(N: NWSDB)
Source:

Colombo MC (CMC) owns the sewerage works and operates and maintains the pumping stations and sewer networks, while the water works is owned and managed by NWSDB.

Kandy MC owns the water and sewerage works, but the O&M of STP will be out-sourced to NWSDB, while the MC will conduct sewer pipe maintenance

The water and sewerage works in Ratmalana-Moratuwa, Ja-ela/Ekala, Hikkaduwa, and Kataragama, are owned and managed by NWSDB.

The ownership and the implementation structure of the sewerage works is determined by each municipality.

5.1.2 Public Works in Anuradhapura MC

Table 5.1-2 shows the water supply, solid waste collection and disposal, on-site sanitation, road construction/maintenance, and storm-water management in the MC.

Table 5.1-2 Public Works in Anuradhapura MC

Water works	Responsible organization		NWSDB, RSC North Central
	Water supply schemes		30
	Blanch offices		33
	Planning & Designing		Engineer 6, Technical 6, Others 6
	WTP	Full scale	12
		Partial scale	7
		Out-sourcing	Cleaning, Security, Labor
	Laboratories		2
		Out-sourcing	Heavy metal, algae TOC analysis
	Transmission and Distribution		Engineer 0, Technical 1, Others 22
	Meter reading		70
	Charge Collection		13
		Out-sourcing	-
Solid waste management	Responsible organization		MC
	Works		Collection, Transportation to dump site
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget
	Service charge		no
	Dumping site	Location	Kirikkulama (14 acres, owned by MC)
		Capacity	280,000 m3
	Collection	Method	
		Vehicles	Compactor 1, Tractor 14, Truck 1, Cart 24
	Staff	PHI	1
		Supervisor	4
		Driver	18
		Labors	186
	Out-sourcing		no
On-site sanitation	Responsible organization		MC
	Works		Provide instruction on construction of facilities, de-sludging of sepitc tanks,taking legal action against rules violation .
	Type of tasks	Planning & Designing	no
		Construction	no
		O&M	Implementing
	No. of septic tanks	At present	42,000
		Future	70000 (2020)
	Financing sources		Service charge, MC budget
	Services	Installation	Provide contractors for Property /land owner or House holder
		Approval	MC (PHI)
		Supervisor	MC (PHI)
	Sludge removal	Frequency	4 times/year
		Procedure	
		Sludge disposal site	At New Bustand, 0.5 Acre
	Service charge	Installation	By Property /land owner or House holder
		Sludge disposal	3,000 Rs + VAT
	Staff	Supervisor	1
		PHI	3
		Driver	2
		Labors	8
	Out-sourcing		no
Road construction and maintenance works	Responsible organization		MC
	Works		Type C and D
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Financing sources		MC budget, Government subsidy
	Staff	Engineer	1
		Technical officer	4
		Others	109
	Out-sourcing	Details	Construction / Rehabilitation
		Type of contract	Short term contract period by
Storm water management	Responsible organization		MC
	Works		Deearin of drains, clearing of blockages, cleaning of drains
	Type of tasks	Planning & Designing	Implementing
		Construction	Implementing
		O&M	Implementing
	Existing drainage system		Open rrain system (2'ø=20km, 20'ø=5km)
	Financing sources		MC budget, Government subsidy
	Staff	Engineer	1
		Technical officer	4
		Others	114
	Out-sourcing		no

Source: MC

Anuradhapura water supply is one of the 30 water supply schemes operated by NWSDB, North Central RSC. The MC carries out all the other public works services from planning to O&M without outsourcing.

Construction of on-site sanitation is managed by house or land owners. The MC is responsible for collection and disposal of septic tank sludge and charges owners for the service.

The MC budget and government subsidies are used to cover the costs of providing the service.

5.1.3 Organizational Options for Implementing Sewerage Works

5 options are prepared for the implementation of sewerage works as shown in Table 5.1-3.

Table 5.1-3 Organizational Options for Implementing Sewerage Works

Activity	Option 1	Option 2	Option 3	Option 4	Option 5
Request of sewerage works	NWSDB	NWSDB	LA	LA	LA
Approval of sewerage works	MWSD	MWSD	MWSD ⇨ MLGPC	MWSD ⇨ MLGPC	MWSD ⇨ MLGPC
Budget Preparation	MWSD ⇨ NWSDB	MWSD ⇨ NWSDB	MLGPC ⇨ LA	MLGPC ⇨ LA	MLGPC ⇨ LA
Project Planning	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA	NWSDB assisted by LA
Planning & Designing	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C
Construction	P/C	P/C	P/C	P/C	P/C
Construction Supervision	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C	NWSDB & C/C
Ownership of facilities	NWSDB	NWSDB	LA	LA	LA
O&M Sewer Networks	NWSDB	P/O supervised by NWSDB	LA	P/O supervised by LA	LA
O&M STP			NWSDB		
Loan Settlement	MWSD ⇨ NWSDB	MWSD ⇨ NWSDB	MLGPC ⇨ LA	MLGPC ⇨ LA	MLGPC ⇨ LA

Notations : 1. LA- Local Authority (MC, Urban Council (UC), Pradeshiya Sabha (PS)
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
6. P/C- Private Contractor
7. P/O- Private Operator

Source: JET

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

In Options 3 and 4, the MC owns the system but 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.

In all five options, the planning, design, and construction is carried out by NWSDB because they are experienced with these tasks.

5.1.4 Preferred Implementation Structure for Sewerage Works

Water works in the MC area are managed by NWSDB, therefore it makes sense that the sewerage works should also be managed by NWSDB for the following advantages:

A) Service charge can be set lower

The integration of water and sewerage services will reduce the duplication of functions such as accounting, personnel management, customer service, and billing. The savings in administrative overhead can help reduce the sewerage service charge.

B) Experience and knowledge

NWSDB has many experienced engineers and skilled labourers that are working in RSC North Central and managing the MC's water works. The Greater Colombo Sewerage (GCS) Office, organized under Assistant General Manager (AGM) (O&M-GC), is responsible for managing several existing sewerage works. Some NWSDB staff can be transferred to the sewerage works in Sri Jayawardenapura Kotte MC to ensure a smooth start-up and operation.

Therefore, Options 1 or 2 are preferred for implementing the sewerage works in Anuradhapura MC.

5.2 ORGANIZATION FOR IMPLEMENTATION

To organize the implementation of the sewerage system in Anuradhapura MC, the detailed roles of NWSDB, relevant RSC and MC must be defined. **Table 5.2-1** shows the roles for each party from planning to O&M for Options 1 and 2.

Table 5.2-1 Role of NWSDB and MC at Various Implementation Stages

Option-1		Stage of sewerage works			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	O&M of sewerage works Consideration of out-sourcing
	Staff	* Technical Team	* PD under DGM * Staff in Project Management Units (PMU)	⇒	* Staff in STP * Staff for sewer networks
RSC	Tasks		Supporting project activities	⇒	Supporting O&M of sewerage system Public awareness Promotion of house connection
	Staff		* Manager in sewerage works	⇒	⇒
MC	Tasks	Cooperation for planning works	Cooperation for land acquisition	Cooperation for STP and sewer networks construction	Monitoring of effluent Public awareness Promotion of house connection
	Staff	* Staff for tasks above	⇒	⇒	⇒

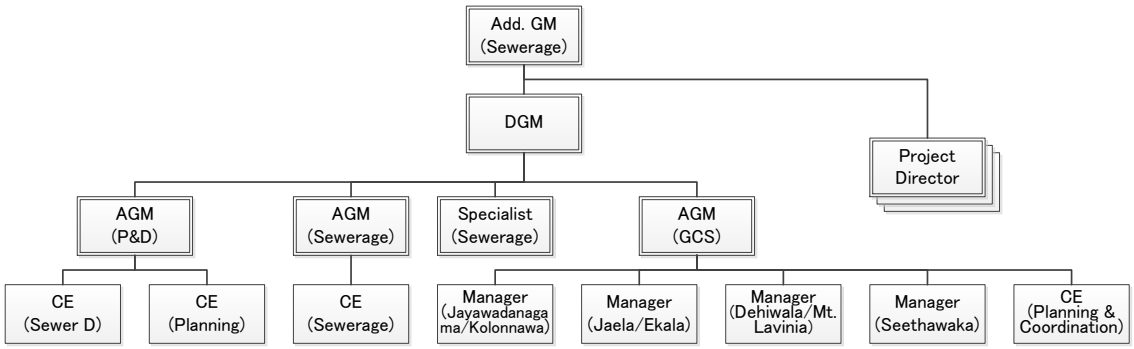
Option-2		Stage of sewerage works			
		Planning	Designing	Construction	O&M
NWSDB	Tasks	Supervision Decision of STP site and others	Supervision	Supervision	Supervision
	Staff	* Technical Team	* PD under DGM * Staff in PMU	⇒	* Supervisor of O&M of sewerage system
RSC	Tasks		Supporting project activities	⇒	Supporting O&M of sewerage system

					Public awareness Promotion of house connection
	Staff		* Manager in sewerage works	⇒	⇒
MC	Tasks	Cooperation for planning works	Cooperation for land acquisition	Cooperation for STP and sewer networks construction	Monitoring of effluent Public awareness Promotion of house connection
	Staff	*Staff for tasks above	⇒	⇒	⇒

Source: JET

5.2.1 Organization of the NWSDB Sewerage Department

The organization of the NWSDB sewerage department is as shown in Figure 5.2-1 When the sewerage project is implemented, the engineering tasks in planning, design, construction, and O&M will increase.

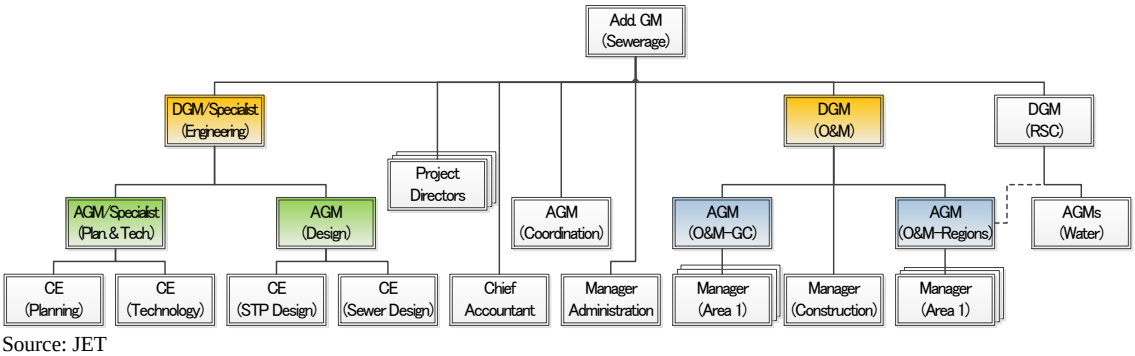


Source: JET

Figure 5.2-1 Organization of the NWSDB Sewerage Department

Some re-organization of the sewerage department must be made to cope with the increased tasks as shown in Figure 5.2-2.

The responsibilities of the Deputy General Manager (DGM) can be split into DGM/Specialist (Engineering) and DGM (O&M). AGM for planning and design (P&D) can be split into AGM (Plan & Tech.) and AGM (Design). AGM (O&M-Regionals) can be added to AGM (O&M-GC) to cope with the increased work load.



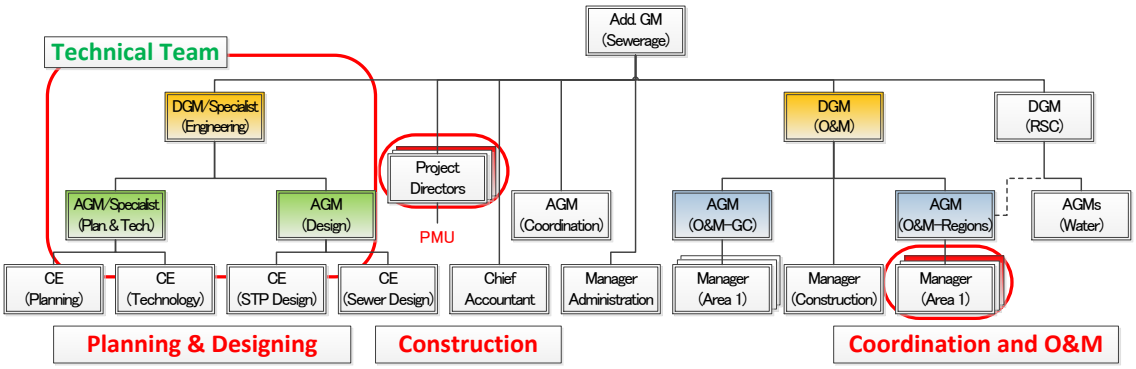
Source: JET

Figure 5.2-2 Proposed Re-organization of the NWSDB Sewerage Department

At the planning and design stage, NWSDB will establish a Technical Team, as shown in **Figure 5.2-3** to work with the consultants. At the construction stage, a Project Director (PD) will be added under the Additional General Manager (Addl. GM) and a PMU for supervising the construction works will be

established under the PD.

A Manager under the AGM (O&M-Regionals) will work with the RSC project to coordinate the O&M of STP and sewer networks.



Source: JET

Figure 5.2-3 NWSDB Sewerage Department Responsibilities for Project Implementation

5.2.2 Organization of RSC North Central

A Manager in charge of the project will be recruited from RSC North Central and will report to DGM (RSC North Central). Because the RSC has little experience in sewerage works, technical support will be provided by AGM (O&M-Regionals). RSC North Central will be responsible for operations and customer services.

5.2.3 Organization of Anuradhapura MC

Anuradhapura MC will support the implementation of the sewerage works by securing the STP site and providing input and assistance to NWSDB during the planning, design, and construction stages.

At the O&M stage, the MC will monitor STP effluent quality and the nearby environment to ensure compliance. The MC will assist NWSDB with building public awareness and the promotion of house connections.

5.3 CAPACITY DEVELOPMENT

5.3.1 Securing Human Resources

(1) NWSDB

A PD and a PMU are required at the construction stage. A Manager reporting to the AGM (O&M-Regionals) and engineers, technical staff, drivers, and labourers are needed to operate and maintain the facilities. Some staff can be transferred from existing sewerage and water supply operations to facilitate the start up. New staff will have to be hired to fill the vacancies left by the transfers.

As shown in Table 5.3-1, besides 13 national universities (most with faculties of civil, mechanical, electrical engineering, chemistry, and environmental sciences), there are 8 technical colleges/high-schools. There will be many graduates who will have the required knowledge to join the work force in the sewerage sector.

Table 5.3-1 Faculties at National Universities and Technical Colleges/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					
College/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

Satisfactory working conditions and compensation are important to keep staff motivated. As shown in Table 5.3-2, NWSDB salaries are higher than those of similar positions in the private sector. NWSDB has a decent promotion system and staff is motivated to perform well.

Table 5.3-2 Comparison of Salaries and Benefits between NWSDB and Private Sector

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

Source: JET

(2) MC

Additional staff will be required for coordination with NWSDB in the acquisition of STP and pumping station sites and in the construction of sewer networks.

At the O&M stage the MC's health department would likely be given extra responsibilities such as monitoring the STP effluent and surrounding areas, conducting public awareness campaigns and promotion of house connections. Therefore additional human resources and training will be required.

5.3.2 Development of Human Resources

A lot of technical knowledge and experience is required from planning to O&M. Capacity development is very important especially when many new staff with almost no experience will be hired. Training seminars and OJT are necessary.

(1) NWSDB Training Centre

The Training Centre currently is not offering many technical programs on sewerage systems. As many staff will need training, this aspect of the Centre's curriculum will have to be enhanced. Table 5.3-3 shows the programs that should be added.

Table 5.3-3 Required Training Programs for Sewerage Systems

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

NWSDB staff, as well as those from relevant MCs and private sector companies (if out-sourcing is used), should participate in the training programs.

(2) On-the-Job Training (OJT)

OJT in the STP, at pumping stations, and sewer networks is necessary. Generally, the contractor will conduct OJT for staff of STP at commissioning. Staff should also be dispatched to other STPs for 6 months to a year to gain experience in maintenance and trouble-shooting.

5.3.3 Sewer Maintenance Equipment and Vehicles

Scheduled sewer cleaning is carried out regularly and at emergency situations. There should be adequate number of specialized machines and vehicles for the work. The operation can start with the number of machines and vehicles other systems are using, as shown in Table 5.3-4 More can be added as the service area expands and as more maintenance is required.

Table 5.3-4 Sewer Maintenance Equipment & Vehicles at Existing Sewerage Works

	Dehiwala – Mount 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

5.3.4 Customer Service

RSC North Central is already managing customer service for water supply. When sewerage is added to their responsibilities, they will have to deal with and track customer complaints such as foul odour and clogged pipes. They can learn from other locations where sewerage systems are already in operation.

5.4 CONSTRUCTION MANAGEMENT FOR THE PROJECT

The PMU established under the PD will oversee the activities during construction.

5.4.1 PMU

There will be 40 staff in the PMU, including engineers and labourers.

5.4.2 Project Office

It would be ideal to have the PMU office in the RSC. However, if this arrangement cannot be accommodated, the office can be set up near the project site. The office should be big enough to house the contractors as well. Another matter to bear in mind is the need to have enough parking for people who have to come to the project site.

CHAPTER 6 COST ESTIMATE AND PROCUREMENT

6.1 PROJECT COST

6.1.1 Construction and Project Costs

Construction cost is estimated based on NWSDB's "RATES 2016". The rates not contained in this schedule are calculated based on previous JICA projects and Pre-F/S reports in Sri Lanka. Construction costs are presented in **APPENDIX 7**.

Project cost is estimated based on the following conditions.

Construction Cost	:	Estimated with price level at January, 2017
Consulting cost	:	Estimated with price level at January, 2017
Consulting period	:	2019～2024
Construction period	:	2021～2024
Administration cost	:	5%
Physical contingency	:	5%
Interest during construction	:	Construction：0.3% Consulting：0.01%
Front end fee	:	0.2%
Tax and duty	:	15%
Price escalation	:	Local currency : 3.8%, Foreign currency : 1.6%
Exchange rate	:	LKR 1 ＝JPY 0.77

Project cost is estimated at approximately 18.0 billion LKR (13.8 billion JPY), excluding tax and duty, as shown in Table 6.1-1 Details of the project cost estimate are presented in **APPENDIX 8**.

Table 6.1-1 Estimated Project Cost

			Amount		Total Amount	Total Amount
			L.C. (LKR)	F.C. (JPY)	LKR	JPY
1	Construction Cost					
	A	Anuradhapura STP (Q=13,600m3/day)	1,899,054,545	2,193,408,000	4,747,636,364	3,655,680,000
	B	Trunk Sewer & Pump Station	500,994,000	665,224,000	1,364,919,000	1,050,992,000
	C	Branch Sewer & Pump Station	3,295,595,000	1,116,360,000	4,745,413,000	3,653,969,000
	D	House Connection	1,372,500,000	0	1,372,500,000	1,056,825,000
	Sub-total of 1(A-D)		7,068,143,545	3,974,992,000	12,230,468,364	9,417,466,000
2	Administration cost		847,000,000	0	847,000,000	652,190,000
3	Consulting cost		465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost		438,000,000	218,000,000	721,117,000	555,260,000
5	Price escalation for construction cost		1,697,000,000	380,000,000	2,190,506,000	1,686,690,000
6	Land acquisition and compensation		-	-	-	-
7	Interest during construction		0	114,000,000	148,052,000	114,000,000
8	Front-end Fee		0	26,000,000	33,766,000	26,000,000
9	Tax and duty		3,049,000,000	0	3,049,000,000	2,347,730,000
	Sub-total of (2-9)		6,496,000,000	1,760,000,000	8,781,714,000	6,761,920,000
	Total including Tax and Duty		13,564,143,545	5,734,992,000	21,012,185,000	16,179,383,000
	Total excluding Tax and Duty		10,515,143,545	5,734,992,000	17,963,185,000	13,831,653,000
	Eligible Portion (1, 3, 4, 5 and 7)		9,668,143,545	5,708,992,000	17,082,419,000	13,153,463,000
	Non-Eligible Portion (2, 6, 8 and 9)		3,896,000,000	26,000,000	3,929,766,000	3,025,920,000

Source: JET

6.1.2 Operation and Maintenance (O&M) Cost

O&M cost is estimated based on the Ratmalana/Moratuwa sewerage system as shown in Table 6.1-2 It includes staff cost, utilities, chemical cost, repair expenses, installation cost, security expenses, and other expenses. The detailed estimate is presented in **APPENDIX 9**

Table 6.1-2 Estimated O&M Cost

	Total Amount (LKR/year)	Total Amount (JPY/year)
Anuradhapura	199,951,000	154,445,000

Source: JET

6.2 MULTI-PHASED CONSTRUCTION

Construction should be conducted in phases because of the size of the project - service area of 1,618 ha and cost of 18.0 billion LKR (13.8 billion JPY).

The total project cost for phased construction would be higher than the estimate shown above. The extra cost will depend on the number of phases and timing.

CHAPTER 7 FINANCIAL PLAN

7.1 FINANCIAL CONDITION OF ANURADHAPURA MUNICIPAL COUNCIL

Table 7.1-1 shows a summary of the Income & Expenditure Statement for the Anuradhapura MC. Revenue should cover total expenditures. Any surplus or deficit is rolled over to the next year. Like other MCs, Anuradhapura MC pays the monthly salaries of central government employees working at the MC and gets reimbursed annually through a central to provincial government budgetary transfer. This is included in the "Revenue, Grant & Reimbursement" account.

Table 7.1-1 Summary of Income & Expenditure of Anuradhapura MC

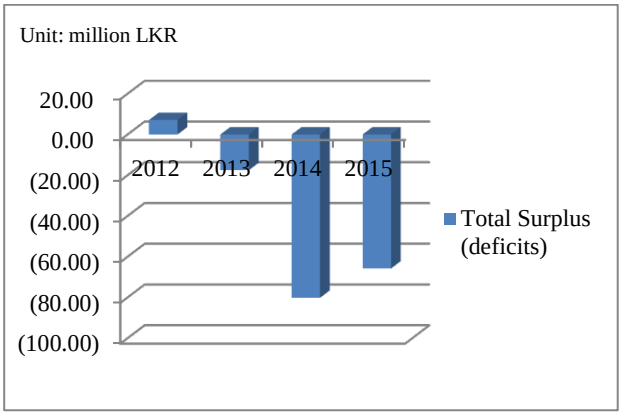
Unit: million LKR

	Year	2012	2013	2014	2015
Actual Revenue					
	Assessment Rates	31.91	49.71	50.44	53.27
	Rent	33.14	27.03	34.12	68.66
	License Fees	22.79	29.53	30.29	18.55
	Charges for Service	10.63	8.19	10.19	11.86
	Warrant Cost/Fine	2.56	4.37	2.88	1.38
	Stamp duty	2.50	4.76	12.00	48.83
	Court Fines	0.77	0.00	0.21	1.86
	Other Revenue	7.01	5.28	10.39	9.56
	Total	**111.33**	**128.87**	**150.51**	**213.99**
Recurrent Expenditure					
	Personal Emoluments	118.55	128.23	201.27	235.62
	Travelling Expenses	0.87	1.14	1.31	0.97
	Supplies & Equipment	31.06	24.58	67.63	45.49
	Repairs to Capital Assets	18.43	57.51	20.23	32.46
	Transport	8.42	6.64	13.77	13.82
	Interest & Dividends	6.50	7.22	7.85	12.48
	Grants	9.85	12.76	19.12	35.25
	Pension Gratuity	2.26	3.68	3.08	1.15
	Total	**195.93**	**241.78**	**334.26**	**377.24**
Actual revenue less Recurrent Expenditure		**-84.60**	**-112.91**	**-183.75**	**-163.25**
	Revenue, Grant & Reimbursement	90.75	98.45	130.03	204.80
	Capital Receipts & Grants	39.56	32.66	39.74	13.74
	Capital Expenditure	38.58	35.72	66.21	121.10
	Total Surplus (deficits)	**7.13**	**-17.53**	**-80.20**	**-65.80**

Source: Anuradhapura MC

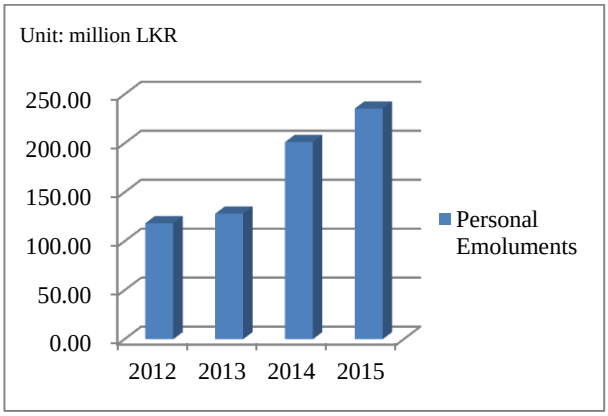
Anuradhapura MC has recorded an annual deficit since 2013, even after including salary reimbursement and capital receipts and grants. The annual deficit peaked in 2014 and decreased slightly in 2015 (Figure 7.1-1). The deficit as a percentage of "Revenue, Grants & Reimbursement" was 7.7%, 28.6%, and 15.7% in 2013, 2014, and 2015. The deficit corresponds to a 99% increase (added 117.07 million LKR) in "Personal Emoluments" (staff salary) from 2012 to 2015 (Figure 7.1-2Compared to staff salaries, total revenue has increased steadily from 2012 to 2015 but at the slightly lower rate of 92% (added 102.66 million LKR) (Figure 7.1-3). One of the other reasons for the annual deficits is the massive 214% increase in capital expenditure from 2012 to 2015 (added 82.51 million LKR) (Figure 7.1-4).

Anuradhapura MC's financial condition is weak. It is recommended that sewerage facilities be implemented and operated by NWSDB with the cost burden for construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government). The sewage tariff should be set to fully recover the O&M costs.



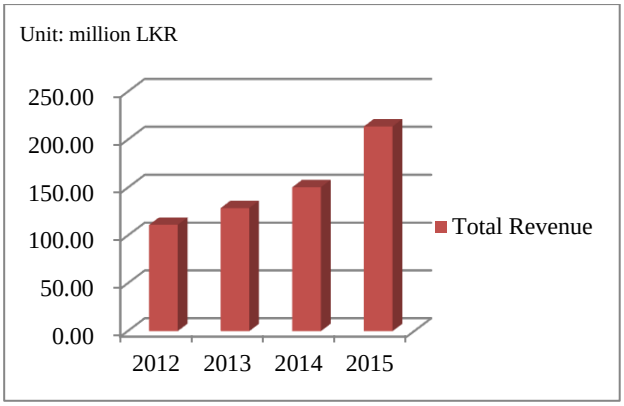
Source: JET, based on Anuradhapura MC data

Figure 7.1-1 Trend of Total Surplus (deficits) - Anuradhapura MC



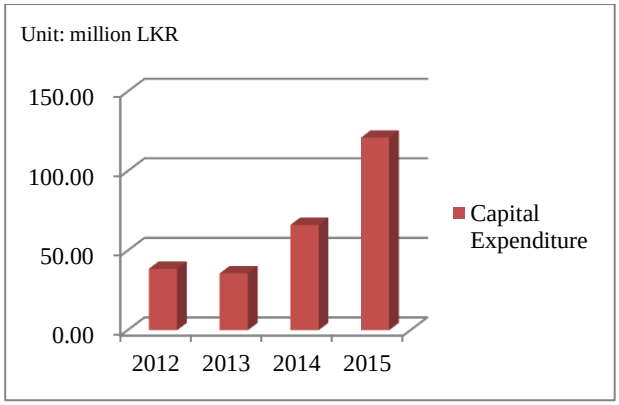
Source: JET, based on Anuradhapura MC data

Figure 7.1-2 Trend of Staff Salaries - Anuradhapura MC



Source: JET, based on Anuradhapura MC data

Figure 7.1-3 Trend of Total Revenue - Anuradhapura MC



Source: JET, based on Anuradhapura MC data

Figure 7.1-4 Trend of Capital Expenditure - Anuradhapura MC

7.2 FINANCING SEWERAGE FACILITY CONSTRUCTION AND O&M

7.2.1 Construction, O&M, and Replacement Costs

The Cabinet Memorandum "Regularizing Foreign Financing Mechanism in Relation to Water Supply and Sewerage Project", dated 26 January 2016, stipulates that the Treasury will bear 100% of the debt service (capital & interest) for sewerage projects.

In many countries including Japan, the sewage 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 usually difficult for the sewage tariff to cover even just the O&M costs because of the low willingness to pay.

The following cost burden principle for sewerage service should be used in Sri Lanka:

- 100% of the construction cost to be covered by the central government, i.e. 100% grant to NWSDB or MC.
- O&M costs shall be covered by the sewage tariff which will be implemented gradually.
- small-scale replacements should be covered by NWSDB's or the MC's own budget, but large-scale ones will be conducted as projects funded by the central government.

Therefore, the sewage tariff is structured to cover the only the O&M costs of the sewerage facilities.

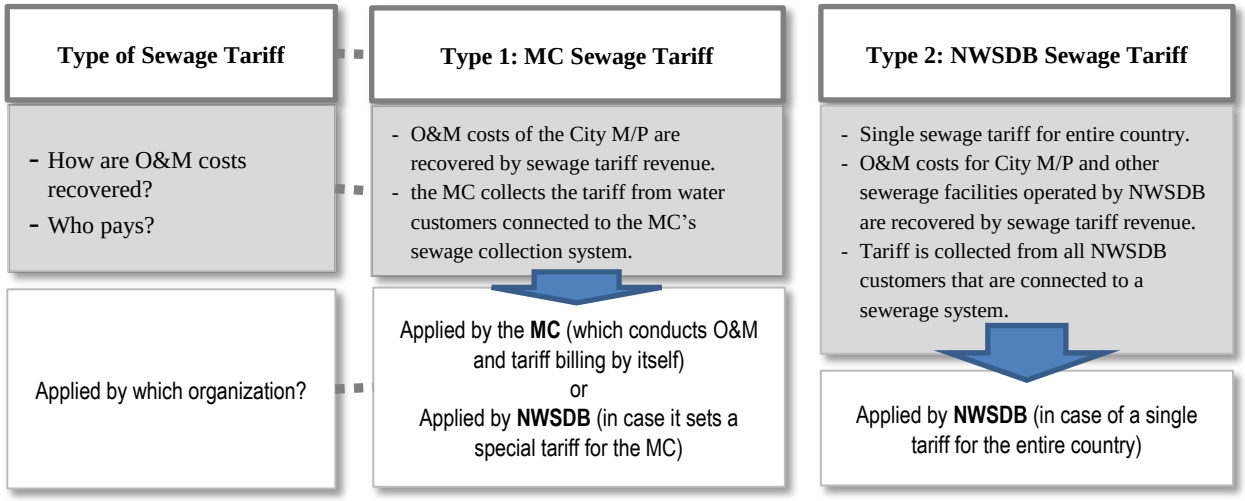
7.2.2 Sewage Tariffs

(1) Two Types of Tariffs

Two types of sewage tariffs are proposed to recover the full costs of O&M for sewerage systems:

Type 1 recovers the O&M costs of the sewerage facilities that serve customers in the MC's sewer service area. MCs would use this type of tariff when they own, operate, and maintain the sewerage system or if NWSDB applies a project specific tariff to the MC instead of the Type 2 tariff.

Type 2 is a uniform, nationwide tariff, that would recover O&M costs of all sewerage facilities owned, operated, and maintained by the NWSDB, including those identified in the City M/P. (refer to **Figure 7.2-1**).



Source: JET

Figure 7.2-1 Difference Between Type 1 and Type 2 Sewage Tariff

(2) Calculation Methodology

The sewage tariff is calculated by dividing the estimated annual O&M costs (excluding depreciation and replacement) by total water consumption of the sewerage customers.

A profit margin is provided to set aside funds for small-scale replacements and contingencies such as unexpected disasters or sudden price hike of cost items. It is set at 10% of the O&M costs for Type 1 and 5% for Type 2 tariff. The higher rate reflects the much smaller budget for MCs compare to that of NWSDB.

Sewage charges will be added to the water bill. The sewage charge is calculated by dividing the total O&M costs by the water consumption volume. Therefore, the sewage charge to each customer is proportional to the amount of water they consume.

(3) Sewage Tariff Proposed by the Strategic M/P

The sewage tariff proposed by the Strategic M/P is calculated for NWSDB to recover all the O&M costs under current conditions. The tariff would be incrementally implemented with increases in 2019 and 2022 (Strategic M/P, Section 7.3.1). The sewage tariff to cover the O&M costs is calculated by considering that it can take up to ten years to reach full operational capacity.

When NWSDB is responsible for the O&M and billing on behalf of the MC, the sewage tariff proposed by the Strategic M/P should be implemented as planned. A tariff increase for each City M/P would be implemented after the STP is operating at full capacity (Figure 7.2-2).

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025
1st Tariff Raise of Strategic M/P			△						
2nd Tariff Raise of Strategic M/P						△			
3rd Tariff Raise of City M/P (if necessary)								△	

Source: JET

Figure 7.2-2 Implementation Schedule for Tariffs

When the MC is responsible for sewerage services, the sewage tariff can be implemented in one step. The timing can be at the discretion of the MC but it should be done before the facilities start to operate.

7.2.3 Assumptions for Calculating Proposed Tariffs

The following assumptions are used to calculate the sewage tariff in the City M/P:

- total volume of water consumption by customers is based on the Design Criteria.
- price inflation is not reflected in the calculation. Inflation adjustment would be included in the calculation of the actual sewage tariff.
- customers are charged for connecting to the sewage collection system (as is the present practice).

7.2.4 Sewage Tariff Calculation

The following Tables show the Types 1 and 2 sewage tariff to cover the O&M cost of the proposed City M/P project. The calculated tariffs are a weighted average that is based on the total water consumption of domestic, commercial, and industrial customers.

(1) Type 1: the MC does the O&M and the billing or NWSDB sets a special tariff for the MC

Table 7.2-1 Calculation of Type 1 Sewage Tariff - Anuradhapura MC

No.	Items	Unit	Description	Amount
1	Annual O&M costs	LKR/year	Total	199,950,582
2	Expected profit (10%) (=1x10%)	LKR/year	Total	19,995,058
3	**O&M costs with profit** (=1+2)	LKR/year	**Total**	**219,945,640**
4	Sewage Flow	m^3/day	Domestic Flow	5,270
		m^3/day	Non-Domestic Flow	3,953
		m^3/day	Point Source	1,169
		m^3/year	Total	3,793,080
5	Sewage Return Factor	%		80.0
6	**Water Consumption Volume** *1	m^3/year	**Total**	**4,741,350**
7	**Sewage tariff** (=3/6)	LKR/m^3		**46.39**

Note: *1; Water consumption volume is calculated by dividing the estimated sewage flow by (Sewage return factor/100).
Source: JET

(2) Type 2: NWSDB Sewage Tariff

Table 7.2-2 Calculation of Type 2 Sewage Tariff (3rd Increment)- Anuradhapura MC

Items	Unit	Description	Amount
Operating Expense	LKR/year	Existing (2015) *1	410,282,866
		New facilities (City M/P)*2	199,950,582
		Total	**610,233,448**
Income to be subtracted from Expense	LKR/year	Connection Charge	25,531,614
		P&D/Bowser*3	160,854,906
		Total	**186,386,520**
O&M costs after subtraction	LKR/year	Total	423,846,928
Expected Profit (5%)	LKR/year	Total	21,192,346
O/M costs after subtraction plus profit	LKR/year	**Total**	**445,039,274**
Water Consumption Volume of Sewerage Customers	m^3/year	Existing (2015)	6,240,008
		New facilities (City M/P)	4,741,350
		Total	**10,981,358**
Sewage tariff	LKR/m^3	-	**40.53**

Note: *1; As O&M costs of the existing sewerage facilities with operational costs of head office, actual costs data in 2015 was utilized.
*2; As O&M costs of the City M/P, maximum O&M costs by full capacity was utilized.
*3; Average value of 3 years data was utilized, including contract service fee, planning and design service, and gully bowser (desludging septic tanks) revenue.
Source: prepared by JET, based on the data from NWSDB

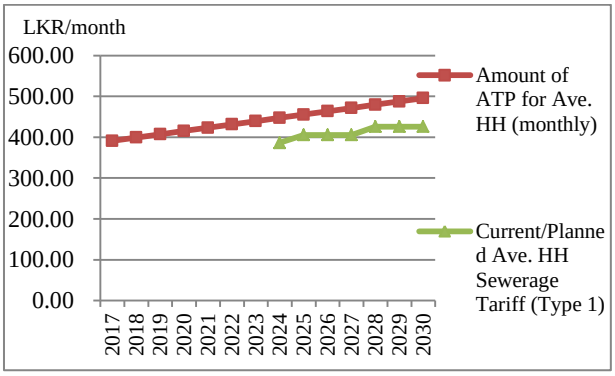
If the City M/P is implemented, the NWSDB sewage tariff would be increased to 40.53 LKR/m^3. (third increase) when the STP operation reaches full capacity.

7.2.5 Affordability and Ability to Pay

The following 3 assumptions are made in the analysis of household ATP sewage charges:

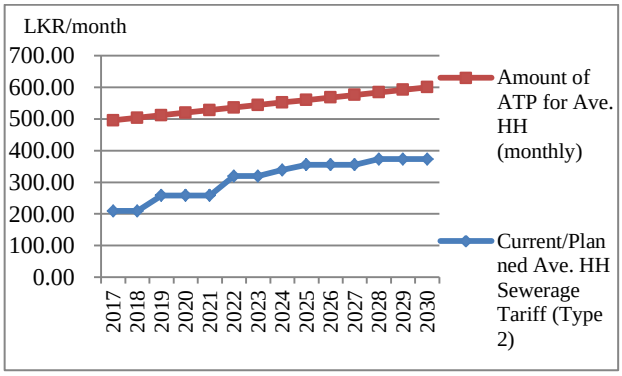
- third tariff increase for City M/P is set for 2024
- trend of household income increase shall continue
- increase in sewage tariff for domestic, commercial, and industrial customers should be the same. If the increase for commercial and industrial customers is higher than that of domestic customers, monthly charge for households should be set lower.

Figure 7.2-3 shows the monthly charge based on Type 1 sewage tariff and the ATP based on household income data for Anuradhapura District. **Figure 7.2-4** shows the monthly charge based on Type 2 sewage tariff for NWSDB and the ATP based on national average household income data. ATP is estimated to be 1% of the average household income (International Bank for Reconstruction and Development (IBRD) , WB).



Note: ATP is estimated based on the District HH income data.
Source: JET

Figure 7.2-3 Comparison of Type 1Tariff and Ability to Pay



Note: ATP is estimated by national average HH income data.
Source: JET

Figure 7.2-4 Comparison of Type 2 Tariff and Ability to Pay

As shown in the Figure 7.2-3, the monthly household sewage charge (Type 1) is 86% to 89% of the ATP, close to the limit of affordability. It will be necessary to check the income levels again when the actual tariffs are prepared and carefully consider the issue of affordability.

As shown in **Figure 7.2-4**, the monthly household sewage charge (Type 2) is 42% to 64% of the of ATP and is affordable.

7.2.6 Sewage Tariff Tables (Type 2 NWSDB)

The previous tariff calculation was based on a weighted average applied to all consumer categories. Table 7.2-3 and Table 7.2-4 are examples of how the sewage tariff (Type 2) can be calculated from the NWSDB water tariff Tables. This method makes it easier to calculate and to avoid charging a customer more for sewage than for water consumption. In this example, the domestic sewage tariff would be 50% of the water tariff and would be added to the water bill.

Table 7.2-3 Example of Domestic Sewage Tariff (for 2024)

Domestic Sewage Tariff = 50% of the following water supply tariffs

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 7.2-4 Example of Non-Domestic Sewage Tariff: (in 2024)

Non-domestic Sewage Tariff as a % of the following water supply tariffs:
- Commercial; 70%
- Government hospital; 70%
- Industries (SME); 150%
- Industries (non-SME & Govt. Institution) 150%

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

Any future increase in water tariffs would result in a corresponding increase in the sewage tariff. The planning for water and sewage tariff increases must be well-coordinated.

The third tariff increment should be implemented by 2024. By then the water supply tariff will have almost certainly been increased. In such a case, the percentages applied to the water tariff (50% of domestic water tariff in Table 7.2-3) would be lower.

7.3 FINANCIAL PLAN CONCLUSIONS

A) The financial condition of Anuradhapura MC is weak. Therefore, the sewerage services should be implemented and operated by NWSDB with the cost burden for construction shifted to the central government (in the event of an ODA loan, repayment should be borne by the central government)

B) The following cost burden principle for sewerage service should be used in Sri Lanka:
- Central government should cover 100% of the construction cost, i.e.100% grant for NWSDB or MC.
- Sewage tariff should be calculated to cover O&M costs, implemented incrementally.
- small-scale replacements should be covered by NWSDB's or the MC's own budget, but large-scale ones should be funded as projects by the central government.

C) Type 1 sewage tariff is calculated to recover O&M costs from revenue collected from the customers in the MC area; Type 2 recovers the total O&M costs of the sewerage business of NWSDB including the O&M costs of City M/P, from revenue NWSDB collects from all its sewerage customers.

D) Type 1 sewage tariff for MC is estimated at LKR 46.39/m^3.

E) Type 2 sewage tariff for NWSDB is estimated at LKR 40.53/m^3.

F) Both sewage charges based on Type 1 and Type 2 tariffs are within the ATP of households (1% of average household income). This indicates that the average household can afford the sewage charge.

G) The latest average household income data should be used for tariff calculation.

CHAPTER 8 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.1 EXISTING CONDITIONS

Environmental and Social conditions in the Project area are outlined in CHAPTER 2.

8.2 REGULATIONS AND ORGANIZATIONS RELATED TO ESC

Laws and regulations related to ESC at the national level, and organizations responsible for implementation, were studied in the Strategic Sewerage Master Plan (Refer to Section 1 Progress Report). No regulations specific to or published by Anuradhapura MC relevant to the Project were identified. National regulations described in the Strategic Sewerage Master Plan can be found in **APPENDIX 10**.

8.3 COMPARISON WITH JICA GUIDELINES

Comparison of national regulations with those of JICA is given in **APPENDIX 11**.

8.4 INTERNATIONAL COMMITMENTS

The Government of Sri Lanka (GOSL) is party to several international agreements related to environment and human rights. Agreements specific to Anuradhapura MC could not be found. The national agreements are given in **APPENDIX 12**.

8.5 ENVIRONMENTAL SCOPING

Scoping is defined as the process of identifying the content and extent of the environmental information to be submitted to the competent authority under the EIA procedure. Scoping of the project components and the reasons for the evaluation are shown in Table 8.5-1.

Table 8.5-1 Environmental Scoping

Item	Evaluation		Reason
1 Air pollution	P/C	B-	Dust and exhaust gases are generated during construction.
	O	D	No impacts are expected during operation.
2 Water pollution	P/C	B-	Excavation and runoff will cause turbidity during construction.
	O	B+	Treatment of sewage and greywater will reduce water pollution.
3 Soil pollution	P/C	B-	Construction equipment and transfer of construction materials contribute to soil pollution.
	O	D	No impacts are expected during operation.
4 Waste	P/C	B-	Construction waste will be generated.
	O	B-	Sludge will be generated during operation of treatment facilities.
5 Noise and vibrations	P/C	B-	Noise and vibrations will be generated during construction.
	O	B-	Noise and vibrations will be generated during operation.
6. Ground subsidence	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
7. Offensive odours	P/C	D	No impacts are expected during construction.
	O	B-/B+	B-: Odour will be generated at the STP during operation. B+: Improved sewerage collection and environmental conditions will reduce offensive odours in the Project area.
8 Geographical features	P/C	C-	Impacts are unknown and require investigation.

Item	Evaluation		Reason
	O	D	No impacts are expected during operation.
9 Bottom sediments	P/C	D	No impacts are expected during construction.
	O	B+	Collection and treatment of waste water will improve benthic conditions of water bodies.
10 Biota and ecosystems	P/C	C-	Impacts are unknown and require investigation. (Included in EIA)
	O	C+/C-	C+: Ecosystems will benefit from improved water quality. C-: Negative impacts of STP are unknown and need investigation.
10b Protected lands	P/C	D	There are no protected natural lands in the Project area.
	O	D	
11 Water usage	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Water usage downstream of Project has not been investigated. Thus, impacts are unknown and require investigation.
12 Accidents	P/C	B-	Construction activities and disruption to traffic will increase risk of accidents.
	O	B-	Accidents may occur in treatment facilities during operation.
13 Global warming	P/C	D	No impacts are expected during construction.
	O	D	No impacts are expected during operation.
14 Land acquisition	P/C	B-	Land for treatment plant, pumping stations, and sewerage lines will be required.
	O	D	No impacts are expected during operation.
15 Local economies	P/C	C+/C-	C+: Construction activities may increase in local employment and economic activities. C-: Construction activities may inconvenience local businesses.
	O	C+	Improved water environment will positively impact aquaculture and businesses (tourism etc)
16 Land use	P/C	C-	Land use patterns may be impacted by acquisition, resettlement, and construction of facilities.
	O	D	No additional impact caused by operation is expected.
17 Social institutions	P/C	D	No impacts are expected during construction.
	O	D	No impacts are expected during operation.
18 Existing social infrastructures and services	P/C	B-	Traffic disturbance will be caused by construction activities.
	O	B+	Infrastructure for sewerage collection and treatment will be created.
19 Poor (low income households)	P/C	C-	Low income people may be impacted by construction activities.
	O	C-	Impacts are unknown and require investigation.
19a Indigenous and ethnic populations	P/C	C-	Socially vulnerable populations may be impacted by construction activities.
	O	C-	Impacts are unknown and require investigation.
20 Misdistribution of benefits and damages	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
21 Local conflicts of interest	P/C	C-	Impacts are unknown and require investigation.
	O	C-	Impacts are unknown and require investigation.
22 Gender	P/C	C-	Women may receive unequal economic opportunities during construction.
	O	C+	Women, who suffer disproportionately from water borne diseases, are expected to benefit from improved water environment.
23 Children's rights	P/C	C-	Child labour may occur during construction.
	O	C+	Children, who suffer disproportionately from water borne diseases, are expected to benefit from improved water environment.
24 Cultural heritage	P/C	C-	Construction activities may impact heritage sites.
	O	C+	Improved water environment and sanitation facilities are expected to reduce negative impacts on heritage sites (especially during pilgrimage and festival periods).
24a Landscapes	P/C	B-	Construction activities will impact landscape in the Project area.
	O	B-	Newly constructed facilities will impact landscape in the Project area.
25 Infectious diseases such as HIV/AIDS	P/C	B-	Influx of construction workers will increase risk of infectious diseases.
	O	B+	Improved sanitation services will decrease incidence of infectious diseases (especially during and following peak pilgrimage periods).

【Evaluation】
A：Significant impact is expected,
B：Some impact is expected,
C：Extent of impact is unknown,
D：No impact is expected
+/-：Impact is Positive/Negative
Source: JET

8.6 TOR FOR ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

8.6.1 Purpose

The purpose of the survey at this preparatory stage is to predict and assess the type and scale of possible project impacts on the natural and social environment.

8.6.2 Items to be Targeted in the Study and Evaluation

Items that received A, B, or C ranking (Table 8.5-1) should be reviewed and evaluated. Other items identified as the survey proceeds should also be included.

8.6.3 Target Areas

The target areas are the proposed construction sites, and areas immediately surrounding the Project facilities.

8.6.4 Target Periods

Target periods are the stages of planning, execution, and operation of the constructed facilities.

8.6.5 Contents and Methods for ESC Study

The information to be collected and the typical counter-measures to be reviewed are presented in.

Table 8.6-1 ESC Study Associated with the Project

Item				Study/Countermeasure	Status
No.	Title	Evaluation			
01	Air Pollution	P/C	B-	Study: Air pollution standards, construction vehicles and methods. Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
02	Water Pollution	P/C	B-	Study: Water pollution standards, construction methods. Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	B+	Study: Water pollution standards, treatment methods, water quality, flow rates, pollution loads.	Complete (M/P stage)
03	Soil Pollution	P/C	B-	Study: Soil pollution standards, prevention measures/construction methods, construction equipment Method: Site survey, literature survey of regulations and standards.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
04	Waste	P/C	B-	Study: Waste management regulations/procedures, Collection and disposal methods, disposal site conditions. Method: Site surveys, hearing surveys of concerned parties.	Complete (M/P stage)
		O	B-	Study: Sludge generation. Method: Treatment method.	F/S stage
05	Noise and Vibrations	P/C	B-	Study: Noise regulations, current condition, construction methods. Method: Site surveys, hearing surveys of concerned parties, noise measurement surveys.	Complete (M/P stage)
		O	B-	Study: Treatment method and possible noise generation.	F/S stage
06	Ground Subsidence	P/C	C-	Study: Geographic conditions. Method: Geographic survey.	F/S stage
		O	C-		
07	Offensive Odours	P/C	D	N/A	N/A
		O	B-/B+	Study: Current odour conditions, treatment method. Method: Site surveys, hearing surveys of concerned parties.	In progress (M/P, F/S stage)
08	Geographical Features	P/C	C-	Study: Geographic conditions. Method: Geographical survey.	F/S stage
		O	D	N/A	N/A

09	Bottom Sediments	P/C	D	N/A	N/A
		O	B+	Study: Sediment conditions of water bodies. Method: Site surveys, literature surveys, water quality surveys.	F/S, EIA stage
10	Biota and Ecosystems	P/C	C-	Study: Inventory of flora and fauna in the construction area. Method: Site survey, hearing survey of concerned parties	F/S, EIA stage
		O	C+/C-		
10a	Protected lands	P/C	D	N/A	N/A
		O	D	N/A	N/A
11	Water Usage	P/C	C-	Study: Water use practices of local communities, impacts of sewerage treatment on water usage. Method: Site surveys, hearing surveys of concerned parties.	In progress (M/P, F/S stage)
		O	C-		
12	Accidents	P/C	B-	Study: Construction/industrial safety regulations, traffic safety/accident prevention methods. Method: Site surveys, literature survey, hearing surveys of concerned parties.	In progress (M/P, F/S stage)
		O	B-	Study: Industrial safety regulations. Method: Literature surveys.	In progress (M/P, F/S stage)
13	Global Warming	P/C	D	N/A	N/A
		O	D	N/A	N/A
14	Land Acquisition	P/C	B-	Study: Land requirements, acquisition procedures, compliance to JICA guidelines. Method: Site surveys, literature surveys, hearing surveys of concerned parties.	In progress (M/P, F/S stage)
		O	D	N/A	N/A
15	Local Economies	P/C	C+/C-	Study: Local economic environment, industries, markets. Relevant laws and regulations. Method: Site surveys, literature surveys, hearing surveys of concerned parties.	In progress (M/P, F/S stage)
		O	C+		
16	Land Use	P/C	C-	Study: Land use practices of local communities. Method: Site surveys, hearing surveys of concerned parties.	F/S
		O	D		
17	Social Institutions	P/C	D	N/A	N/A
		O	D	N/A	N/A
18	Existing Social Infrastructures and Services	P/C	B-	Study: Traffic patterns, location of important social infrastructure (schools, hospitals, religious institutions, etc) Method: Site survey, inventory survey, public consultation.	In progress (M/P, F/S stage)
		O	B+		
19	Poor (low income households)	P/C	C-	Study: Census/demographic data, economic status, and land use patterns of affected peoples. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S, EIA stage)
		O	C-		
19a	Indigenous and ethnic populations	P/C	C-	Study: Census/demographic data, economic status, and land use patterns of affected peoples. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S, EIA stage)
		O	C-		
20	Misdistribution of benefits and damages	P/C	C-	Study: Social and economic conditions. Method: Interview surveys of concerned parties, public consultation.	In progress (M/P, F/S stage)
		O	C-		
21	Local Conflicts of interest	P/C	C-	Study: Risks and prevalence of conflicts of interest. Method: Interview surveys of concerned parties, public consultation.	In progress (M/P, F/S stage)
		O	C-		
22	Gender	P/C	C-	Study: Working conditions/statistics of women, gender equality policies. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S stage)
		O	C+	Study: Health and working conditions of women. Method: Interview survey of concerned parties, data collection.	In progress (M/P, F/S stage)
23	Children's Rights	P/C	C-	Study: Child labour laws. Method: Interview survey of concerned parties, relevant laws, and regulations.	In progress (M/P, F/S, EIA stage)
		O	C+	Study: Water borne diseases and children Method: Interview survey of concerned parties, data collection.	In progress (M/P, F/S stage)
24	Cultural Heritage	P/C	C-	Study: Location of cultural heritage sites. Method: Site survey, location of registered heritage/historical sites, Interview survey of concerned parties.	In progress (M/P, F/S, EIA stage)

		O	C+	Study: Impacts of pollution on heritage sites. Method: Interview survey of concerned parties.	
24a	Landscapes	P/C	B-	Study: Location of significant cultural, religious, and tourism sites, construction locations and methods. Method: Site survey, Interview survey of concerned parties.	In progress (M/P, F/S, EIA, D/D stage)
		O	B-		
25	Infectious Diseases such as HIV/AIDS	P/C	B-	Study: Prevalence of AIDS/HIV and other infectious diseases, current prevention programs. Method: Data collection, Interview surveys of concerned parties.	In progress (M/P, F/S stage)
		O	B+	Study: Prevalence of water borne and other environmental diseases. Method: Data collection, Interview surveys of concerned parties	

Source: JET

8.6.6 Prediction and Evaluation of Potential Impacts

Prediction and evaluation of potential impacts should be conducted for items ranked A, B, or C in Section 8.5: Scoping.

Each item should be re-evaluated as the survey proceeds, and the scoping Table updated accordingly. Subsequently, items with A or B ranking should be evaluated in terms of the extent of the impact.

8.6.7 Consideration for the EMP and EMoP

When the Project causes foreseeable but unavoidable environmental impacts, EMP will determine how to mitigate the impacts, and EMoP will identify steps to be taken by relevant authorities to ensure that mitigation measures are effectively implemented. Execution plans, frequency of measures, lead organization, support for the organization, and budget should be provided for EMP and EMoP.

8.6.8 Stakeholder Consultation

Consultations with UNI and NGO were conducted at the start of the study to gain information about the needs and attitudes in the area, and the relevance of the Project. Details of the meeting minutes are given in **APPENDIX 13.**

The results of the ESC studies should be presented at stakeholder consultations, and the stakeholder feedback should be collected.

8.7 DRAFT EMP AND EMOP

Environmental and social considerations will be managed through EMP. EMP will be implemented through EMoP. EMP development is not appropriate at this stage. Draft versions of EMP and EMoP are presented in **APPENDIX 14**. They will be further developed as the Project proceeds and as more information becomes available.

8.8 SCHEDULE OF ESC ACTIVITIES

Surveys related to ESC will be conducted according to the schedule shown in Figure 8.8-1.

Stage	Period		ESC Expert	EIA Study	Target		Environmental Study	Remark
					Original	Selected		
Strategic MP	2016	Jan			335 local authorities (79)	(Approx.) 5 local authorities	Primary study	➢ Environmental policies, plans and programs ➢ National level research
		Feb						
		Mar						
		Apr						
5 Cities M P (Pre-F/S)		May			5 local authorities	2 local authorities	Preparation study for IEE/EIA	➢ Literature search ➢ Site survey
		Jun						
		Jul						
		Aug						
		Sep						
Feasibility Study (F/S)	2017	May			Anuradhapura MC (If selected for F/S)		EIA Study	➢ EMP(draft) ➢ Monitoring Plan(draft) ➢ EIA Report ➢ Resettlement Action Plan ➢ Stakeholder Meeting
		Jun						
		Jul						
		Aug						
		Sep						
		Oct						
		Nov						
		Dec						

Source: JET

Figure 8.8-1 Schedule for ESC Surveys

CHAPTER 9 CONCLUSION AND RECOMMENDATION

9.1 F/S IMPLEMENTATION

A treatment plant site has been identified and it is confirmed that the land is owned by the City. The final disposal site for sludge has a composting facility and is being operated properly.

The most important aspect in implementing a sewerage project is the acquisition of land for the STP and the final disposal site. The former is not a problem in Anuradhapura, and the final disposal site will be expanded under KOICA's Pilisaru' (recycling resources) Project and Integrated Sustainable Waste Management Programme (ISWMP).

Therefore, a sewerage project in Anuradhapura could be started right after the completion of a F/S.

The Joint Coordinating Committee (JCC) has informed that the F/S will not be conducted for this City M/P because AFD has announced its intention to develop a sewerage system as part of the Strategic City Development Project for Anuradhapura City that is currently underway.

9.2 RISK AND MITIGATION MEASURES

Table 9.2-1 lists the risks and mitigation measures associated with the implementation of the Project. In designing sewer pipes and other sewerage facilities, special attention should be paid to the locations of ruins, even though the UNESCO World Heritage Site is outside the project area and will not be directly affected by the sewerage system. Inadvertent excavation of archaeological artefacts would cause a delay in construction.

Table 9.2-1 Risks and Mitigation Measures

Risks	Mitigation Measures
Delay: due to the start of pipe, pumping stations and STP, if necessary approval for the EIA is not granted before the commencement of project	MC, UDA, NWSDB and other relevant agencies must take appropriate action in a timely manner to obtain the necessary approval before the construction
Delay: due to the start of Pumping Stations, if the identified lands are not acquired before the commencement of the project	MC, UDA, NWSDB and other relevant agencies must take appropriate actions in a timely manner for clearing project sites before the construction.
Cost Increase: if there are variances in cost for building foundations and pipe trenching and bedding.	Soil test must be carried out to identify the soil conditions.
Low Inflow: of sewage at the treatment plant, if the development of the city is delayed.	NWSDB must make the appropriate stage wise sewerage development plan based on city development plan by AFD and the local authority.

Source: JET

9.3 CONCLUSION AND RECOMMENDATIONS

Anuradhapura MC is one of Sri Lanka's National Growth Centres and an important gateway to the northern region. It is also an internationally-renowned tourist destination. For these reasons, implementing a sewerage system to improve the water quality of Malwathu Oya flowing through the World Heritage Site is a very high priority. Although the STP will be constructed on a plot of land

owned by the city, it will be necessary to conduct an EIA and obtain approval. It will also be important to confirm the location of the sewerage facilities in relation to the structures and monuments of the nearby World Heritage Site. The F/S should include geotechnical and other basic site investigations to obtain data to accurately estimate the construction cost, avoid budget over-run and reduce the risks of encountering problems during construction.

APPENDICES

APPENDICES

APPENDIX 1: Anuradhapura Waste Water Flow Forecast

ANURADHAPURA WASTE WATER FLOW FORECAST-

b	Water consumption	120 lpcd
c	Domestic Waste Water /Water	80%
	Non-Domestic ww/Domestic	75%
	Infiltration	20%

							a	a x b	d = a x b x c	e = d x 75%	f	d+e+f	g=(d+e+f)x20%	h = d+e+f+g
	Anuradhapura DSD		Population 2001	Population 2012	Population 2046	% covered	Population 2046 in covered area	Domestic Water consumption(cum/d)	Domestic Waste Water Flow (cum)	Non-Domestic Flow(cum/d)	Point Source waste water flow	Domestic + Non-Domestic+ Point source Waste Water Flow (cum/d)	Infiltration (cum/d)	Total Waste Water Flow (cum/d)
1.1	250	Nuwarawewa	2,162	1894	1894	100	1894	227	182	136		318	64	382
1.2	248	Stage 1 Part 1	3,228	1859	1859	100	1859	223	178	134		312	62	375
1.3	239	Wannithammennawa	2,331	1681	1681	50	841	101	81	61		141	28	169
1.4	240	Thammennakulama	3,358	4379	6843	100	6843	821	657	493		1150	230	1380
1.5	249	Stage 1 Part 2	6,000	2517	2517	100	2517	302	242	181		423	85	507
1.6	253	Stage 2 Part 3	2,797	2653	2653	100	2653	318	255	191		446	89	535
1.7	252	Stage 2 Part 2	4,717	4560	4560	100	4560	547	438	328		766	153	919
1.8	257	Stage 3 Part 3	4,259	4814	7053	100	7053	846	677	508		1185	237	1422
1.9	251	Stage 2 Part 1	4,648	4726	4978	100	4978	597	478	358		836	167	1004
2.0	254	Stage 2 Part 4	3,000	3082	3352	100	3352	402	322	241		563	113	676
2.1	245	Wanniyakulama Kotasa 4	1,231	1719	2686	100	2686	322	258	193		451	90	541
2.2	246	Wanniyakulama Kotasa 5	1,513	2001	3127	60	1876	225	180	135		315	63	378
2.3	247	Wanniyakulama Kotasa 6	1,289	1785	2789	60	1673	201	161	120		281	56	337
2.4	255	Stage 3 Part 1	2,822	3255	5080	100	5080	610	488	366		853	171	1024
2.5	256	Stage 3 Part 2	2,683	3202	5003	100	5003	600	480	360		841	168	1009
2.6	244	Wanniyakulama Kotasa 3	1,070	1301	2033	100	2033	244	195	146		342	68	410
		Point Source									1169	1169	234	1403
		Total	47,108	45428	58108		54901	6588	5271	3953	1169	10392	2078	12471

APPENDIX 2: Inflow Sewage Quality

Inflow sewage quality - Measured data of inflow sewage -

The planned inflow water quality values of Moratuwa/Rathmalana STP are considerably higher than the actual data.

		Raddolugama [1)]	Maththegoda [1)]	Hikkaduwa [1)]	Moratuwa/ Rathmalana**	Ja-Ela/ Ekara***	Average	Design raw water quality	Moratuwa/Rathmalana (First stage planned values)	
pH at 26^{0}C		6.7	6.4	7.0	6.6-8.5	-	6.7			pH at 26^{0}C
Total Suspended Solids at 104^{0}C	mg/l	163	90	139	232	-	156	160	458	Total Suspended Solids at 104^{0}C
Chemical Oxygen Demand Total	mg/l	609	473	446	274	628	486	600	1057	Chemical Oxygen Demand Total
Chemical Oxygen Demand Soluble	mg/l	241	241	206	-	-	229	-	-	Chemical Oxygen Demand Soluble
Biochemical Oxygen Demand- 5Total	mg/l	383	247	240	87	187	229	240	355	Biochemical Oxygen Demand- 5Total
Biochemical Oxygen Demand- 5 Soluble	mg/l	159	116	149	-	-	141	-	-	Biochemical Oxygen Demand- 5 Soluble
Nitrate- Nitrogen and Nitrite Nitrogen	mg/l	2.3	2.5	5.7	1.0	-	2.9	-	-	Nitrate- Nitrogen and Nitrite Nitrogen
Ammoniacal Nitrogen	mg/l	26	28	24	14	-	23	-	-	Ammoniacal Nitrogen
Total Nitrogen	mg/l	39	34	33	42	-	37	45	55	Total Nitrogen
Total Phosphorous	mg/l	5.9	3.3	2.9	2.8	-	3.7	6	12	Total Phosphorous

1) Average values of the three measurements which were conducted from December 2016 to January 2017 (Annex 1)

**Data taken between October 2013 and February 2016

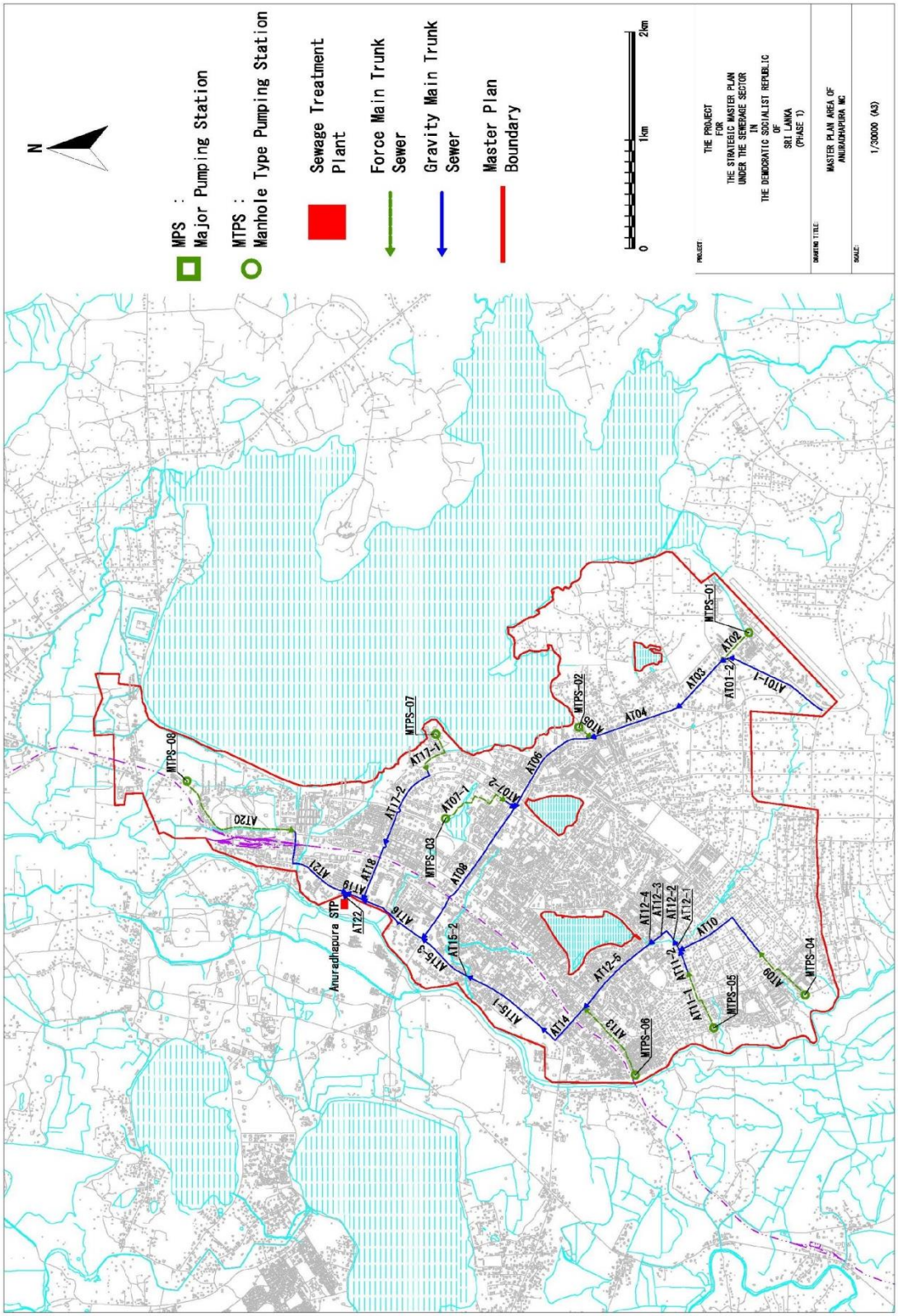
***Average of 1-year measurement

The Result of Sewage Analysis

		Raddolugama			Maththegoda			Hikkaduwa		
		23,24 Nov.2016	29,30 Nov.2016	5,6 Dec 2016	25,26 Nov.2016	1,2 Dec 2016	7,8 Dec 2016	27,28 Dec 2016	3,4 Dec 2016	9,10 Dec 2016
pH at 26^{0}C		6.6	6.93	6.7	6.2	6.9	6.2	7.3	6.42	7.4
Total Suspended Solids at 104^{0}C	mg/l	814*	115	211	54	115	100	59	165	194
Chemical Oxygen Demand Total	mg/l	752*	650	567	510	670	239	344	406	587
Chemical Oxygen Demand Soluble	mg/l	184*	261	220	312	330	80	206	201	212
Biochemical Oxygen Demand- 5Total	mg/l	669*	402	363	189	390	162	186	213	321
Biochemical Oxygen Demand- 5 Soluble	mg/l	99.8*	136	181	120	181	48	109	167	172
Nitrate- Nitrogen and Nitrite Nitrogen	mg/l	2.2	28*	2.4	2.5	1.4	3.5	1.2	13.7	2.2
Ammoniacal Nitrogen	mg/l	10	30	38	19	42	24	18	19	35
Total Nitrogen	mg/l	13	61	42	25	46	32	21	35	42
Total Phosphorous	mg/l	4	8.8	4.8	0.4	5.8	3.8	0.6	4.1	4.1

*JET considered values in gray as outliers and not used for the design.

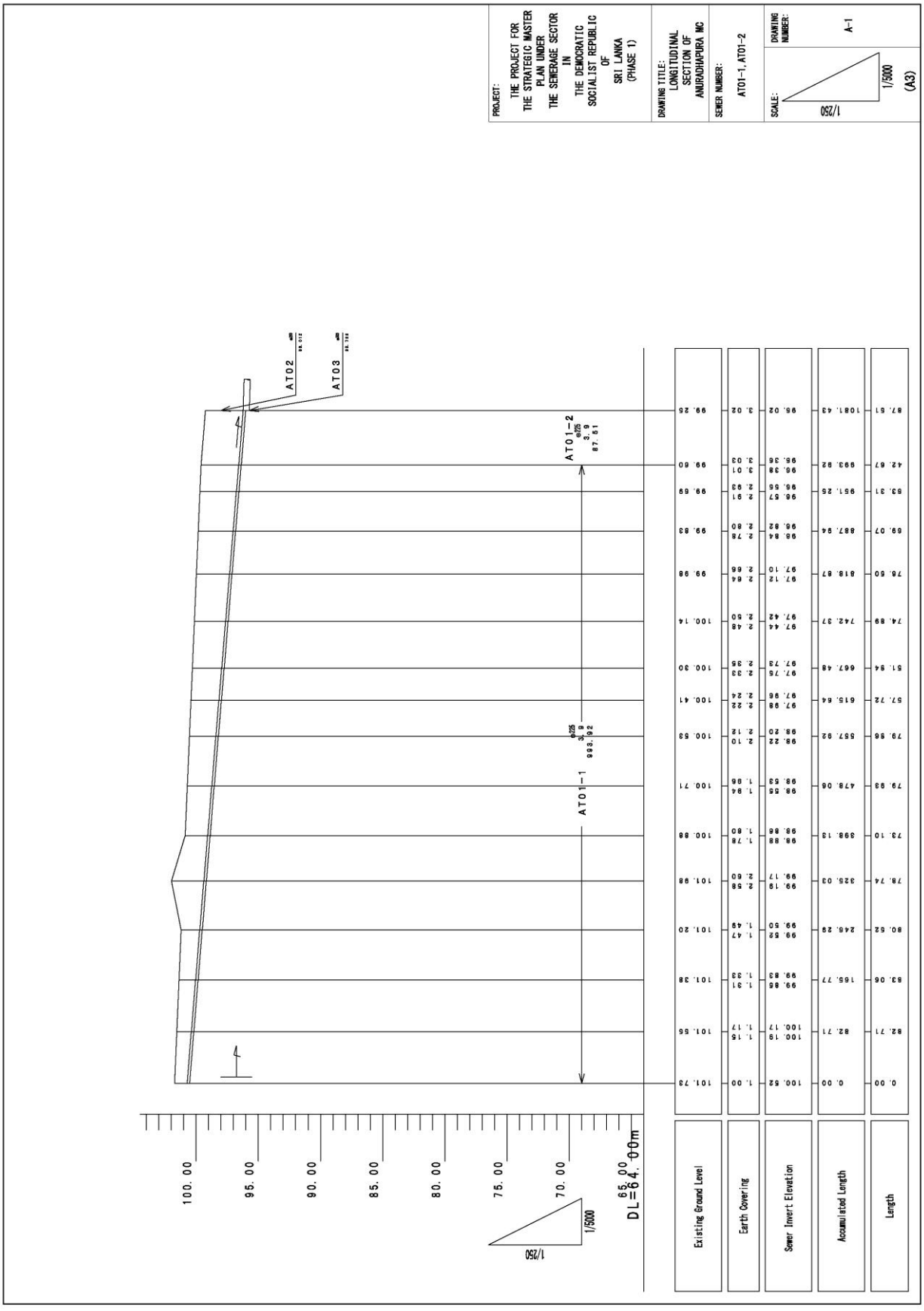
APPENDIX 3: Layout Plan, Sewer Design Calculations and Longitudinal Cross Section



SEWER DESIGN CALCULATIONS

Master Plan Area	Unit Sewer Water ($m^3/s/ha$)	Legend	P
Anuradhapura MC	0.000213	◎:Main Sewer	P_ 1

Line No.		Catchment Area		Length	Design Outflow			Design Sewer Line							Note
					Sewer Water Outflow		Total Outflow	Dia (Internal Diameter)	Slope	V	Cap	Existing Ground Level	Sewer Invert Elevation	Earth Covering	
		Area	Accumulated Area	Accumulated Length	Area Input	Point Input						Upper / Lower	Upper / Lower	Upper / Lower	
		(ha)	(ha)	(m)	(m^3/s)	(m^3/s)	(m^3/s)	(mm)	(‰)	(m/s)	(m^3/s)	(m)	(m)	(m)	
				994				HDPE				101.73	100.517	1.00	
AT01-1	◎	24.60	24.60	994	0.005		0.005	⊙ 225 (201)	3.90	0.65	0.021	99.60	96.382	3.01	
				88				HDPE				99.60	96.362	3.03	
AT01-2	◎		24.60	1082	0.005		0.005	⊙ 225 (201)	3.90	0.65	0.021	99.25	96.021	3.02	To AT03
				375		0.041		HDPE	Force Main			93.25	92.013	1.00	From MTPS-01
AT02	◎	59.35	59.35	375	0.013	0.041	0.054	⊙ 250 (223.6)				99.25	98.012	1.00	
				590				GRP				99.25	95.722	3.02	From AT01-2 and AT02
AT03	◎	25.92	109.87	1672	0.023	0.041	0.064	⊙ 500 (500)	1.50	0.74	0.146	97.66	94.000	3.15	
				840				GRP				97.66	93.980	3.17	
AT04	◎	36.86	146.73	2511	0.031	0.041	0.072	⊙ 500 (500)	1.50	0.74	0.146	90.34	86.867	2.97	To AT06
				150				HDPE	Force Main			88.53	87.315	1.00	From MTPS-02
AT05	◎	179.90	179.90	150	0.038		0.038	⊙ 225 (201)				90.34	89.127	1.00	
				1026				GRP				90.34	86.667	2.96	
AT06	◎	132.79	459.42	3536	0.098	0.041	0.139	⊙ 700 (700)	1.00	0.76	0.293	87.85	85.180	1.96	To AT08
				748				HDPE	Force Main			82.45	81.344	1.00	From MTPS-03
AT07-1	◎	42.48	42.48	748	0.009		0.009	⊙ 110 (98)				88.88	87.774	1.00	
				108				HDPE				88.88	87.095	1.57	
AT07-2	◎	1.07	43.55	856	0.009		0.009	⊙ 225 (201)	3.90	0.65	0.021	87.85	86.637	1.00	
				1484				GRP				87.85	85.150	1.99	
AT08	◎	86.17	589.14	5020	0.125	0.041	0.166	⊙ 700 (700)	1.00	0.76	0.293	78.08	74.166	3.21	To AT16
				607				HDPE	Force Main			84.32	83.214	1.00	From MTPS-04
AT09	◎	52.56	52.56	607	0.011		0.011	⊙ 110 (98)				91.45	90.344	1.00	
				987				GRP				91.45	89.984	1.06	
AT10	◎	93.06	145.62	1594	0.031		0.031	⊙ 400 (400)	1.80	0.70	0.088	87.16	85.754	1.00	To AT12-1
				597				HDPE	Force Main			82.40	81.264	1.00	From MTPS-05
AT11-1	◎	73.50	73.50	597	0.016		0.016	⊙ 140 (125)				88.74	87.604	1.00	
				213				HDPE				88.74	87.457	1.02	
AT11-2	◎	1.36	74.86	810	0.016		0.016	⊙ 280 (250.2)	3.10	0.67	0.033	87.16	85.894	1.00	
				102				GRP				87.16	85.051	1.65	From AT10 and AT11-2
AT12-1	◎	5.01	225.49	1695	0.048		0.048	⊙ 450 (450)	1.70	0.74	0.118	86.36	84.859	1.04	
				24				HDPE	Inverted Siphon			86.36	83.000	3.06	
AT12-2	◎		225.49	1719	0.048		0.048	⊙ 315 (281.8)				85.99	83.000	2.69	
				286				GRP				85.99	84.659	0.72	
AT12-3	◎	153.33	378.82	2005	0.081		0.081	⊙ 600 (600)	1.20	0.75	0.213	85.49	83.678	1.20	
				29				GRP	Inverted Siphon			85.49	82.000	3.08	
AT12-4	◎		378.82	2033	0.081		0.081	⊙ 400 (400)				85.36	82.000	2.95	
				832				GRP				85.36	83.520	1.23	
AT12-5	◎	31.28	410.10	2865	0.087		0.087	⊙ 600 (600)	1.20	0.75	0.213	85.99	82.262	3.12	To AT14
				792				HDPE	Force Main			80.71	79.583	1.01	From MTPS-06
AT13	◎	62.38	62.38	792	0.013		0.013	⊙ 125 (111.6)				85.99	84.870	1.00	
				572				GRP				85.99	82.162	3.12	From AT12-5 and AT13
AT14	◎	38.63	511.11	3437	0.109		0.109	⊙ 700 (700)	1.00	0.76	0.293	80.25	77.110	2.43	
				837				GRP				80.25	77.090	2.45	
AT15-1	◎	58.36	569.47	4273	0.121		0.121	⊙ 700 (700)	1.00	0.76	0.293	78.65	75.152	2.79	
				19				GRP	Inverted Siphon			78.65	74.000	4.24	
AT15-2	◎		569.47	4292	0.121		0.121	⊙ 400 (400)				78.70	74.000	4.29	
				534				GRP				78.70	74.920	3.07	
AT15-3	◎	93.41	662.88	4826	0.141		0.141	⊙ 700 (700)	1.00	0.76	0.293	78.08	74.207	3.16	
				698				GRP				78.08	73.966	3.20	
AT16	◎	24.14	1276.16	5717	0.272	0.041	0.313	⊙ 900 (900)	0.80	0.80	0.512	76.28	72.358	3.01	To AT19
				467				HDPE	Force Main			89.75	88.640	1.00	From MTPS-07
AT17-1	◎	13.94	13.94	467	0.003		0.003	⊙ 110 (98)				92.80	91.694	1.00	
				858				HDPE				92.80	90.740	1.85	
AT17-2	◎	13.18	27.12	1325	0.006		0.006	⊙ 225 (201)	3.90	0.65	0.021	82.71	81.497	1.00	
				579				HDPE				82.71	81.373	1.00	
AT18	◎	76.17	103.29	1903	0.022		0.022	⊙ 355 (317.6)	2.40	0.70	0.055	76.28	74.943	1.00	
				164				GRP				76.28	72.328	3.04	From AT16 and AT18
AT19	◎	1.18	1380.63	5881	0.294	0.041	0.335	⊙ 900 (900)	0.80	0.80	0.512	76.53	72.136	3.48	To AT22
				1252				HDPE	Force Main			75.72	74.528	1.00	From MTPS-08
AT20	◎	150.95	150.95	1252	0.032		0.032	⊙ 200 (178.6)				81.17	79.978	1.00	
				884				GRP				81.17	79.247	1.47	
AT21	◎	86.14	237.09	2136	0.051		0.051	⊙ 450 (450)	1.70	0.74	0.118	76.53	71.878	4.20	
				40				GRP				76.53	71.328	4.19	From AT19 and AT21
AT22	◎		1617.72	5921	0.345	0.041	0.386	⊙ 1000 (1000)	0.70	0.81	0.634	76.53	71.300	4.22	To STP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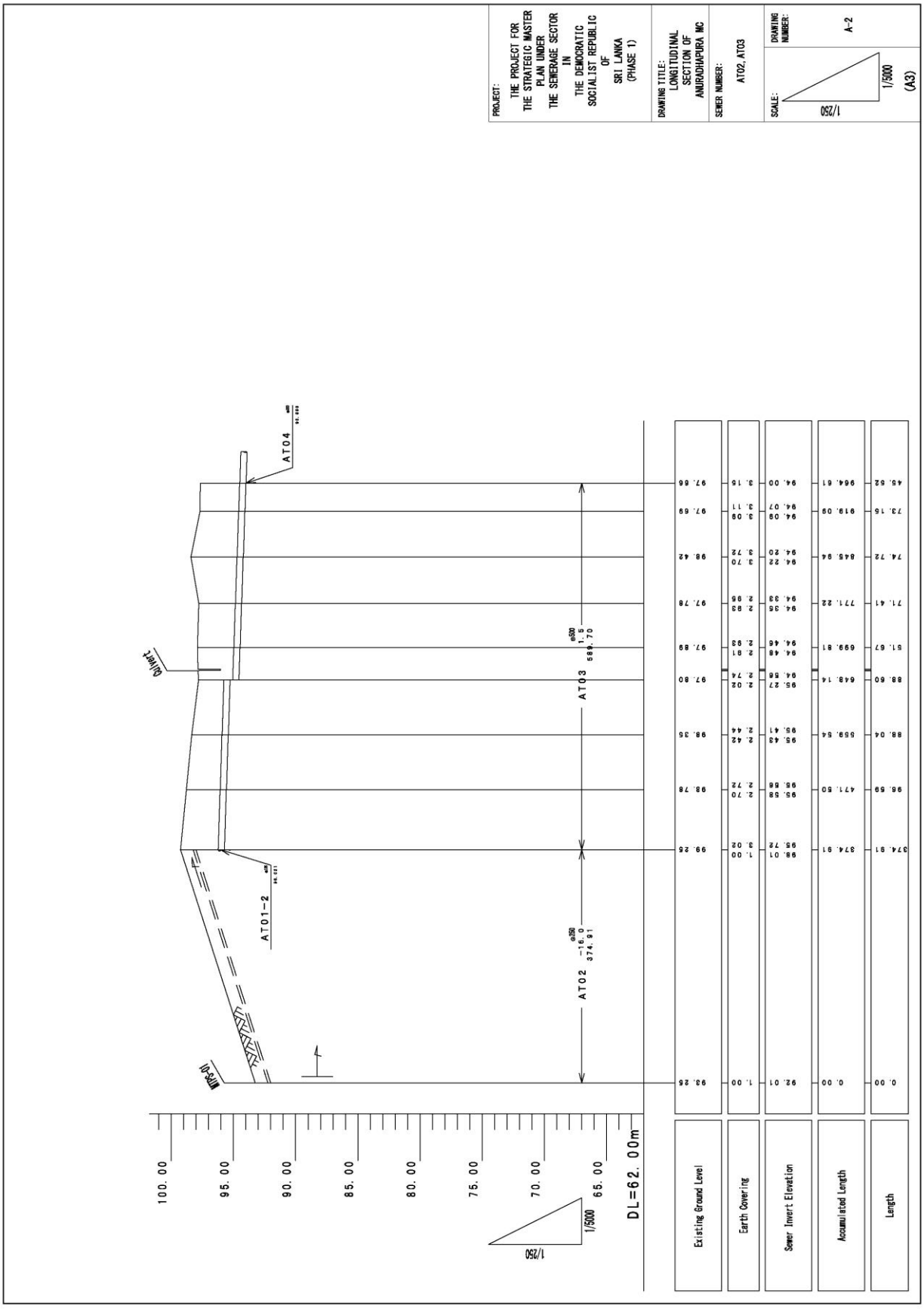
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT01-1, AT01-2
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-1
AT02
AT03
AT01-2
AT01-1
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
DL=64.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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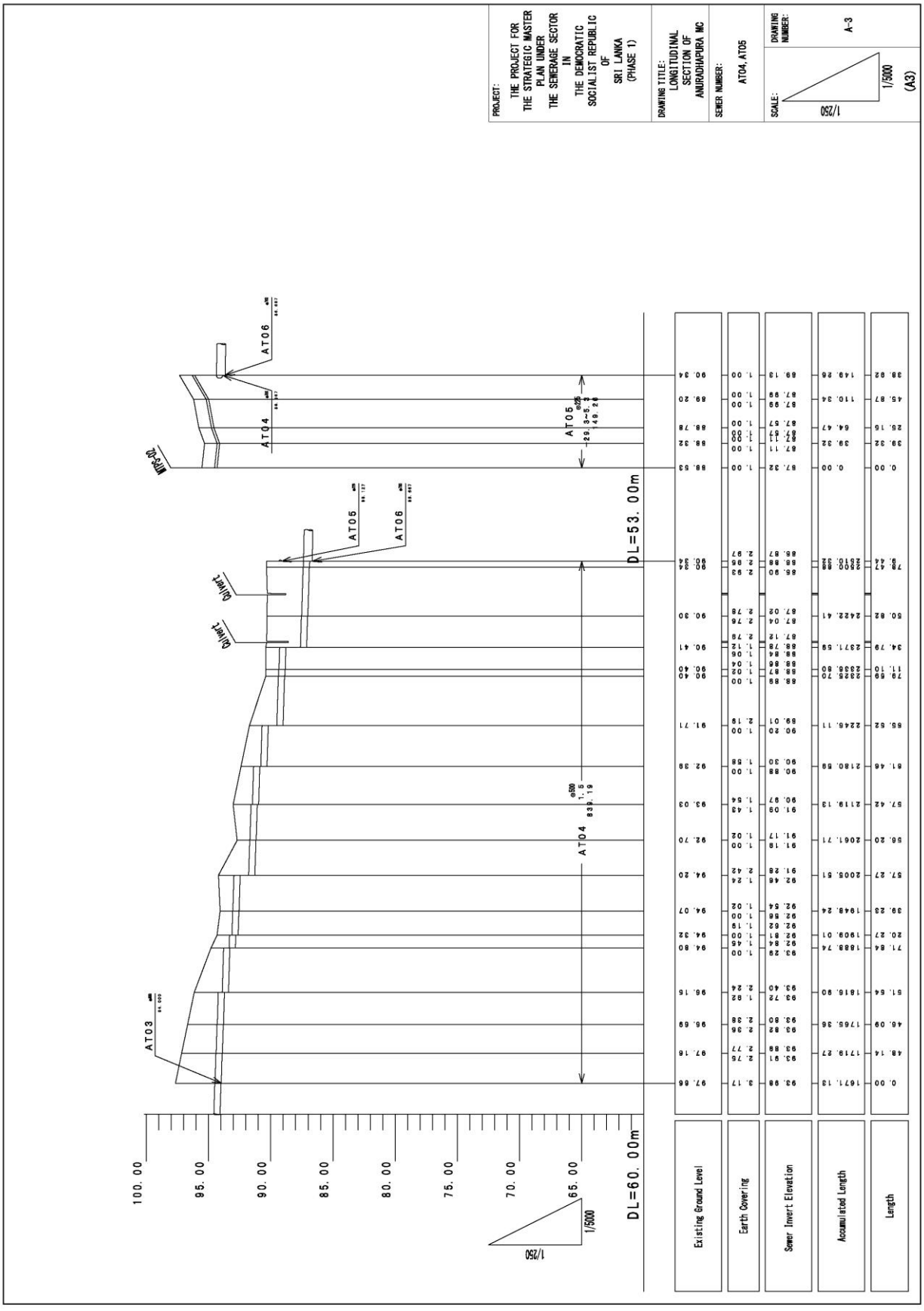
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT02, AT03
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-2
AT04
AT03
AT01-2
AT02
MH5-01
DL=62.00m
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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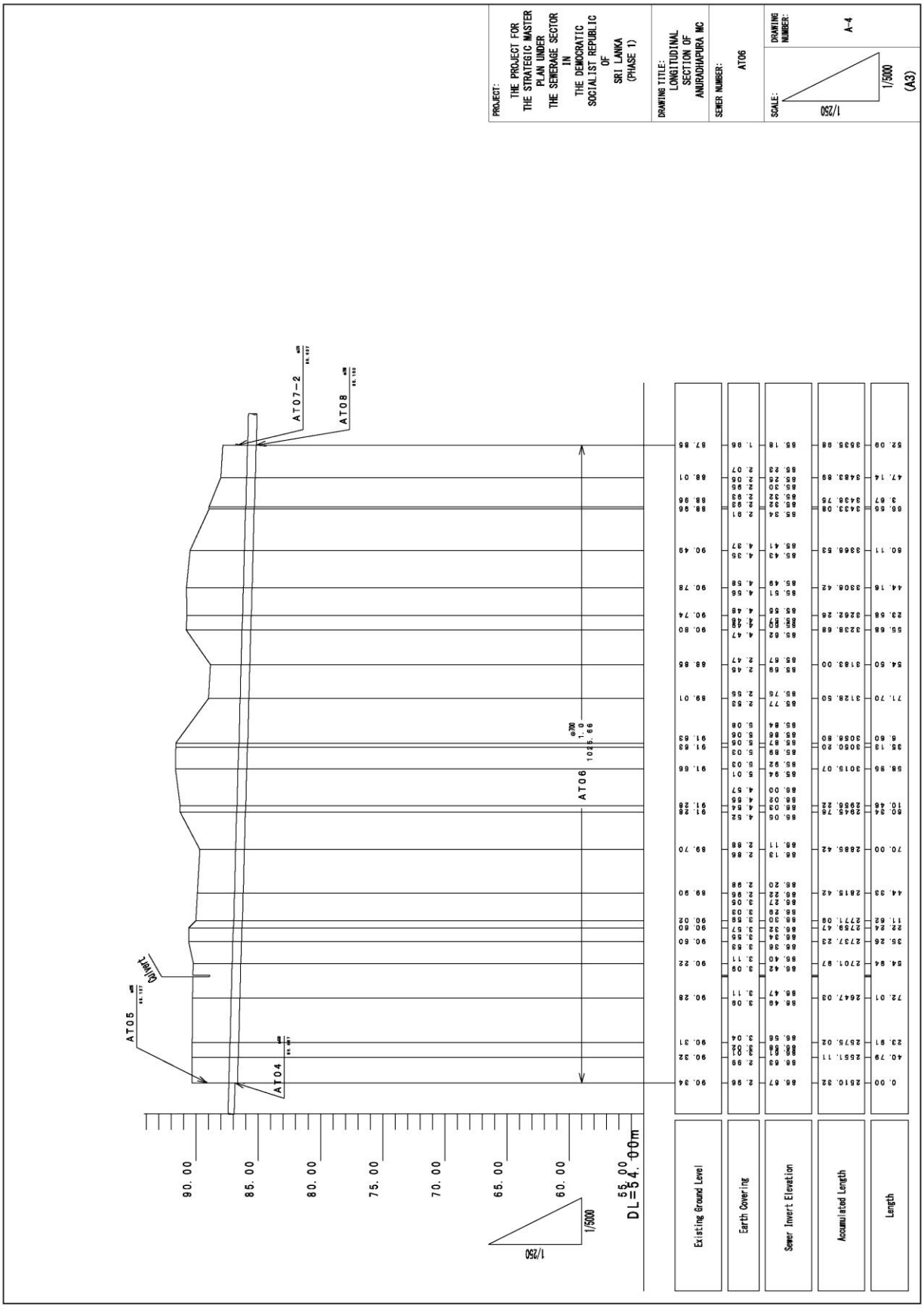
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT04, AT05
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-3
AT03
AT04
AT05
AT06
MH5-30
DL=60.00m
DL=53.00m
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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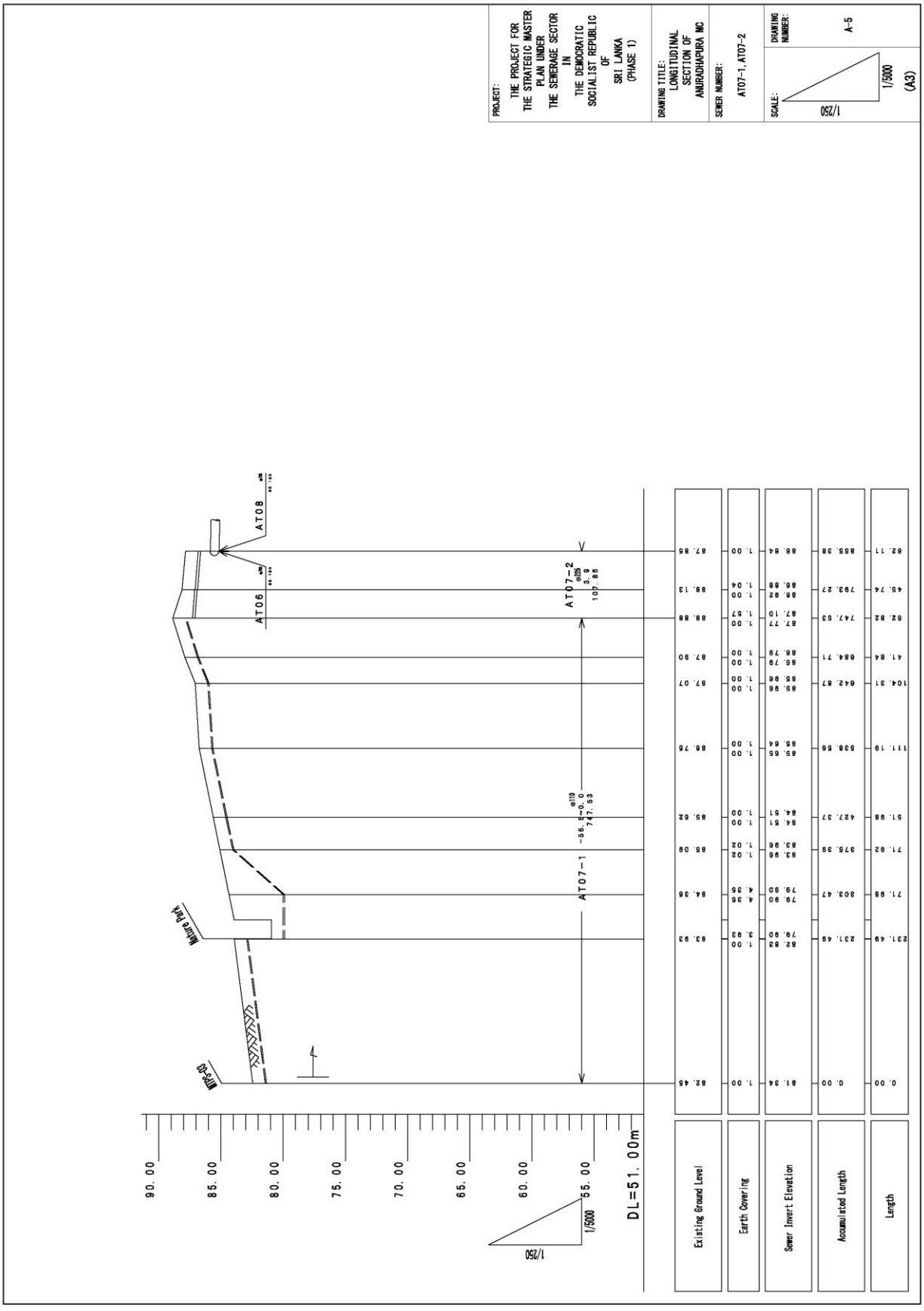
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT06
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-4
AT07-2
AT08
AT06
AT05
AT04
Culvert
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
DL=54.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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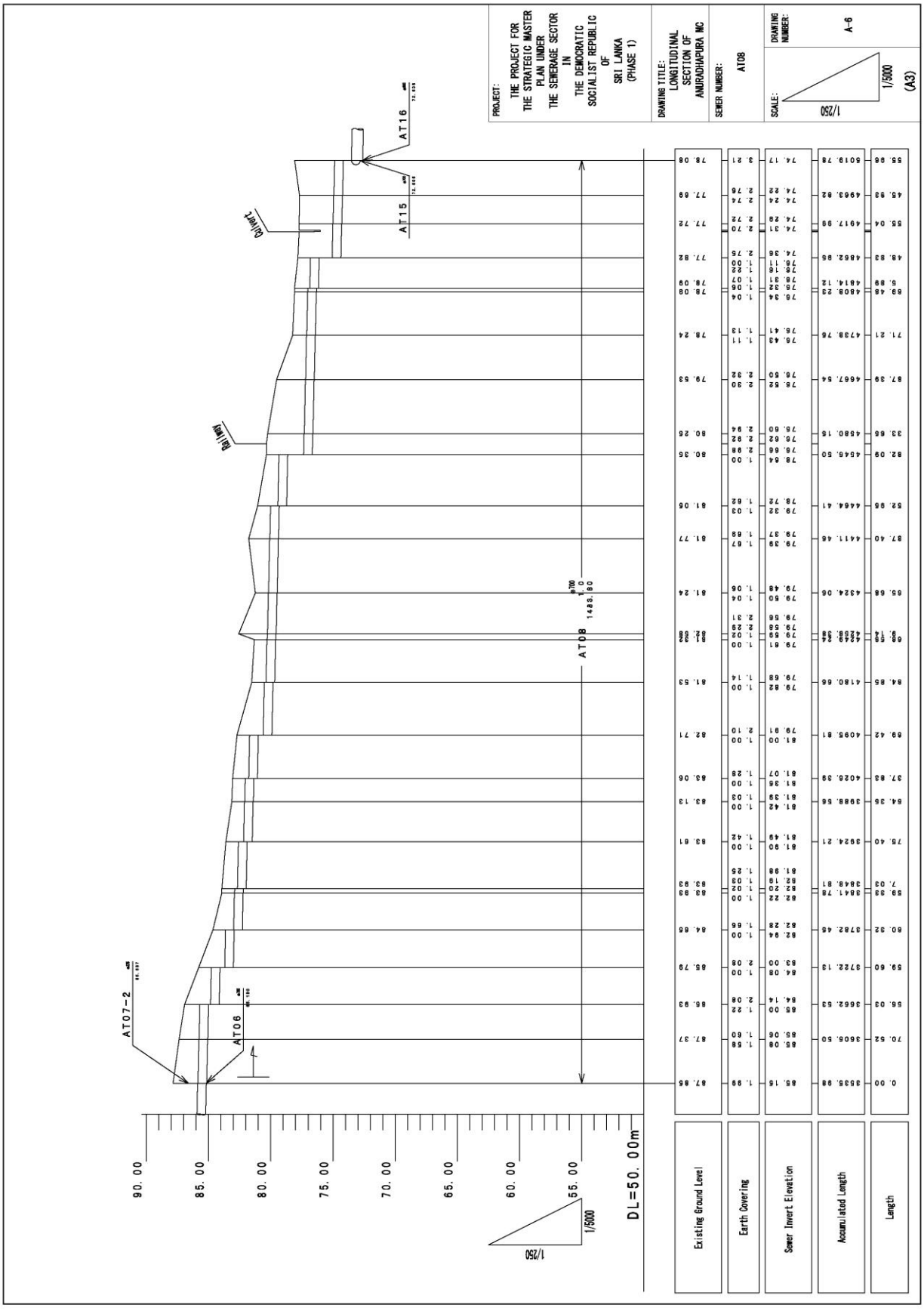
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT07-1, AT07-2
DRAWING NUMBER:
A-5
SCALE:
1/250
1/5000
(A3)
AT08
AT06
AT07-2
AT07-1
MH5-03
Mahure Park
DL=51.00m
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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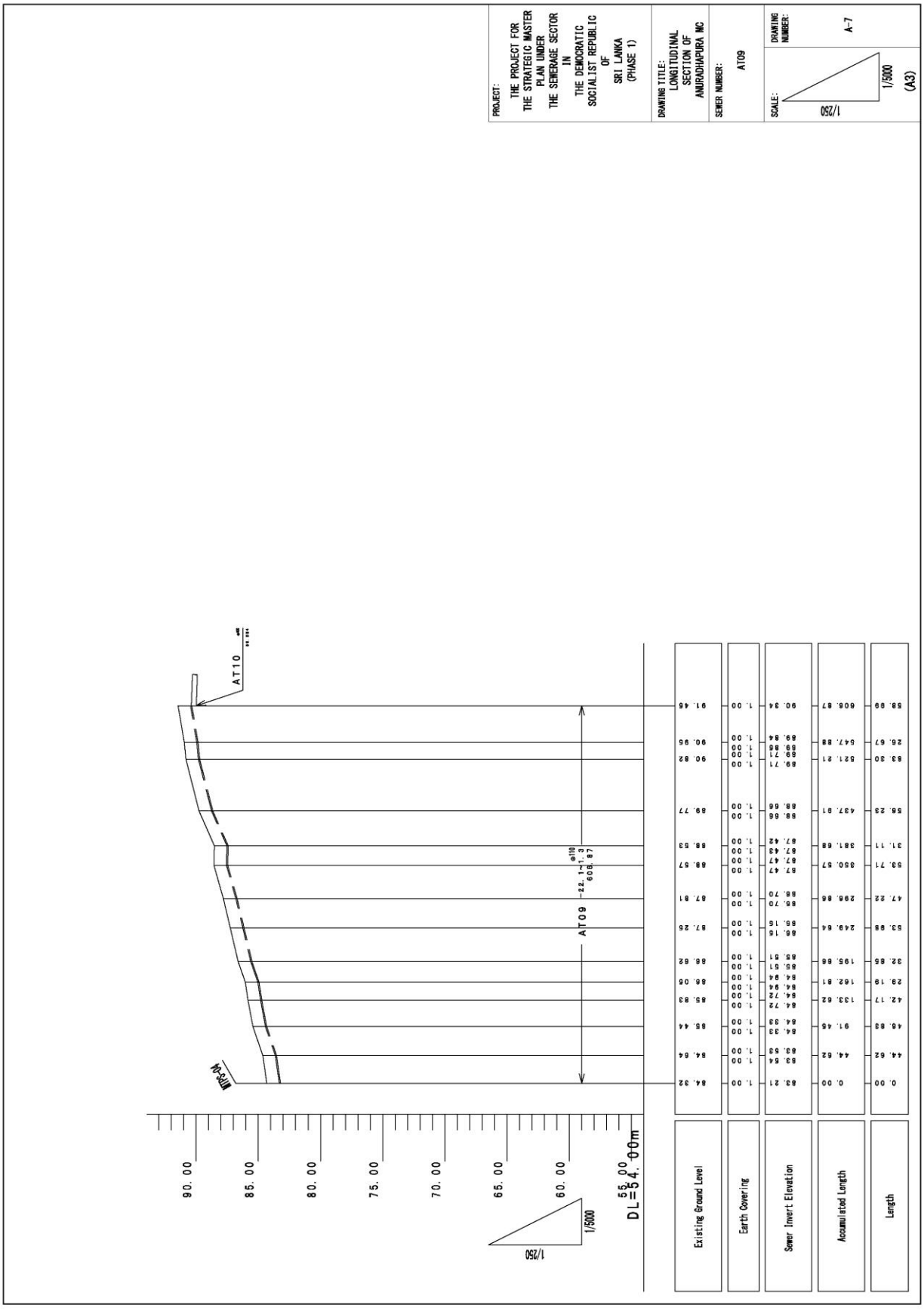
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT08
DRAWING NUMBER:
A-6
SCALE:
1/250
1/5000
(A3)
AT16
AT15
AT08
AT07-2
AT06
DL=50.00m
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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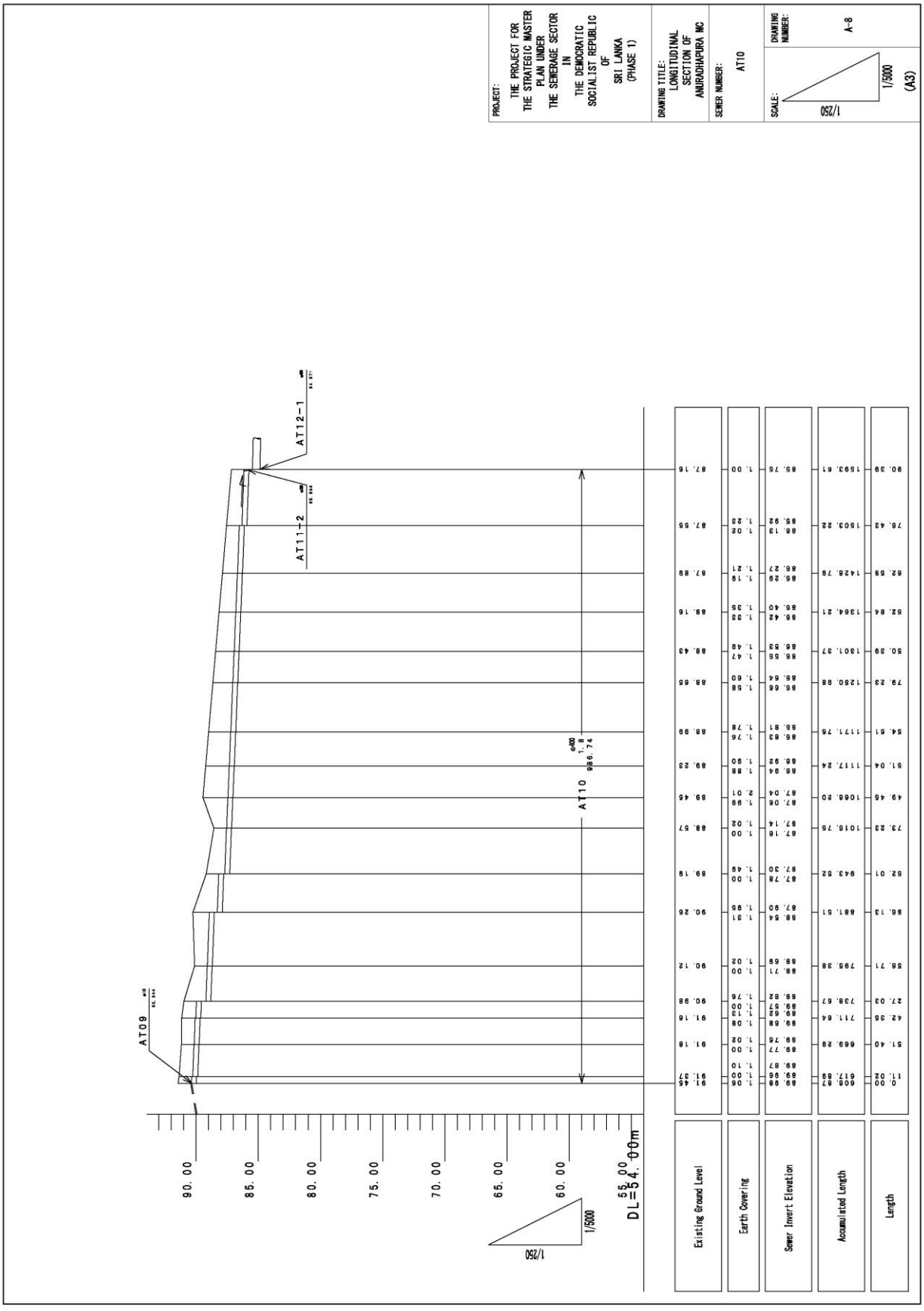
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT09
DRAWING NUMBER:
A-7
SCALE:
1/250
1/5000
(A3)
AT10
AT09
MH9-04
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
DL=54.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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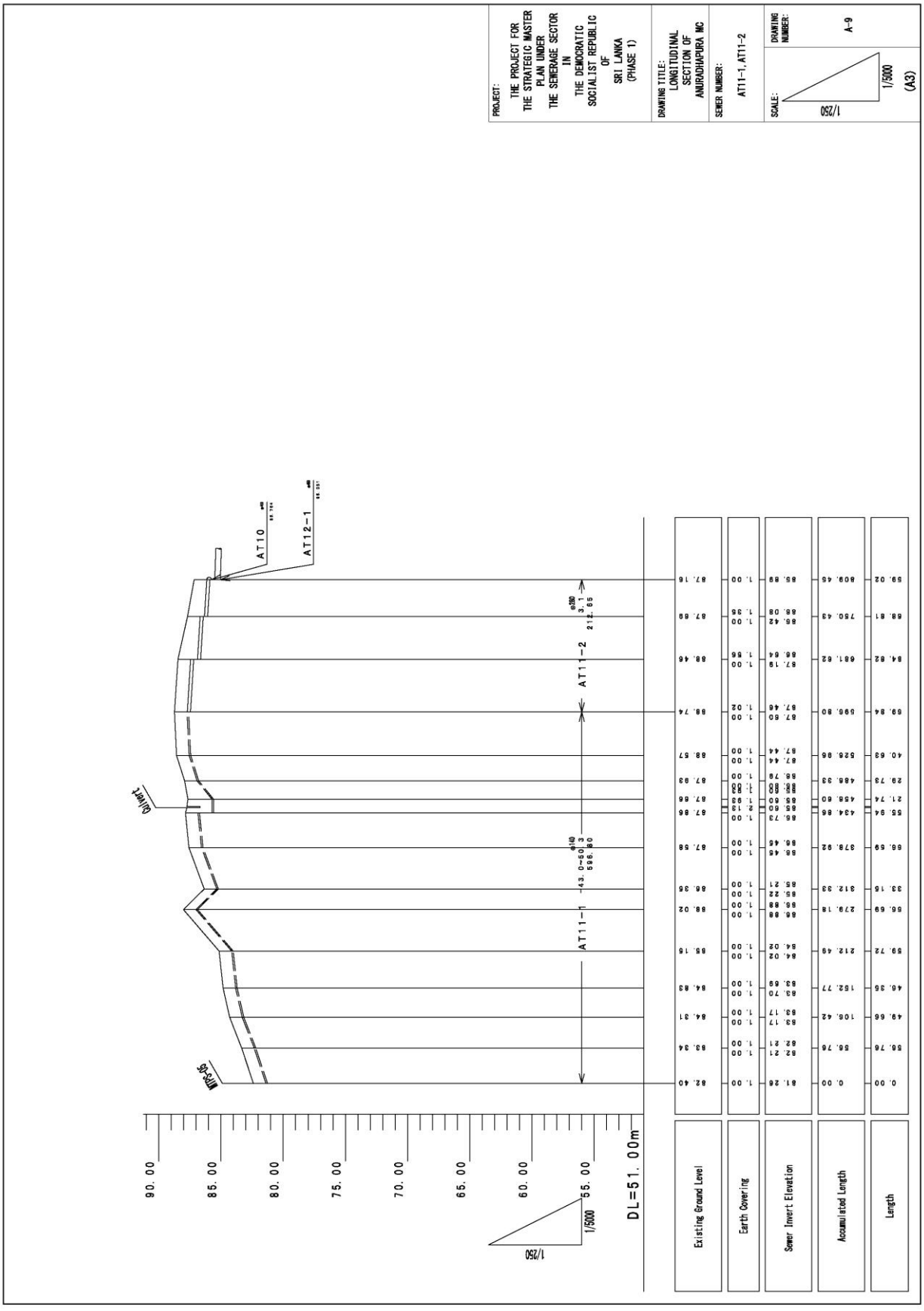
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT10
DRAWING NUMBER:
A-8
SCALE:
1/250
1/5000
(A3)
AT09
AT10
AT11-1
AT11-2
AT12-1
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
DL=54.00m
1/250
1/5000
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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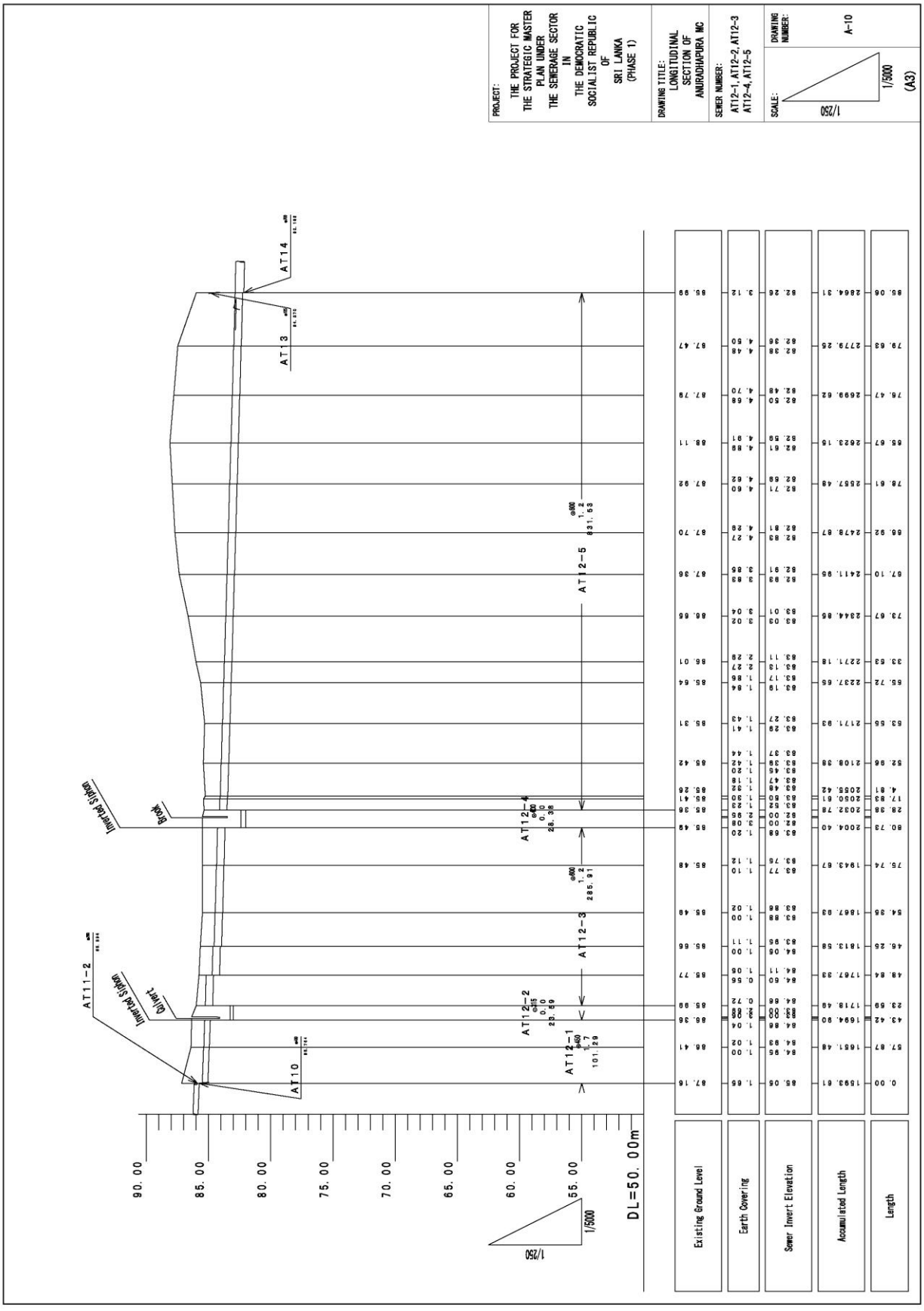
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT11-1, AT11-2
DRAWING NUMBER:
A-9
SCALE:
1/250
1/5000
(A3)
AT10
AT12-1
AT11-2
AT11-1
OUTFALL
MH5-16
DL=51.00m
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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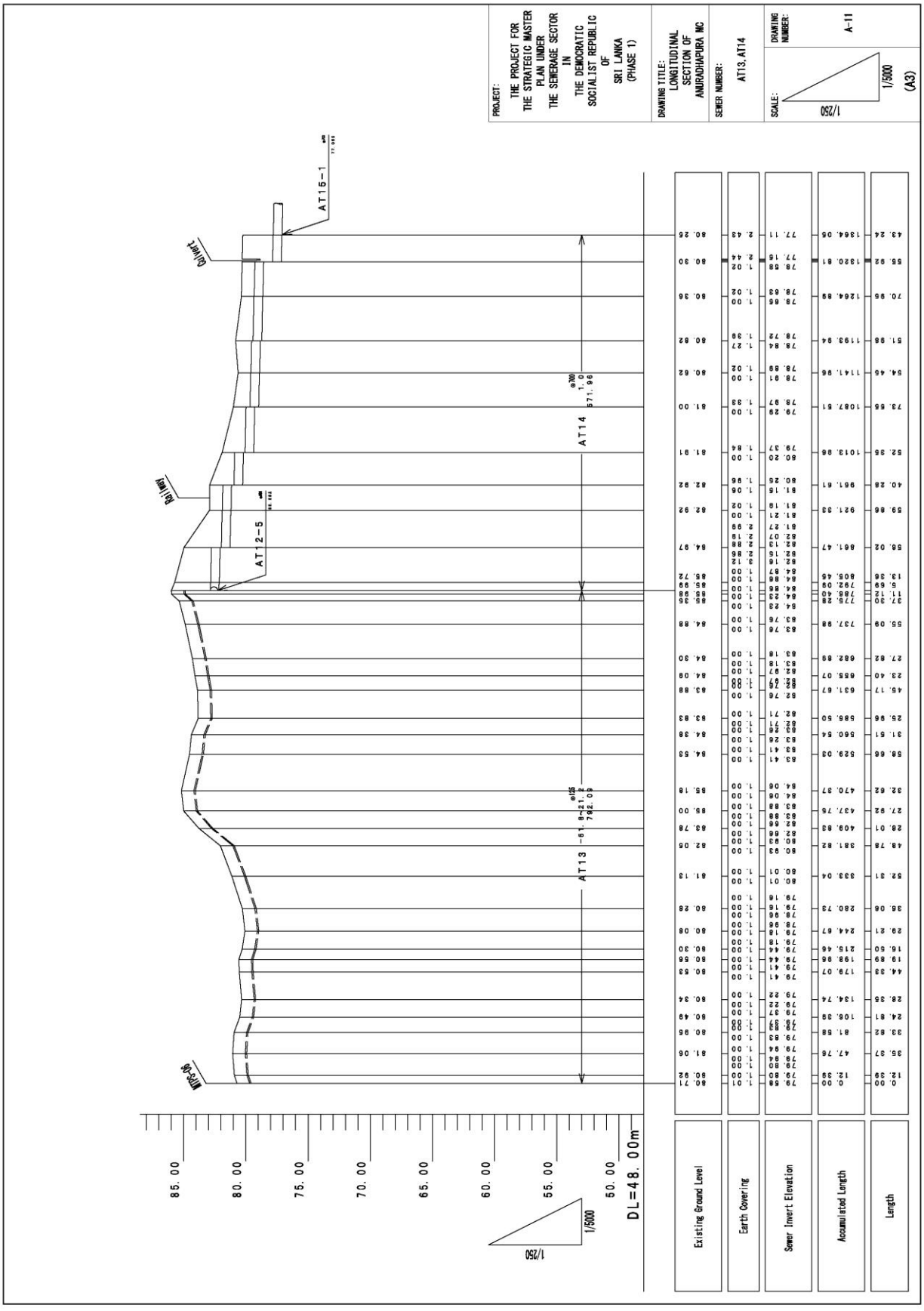
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT12-1, AT12-2, AT12-3
AT12-4, AT12-5
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-10
AT14
AT13
AT12-5
AT12-4
AT12-3
AT12-2
AT12-1
AT11-2
AT10
BROOK
INVERTED SIPHON
CULVERT
INVERTED SIPHON
90.00
85.00
80.00
75.00
70.00
65.00
60.00
55.00
DL=50.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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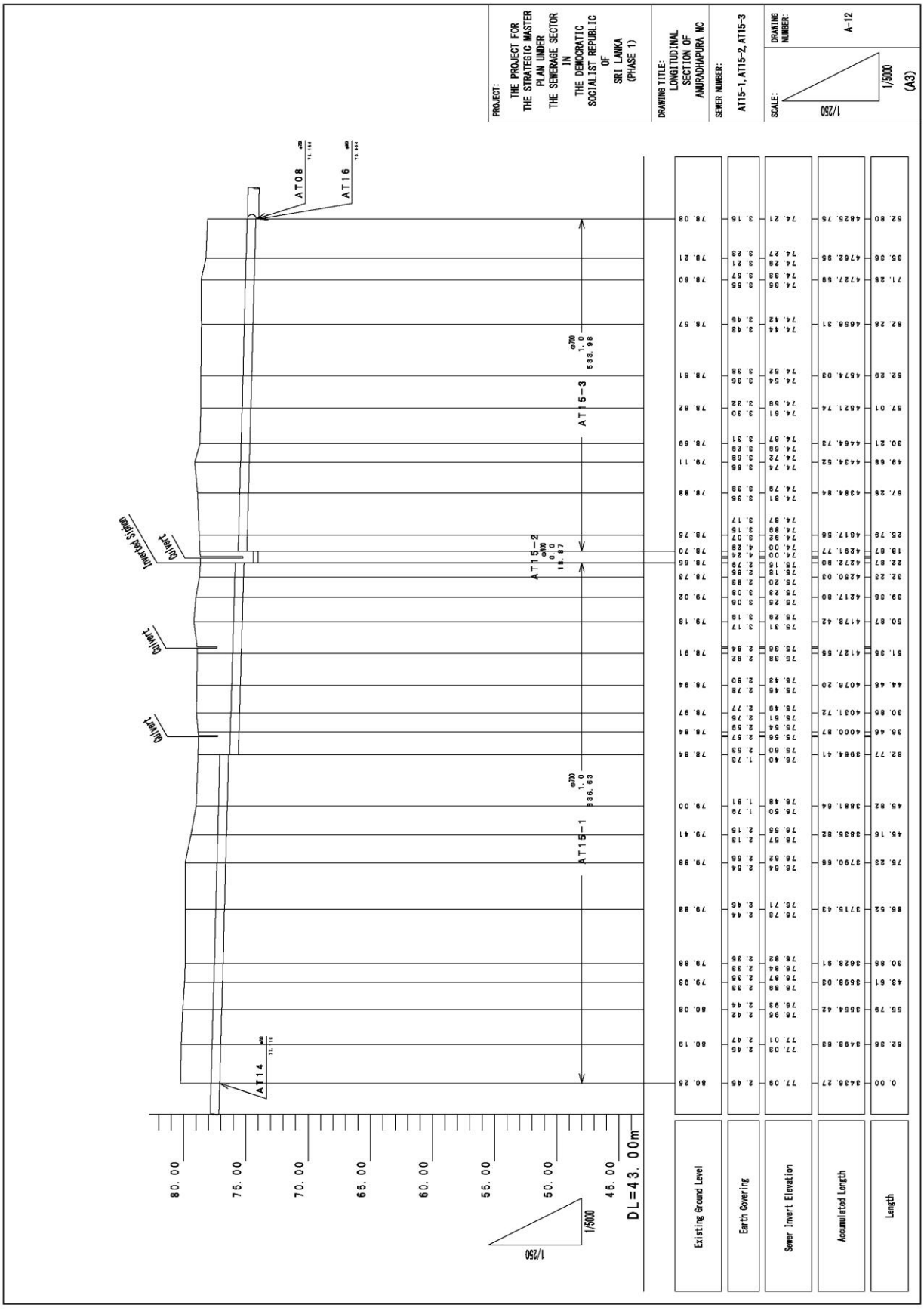
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT13, AT14
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-11
AT16-1
AT14
AT12-5
AT13
DL=48.00m
85.00
80.00
75.00
70.00
65.00
60.00
55.00
50.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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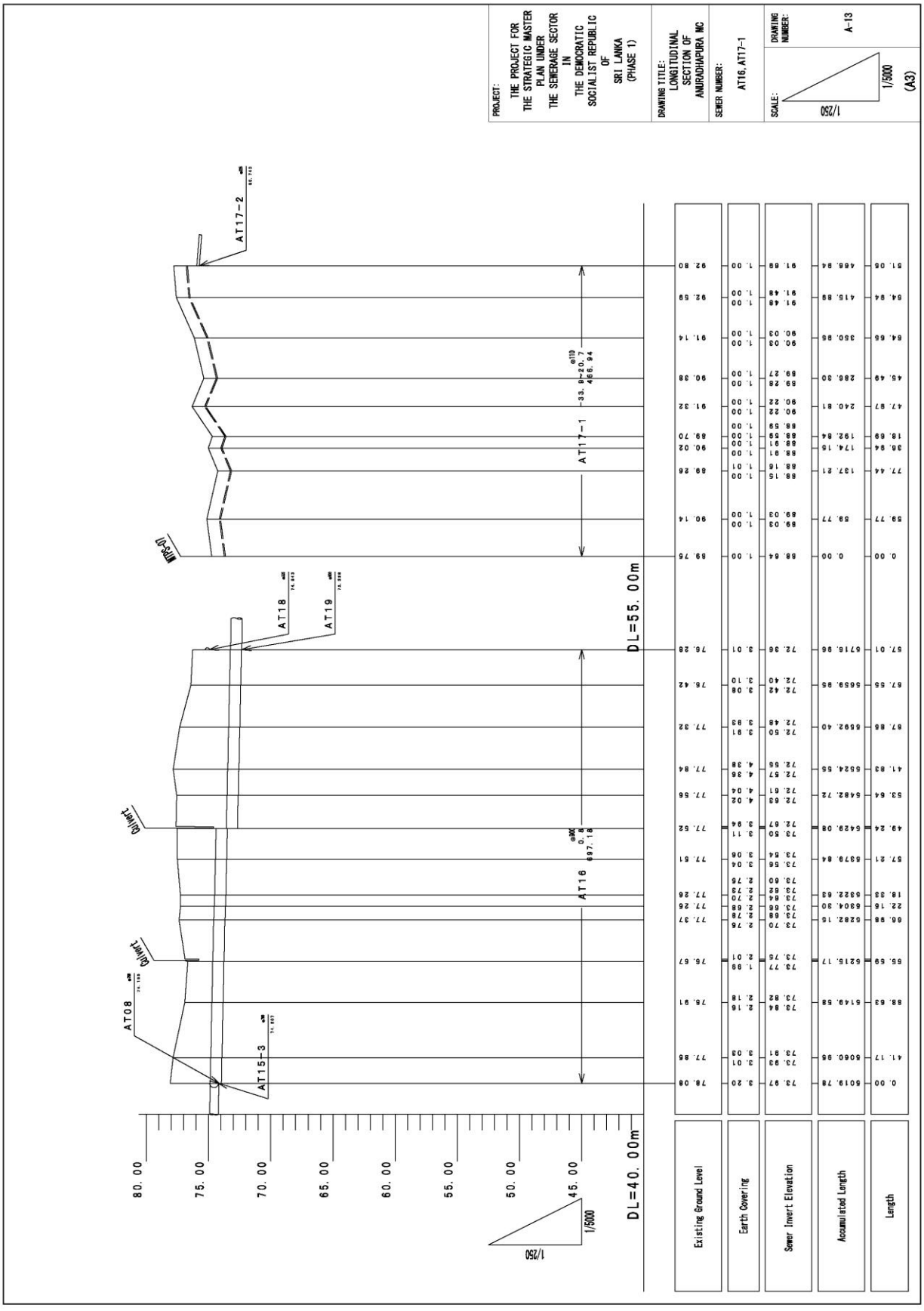
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT15-1, AT15-2, AT15-3
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-12
AT08
AT16
AT15-3
AT15-2
AT15-1
AT14
Inverted Siphon
Culvert
Culvert
Culvert
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
DL=43.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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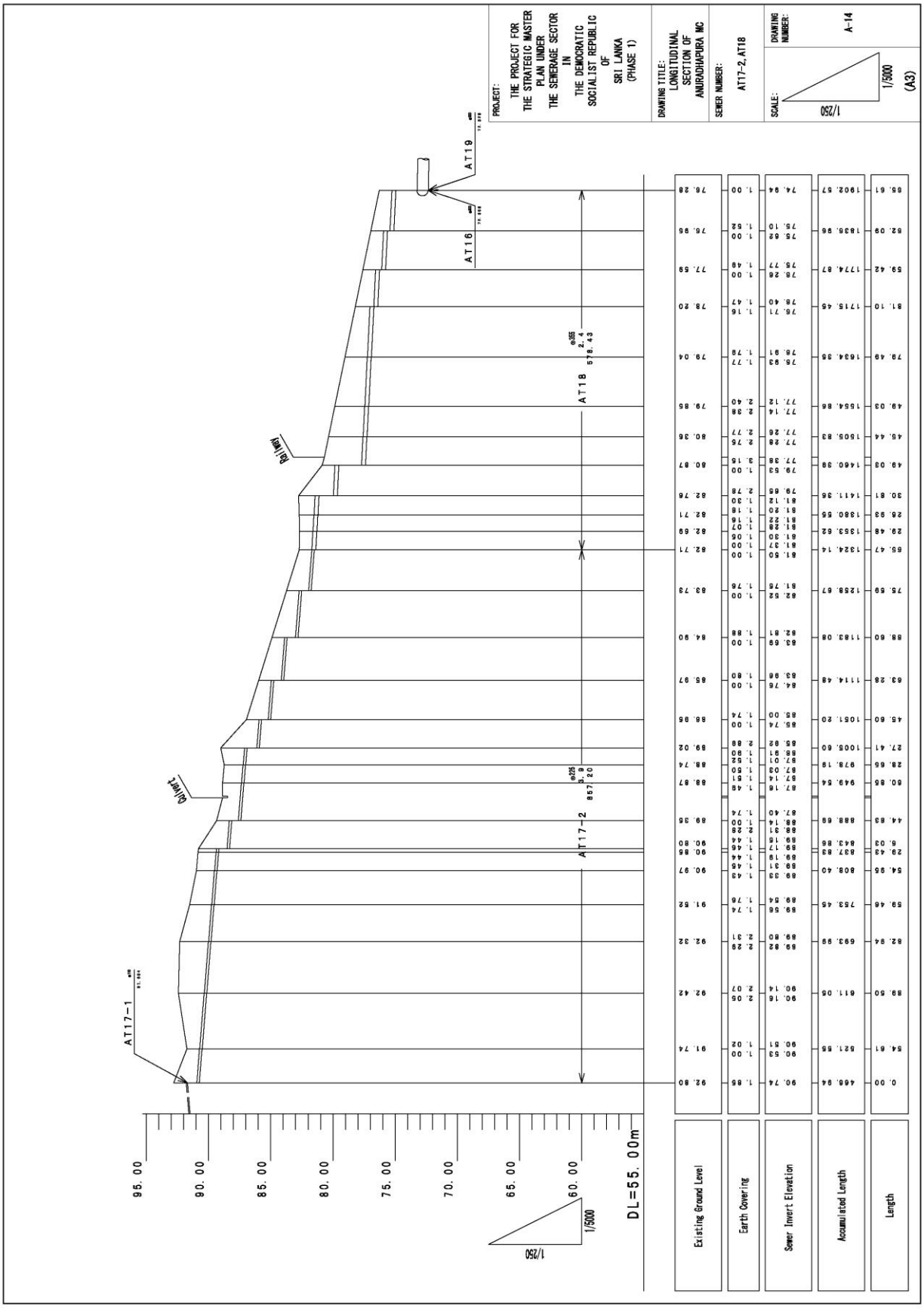
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT16, AT17-1
SCALE:
1/250
1/5000
DRAWING NUMBER:
A-13
(A3)
AT17-2
AT17-1
AT18
AT19
AT16
AT15-3
AT08
MH-AT1
CULVERT
CULVERT
DL=55.00m
DL=40.00m
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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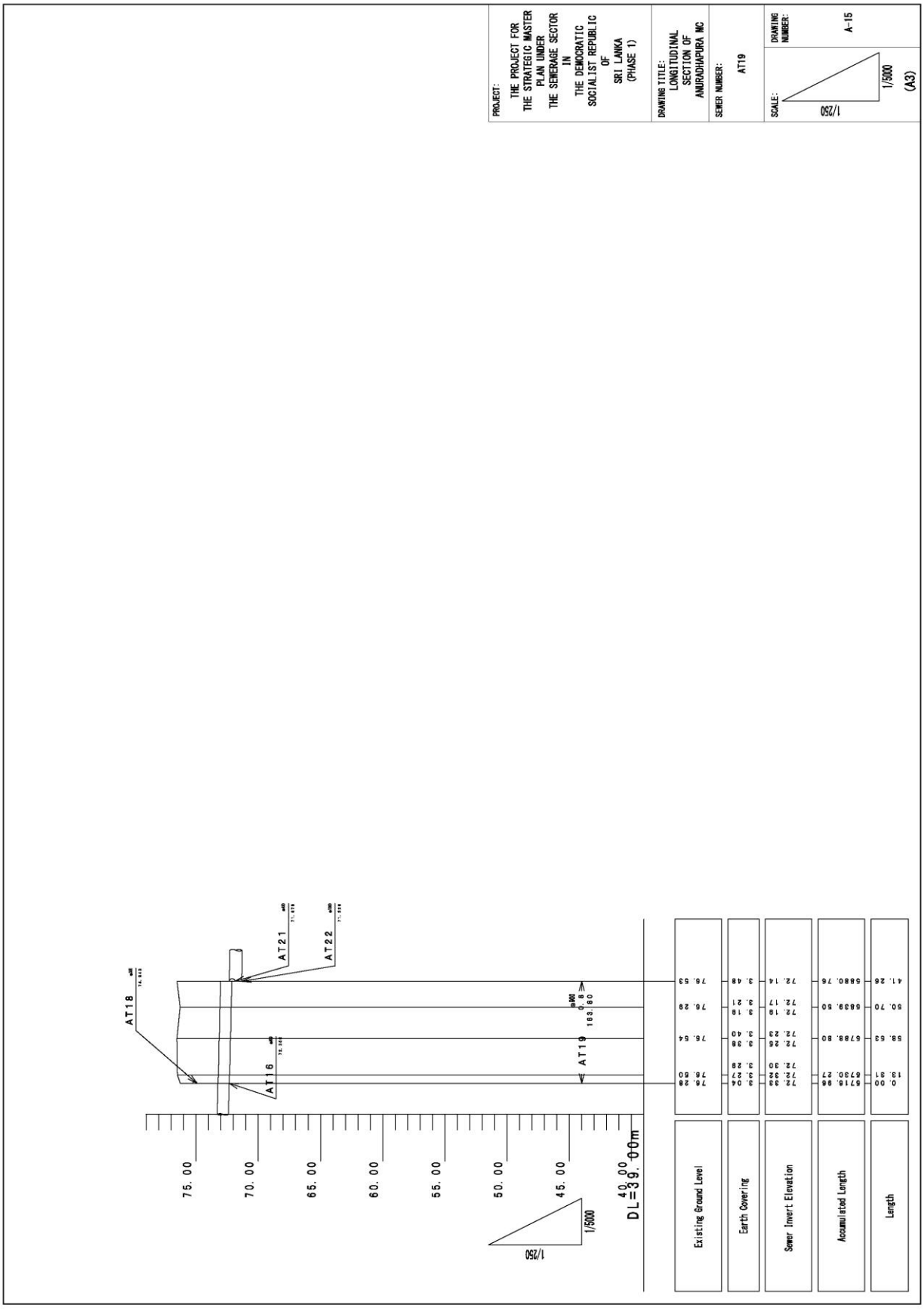
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT17-2, AT18
DRAWING NUMBER:
A-14
SCALE:
1/250
1/5000
(A3)
AT19
AT16
AT18
AT17-2
AT17-1
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
DL=55.00m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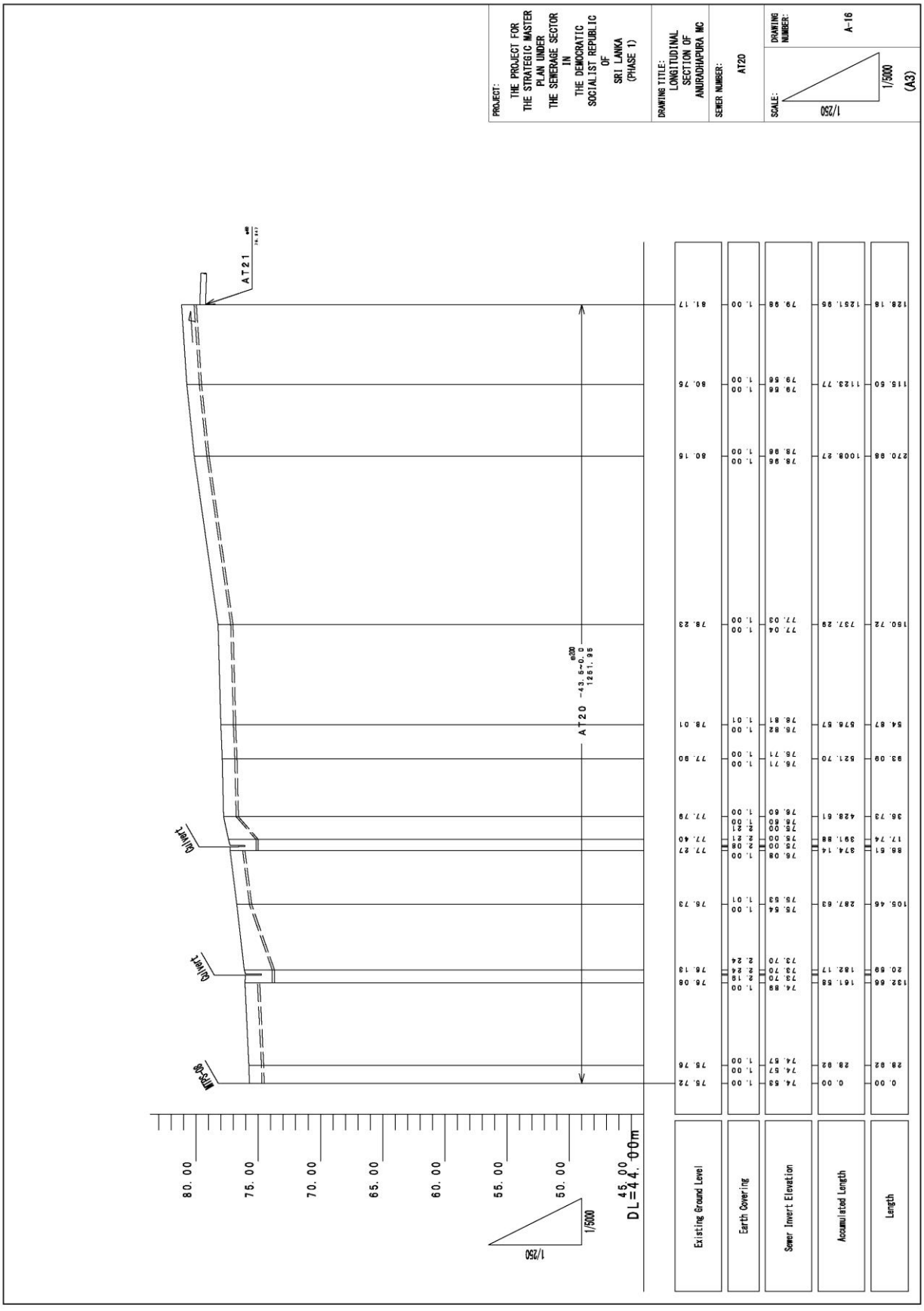
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT19
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-15
AT18
AT16
AT21
AT22
AT19
75.00
70.00
65.00
60.00
55.00
50.00
45.00
40.00
DL=39.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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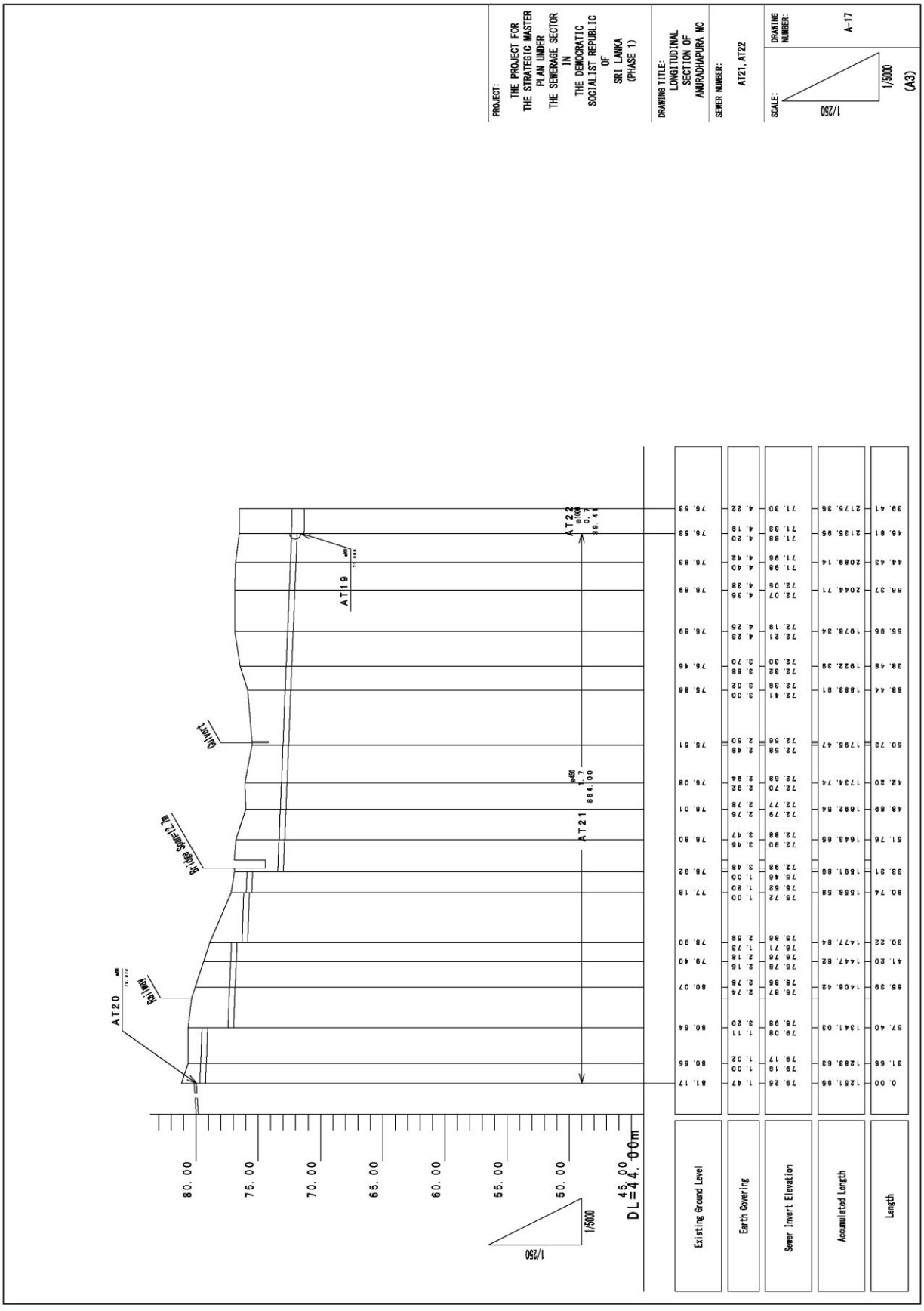
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT20
DRAWING NUMBER:
A-16
SCALE:
1/250
1/5000
(A3)
AT21
AT20 -43.5-0.0 1261.95
DL=44.00m
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length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THE PROJECT FOR THE STRATEGIC MASTER PLAN UNDER THE SEWERAGE SECTOR IN THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA (PHASE 1)
DRAWING TITLE:
LONGITUDINAL SECTION OF ANURADHAPURA MC
SEWER NUMBER:
AT21, AT22
SCALE:
1/250
1/5000
(A3)
DRAWING NUMBER:
A-17
AT20
AT19
AT21
AT22
Ditch
Bridge Span=12.7m
80.00
75.00
70.00
65.00
60.00
55.00
50.00
45.00
DL=44.00m
Existing Ground Level
Earth Covering
Sewer Invert Elevation
Accumulated Length
Length

APPENDIX 4: Draft Amendment of Tolerance Discharge Limits

Schedule III

Tolerance limit values for the discharge of wastewaters or effluents (industrial / domestic) from a prescribed activity into the inland surface waters

No.	*Parameter*	*Unit, type of limit*	*Tolerance limit values for Inland surface waters*
1.	Total suspended solids	mg/1, max.	50
2.	Total dissolved solids	mg/1, max.	1000
3.	pH at ambient temperature	-	6.0 – 8.5
4.	Biochemical oxygen demand (BOD_5 in 5 days at 20^0 C)	mg/1,max.	30
5.	Temperature at the point of discharge	^{0}C, max.	Ambient water temperature ± 5 or 40 whichever is lesser
6.	Oils and greases	mg/1,max.	10
7.	Phenols (as C_6H_5OH)	mg/1,max.	1.0
8.	Chemical oxygen demand (COD)	mg/1,max.	250
9.	Colour (Maximum spectral absorption coefficient)	Wave length range 436 nm, (Yellow range) 525 nm, (Red range) 620 nm, (blue range)	 $7m^{-1}$ $5m^{-1}$ $3m^{-1}$
10.	Dissolved phosphates (as P)	mg/1,max.	5

11.	Total Kjeldhal nitrogen (as N)	mg/1,max.	150
12.	Ammoniacal nitrogen (as N)	mg/1,max.	50
13.	Nitrate (as N)	mg/1,max.	10
14.	Cyanide (as CN)	mg/1,max.	0.05
15.	Total residual chlorine (as Cl_2)	mg/1,max.	0.5
16.	Chlorides (as Cl)	mg/1,max.	400
17.	Fluorides (as F)	mg/1,max.	2.0
18.	Sulphides (as S)	mg/1,max.	0.5
19.	Arsenic, total (as As)	mg/1,max.	0.05
20.	Cadmium, total (as Cd)	mg/1,max.	0.03
21.	Chromium, total (as Cr)	mg/1,max.	0.05
22.	Chromium, hexavalent (as Cr^{6+})	mg/1,max.	0.01
23.	Copper, total (as Cu)	mg/1,max.	0.05
24.	Iron, total (as Fe)	mg/1,max.	3.0
25.	Lead, total (as Pb)	mg/1,max.	0.05
26.	Mercury, total (as Hg)	mg/1,max.	0.001
27.	Nickel, total (as Ni)	mg/1,max.	0.2
28.	Selenium, total(as Se)	mg/1,max.	0.05
29.	Zinc, total (as Zn)	mg/1,max.	2.0
30.	Silver, total (as Ag)	mg/1,max.	0.035
31.	Pesticides (Total)	mg/1,max.	0.005
32.	Surfactants (Total)	mg/l, max.	5.0
33.	Faecal coliform	MPN/100ml, max.	150

34.	Sulphates (as S)	mg/l, max.	250
35.	Radio Active Material: (a) Alpha emitters (b) Beta emitters	 micro curie/ml, max micro curie/ml, max	 10^{-8} 10^{-7}

Note 1: All efforts should be made to remove unpleasant odour as practicable as possible.

Note 2: These limit values are based on the premise that for inland surface water the dilution factor may be at least 1:8. In an event where the dilution factor is found to be less, the limit values in the Schedule should be adjusted on a proportional basis so as to give rise to more stringent limit values.

Note 3: The above mentioned general standards and criteria should cease to apply with regard to a particular industry when industry specific standards and criteria are stipulated for that industry.

APPENDIX 5: Land Confirmation for STP

English Translation

MUNICIPAL COUNCIL ANURADHAPURA

My Ref : 2/4/5/1/113/2016 Your Ref. Date: 07.-09.2016

Sewerage Planning Engineer,

Sewerage Planning Project operating in aid of
International Japanese cooperation,
No. 25, Borupana Road,
Ratmalana.

Regarding to obtain the necessary information for Sewerage Planning Project operating in aid of Institute of International Japanese cooperation

Reference to your letter dated 01.09.2016 for the above fact .

02. According to that I am kindly herewith giving my authorization to use the land belongs to Walisinghe Harischandra Sports Complex under the Municipal Council Anuradhapura to the above proposed project .

Sgd. Illegibly
Ajantha Gunawardena
Municipal Commissioner
Municipal Council
Anuradhapura

Seal of : Municipal Commissioner
Municipal Council
Anuradhapura

Translated By me
I. S. Perera
(Mrs.) M.I.S. PERERA
(Sworn Translator - District Court of Colombo - Sri Lanka)
Date: 19.9.2016.

අනුරාධපුර මහා නගර සභාව
அனுராதபுரம் மாநகர சபை
MUNICIPAL COUNCIL ANURADHAPURA

මගේ අංකය : எனது இல My Ref : 2/4/8/1/1/13/2016
ඔබේ අංකය : உமது இல Your Ref :
දිනය : திகதி Date : 2016.09.07

මළාපවහන සැලසුම් ඉංජිනේරු,

ජපන් ජාත්‍යන්තර සහයෝගීතා ආධාර මත ක්‍රියාත්මක

උපාය මාර්ගික මළාපවහන සැලසුම් ව්‍යාපෘතිය,

නො - 25,

බොරුපන පාර,

රත්මලාන.

ජපන් ජාත්‍යන්තර සහයෝගීතා ආයතනයේ ආධාර මත ක්‍රියාත්මක කරනු ලබන මළාපවහන සැලසුම් කාර්යය සඳහා අවශ්‍යය කොරතුරු ලබා ගැනීම සම්බන්ධව.

උක්ත කරුණ සම්බන්ධයෙන් ඔබ විසින් එවන ලද 2016.09.01 දිනැති ලිපිය හා බැඳේ.

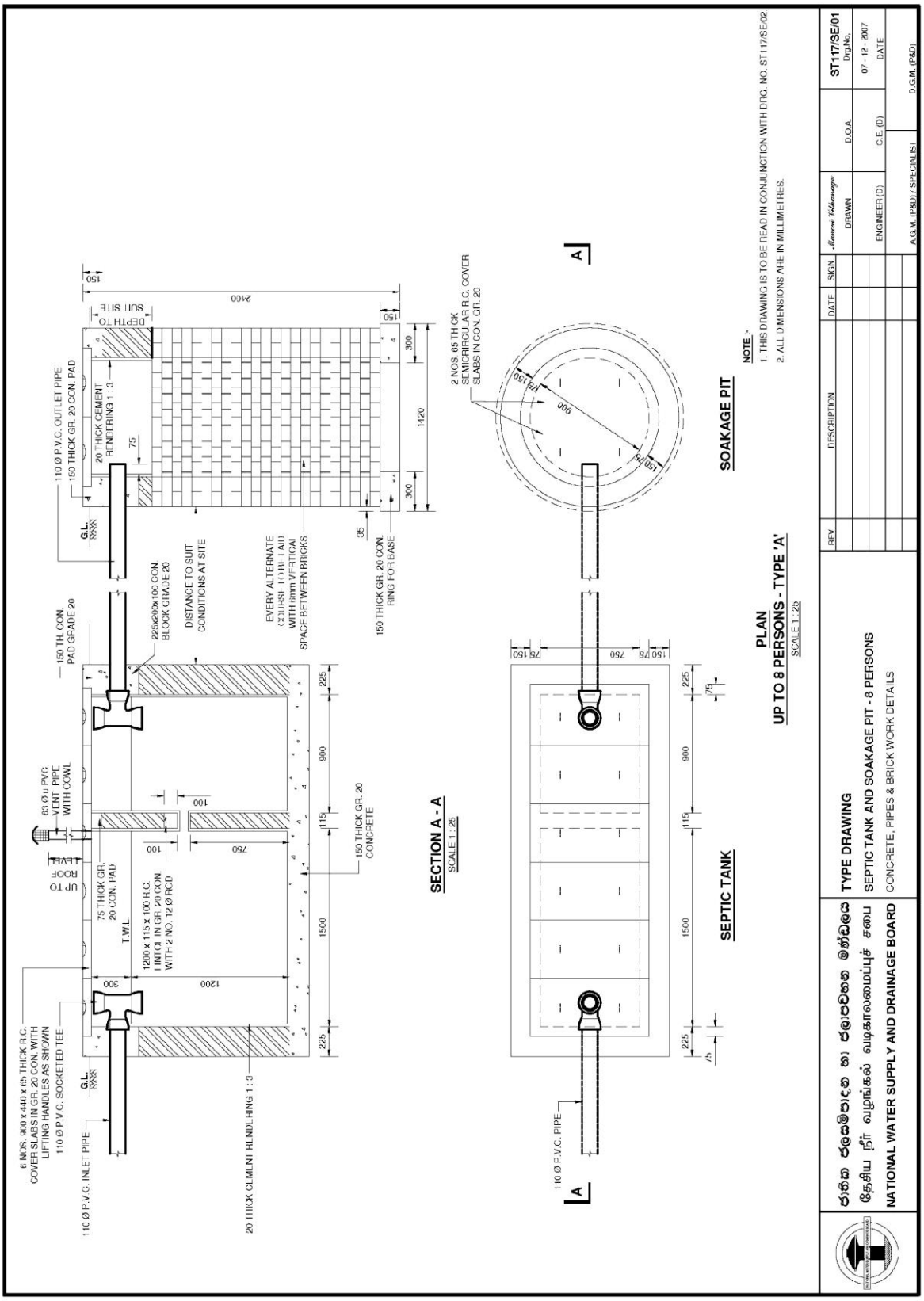
02.ඒ අනුව අනුරාධපුර මහා නගර සභාව යටතේ ඇති වළිසිංහ හරිස්චන්ද්‍ර ක්‍රීඩාංගනයට අයත් භූමිය යෝජිත ව්‍යාපෘතිය සඳහා යොදා ගත හැකි අතර, ඒ සඳහා මාගේ එකඟතාවය ලබා දෙන බව මෙයින් කාරුණිකව දන්වා සිටිමි.

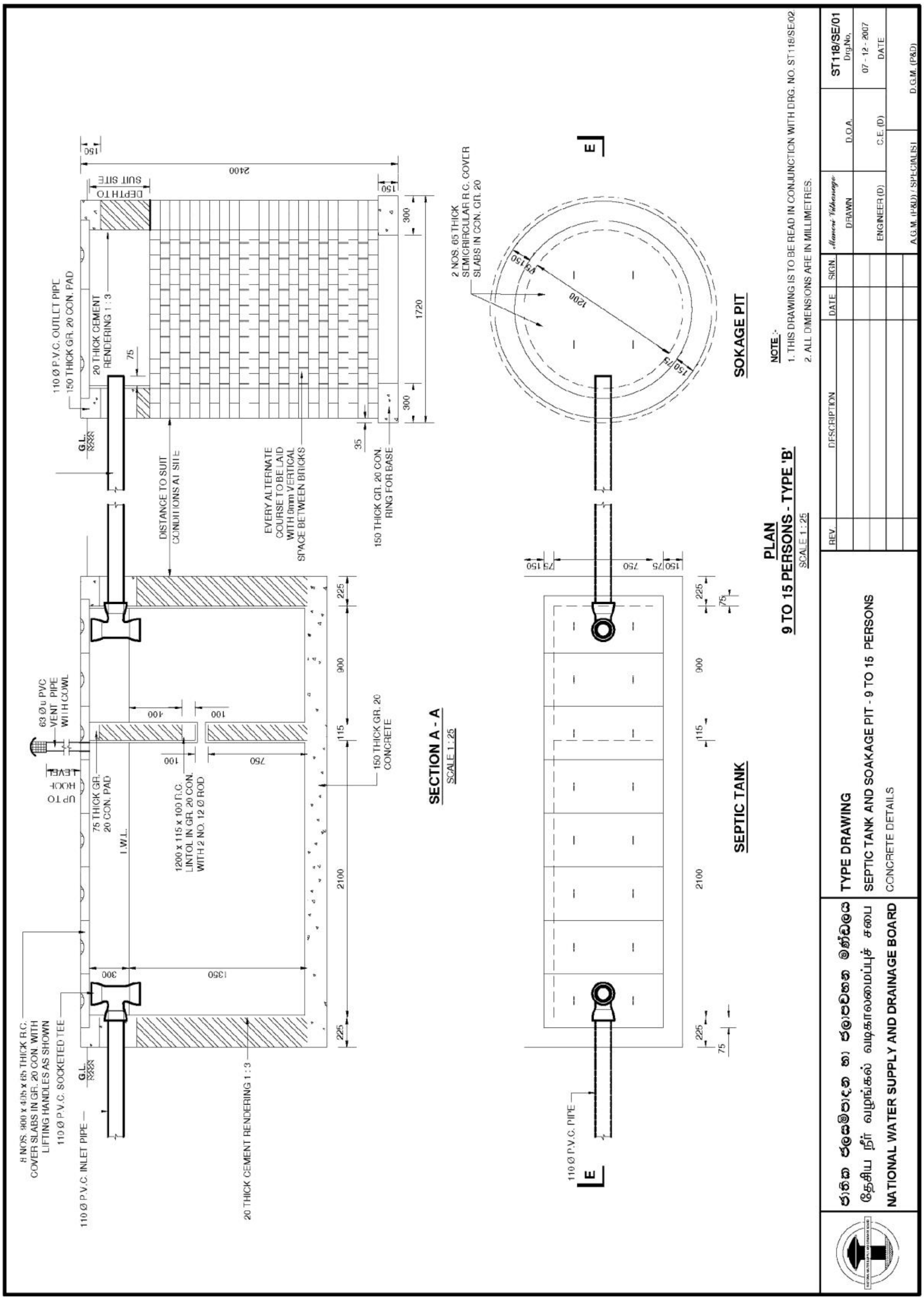
අජන්ත ගුණවර්ධන,
නාගරික කොමසාරිස්,
මහා නගර සභාව,
අනුරාධපුරය.

නාගරික කොමසාරිස්
මහා නගර සභාව
අනුරාධපුර

නගරාධිපති நகரபிதா Mayor : 025-2222434 077-7481745
නාගරික කොමසාරිස් ஆணையாளர் Commissioner : 025-2222276 071-5327127
කාර්යාලය காரியாலயம் Office : 025-2222275
ෆැක්ස්/පෙක්ස/Fax : 025-2222434/025-2222276
mca.planning@gmail.com

APPENDIX 6: General Layout of Septic Tank




SECTION A - A
SCALE 1 : 25
SEPTIC TANK
SOKAGE PIT
PLAN
9 TO 15 PERSONS - TYPE 'B'
SCALE 1 : 25
110 Ø P.V.C. INLET PIPE
110 Ø P.V.C. OUTLET PIPE
150 THICK GR. 20 CON. PAD
20 THICK CEMENT RENDERING 1 : 3
63 Ø u PVC VENT PIPE WITH COWL
75 THICK GR. 20 CON. PAD
I.W.L.
150 THICK GR. 20 CONCRETE
DISTANCE TO SUIT CONDITIONS AT SITE
EVERY ALTERNATE COURSE TO BE LAID WITH 6mm VERTICAL SPACE BETWEEN BRICKS
150 THICK GR. 20 CON. RING FOR BASE
2 NOS. 65 THICK SEMICIRCULAR R.C. COVER SLABS IN CON. GR. 20
110 Ø P.V.C. PIPE
NOTE :-
1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRG. NO. ST118/SE/02
2. ALL DIMENSIONS ARE IN MILLIMETRES.
NATIONAL WATER SUPPLY AND DRAINAGE BOARD
TYPE DRAWING
SEPTIC TANK AND SOAKAGE PIT - 9 TO 15 PERSONS
CONCRETE DETAILS
ST118/SE/01
Drg.No.
07 - 12 - 2007
DATE
DRAWN
ENGINEER (D)
C.E. (D)
D.G.M. (P&D)

APPENDIX 7: Detail of Project Costs and Annual Fund Requirement

1USD=	145	LKR	
1USD=	112	YEN	
1LKR	0.770	YEN	

Anuradhapura Master Plan Area = 1618 ha

	Item Description	Spec	Unit	Quantity	Unit Price		Amount		Total Amount	Total Amount
					L.C.	F.C.	L.C.	F.C.		
					LKR	JPY	LKR	JPY	LKR	JPY
1	**Construction Cost**									
A	**STP**									
A1	**STP**									
	Anuradhapura STP (Q=13,600m3/day)	About 2400 USD/m3	Ls	1			1,899,054,545	2,193,408,000	4,747,636,364	3,655,680,000
	Sub-total of A						**1,899,054,545**	**2,193,408,000**	**4,747,636,364**	**3,655,680,000**
B										
B1	**Trunk Sewer**									
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	344	2,800	3,800	963,000	1,307,000	2,660,000	2,049,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.0m	m	625	3,900	4,200	2,438,000	2,625,000	5,847,000	4,502,000
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	541	4,400	4,200	2,381,000	2,272,000	5,332,000	4,105,000
	Supply and install of HDPE OD225	Depth : not exceeding 3.0m	m	406	5,400	4,500	2,194,000	1,828,000	4,568,000	3,517,000
	Supply and install of HDPE OD225	Depth : not exceeding 3.5m	m	130	5,500	4,500	716,000	586,000	1,477,000	1,137,000
	Supply and install of HDPE OD280	Depth : not exceeding 1.5m	m	144	2,900	5,700	417,000	820,000	1,482,000	1,141,000
	Supply and install of HDPE OD280	Depth : not exceeding 2.0m	m	69	4,100	6,000	282,000	413,000	818,000	630,000
	Supply and install of HDPE OD315	Depth : not exceeding 3.5m	m	24	5,400	7,600	127,000	179,000	359,000	277,000
	Supply and install of HDPE OD355	Depth : not exceeding 1.5m	m	209	3,100	8,700	647,000	1,816,000	3,005,000	2,314,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.0m	m	147	4,200	9,000	616,000	1,320,000	2,330,000	1,794,000
	Supply and install of HDPE OD355	Depth : not exceeding 2.5m	m	79	4,400	9,000	350,000	715,000	1,279,000	985,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.0m	m	98	5,400	9,300	530,000	912,000	1,714,000	1,320,000
	Supply and install of HDPE OD355	Depth : not exceeding 3.5m	m	45	5,400	9,300	245,000	423,000	794,000	612,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 1.5m	m	583	3,800	22,700	2,217,000	13,243,000	19,416,000	14,950,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.0m	m	352	4,900	23,000	1,726,000	8,103,000	12,249,000	9,432,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 2.5m	m	51	7,300	23,000	373,000	1,174,000	1,898,000	1,461,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 3.5m	m	28	8,700	23,400	247,000	664,000	1,109,000	854,000
	Supply and install of GRP/FRP ND400	Depth : not exceeding 4.5m	m	19	10,100	23,700	191,000	447,000	772,000	594,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 1.5m	m	166	5,000	28,300	829,000	4,692,000	6,923,000	5,330,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 2.0m	m	58	6,500	28,800	376,000	1,667,000	2,541,000	1,957,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 2.5m	m	30	9,300	28,800	281,000	870,000	1,411,000	1,086,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 3.0m	m	313	10,900	29,200	3,415,000	9,149,000	15,297,000	11,779,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 3.5m	m	166	11,100	29,200	1,843,000	4,848,000	8,139,000	6,267,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 4.0m	m	38	12,700	29,600	489,000	1,139,000	1,968,000	1,516,000
	Supply and install of GRP/FRP ND450	Depth : not exceeding 4.5m	m	214	13,000	29,600	2,776,000	6,321,000	10,985,000	8,459,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 1.5m	m	220	5,800	28,300	1,276,000	6,228,000	9,364,000	7,211,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.0m	m	127	7,400	28,800	940,000	3,657,000	5,689,000	4,381,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 2.5m	m	348	8,000	28,800	2,782,000	10,016,000	15,790,000	12,158,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 3.0m	m	396	12,800	29,200	5,068,000	11,561,000	20,082,000	15,463,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 3.5m	m	190	13,100	29,200	2,492,000	5,555,000	9,706,000	7,474,000
	Supply and install of GRP/FRP ND500	Depth : not exceeding 4.0m	m	148	14,700	29,600	2,174,000	4,377,000	7,858,000	6,051,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 1.5m	m	425	6,400	34,000	2,720,000	14,452,000	21,489,000	16,546,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.0m	m	66	7,800	34,500	513,000	2,267,000	3,457,000	2,662,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 2.5m	m	34	12,000	34,500	402,000	1,157,000	1,905,000	1,467,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 3.5m	m	74	14,000	34,900	1,031,000	2,571,000	4,370,000	3,365,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.0m	m	67	15,700	35,300	1,053,000	2,369,000	4,130,000	3,180,000
	Supply and install of GRP/FRP ND600	Depth : not exceeding 4.5m	m	152	16,200	35,300	2,462,000	5,365,000	9,430,000	7,261,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 1.5m	m	720	8,200	42,400	5,907,000	30,545,000	45,576,000	35,093,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 2.0m	m	617	10,100	43,000	6,232,000	26,531,000	40,688,000	31,330,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 2.5m	m	771	16,800	43,600	12,955,000	33,620,000	56,617,000	43,595,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 3.0m	m	860	19,000	44,200	16,346,000	38,025,000	65,729,000	50,611,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 3.5m	m	734	21,300	44,800	15,644,000	32,903,000	58,375,000	44,949,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 4.0m	m	256	19,700	44,200	5,036,000	11,300,000	19,711,000	15,178,000
	Supply and install of GRP/FRP ND700	Depth : not exceeding 4.5m	m	146	20,200	44,200	2,945,000	6,445,000	11,315,000	8,713,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 2.5m	m	66	17,300	62,000	1,135,000	4,067,000	6,417,000	4,941,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 3.0m	m	107	19,800	62,600	2,128,000	6,727,000	10,864,000	8,366,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 3.5m	m	457	20,300	62,600	9,278,000	28,612,000	46,436,000	35,756,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 4.0m	m	68	22,600	63,200	1,527,000	4,269,000	7,071,000	5,445,000
	Supply and install of GRP/FRP ND900	Depth : not exceeding 4.5m	m	163	23,200	63,200	3,789,000	10,322,000	17,194,000	13,240,000
	Supply and install of GRP/FRP ND1000	Depth : not exceeding 4.5m	m	39	25,600	102,400	1,009,000	4,036,000	6,251,000	4,813,000
	Supply and install of HDPE OD110	Depth : not exceeding 1.5m	m	1,677	600	1,000	1,006,000	1,677,000	3,184,000	2,452,000
	Supply and install of HDPE OD110	Depth : not exceeding 4.5m	m	144	2,000	1,000	288,000	144,000	475,000	366,000
	Supply and install of HDPE OD125	Depth : not exceeding 1.5m	m	792	600	1,200	475,000	951,000	1,710,000	1,317,000
	Supply and install of HDPE OD140	Depth : not exceeding 1.5m	m	545	600	1,500	327,000	818,000	1,389,000	1,070,000
	Supply and install of HDPE OD140	Depth : not exceeding 2.0m	m	30	700	1,500	21,000	45,000	79,000	61,000
	Supply and install of HDPE OD140	Depth : not exceeding 2.5m	m	22	1,700	1,500	37,000	33,000	80,000	61,000
	Supply and install of HDPE OD200	Depth : not exceeding 1.5m	m	1,071	800	3,300	857,000	3,536,000	5,449,000	4,196,000
	Supply and install of HDPE OD200	Depth : not exceeding 2.5m	m	181	1,600	3,300	289,000	596,000	1,063,000	819,000
	Supply and install of HDPE OD225	Depth : not exceeding 1.5m	m	149	900	3,700	134,000	552,000	851,000	655,000
	Supply and install of HDPE OD250	Depth : not exceeding 1.5m	m	375	900	4,800	337,000	1,800,000	2,675,000	2,059,000
	Supply and install of GRP/FRP ND600(PJ)	Depth : not exceeding 10m	m	300	38,500	379,302	11,565,000	113,935,000	159,533,000	122,840,000
	Supply and install of GRP/FRP ND700(PJ)	Depth : not exceeding 10m	m	347	40,600	479,710	14,102,000	166,627,000	230,501,000	177,486,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	23,450	2,000	0	46,901,000	0	46,901,000	36,114,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	23,450	4,910	0	115,142,000	0	115,142,000	88,659,000
B2	**Pump Station**									
	Manhole Type Pumping Station		pc	8	22,000,000	0	176,000,000	0	176,000,000	135,520,000
	Major Pumping Station		pc	0	570,000,000	0	0	0	0	0
	Sub-total of B						**500,994,000**	**665,224,000**	**1,364,919,000**	**1,050,992,000**
C	**Branch Sewer**									
C1										
	Supply and install of HDPE OD225	Depth : not exceeding 2.5m	m	242,700	4,400	4,200	1,067,880,000	1,019,340,000	2,391,698,000	1,841,608,000
	Temporary road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	320,364	2,000	0	640,728,000	0	640,728,000	493,361,000
	Permanent road reinstatementAsphalt concete	Add 10% of pipeline(W=1.2)	m2	320,364	4,910	0	1,572,987,000	0	1,572,987,000	1,211,200,000
	Manhole Type Pump		pc	14	1,000,000	6,930,000	14,000,000	97,020,000	140,000,000	107,800,000
	Sub-total of C						**3,295,595,000**	**1,116,360,000**	**4,745,413,000**	**3,653,969,000**
D	**House Connection**									
D1										
	House Connection		HH	13,725	100,000	0	1,372,500,000	0	1,372,500,000	1,056,825,000
	Sub-total of D						**1,372,500,000**	**0**	**1,372,500,000**	**1,056,825,000**
	Sub-total of 1						**7,068,143,545**	**3,974,992,000**	**12,230,468,364**	**9,417,466,000**
2	Administration cost						847,000,000	0	847,000,000	652,190,000
3	Consulting cost						465,000,000	1,022,000,000	1,792,273,000	1,380,050,000
4	Physical contingency for construction cost						438,000,000	218,000,000	721,117,000	555,260,000
5	Price escalation for construction cost						1,697,000,000	380,000,000	2,190,506,000	1,686,690,000
6	Land acquisition and compensation									
7	Interest during construction						0	114,000,000	148,052,000	114,000,000
8	Front-end Fee						0	26,000,000	33,766,000	26,000,000
9	Tax and duty						3,049,000,000	0	3,049,000,000	2,347,730,000
	Sub-total of (2-9)						**6,496,000,000**	**1,760,000,000**	**8,781,714,000**	**6,761,920,000**
	Total including Tax and Duty						**13,564,143,545**	**5,734,992,000**	**21,012,185,000**	**16,179,383,000**
	Total excluding Tax and Duty						**10,515,143,545**	**5,734,992,000**	**17,963,185,000**	**13,831,653,000**
	Eligible Portion (1, 3, 4, 5 and 7)						**9,668,143,545**	**5,708,992,000**	**17,082,419,000**	**13,153,463,000**
	Non-Eligible Portion (2, 6, 8 and 9)						**3,896,000,000**	**26,000,000**	**3,929,766,000**	**3,025,920,000**

APPENDIX 8: Detail of Annual Fund Requirement

Annual Fund Requirement of Anuradhapura MC

Base Year for Cost Estimation:	Jan, 2017				FC & Total:	million JPY
Exchange Rates	LKR = JPY		0.77		LC :	million LKR
Price Escalation:	FC:	1.6%	LC:	3.8%		
Physical Contingency	5%					
Physical Contingency for Consultant	5%					

Annual Fund Requirement of Anuradhapura MC

Item	Total FC	Total LC	Total Total	2017 FC	2017 LC	2017 Total	2018 FC	2018 LC	2018 Total	2019 FC	2019 LC	2019 Total	2020 FC	2020 LC	2020 Total
A. ELIGIBLE PORTION															
I) Procurement / Construction	4,573	9,203	11,659	0	0	0	0	0	0	0	0	0	0	0	0
STP	2,193	1,899	3,656	0	0	0	0	0	0	0	0	0	0	0	0
Trunk Sewer	665	501	1,051	0	0	0	0	0	0	0	0	0	0	0	0
Branch Sewer	1,116	3,296	3,654	0	0	0	0	0	0	0	0	0	0	0	0
House Connection	0	1,373	1,057	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	3,975	7,068	9,417	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	380	1,697	1,686	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	218	438	555	0	0	0	0	0	0	0	0	0	0	0	0
II) Consulting services	1,022	465	1,380	0	0	0	0	0	0	217	83	280	166	60	212
Base cost	907	372	1,194	0	0	0	0	0	0	200	73	256	151	51	190
Price escalation	66	71	121	0	0	0	0	0	0	6	6	11	7	6	12
Physical contingency	49	22	66	0	0	0	0	0	0	10	4	13	8	3	10
Total (I + II)	5,595	9,668	13,039	0	0	0	0	0	0	217	83	280	166	60	212
B. NON ELIGIBLE PORTION															
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	847	652	0	0	0	0	0	0	0	18	14	0	14	11
d VAT	0	2,540	1,956	0	0	0	0	0	0	0	55	42	0	41	32
e Import Tax	0	509	392	0	0	0	0	0	0	0	20	15	0	15	12
Total (a+b+c+d+e)	0	3,895	2,999	0	0	0	0	0	0	0	92	71	0	70	54
TOTAL (A+B)	5,595	13,563	16,038	0	0	0	0	0	0	217	175	351	166	130	266
C. Interest during Construction	114	0	114	0	0	0	0	0	0	0	0	0	0	0	0
Interest during Construction(Const.)	113	0	113	0	0	0	0	0	0	0	0	0	0	0	0
Interest during Construction (Consul.)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	26	0	26	0	0	0	0	0	0	26	0	26	0	0	0
GRAND TOTAL (A+B+C+D)	5,735	13,563	16,179	0	0	0	0	0	0	243	175	378	166	130	267
E. JICA finance portion incl. IDC (A + C)	5,709	9,668	13,153	0	0	0	0	0	0	217	83	280	166	60	212

Item	2021 FC	2021 LC	2021 Total	2022 FC	2022 LC	2022 Total	2023 FC	2023 LC	2023 Total	2024 FC	2024 LC	2024 Total
A. ELIGIBLE PORTION												
I) Procurement / Construction	794	1,538	1,979	1,162	2,300	2,933	1,180	2,387	3,018	1,199	2,478	3,107
STP	392	339	653	564	488	940	564	488	940	564	488	940
Trunk Sewer	119	89	188	171	129	270	171	129	270	171	129	270
Branch Sewer	199	588	652	287	847	940	287	847	940	287	847	940
House Connection	0	245	189	0	353	272	0	353	272	0	353	272
Base cost for JICA financing	710	1,262	1,682	1,022	1,818	2,422	1,022	1,818	2,422	1,022	1,818	2,422
Price escalation	47	203	203	84	373	371	102	456	453	120	542	538
Physical contingency	38	73	94	55	110	140	56	114	144	57	118	148
II) Consulting services	130	50	169	164	81	227	143	82	206	202	109	286
Base cost	116	41	148	145	64	194	124	62	172	172	80	233
Price escalation	8	7	13	12	13	22	12	16	24	20	24	39
Physical contingency	6	2	8	8	4	11	7	4	10	10	5	14
Total (I + II)	924	1,589	2,148	1,326	2,381	3,159	1,324	2,469	3,224	1,401	2,587	3,393
B. NON ELIGIBLE PORTION												
a Procurement / Construction	0	0	0	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0	0	0	0
c Administration cost	0	139	107	0	205	158	0	209	161	0	220	170
d VAT	0	418	322	0	615	474	0	628	484	0	661	509
e Import Tax	0	84	65	0	121	93	0	120	93	0	127	98
Total (a+b+c+d+e)	0	642	494	0	941	725	0	958	738	0	1,009	777
TOTAL (A+B)	924	2,231	2,642	1,326	3,322	3,884	1,324	3,427	3,962	1,401	3,595	4,169
C. Interest during Construction	6	0	6	15	0	15	24	0	24	33	0	33
Interest during Construction(Const.)	6	0	6	15	0	15	24	0	24	33	0	33
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0	0	0	0
D. Front End Fee	0	0	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	930	2,231	2,648	1,341	3,322	3,899	1,347	3,427	3,986	1,434	3,595	4,203
E. JICA finance portion incl. IDC (A + C)	930	1,589	2,154	1,341	2,381	3,174	1,347	2,469	3,248	1,434	2,587	3,426

Item	2025 FC	2025 LC	2025 Total	2026 FC	2026 LC	2026 Total	2027 FC	2027 LC	2027 Total
A. ELIGIBLE PORTION									
I) Procurement / Construction	237	500	622	0	0	0	0	0	0
STP	110	95	183	0	0	0	0	0	0
Trunk Sewer	33	25	53	0	0	0	0	0	0
Branch Sewer	56	165	183	0	0	0	0	0	0
House Connection	0	69	53	0	0	0	0	0	0
Base cost for JICA financing	199	353	471	0	0	0	0	0	0
Price escalation	27	123	122	0	0	0	0	0	0
Physical contingency	11	24	30	0	0	0	0	0	0
II) Consulting services	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0
Total (I + II)	237	500	622	0	0	0	0	0	0
B. NON ELIGIBLE PORTION									
a Procurement / Construction	0	0	0	0	0	0	0	0	0
Base cost for JICA financing	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0
b Land Acquisition	0	0	0	0	0	0	0	0	0
Base cost	0	0	0	0	0	0	0	0	0
Price escalation	0	0	0	0	0	0	0	0	0
Physical contingency	0	0	0	0	0	0	0	0	0
c Administration cost	0	40	31	0	0	0	0	0	0
d VAT	0	121	93	0	0	0	0	0	0
e Import Tax	0	22	17	0	0	0	0	0	0
Total (a+b+c+d+e)	0	183	141	0	0	0	0	0	0
TOTAL (A+B)	237	683	763	0	0	0	0	0	0
C. Interest during Construction	35	0	35	0	0	0	0	0	0
Interest during Construction(Const.)	35	0	35	0	0	0	0	0	0
Interest during Construction (Consul.)	0	0	0	0	0	0	0	0	0
D. Front End Fee	0	0	0	0	0	0	0	0	0
GRAND TOTAL (A+B+C+D)	272	683	798	0	0	0	0	0	0
E. JICA finance portion incl. IDC (A + C)	272	500	657	0	0	0	0	0	0

APPENDIX 9: Breakdown of Operating Expenditure

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**

Soysapura	Treatment Plant and Network	
Present, Inflow, 5000m3/d (RS/m3/d/year)	39.13	LKR/m3/day
Capacity, 17000m3/d (RS/m3/d/year)		

			Total Amount (LKR)
Sri Jayawardanapura Kotte MC	35000	m3/d -> 35000 x 39.13 x 365 =	499,876,455
Anuradhapura MC	14000	m3/d -> 1400 x 39.13 x 365 =	199,950,582
Badulla MC	4000	m3/d -> 4000 x 39.13 x 365 =	57,128,738
Nuwara Eliya MC	4700	m3/d -> 4700 x 39.13 x 365 =	67,126,267
Dehiwala-Mt Lavinia MC	20000	m3/d -> 20000 x 39.13 x 365 =	285,643,689

APPENDIX 10: Regulations and Organizations Related to ESC

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 and 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

1.2 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.

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.

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.

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.

Mahaweli Authority of Sri Lanka (MASL)

As the responsible agency for Mahaweli River, the 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.

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.

Department of Archaeology
It is the state agency responsible for conservation of archaeological artefacts 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.

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.

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.

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.

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.

1.3 EIA Procedure Under NEA

Environmental Impact Assessment (EIA) is the general process of finding the impacts on natural and social environments and proposing preventive or minimising measures to enhance positive impacts. The broader legal framework for the EIA process in Sri Lanka was laid down by the amendments made to NEA in 1988 through the National Environmental (Amendment) Act No. 56 of 1988. The provision relating to EIA is contained in Part IV C of the National Environmental Act. Regulations pertaining to this process are published in Government Gazette Extraordinary No.772/72 dated 24th June 1993 and in several subsequent amendments. The procedure stipulated in the Act for the approval of projects provides for the submission of two types of reports: Initial Environmental Examination (IEE) report or EIA report. Such reports are required in respect of "prescribed projects" included in EIA regulations.

The EIA process is implemented through designated Project Approving Agencies (PAAs). A list of line ministries and agencies that are designated as PAAs is depicted in Government Gazette (Extra Ordinary) No. 859/14 dated February 13, 1995. The PAA's are basically responsible for the administration of the EIA process under NEA, which includes but not limited to:

- Subject all prescribed projects to IEE/EIA requirements
- Ensure and guide proper scoping process for IEEs/EIAs
- Draft Term of Reference (ToR) for IEEs/EIAs
- Establish, conduct and participate in Technical Evaluation and reviews during and after IEE/EIA report preparation
- Ensure public notification of availability of EIA for public review
- Evaluate the comments received from the public and other agencies
- Establish appropriate mitigatory measures and ensure that they are incorporated in the approval conditions
- Ensure implementation of the conditions through effective monitoring
- Obtain concurrence of the CEA prior to taking decision on the EIA report.

In order to obtain environmental approval for a prescribed project, the project proponent should submit either an IEE report or an EIA report as required by the PAA. Determination of whether an IEE or EIA is required for a proposed prescribed project is based on an assessment of the likely significance of the impacts of the proposed project on the environment. EIAs, rather than IEEs, are required for prescribed projects that are

likely to have significant impacts. Determination of Significance is based on the consideration of both context and intensity of the potential impacts.

In the event that an EIA is required, the PAA in consultation with CEA is responsible for subjecting the preliminary information submitted by the project proponent to environmental scoping, in order to set the Terms of Reference (TOR) for the EIA within 30 days from the date of acknowledging receipt of the preliminary information. The TOR is prepared by a scoping committee comprising experts in the relevant field, appointed by the PAA. In developing the TOR, the EIA regulations provide for the PAA to consider the views of state agencies and the public.

Upon submission of the EIA report by the project proponent, the PAA is required to determine whether issues referred to in the TOR have been addressed and notify the proponent of any inadequacies within 14 days. In the event any inadequacies are identified, the project proponent is required to make necessary amendments and resubmit the report. Once accepted, in addition to the EIA being forwarded to the CEA by the PAA, notice is also placed in a national newspaper published daily in Sinhala, Tamil and English languages inviting the public to make written comments, if any, to the PAA within 30 days from the date of first appearance of the notice. According to the legislation, public consultation is mandatory is only at this stage of the EIA process. Informal consultation with Non-Governmental Organisations (NGOs), interested groups and civil society may occur during early stages of environmental studies depending on the type of project and public interest in the project. The notification would specify the times and places at which the EIA would be available to the public. As a minimum the report would be available at the CEA, PAA and in appropriate government agencies in the project area. The environmental regulations have provisions for public hearings on the project although it is not mandatory. The PAA can use its discretion and hold a public hearing if it would be in the interest of the public. The PAA is required to forward all comments, either written or raised during any public hearing, to the project proponent for review and response within 6 days of completion of the public comment period. The project proponent is required to respond to all such comments in writing to the PAA.

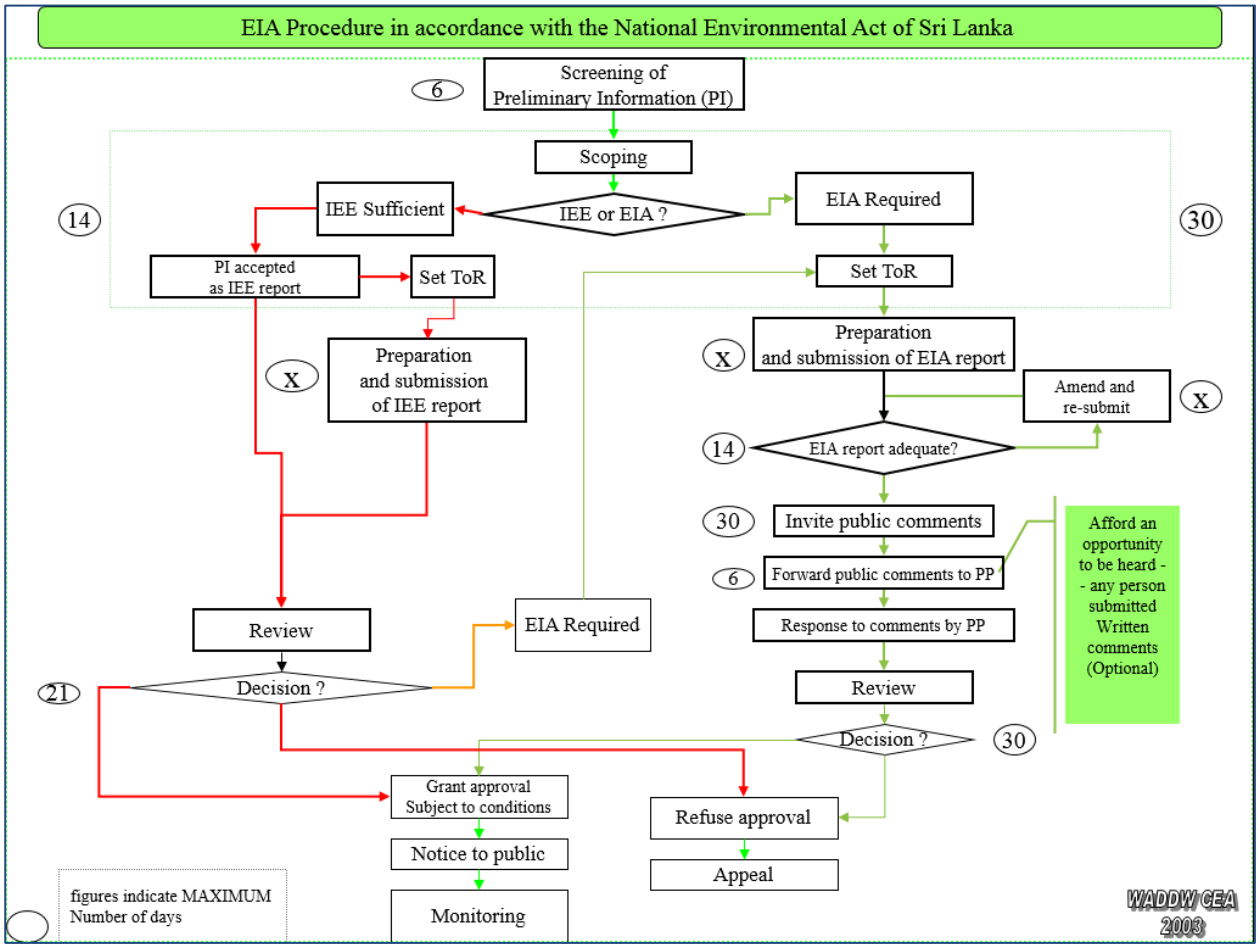
The Technical Evaluation Committee (TEC) appointed by the PAA would then evaluate the EIA and require the project proponent to respond to any queries raised by the TEC. The TEC would also evaluate the adequacy of the project proponent's response to any comments raised during the public comments period. Upon completion of the evaluation of the TEC, the PAA with the concurrence of the CEA would either grant approval for the implementation of the proposed project subject to specified conditions or refuse approval for implementation of the project, with reasons for doing so. This decision must be made within 30 days of the receipt of responses from the project proponent. The PAA is required to specify a period within which the approved project should be completed. In the event the proponent is unable to complete the project within the specified period, written permission for an extension has to be obtained from the PAA, 30 days prior to the expiration date.

Upon review of the preliminary information provided by the project proponent (PP), if the PAA determines that the project would have no long-term adverse environmental impacts, an IEE would be considered adequate. Under such circumstances, the proponent will be required to submit a detailed IEE for review and approval by the PAA. The IEE will identify potential environmental and social issues and the complexity of possible remedial actions. Upon reviewing the IEE, if the TEC identifies any substantial environmental issues that may arise as a result of the proposed project, the proponent will be required to undertake a detailed EIA. The IEE review process is similar to the EIA review process, except for the level of detail and analysis involved, which is proportionate to the anticipated environmental and social impacts. The IEE is not required by law to be opened for the public for comments and does not go through the public consultation process.

Projects Subject to EIA

According to the EIA regulations, "Sewerage Treatment" is not a prescribed activity requiring an IEE/EIA. However, "Laying of gas and liquid (excluding water) transfer pipelines of length exceeding 1 kilometre" is a prescriber activity. However, any project or undertaking irrespective of their magnitude, if located partly or wholly within an environmental sensitive area, will become a prescribed project requiring approval under the EIA regulations. Environmental sensitive areas are defined as;

- Any erodible area declared under the Soil Conservation Act (1951, 1953);
- Any Flood Area declared under the Flood Protection Ordinance (1924, 1955) and any Flood Protection Area declared under the Sri Lanka Land Reclamation and Development Corporation Act (1968, 1982);
- 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 (1965);
- Any area declared under the Botanic Gardens Ordinance (1928, 1973);
- Areas within, or less than 100m from the boundaries of any area declared under the National Heritage and Wilderness Act (1988): the Forest Ordinance;
- Areas within, or less than 100m from the boundaries of any area declared as a Sanctuary under the Fauna and Flora Protection Ordinance (1937);
- Areas within, or less than 100m from the high flood level contour of a public lake as defined by the Crown Lands Ordinance (1947, 1949, 1956) including those declared under Section 71 of the Ordinance;
- Areas 60m or less from the bank of a public stream as defined in the Crown Lands Ordinance, with a width of more than 25m at any point.



Source: Central Environmental Authority

Figure A8-1: Procedure for obtaining Environmental Clearance

APPENDIX 11: Comparison with JICA Guidelines

There are some gaps between the current Sri Lankan Regulations and JICA Guideline, but they are rather insignificant. The governmental laws pay less attention to the social impacts than JICA Guidelines. Thus, the preparing of the Resettlement Action Plan (RAP) is not mandatory. The 30 day term for public comment that the government stipulates differs greatly from the recommended 120-day JICA policy. Although JICA's guidelines suggest that the project proponents should disclose information related to it, under the Sri Lanka's legislation, the responsibility of information disclosure is incurred not by the project proponent but by the PAA.

Comparison of JICA and Sri Lankan Policies and Guidelines

Item	JICA Guidelines	Sri Lankan Policies and Regulations
EIA / IEE Process	At the scoping stage and EIA draft report stage, the project proponent has to hold stakeholder meetings in the area to explain the contents. The comments should be reflected in the plan. EIA reports / RAP will be disclosed 120 days prior to concluding the agreement documents.	Stakeholders are provided an opportunity to comment in the scoping stage. The stakeholders are usually related governmental organizations (not local community/general public). The stakeholders and public can submit queries and comments on the EIA draft report. The comments should be addressed in the final report. EIA reports will be opened for 30 days for public comments.
Environmental Checklist	A check list is provided for each sector. These items should be included in the EIA report.	The PAA shall prepare terms of reference for an EIA. No specific checklist is provided.
Involuntary Resettlement Process	The project proponent is obliged to prepare a RAP. If number of resettled household is small (e.g. one household), the RAP can be simplified one. The RAP is prepared as part of the EIA Report.	In case that the number of resettled households is 20 or more, the NIRP requires a RAP.
Compensation for land resettlement	Full replacement cost must be applied as much as possible.	The Land Acquisition Act (LAA) provides for the payment of compensation on the basis of "market value" which is defined as the "amount which the land might be expected to have realized if sold by a willing seller in the open market as a separate entity". The National Involuntary Resettlement Policy (NIRP) recommends that compensation for loss of land, structures, other assets and income should be based on full replacement cost and should be paid promptly together with transaction costs.
Compensation for non-registered residents	All residents before the cut-off-date are eligible.	The LAA does not have any provisions on this issue. The NIRP recommends that affected persons who do not have documented title to land should receive fair and just treatment.
Grievance redress mechanism	The project proponent is obliged to have a grievance redness mechanism.	The LAA provides a limited grievance redress mechanism whereby certain grievances of the affected persons relating to compensation can be referred to the Board of Review established under the LAA. The NIRP recommends the establishment of an internal monitoring system by project executing agencies to monitor the implementation of RAPs and handling of grievances. Grievances redress mechanism formally instituted by the

Item	JICA Guidelines	Sri Lankan Policies and Regulations
		project authorities with the support of the Divisional Secretaries of the project area.

APPENDIX 12: International Commitments related to ESC

International Commitments

A list of Environment-related International Conventions, Protocols, and Treaties is given in Table.

Table: List of Environment-related International Conventions, Protocols, and Treaties

No	Environment-Related International Conventions, Protocols, and Treaties
1	International Plant Protection Convention (Rome, 1951)
2	Plant Protection Agreement for the South East Asia and Pacific Region (Rome, 1956)
3	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)
4	Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)
5	Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973)
6	Convention on Conservation of Migratory Species (Bonn, 1979)
7	Vienna Convention for the Protection of the Ozone Layer (Vienna, 1985)
8	Montreal Protocol on Substances that Deplete the ozone Layer (Montreal 1987)
9	United Nations Framework Convention on Climate Change (New York, 1992)
10	Convention on Biological Diversity (Rio De Janeiro, 1992)
11	International Convention to Combat Desertification (Paris 1994)
12	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris, 1994)
13	Kyoto protocol to the United Nations Framework Convention on Climate Change (Kyoto, 1997)
14	Cartagena protocol on Biosafety to the Convention on Biological Diversity (Cartagena, 2003)
15	Convention on Conservation of Migratory Species (Bonn, 1979)

APPENDIX 13: Record of Consultation with Public and Authorities

Record of Meeting/Discussion

Date:	02/05/2016	**Time**:	from	10:30	to	12:00	
Venue:	CEA Director of EIA office						

Attendants

Name	Position	Department/Organization
Name		
Kanthi De Silva	Director of EIA	CEA
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
Ranjith Warusamana	Deputy Team Leater (Local expert)	JET (Local expert)
Ms. KPP Dharmasena	Chief Engineerg (P&D - Sewerage)	NWSDB

Main Subject:
1. Verify CEA requirments for environmental and social studies at each stage of the project
2. Acquire documentation/guidelines related to requirements

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation). JET understanding is environmental studies are required at each stage, as follows 1) National M/P: SEA required 2) Priority Cities M/P: IEE required 3) F/S for final two cities: EIA or IEE required.	
2	CEA response: SEA is not required for any stage. SEA is performed generally to determine the type of project to select. Since the current project is already defined as a sewerage project, no study is required. Furthermore, any environmental evaluation undertaken at this stage will not be considered or accepted as an SEA by CEA. There is no law or procedure for SEA.	
3	Requirements for IEE/EIA: IEE/EIA will NOT be required at the Cities M/P stage. EIA will be required for approval of the F/S for each of the selected cities. The TOR for the EIA can be issued based on the Project Proposal submitted to CEA at the the Cities M/P stage for preparation of coming EIA for the F/S.	
4	Minitry of Land is responsible for the Resettlement Action Plan.	
	Documents: SEA for water reources and irrigation development in Sri Lanka, TOR	

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

Date:	02/11/2016	**Time**:	from	15:30	to	16:30	
Venue:	CEJ office						

Attendants

Name	Position	Department/Organization
Name		
Mr. Hemantha Withanage	Executive director	CEJ
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
WADD Wijesooriya	Director	EMAC
Buddhika De Silva	Director	EMAC

Main Subject:
1. To make known the JET's intention to perform M/P for the Project, and its contents.
2. To collect thoughts and opinions regarding the Project and apply them for its implementation

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation).	
2	CEJ: Kaduwela may be an interesting location for sewerage project. a) High domestic sewerage needs: direct dumping of domestic sewerage to Kelani River, complaints of itchiness and reactions to bathing in river, etc b) Highly industrialized: industrial effluent and solid waste in Kelani river c) Water treatment plant located downstream is affected by pollution at Kaduwela. Many other water and land pollution issues were discussed	
3	CEJ and JET will further consult each other as the Project progresses.	
4		
	Documents: Kelani River Edatabase.pdf Content-Kelani River industrial pollution 2015 Kelani River industrial pollution	

Actions to be taken	by Whom	until When

Record of Meeting/Discussion

Date:	02/11/2016	**Time**:	from	14:00	to	15:00	
Venue:	Office of Professor Jayathunge, Faculty of Science, University of Colombo						

Attendants

Name	Position	Department/Organization
Name		
Prof. Amaramalee Jayathunge	Prof. Zoology	Faculty of Science, University of Colombo
JICA Experts (Name)		
Koji KIMURA	Deputy Team Leader	JET
Yudai TADAKI	Environmental and Social Consid.	JET
WADD Wijesooriya	Director	EMAC
Buddhika De Silva	Director	EMAC

Main Subject:
1. To make known the JET's intention to perform M/P for the Project, and its contents.
2. To collect thoughts and opinions regarding the Project and apply them for its implementation

Topic	Contents of Discussion	Conclusion
1	By JET: General introduction of current project (Presented: IC/R presentation).	
2	Prof. Jayathunge's response: Odor issues should be controlled. The extent of industrial and medical waste water included in the study, or treated at the waste water treatment plant should be discussed.	
3	Prof. Jayathunge will be leaving the department due to retirement. She will appoint others to participate in the consultations, from chemistry and biology backgrounds.	
4		

Actions to be taken	by Whom	until When

APPENDIX 14: Draft EMP and EMoP

Mitigation Measures

Mitigation measures proposed with respect to the stages of: (i) planning and design (ii) construction and (iii) operation is given in Table 1.

Table 1: Environmental Impact – Mitigation Matrix

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Planning and Design Phase			
Site Selection	▪ Site selection process shall avoid land acquisition and involuntary resettlement where possible, including impacts on vulnerable persons. ▪ Locate sewage pipelines within the right of ways of roads to eliminate acquisition of new land. ▪ Avoid locating sewage pumping stations and wet wells within close proximity of any inhabited areas, sensitive sites such as hospitals, schools, temples, etc. to minimize nuisance impacts from odor, rodents, etc. as much as possible	Consultant/ NWSDB	NWSDB
Overall Environmental Management	▪ An Environmental Management Plan shall be prepared and implemented.	Consultant/ NWSDB	NWSDB
Discharge standards	▪ The design will specify the guidelines for the proper handling and disposal of waste to predetermined authorized disposal sites;	Consultant/ NWSDB	NWSDB
Archaeological resources	▪ Consult the relevant records of national and/or local archaeological agencies regarding the archaeological potential of proposed sites of STP, pumping stations, and main sewers, to ensure that these are located in areas where there is a low risk of chance finds.	Consultant/ NWSDB	NWSDB
Public utilities	▪ Telephone lines, electric poles and wires, and water pipes (old) existing within right-of-way (ROW) require shifting without disruption to services.	Consultant/ NWSDB	NWSDB
Traffic	▪ In order to limit the disruption to the neighborhood and traffic flow, coordinate with NWSDB to provide guidance to the organization of construction works. ▪ The design will specify the handling and transportation of construction materials and equipment.	Consultant/ NWSDB	NWSDB
Safety	▪ The design will include guidelines for site safety which will include specific requirements for physical division (fence), where necessary, of the construction site from passing pedestrians, children at play, vehicles, and any other people at risk. ▪ The design will include guidelines for workers' safety on site and the safety of visitors. Bills of quantities and technical description of works will include needed safety equipment.	Consultant/ NWSDB	NWSDB
Construction Phase			
Soil erosion and sedimentation	▪ Careful planning of construction activities that lead to heavy erosion, to avoid heavy rainy seasons ▪ Remove waste soil as soon as it is excavated, by loading directly onto trucks; ▪ The work, permanent or temporary shall consist of measures to control soil erosion, sedimentation and water pollution. Typical measures include the use of berms, dikes, sediment basins, fiber mats, mulches, grasses, slope drains and other devices. ▪ Adequate compaction of filled surfaces on completion and progressive re-vegetation of all disturbed areas as quickly as possible ▪ Protection of drainage channels with berms (i.e. ridge or embankment bordering channel) to prevent overspill ▪ Sedimentation traps will be constructed to reduce suspended solids before water is discharged to water bodies where applicable. ▪ All debris and residual spoil material including any excess earth will be disposed only at designated locations. ▪ The debris and spoil material will be disposed in such a manner that (i) watercourses and drainage paths are not blocked; (ii) the disposed material will not be washed away by floods and (iii) will not be a nuisance to the public.	Contractor	Consultant/ NWSDB
Transport of earth material	▪ Vehicles will be properly maintained to ensure the good running conditions and those which are not in suitable condition will be replaced. ▪ Provide covers during transportation	Contractor	Consultant/ NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Dust Control	▪ Enclosing or covering the construction site in order to control the dust dispersion. ▪ Protecting stockpiles from water and wind erosion; ▪ Using a water truck for dust suppression on all exposed areas ▪ Establishing and enforcing vehicle speed limits to minimize dust generation; ▪ Use tarpaulins to cover loose material when transported to and from the site. ▪ Locating stockpiles away from sensitive receptors; ▪ Loaded haul trucks travelling to and from the site having loads leveled to avoid spillage; ▪ Carrying out progressive rehabilitation of cleared land;	Contractor	Consultant/ NWSDB
Burrow pits	▪ Eligible contractor/s who are operating burrow pits with necessary approvals / permits, will only be selected. ▪ Noise, dust and related safety issues during loading, transportation and unloading will be controlled to meet` the standards and norms	Contractor	Consultant/ NWSDB
Construction Waste Disposal	▪ System to collect waste cement slurry will be provided to avoid contamination of drainage paths. ▪ Wastewater from washing of equipment used for concrete mixing and transporting of concrete will be disposed safely. ▪ All discarded and used oil and grease will be collected, stored and disposed (reuse / sell). ▪ All potentially water polluting chemicals and oils will be stored (a) at locations sufficiently away from watercourses and storm water drainage paths and (b) in a manner that would minimize chances of spillage. ▪ Minimize the oil and chemical spillages during operation and properly maintain the equipment and machinery. ▪ Debris and spoil will be disposed of only to designated places in such a manner that (i) waterways and drainage paths are not blocked, and (ii) the disposed material will not be washed away by heavy storm water flows.	Contractor	Consultant/ NWSDB
Drainage issues	▪ STP site should be located on the high ground to avoid water ingress ▪ Natural drain paths should not be disturbed during any construction activity	Contractor	Consultant/ NWSDB
Noise and vibration	▪ Temporary noise barriers / screens will be placed. ▪ All construction work will be carried out during day time as much as possible and work will be stopped after 6 pm. ▪ Workers involved in high noise generating activities (such as compacting, concrete/cement mixing operations using the mixers) and handling high noise generating machinery and equipment will be provided with ear plugs or mufflers. ▪ To the extent possible, attempts will be made to use equipment and machinery that produce low noise levels ▪ Proper and regular maintenance and/or servicing of equipment and machinery will be carried out.	Contractor	Consultant/ NWS&DB
	Operational phase		
Impacts on Water Resources	▪ Prevent seepage of polluted water to the ground by applying suitable lining for the ponds, raise the levels of the site and the tanks etc as applicable. ▪ Establish the STP on a sufficient high ground to avoid the flood impact. ▪ Avoid spillages of septage during operation – specially during unloading - and take precautionary measures to prevent mixing septage with storm water drainage system. ▪ As a precautionary step, it is proposed to monitor the ground water quality in the area. ▪ Ensure the disposal of treated effluent to a reed bed (artificial wet-land) with species which suit the climatic and coastal conditions of the area. ▪ Ensure the necessary effluent quality for disposal to inland waters	NWS&DB / MC	NWS&DB / MC / Consultant
Odor from STP	▪ Shielding of the unloading bay to an extend to prevent odorous gases being blown away by the wind ▪ Hydraulic arrangements that would minimize agitation of sewage during the release to the treatment system ▪ Keeping much of the screen channel close to prevent release of gases to air ▪ Establish and properly maintain a thick green belt along the STP site and pumping station where applicable.	NWS&DB / MMC	MMC / NWSDB

Environmental Impact / Issue	Mitigation Measure	Implementing Organization	Responsible Organization
Sludge disposal	▪ Use dewatered sludge as fertilizer. ▪ It is recommended that the sludge be disposed at suitable site such as coconut land or suitable plantation land or through burial in to dug pits.	NWS&DB / MMC	MMC / NWSDB

DRAFT ENVIRONMENTAL MONITORING PLAN

Objective Of Environmental Monitoring Plan

In order to fulfil the following objectives an appropriate Environmental Monitoring Programme (EMoP) will be carried out.

- Check the implementation of mitigatory measures to ensure whether they are in conformity with the requirements
- Ensure that the impact does not exceed legal standards
- Provide timely warnings of potential environmental damages

The EMoP characterizes the proposed mitigation and monitoring actions as a set of tasks. In the EMoP the specific responsibilities on task implementation on the project proponent, the contractor(s), and the regulatory agency (agencies) are assigned. These tasks should be implemented within a specified time/period by the agency responsible and as per the specifications set out in the EMoP.

Environmental monitoring committee

The monitoring programme will be undertaken by a committee and all relevant line agencies, local government bodies and interested parties shall take part in the monitoring activities. An Environmental Monitoring Committee (EMC) consisting of the members from the following agencies shall be set up by CEA.

- Central Environmental Authority
- Municipal Council
- National Water Supply and Drainage Board
- Divisional Secretariat
- RDHS and Anuradhapura General Hospital
- Irrigation Department
- Archaeological Department
- Road Development Authority
- Provincial Road Development Authority
- Sri Lanka Railway
- Department of Forest Conservation
- Department of Wildlife Conservation
- Any other agency deemed necessary by the EMC

Outline of environmental monitoring plan

Environmental Monitoring activities shall take place during Design, Construction and Operation stages of the project. Regular site inspections are required to assess whether the various mitigatory measures suggested are properly implemented and they are effective in achieving the objectives of environmental protection. Outline of the Environmental Monitoring Plan is presented in Table 2.

One important aspect of monitoring should be to assess the effectiveness of the mitigation measures suggested, where they are found lacking, appropriate new actions to mitigate any adverse effects should be undertaken. This requires measurements of selected environmental parameters at identified locations and a summary of the measurement schedule proposed is given in Table 3.

Table 2: Outline of the Environmental Monitoring Plan

Activity	Expected Negative Impact	Mitigation measures	Responsible for Mitigation	Responsible for Monitoring	Parameters to be monitored	Location	Frequency
Pre-construction stage	Cutting of trees	Permits to be obtained for cutting trees. Cut down of branches wherever possible, rather than cutting the whole tree	Contractor	MC / NWSDB	Number of trees in the project area	Project sites	Before commencing
	Burrowing of earth	Approvals to be obtained	Contractor	MC / NWSDB	Field reports and observations	Project sites	Before commencing
Construction stage	Damages to existing roads	Excavation should be done after studying the design drawings	Contractor	MC / NWSDB	Field reports and observations	Project sites	Once every two months
	Traffic congestion	Implement a proper traffic management plan. Use sign boards and barricaes	Contractor	MC / NWSDB	Field reports and observations	Project sites	Weekly
	Generation of dust	Systemic watering on excavated soil	Contractor	MC / NWSDB	Field reports and observations	Project sites	Once every two weeks
		Using a tarpaulin cover while transporting the materials such as sand, cement and excavated soil	Suppliers	MC / NWSDB	Field report and complaints if any	Off the project site	Weekly
		Taking measures to minimize the dust when loading and unloading the materials	Contractor	MC / NWSDB	Field report and complaints if any	Project site	Weekly
	Increased noise level	Machinery should not produce a noise level above 75db. Relevant equipment should be used to monitor the noise levels	Contractor	MC / NWSDB	Noise reports and complaints if any	Project site	Daily
	Waste generation and camping on the location	Solid waste generated should be disposed properly and removed to appropriate disposal yards	Contractor	MC / NWSDB	Field reports	Project site	Once every three months
	Impacts on existing habitats	No endemic or endangered species are damaged. Cutting of tree should be compensated by planting of more trees around the area	Contractor	MC / NWSDB	Field reports	Project site	Once every six months
Operation and maintenance stage	Sludge generation	Collecting sludge in an underground chamber and proper disposal of it	MC / NWSDB	MC / NWSDB	Maintenance report	Project area	Daily
	Possible negative impacts on water quality and quantity	Water quality and quantity tests to be carried out regularly	MC / NWSDB	MC / NWSDB	Field reports	Project site	Once every month

Table 3: Environmental Monitoring Schedule

Aspect	Parameter	Method	Stage	Frequency	Responsibility	Location
Noise level	Day and Night time Noise level (dB)	Portable noise meter (range 0-120 dB(A))	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	At STP site boundary; Sensitive locations along the sewer network; Selected pumping stations;
			Construction	Once a year	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	
Air quality / Odour	SO_2, NO_2, CO, PM_{10}, SPM	Spectrometric method; High volume sampling and Gravimetric analysis	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	At STP site; Sensitive locations along the sewer network; Selected pumping stations;
			Construction	Two times	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	
Water Quality	EC, TSS, DO, BOD, COD, pH, Oil and grease, E-coli	Portable water quality meter, Spectrometric method	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	Malwathu Oya near STP site - (i) upstream and (ii) downstream; Streams at sensitive locations along the sewer network; Streams at selected pumping stations;
			Construction	Two times	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	

Table 3: Environmental Monitoring Schedule

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Water Quality	EC, TSS, DO, BOD, COD, pH, Oil and grease, E-coli	Portable water quality meter, Spectrometric method	Pre-construction	Once (Baseline measurement)	Contractor / NWSDB / EMC	Malwathu Oya near STP site - (i) upstream and (ii) downstream; Streams at sensitive locations along the sewer network; Streams at selected pumping stations;
			Construction	Two times	Contractor / NWSDB / EMC	
			Operation	Yearly; On complaints	NWSDB / EMC	