Metro Colombo Urban Development Project

Democratic Socialist Republic of Sri Lanka

Ministry of Urban Development and Housing

PROJECT COMPLETION REPORT

Funded by:

THE WORLD BANK

IBRD - 8145 LK

November 2022

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NOVEMBER 2022

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Basic Information

Project Name
Metro Colombo Urban Development Project (MCUDP)

Country
Sri Lanka

Financing
World Bank (IBRD 8145) – USD 213 Million
Borrower's contribution – USD 108 Million

Key Dates

Agreement signed	*Effectiveness*	*MTR Review*	*Original Closure*	*Actual Closure*
18 May 2012	10 July 2012	Nov - Dec 2014	31 Dec 2017	31 Dec 2021

Project Development Objectives

1. Reduce flooding in catchment of the Colombo water basin
2. Strengthen the capacities of local authorities in the CMA to rehabilitate, improve and maintain local infrastructure and services through selected demonstration investments

Project Director

At Approval	*At ICR*
Eng. Rohan Seneviratne	Eng. Thushari Andra Hennadige

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Acronyms

BOQs	Bills of Quantities
CM	Colombo Metropolitan (Area)
CMC	Colombo Municipal Council
CWB	Colombo Water Basin
CRes MPA	Climate Resilience Multi Phased Programmatic Approach
CRIP	Climate Resilience Improvement Project
CUrW	Center for Urban Water
DEM	Digital Elevation Model
DIAS	Data Integration and Analysis System
DSM	Digital Surface Model
DMMC	Dehiwala – Mount Lavinia Municipal Council
EAD	Expected Annual Damage
EMF	Environmental Management Framework
FAT	Factory Acceptance Test
FEWS	Flood Early Warning System
FRA	Flood Risk Assessment
GBR	Geotechnical Baseline Report
GDP	Gross Domestic Product
GIS	Geographic Information System
GOSL	Government of Sri Lanka
HSE	Health, Safety and Environment
IBRD	International Bank for Reconstruction and Development
IDF	Intensity-Duration-Frequency (curves)
IFMS	Integrated Flood Management System
JAXA	Japan Aerospace Exploration Agency
JICA	Japan International Cooperation Agency
KUC	Kolonnawa Urban Council
KMP	Key Management Personnel
LHI	Lanka Hydraulic Institute
LiDAR	Light Detection and Ranging
LKR	Sri Lankan Rupee
M&E	Monitoring and Evaluation
MCUDP	Metro Colombo Urban Development Project
MSL	Mean Sea Level
NAM	Nedbør-Afstrømnings Model
NWP	Numerical Weather Prediction
O&M	Operation and Management
PAD	Project Appraisal Document

PAP	Project Affected People
PDOs	Project Development Objectives
PHRD	(Japan) Policy and Human Resources Development (Fund)
PIAs	Project Implementing Agencies
PLAs	Project Local Authorities
PMU	Project Management Unit
PRDA	Provincial Road Development Authority (Western Province)
QA/QC	Quality Assurance and Quality Control
RDA	Road Development Authority
RTC	Real Time Control
SCADA	Supervisory Control and Data Acquisition
SJKMC	Sri Jayewardenepura – Kotte Municipal Council
SLLDC	Sri Lanka Land Development Corporation
SMF	Social Management Framework
SOP	Standard Operating Procedure
SSP	Shared Socioeconomic Pathways
TEC	Technical Evaluation Committee
TOR	Terms of Reference
UDA	Urban Development Authority
USD	United States Dollar
WMS	Wetland Management Strategy
WRF	Weather Research and Forecast

Executive Summary

Colombo, being the commercial capital and largest city of Sri Lanka and having an extended metropolitan area, is of utmost importance to the country's ambitious post-war economic transformation. However, being largely a low-lying area with parts of it built on reclaimed marshy lands, the Colombo Metropolitan (CM) area is subject to severe flooding due to high intensity rainfall associated with climate change, rapid urbanization, and lack of maintenance of the drainage network. At the same time, several other problems had been identified in the such as poor road network, inefficient solid waste management, lack of facilities at public spaces, etc., which were obstacles to achieving the city's economic potential.

In order to support the urban regeneration efforts of the Government of Sri Lanka (GOSL) for CM area, the International Bank for Reconstruction and Development (IBRD) provided funding for the implementation of Metro Colombo Urban Development Project (MCUDP), which kicked off in 2012. The IBRD made a total allocation of USD 213 million, while the GOSL pledged a total of USD 108 million, towards the total cost of MCUDP. This report, which presents a detailed outline of all aspects of MCUDP, is prepared upon successful completion of MCUDP in December 2021. Part I of the report covers background details such as country context, need and rationale of the project. In addition, it introduces the two (2) major components of the project, which in turn comprises of six (6) sub-components, namely; (1.1) Enhancement of drainage capacity in Colombo water basin, (1.2) Rehabilitation and upgrading of micro drainage system within CMC area, (1.3) Capacity enhancement for flood and drainage management, (1.4) Beira Lake linear park and Beddagana park, (2.1) Investment support to local authorities, and (2.2) Institutional strengthening and capacity building for local authorities.

Part II of the report describes the two (2) Project Development Objectives (PDOs) and ten (10) Intermediate Results Indicators, with baseline values and end targets. The two (2) PDOs are; (1) Reduction in the area under risk of flooding (50-year return period) in the project area (from 0 to 3km^2) and (2) Increase in percentage of total urban roads maintained by the four PLAs that are in good and fair condition (from 50 to 70%).

The approach to selected exact interventions to be implemented under each sub-component is detailed under Part III of the report. This comprises of three (3) chapters rich in technical content, describing the study phase, methodology of selecting sub-projects and the preliminary and detailed designs of interventions. The study phase in thoroughly detailed, including review of available technical literature, timeline of studies undertaken as part of MCUDP, and the numerous data collected and analyses performed such as rainfall, canal and water levels, tidal levels, river discharges, survey works (LiDAR and physical), land use analysis and traffic surveys. It also discusses the comprehensive hydrological modeling exercise, as well as the Flood Risk Assessment and Wetland Management Strategy conducted under PHRD grant fund that complemented the activities under MCUDP. The rationale behind the selection of each intervention implemented under MCUDP and aspects of preliminary and detailed designs of those are also discussed in detail. It is to be noted that majority of the design works was carried out by the in-house technical teams and only the technically complex ones were outsourced to external consultants, still ensuring a reasonable degree of knowledge transfer to the local technical staff.

The project implementation framework is covered in Part IV of the report. It includes the roles of the line ministry, Project Management Unit (PMU), Project Implementing Agencies (PIAs) and Project Local Authorities (PLAs), and the manner in which sub-projects were managed by each PIA and PLA. This part also discussed the effects of Covid-19, which had a significant impact on project implementation, posing novel challenges and continuously affecting the time targets. The overall implementation timeline is also detailed, where two (2) extensions to the project had been granted by the IBRD, first up to 30th June 2020

and then up to 31st December 2021. However, the impact of Covid-19 was never considered for any further extensions, despite having a severe impact during the last two (2) years of project implementation.

Part V of the report entails the two (2) critical safeguards management aspects; environmental and social. With respect to environmental safeguards, three (3) of the identified sub-projects fell into Category A, requiring detailed environmental assessments. The remaining fifty-two (52) sub-projects came under Category B. As far as social safeguards are concerned, six (6) sub-projects fell under Category A, and four (4) under Category B, requiring resettlement action plans (full or abbreviated as appropriate). The remaining forty-five (45) sub-projects came under Category C. The screening, study and assessment processes, steps taken to address specific considerations and particular important actions taken at sub-project level are discussed in this part, in terms of both environmental and social safeguards.

The project outcomes are discussed in Part VI of the report. It is to be especially noted that both PDOs have been achieved successfully; (1) Reduction in the area under risk of flooding (50-year return period) in the project area (achievement of 3.03km^2 against target of 3km^2) and (2) Increase in percentage of total urban roads maintained by the four PLAs that are in good and fair condition (achievement of above 70% against target of 70%). Out of the ten (10) Intermediate Results Indicators, nine (9) have been achieved or exceeded, with the only exception being Norris Canal, which has only been partially completed, due to unforeseen delays in the resettlement process. Even under such circumstances, measures have been taken to ensure that there is no adverse impact due to the incomplete portion, which has been verified with physical observations. Further, performance of the improved drainage system during the latest rainfall events, i.e., in May-June 2021 and November 2021, is also explained under this part and it is observed that the system is performing up to the expected level, meeting or even exceeding the design criteria.

Part VII of the report contains a comprehensive economic analysis that takes the investment, expected direct and indirect benefits, and Operation and Maintenance (O&M) aspects into account. The analysis concluded that the Economic Internal Rate of Return (EIRR) of the overall project reaches 26.31% for the base case, as compared to Estimated Opportunity Cost of Capital (EOCC) of 10%, making the project significantly viable in the economic sense. Even when uncertainties such as increased O&M cost and delay in achieving benefits are taken into account, the EIRR would comfortably exceed 20%.

The procurement, contract and finance management aspects are covered in Part VIII of the report. This includes details such as procurement guidelines followed, methods adopted, reporting requirements complied with, and challenges faced in both procurement and contract management. The finance management arrangements and actual expenditure against allocation are also discussed.

Part IX of the report covers Monitoring and Evaluation (M&E) aspects and lessons learned. It contains details on the M&E process, progress monitoring and reporting arrangements, and the proactive actions taken at sub-project level to mitigate specific issues and delays. Lessons that have been learned throughout various stages of MCUDP that can be used as important references prior to undertaking similar endeavors in future have been summarized.

Sustainability aspects are covered in Part X, which is the final part of the report. This includes initiatives undertaken for enhancement of capacity and technical expertise of both individual team members as well as the PIA and PLAs of the project. The project exit strategy is explained, which was adopted to ensure effective taking over and integration of the project outcomes into routine operations of the respective agencies. Actions taken for sustainability, standalone as well as those embedded into project design, are also discussed. Finally, the next steps of the master plan (both structural and non-structural measures) to be undertaken for further improvement of the stormwater drainage in Colombo Metropolitan area are listed at the end of the report.

Part I - The Project

1. Country Context

Sri Lanka, formerly known as Ceylon, has an impressive civilizational and cultural history of over 2,500 years, and has always been known as a trade hub in the Indian Ocean, particularly because of its capital Colombo, which is recognized worldwide as a gateway between East and West.

A country with tropical climatic conditions and known as the "The Pearl of the Indian Ocean", Sri Lanka has a population of over 20 million as per the census of 2012, with a nominal Gross Domestic Product (GDP) of USD 2,400 per capita. With the end of civil unrest in 2009, Sri Lanka was on a path of rapid urbanization and cities needed to become more productive and their job markets more competitive. The then Government of Sri Lanka (GOSL) envisioned an increase in per capita GDP up to USD 4,000 by 2016. For this purpose, a medium-term development plan was designed to achieve economic growth exceeding 8% per year for the period 2010-2015.This development plan envisioned a profound economic transformation process, with increased infrastructure investment to cater to the planned increase of the share of urban population from 25% to 35%.

Colombo is the commercial capital and largest city of Sri Lanka and its metropolitan area extends into neighboring localities, forming Colombo Metropolitan (CM) area, which is the most important industrial, commercial and administrative center of the country. A major share of the country's export-oriented manufacturing takes place in the Western Province, in which CM area is the engine of growth. The Western Province contributes more than 50% to the Gross Domestic Product (GDP) and about 80% of industrial value addition ***[Source: Project Appraisal Document (PAD), Chapter I, Page 1]***, although it accounts for only 5.7% of the country's geographic area. It was established that Sri Lanka required to work on the competitive advantages of CM area, in order to accelerate growth. The CM area is, therefore, crucial for achieving the country's long-term development plans in economic growth and social well-being, and for the development of capital, human resources and technological services that are needed for development of the country.

2. Need of the Project

Being largely a low-lying area, with parts of it built on reclaimed marshy lands, the CM area has an extensive canal network that caters to its natural drainage requirements, with outfalls to Kelani River and Indian Ocean as described above. However, high intensity rainfall associated with climate change, rapid urbanization, and lack of maintenance have resulted in severe changes of drainage patterns, leading to flash floods unprecedented in magnitude and damage caused. Three (3) major inadequacies have been identified with regard to the overall macro drainage system, i.e.: storage capacity, conveyance capacity and outflow capacity.

In the decade preceding 2012, the storage capacity in the basin had reduced by about 30% ***(Source: PAD, Annex 7, Page 72)***, due to uncontrolled landfilling and encroachment of flood plains by illegal settlements. With the rapid expansion of industrial activities in the CM area, the land use pattern has changed dramatically during the last few decades and large extents of low-lying areas acting as flood retention areas have been reclaimed for housing and other industrial activities. The conveyance capacity has been restricted by solid waste dumping, floating debris and bottlenecks in the canal system. The outflow capacity of the system is not sufficient to cater for rainfalls of higher return periods.

Further, localized flooding during heavy rains is experienced at several locations, particularly within the CMC area, mainly due to the inadequate conveyance and outflow capacities of the micro drainage system.

Heavy storms occur mainly during the South-west monsoon period from May to September and the second inter-monsoon period from October to November and occasionally, in the months of March and April. The outflow is further restricted when the heavy local rainfall coincides with high water levels in Kelani River. All these impacts are likely to worsen in the future, due to the combined effects of the climate change. Rainfall trends indicate that overloading of the system and rise in sea levels further impede gravity drainage towards the sea.

The floods experienced in 1992 and 2010 were two of the worst floods in the recent history that inundated large areas of the CM area under water.

In addition, several other problems were identified in the CM area which had to be addressed in order to optimize its economic potential, such as the inadequate capacity and poor condition of the road network and less convenience for pedestrians, inefficient solid waste management and collection process, underutilization of the public spaces, and unavailability of the public facilities such as those required for recreation and sanitation.

In order to facilitate the transformation of Colombo to a capital of international standards, the Government of Sri Lanka (GOSL) had to address the above critical problems that have for long been obstructing the economic and physical urban regeneration of the city. As part of the initiative to support the urban regeneration of Colombo and its metropolitan area, the GOSL mobilized funds from the International Bank for Reconstruction and Development (IBRD) for the implementation of Metro Colombo Urban Development Project (MCUDP), which kicked off in 2012.

3. Project Rationale

The project rationale was to ensure rapid growth and trade expansion in the CM area, ensuring continued activities and operation, without being hampered due to flood and other natural disasters. Upgrading the living standards of the unprivileged in the region and providing them alternate shelter with better living conditions were also important considerations.

The objective of the project is to assist the Borrower to (i) reduce flooding in the catchment of the Colombo Water Basin, and (ii) to strengthen the capacity of local authorities in the Colombo Metropolitan Area to rehabilitate, improve and maintain local infrastructure and services through selected demonstration investments. Thus, the project comprises of three (3) main parts (refer to loan agreement):

- Flood and drainage management in the Colombo water basin;
- Urban development, infrastructure rehabilitation, and capacity building;
- Implementation support.

The project rationale is justified by the fact that economic density in the country is concentrated in the CM area. and its related activities account for almost half of the national GDP. A contiguous urban belt encircles Colombo, covering sections of the west coast and spreading both north and south. This is the major urban agglomeration in the country and is growing faster than any other in Sri Lanka.

The IBRD made a total allocation of USD 213 million, whereas the GOSL pledged a total of USD 108 million, towards the total cost of MCUDP. The IBRD component funded the procurement of goods, works and consultancies, while the GOSL component funded implementation support, taxes and duties, and implementation of the social and environmental safeguard policy frameworks.

This report is prepared upon successful completion of MCUDP and it presents a detailed outline of all aspects of MCUDP.

4. Detailed Scope of the Project

Part one of the project objective targeted addressing the urgent issue of urban flooding, which regularly paralyzes the economy of the CM area with high socio-economic costs. This has been formulated into Component 1 of the project, which financed both structural and non-structural activities related to flood control and drainage management, identified as priority projects after detailed studies carried out under MCUDP, and implemented under four (4) sub-components as per the Project Appraisal Document (PAD).

Table 4.1 Sub-components of component 1

Sub-component		Financed by
1.1	Enhancement of drainage capacity in Colombo water basin	IBRD
1.2	Rehabilitation and upgrading of micro drainage system within CMC area	IBRD
1.3	Capacity enhancement for flood and drainage management	IBRD
1.4	Beira Lake linear park and Beddagana park	IBRD

Part two of the project objective targeted development of CM area into a world class city by improving its services to the public, laying foundation for a healthy lifestyle and promoting tourism. This has been formulated into Component 2 of the project, which consisted of two sub-components as per the PAD.

Table 4.2. Sub-components of component 2

Sub-component		Financed by
2.1	Investment support to local authorities	IBRD
2.2	Institutional strengthening and capacity building for local authorities	GOSL

The above scope had to be managed within the IBRD and GoSL fund allocations stated in the Loan Agreement.

4.1. Project Area

For the purposes of MCUDP, the CM area is defined as the area comprising of local authority areas of Colombo Municipal Council (CMC), Sri Jayewardenepura – Kotte Municipal Council (SJKMC), Dehiwala – Mount Lavinia Municipal Council (DMMC) and Kolonnawa Urban Council (KUC). But the Colombo Water Basin (CWB) is quite different from this, since it is dependent on the topography and hydrology of the area. Figure 4.1 shows the area of project intervention.

Figure 4.1 Area of Project Intervention (Source: PAD, Annex 9)

4.2. Topography and Hydrology

The CM area is generally flat with ground levels rising from less than +1m MSL to +6m MSL, with a few elevated and hilly areas rising to levels ranging from about +15m MSL to about +22m MSL. These elevated lands are located mostly in the eastern and southern parts of the CM area. There are more than 500ha of marshes and swamps in the area, most of which are located along drainage canals east of the city's built-up areas along the coastal line. These marshes and swamps are generally at elevations below +1m MSL, with no particular land use activity. Topography of the CM area is shown in Figure 4.2.

The CWB is about 105 km^2 in area and comprises of a network of interconnected canals and marshes functioning as retention areas, with its center at Parliament Lake (Diyawanna Lake).

Some of the prominent canals are; Kirulapone Canal, Wellawatte Canal, Dehiwala Canal, Kolonnawa Canal, Dematagoda Canal, St. Sebastian Canal (North and South) and Main Drain.

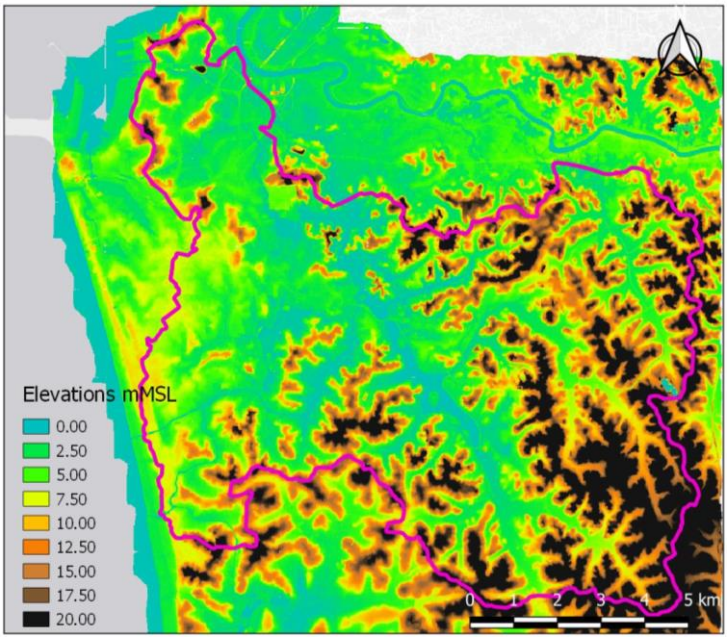


Figure 4.2 Topography of CM Area (Source: LiDAR Survey)

As of the inception of MCUDP, the system had four (4) direct outlets; three (3) to Indian Ocean, i.e., Dehiwala, Wellawatte and Mutwal and one (1) to Kelani River, i.e., at Nagalagam Street (North Lock Gate). The fifth outlet at Ambathale is in fact an indirect one, discharging water from the trans-basin Madiwela East Diversion Scheme that carries water from the upper watersheds of Parliament Lake to Kelani River through Malabe basin, thereby relieving the flood burden on Parliament Lake and its direct outlet. Further, a connection had existed in the past between the canal system and Beira Lake at Maradana (South Lock Gate), by pumping water from St. Sebastian South Canal to the lake, the latter having a higher water level, mainly to maintain the water level of the lake ***(Ali and Kadija, 1991)***. However, as of the inception of MCUDP, this outlet was not functioning, making South Lock Gate a dead-end of the system.

The above-mentioned main canal system with its outfalls is referred to as the macro-drainage system of Colombo.

Apart from this, Colombo Municipal Council (CMC) area has an extensive secondary and tertiary urban drainage network consisting of several natural and man-made open drains, canals, underground box drains, pipes, culverts and manholes. Part of this stormwater drainage system is discharging into the main canal system in the Metro Colombo water basin (managed by SLLDC and referred to as macro-drainage system). The rest discharges directly into Beira Lake, Kelani River, or the sea. Collectively, this secondary and tertiary drainage system is referred to as the micro-drainage system of Colombo.

Hydrology of Colombo Water Basin with major outlets is shown in Figure 4.3.

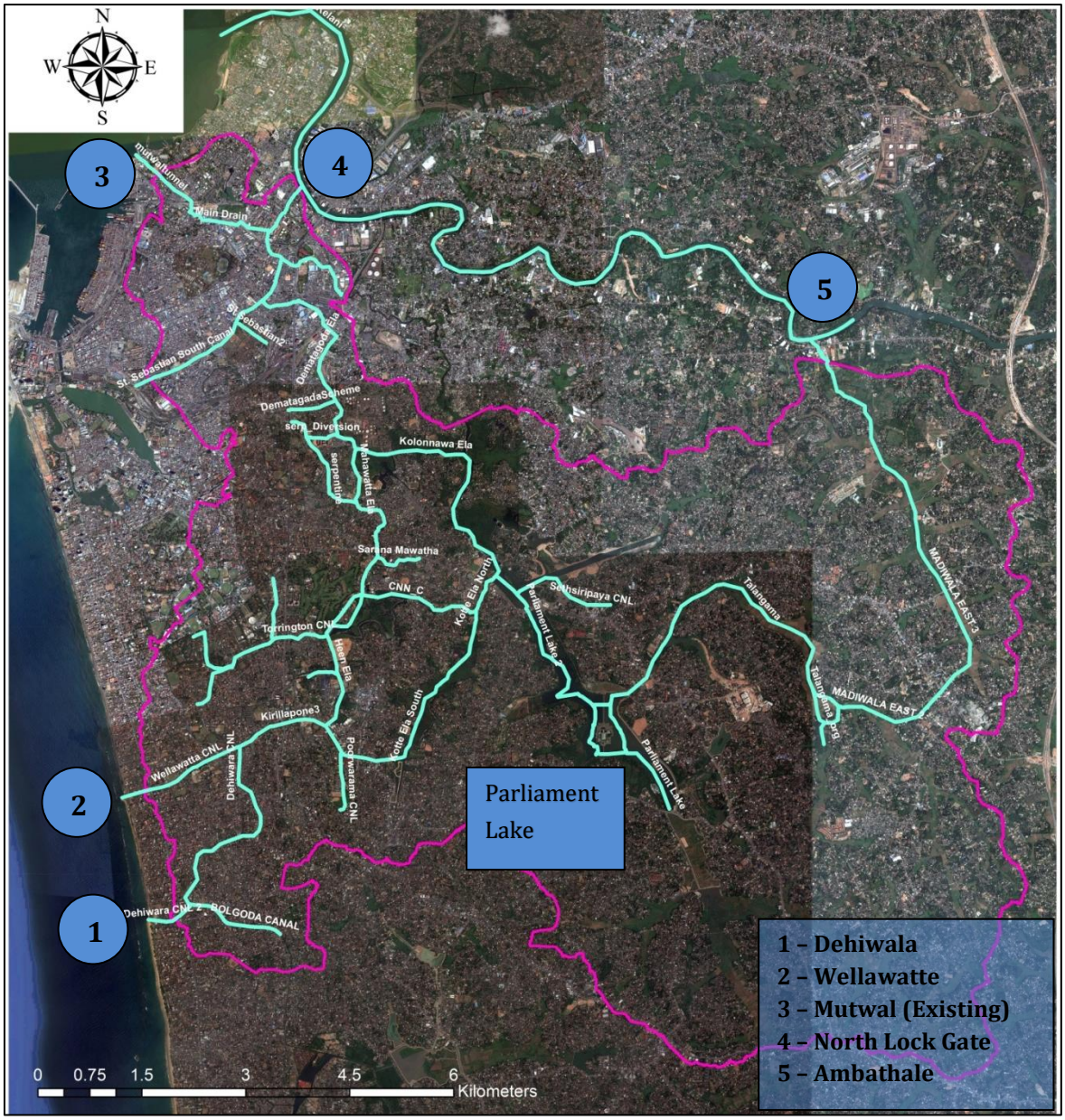


Figure 4.3 Hydrology of Colombo Water Basin with Major Outlets

(Basin boundary is shown in Magenta color)

4.3. Roads and Public Spaces

Colombo, the commercial capital of Sri Lanka, connects to other cities through a dense network of roads consisting of several categories of roads, where arterial roads increase mobility and collector roads increase accessibility. All roads within CMC area are maintained by CMC. In other PLAs, main roads are maintained by Road Development Authority (RDA) and Provincial Road Development Authority (PRDA), while local roads are maintained by the respective PLA. The expressway network running through the suburbs of Colombo can be accessed through the interchanges at Kaduwela, Kothalawala, Athurugiriya and Kottawa. The Colombo main bus station in Pettah is the starting point for the general public to reach almost all the cities connecting and beyond.

Main four train routes, i.e., Main line, Coastal line, Kelani Valley line and Puttalam line starting from Colombo interconnects main cities. About half a million population commutes into Colombo through these routes on daily basis *(Source: PAD, Page 4)* for work, commercial, educational, health and other needs. The road network in Colombo and public services, including sanitation, required improvements to meet the demands.

A few places were available for the public in Colombo to gather, rest and relax. One major location was Vihara Maha Devi Park at the center of Colombo. Galle Face Green nearby the beach is another place gathered by public. People would flock to Galle Face Green, especially in the evenings, to see the sunset, fly kites, etc. Independence Square is another public place, where the memorial hall has been built to commemorate independence of Sri Lanka. However, prior to the implementation of MCUDP, no proper place was available for the public in northern part of Colombo for recreational activities. The existing spaces also lacked facilities for the public. These public places also were identified to be revitalized with necessary facilities and promote urban life. Road network and other salient features of the city are shown in Figure 4.4.

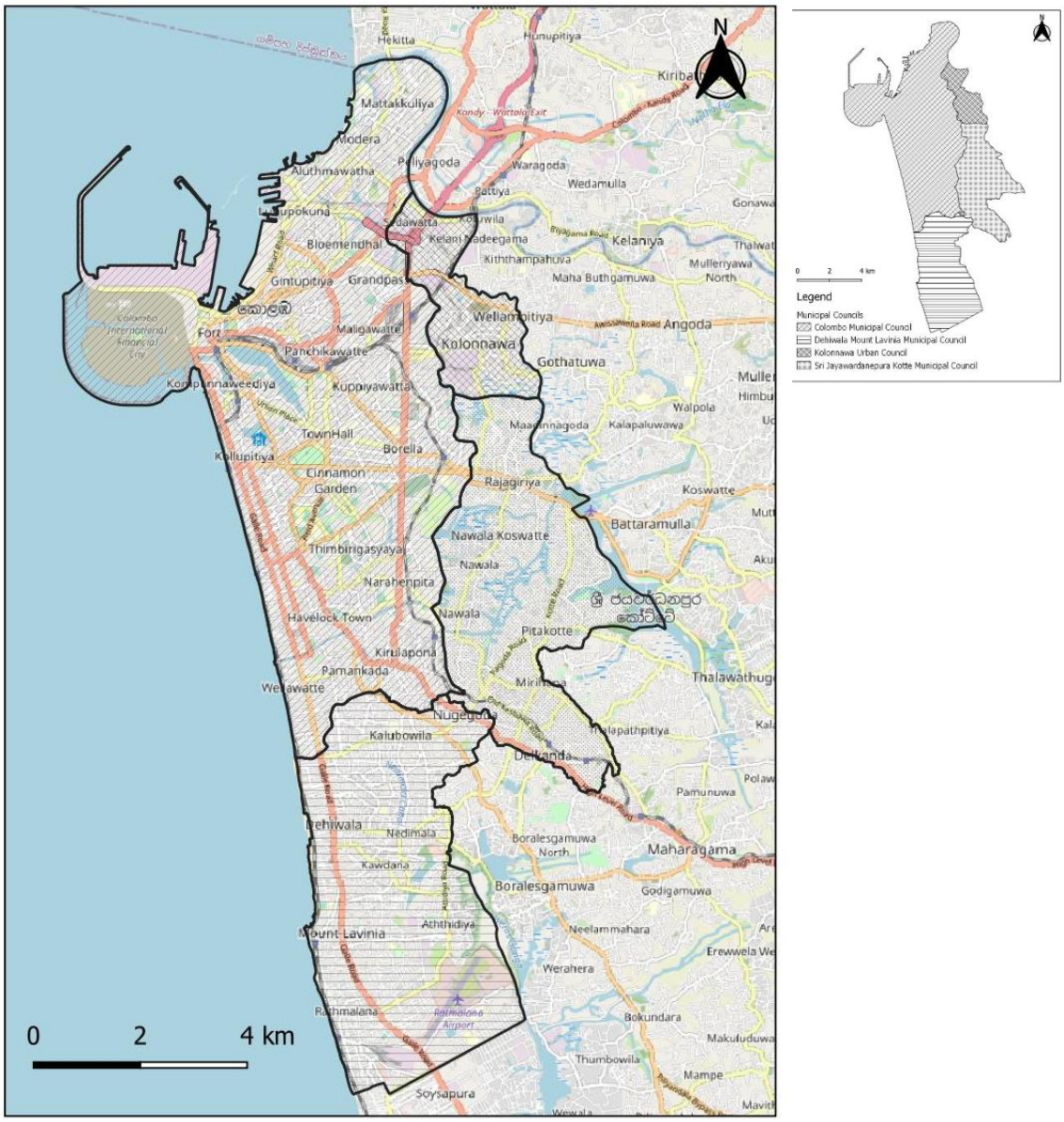


Figure 4.4 Road Network and Other Salient Features of the City

Part II - Project Development Objectives

5. Project Development Objectives (PDOs) and Intermediate Results Indicators

Project Development Objectives (PDOs), according to the revised Loan Agreement and subsequent Aide-Memoire, is given in Table 5.1.

Table 5.1 PDOs and Intermediate Results Indicators as per the revised Loan Agreement (October 2017) and Subsequent Aide Memoire

No.	Indicator at Restructuring	Unit of Measure	Baseline	End Target	Remarks
PDO Level Indicators					
1	Reduction in the area under risk of flooding (50-year return period) in the project area.	km^2	0	3	
2	Increase in percentage of total urban roads maintained by the four PLAs that are in good and fair condition	%	50	70	Roads with International Roughness Index (IRI) between 3 and 7 are considered in good and fair conditions based on the Sri Lanka Road Development Authority classification
Intermediate Result Indicators					
1.1	Length of primary canals improved by the project	km	0	9.2	
1.2	Increase in drainage capacity (gravity system)	m^3/s	100	185	
1.3	Increase in drainage capacity (pumping system) subject to the results of the hydrological model)	m^3/s	3.5	25	
1.4	Micro-drainage sub-projects implemented under the Project that reduce risk of flooding in localized areas (10-year return period)	Nos.	0	6*	
1.5	RTC developed and integrated into SLLRDC's operation	Yes / No	No	Yes	
1.6	User's satisfaction with the condition of Beira Lake and Beddagana and Rampart Park	%	31	80	By carrying out User satisfaction surveys
2.1	km of road/drainage built/rehabilitated based on prescribed standards	km	0	45	
2.2	Users satisfied with area-based demonstration projects in Colombo City	%	0	70	By carrying out user satisfaction surveys
2.3	Number of Public spaces/parks upgraded and revitalized by the project	Nos.	0	3	
2.4	Number of Public convenience complexes maintained by PLAs that are in good and fair condition	Nos.	0	16	

* Aide Memoire 16th Feb-2nd March 2021 (Same in Aide Memoire 29th Nov – 14th Dec 2021)

Part III - Approach to Select Interventions

6. Study Phase

6.1. Literature Review

6.1.1. Report of JICA / Nippon Koei Studies

Out of a number of studies undertaken during the few decades preceding MCUDP, regarding the issue of flooding in Colombo and its metropolitan area, "The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka (2003)"is the most well-known study., Funded by the Japan International Cooperation Agency (JICA) and thus widely known simply as the "JICA study", this study was completed in 2003, with its major outcome being the formulation of a master plan for stormwater drainage in the Colombo Metropolitan Region.

6.1.2. Report on Proposed Remedial Measures for Floods in the Colombo City

This document was submitted to the World Bank in March 2011 before formulation MCUDP, as the project proposal from GoSL for the Flood and Drainage Management component. This document has taken into account the recommendations of the Presidential Task Force appointed immediately after 2010 floods, in order to study and recommend solutions to the problem of flooding in Colombo.

6.1.3. Plans and Proposals on Urban Development

Beira Lake Restoration Project Master Plan (1995) prepared by UDA was referred in planning the improvements for Beira Lake and surroundings. In addition, development plans / proposals available with UDA and CMC and the latest zoning plans of UDA were used as guidance on identifying suitable infrastructure development interventions to meet the PDOs

6.2. Timeline of Studies

6.2.1. Component 1

The following is a list of the reports prepared under MCUDP:

- Proposed Remedial Measures for Floods in the Colombo City (Sri Lanka Land Reclamation & Development Corporation) (March 2011, i.e., at the formulation of the project)
- Business development plan for Beira Lake developments (John Burrows)
- Hydrological and hydraulic modeling (COWI A/S, Denmark) (March 2013) together with SLLDC and CMC Engineers
    - Report on upgrading and application of the hydraulic model (macro model)
    - Report on development and application of the urban model (micro model)
    - Additional services completion report
- Pumping Stations (Kunhwa Engineering and Consulting Co., Ltd., Korea) (April 2015)
    - Preliminary Design Report of North Lock Stormwater Pumping Station
    - Preliminary Design Report of Ambathale Stormwater Pumping Station
- Tunnels (Geodata S.p.A., Italy) (2015)
    - Information Review Report
    - Geotechnical Baseline Report
    - Risk Management Strategy

- Colombo Wetland Management Strategy (WMS) under PHRD (Signes, France) (January 2016)
    - Inception report
    - Interim reports
    - Wetland Management Strategy - Final Report Plus annexes
    - Outcomes from the workshops with stakeholders
- Flood Risk Assessment (FRA) under PHRD (Deltares, the Netherlands) (January 2017)
    - Report on hazard assessment and hydraulic modelling
    - Report on data collection and development of damage functions
    - Report on detailed flood risk analysis and impact of interventions
    - Report on simplified FRA for the outer area
    - Report on development of a reliable and sustainable flood early warning system
    - Report on urban planning and building construction guidelines
- Conceptual design reports and detailed design reports for other sub-projects relevant to macro- and micro-drainage, prepared by the respective PIAs

- "RTC Proposal for MCUDP" (April 2017) under sub-component 1.3

- Further studies and designs under sub-component 1.4 based on "Beira Lake Restoration Project Master Plan" (1995) (Water Management Plan, Environment Improvement Plan and Business Plan)
- Studies done for wetland management with Dr. Mathew Simpson (Associate Director, WWT Consulting / Consultant to the World Bank)

- Wetlands Conservation and Management: A New Model for Urban Resilience in Colombo (November 2015) published by World Bank based on the studies done with MCUDP team

- Baseline user satisfaction surveys [Resources Development Consultants (RDC), Sri Lanka] (May 2014) for:
    - Development of Beira Lake Linear Park
    - Development of Beddagana Park

- Feasibility Study for a Municipal Solid Waste Disposal System Including Sanitary Landfill, Transfer Station, Rail Transportation Improvements and Preparation of Tender Documents for a Design & Build Contract (Dohwa Engineering Company Limited) (2014)
    - Volume 1: Feasibility Study Report (Main Report)
    - Volume 2: Conceptual Design Drawings
    - Volume 3: Results of Site Surveys
- Project Interventions Impact Survey by independent consultant Dr Jagath Munasinghe
    - The impacts of flood control systems (done with 551 participants)
    - The impacts of urban upgrading (done with 457participants)

6.2.2. Component 2

The sub-projects under Component 2 were mostly either rehabilitations or renovations. Therefore, detailed studies prior to detailed designs were not required for most of the sub-projects. However, for the "Rehabilitation of Galle Road and R. A. De Mel Mawatha" being two major roads running through Colombo city, traffic surveys were carried out. Level of service was calculated using these studies and the existing traffic database with CMC.

6.3. Data Collection and Analysis

An outline of the hydrological study is presented in Figure 6.1 and the required data were lined up accordingly.

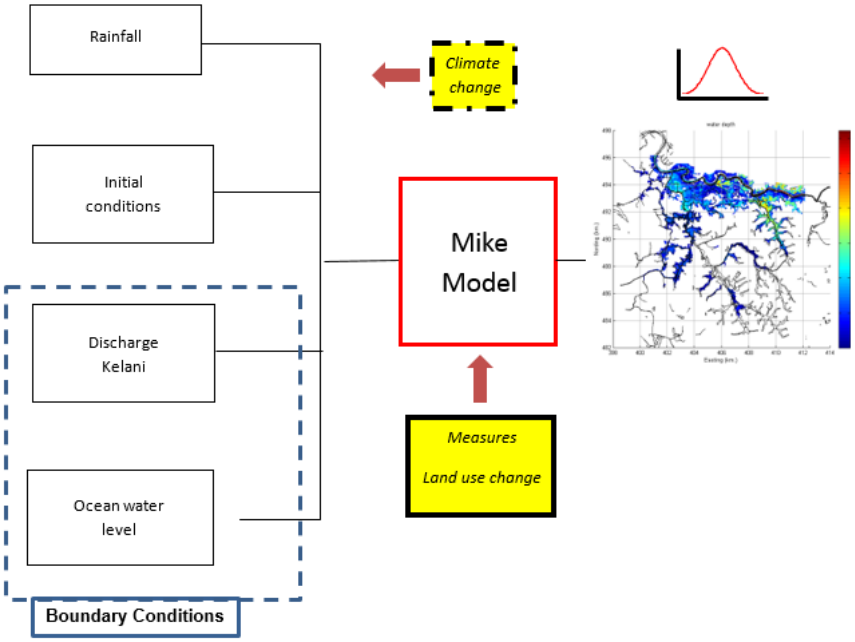


Figure 6.1 Overview of the data requirement for component 1

6.3.1. Rainfall Data

15-minute interval rainfall data covering 30 years (1981-2011) for the Colombo meteorological station and daily rainfalls for the same duration at Colombo, Katunayake and Ratmalana stations of Meteorological Department of Sri Lanka.

A comprehensive rainfall analysis for Colombo meteorological station has been carried out under MCUDP as it is the representative rainfall station for the basin by considering 30 years (1981-2010) rainfall record for the Colombo meteorological station and developed Intensity-Duration-Frequency (IDF) tables.

Table 6.1 24 hr Rainfall for Different Return Periods for Metro Colombo

Return Period	**T2**	**T5**	**T10**	**T25**	**T50**	**T100**
24 hr rainfall (mm)	144.0	196.6	256.1	363.8	476.5	626.5

The developed statistical rainfalls by the frequency analysis were used to obtain the design rainfalls for the specified design horizon, as shown in Figure 6.2.

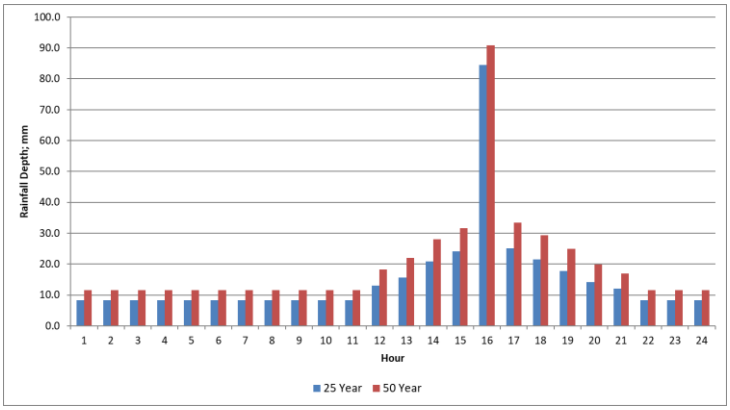


Figure 6.2 25-year and 50-year Design Rainfalls Derived from the Study

Note: The design duration of the design storms used in Figure 6.2 *is 24 hours and the interval of ordinates is 1 hr. It is further empathized that the "Areal reduction" of the rainfall is accommodated in terms of an "Areal Reduction Factor (ARF)" for above design storms.*

The design storms with duration of 1-day shown in Figure 6.2 and Table 6.1 were used for the simulation of the macro-drainage network.

The sub-catchments in the micro-drainage networks are extremely small and extremely high intensity short term rainfalls are the form of rainfall which causes localized floods. Therefore, the duration of design rainfalls for micro model was assumed as 1-hr and the design frequency was 100.68 mm (per hour) for "10-year return period", as shown in Figure 6.3.

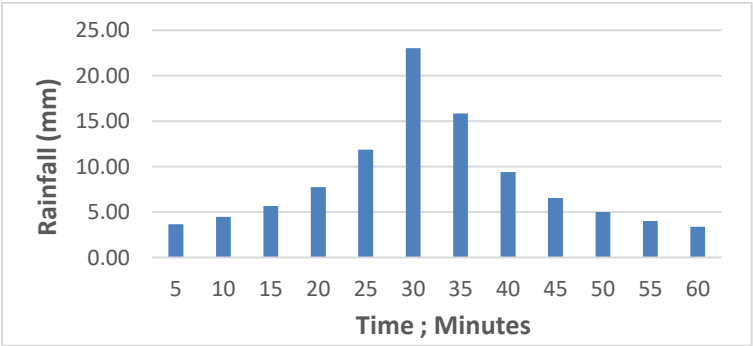


Figure 6.3 Design Rainfall for Micro Drainage Model

Note: The design storm used for micro drainage in Figure 6.2 *is 1 hour and the interval of ordinates is 5 minutes. The design storm was prepared without an Areal Reduction Factor due to smaller catchment areas.*

6.3.2. Canal and River Water Level Data

Water levels of Kelani and water levels at selected stations within the canal system were collected for the purpose of calibration the model. Water levels of the river were obtained for a period of 30 years (1981-2010) from Department of Irrigation and canal water levels for a period of 10 years (2000-2010) were obtained from Sri Lanka Land Development Corporation. Locations where water level data were collected are shown in Figure 6.4.

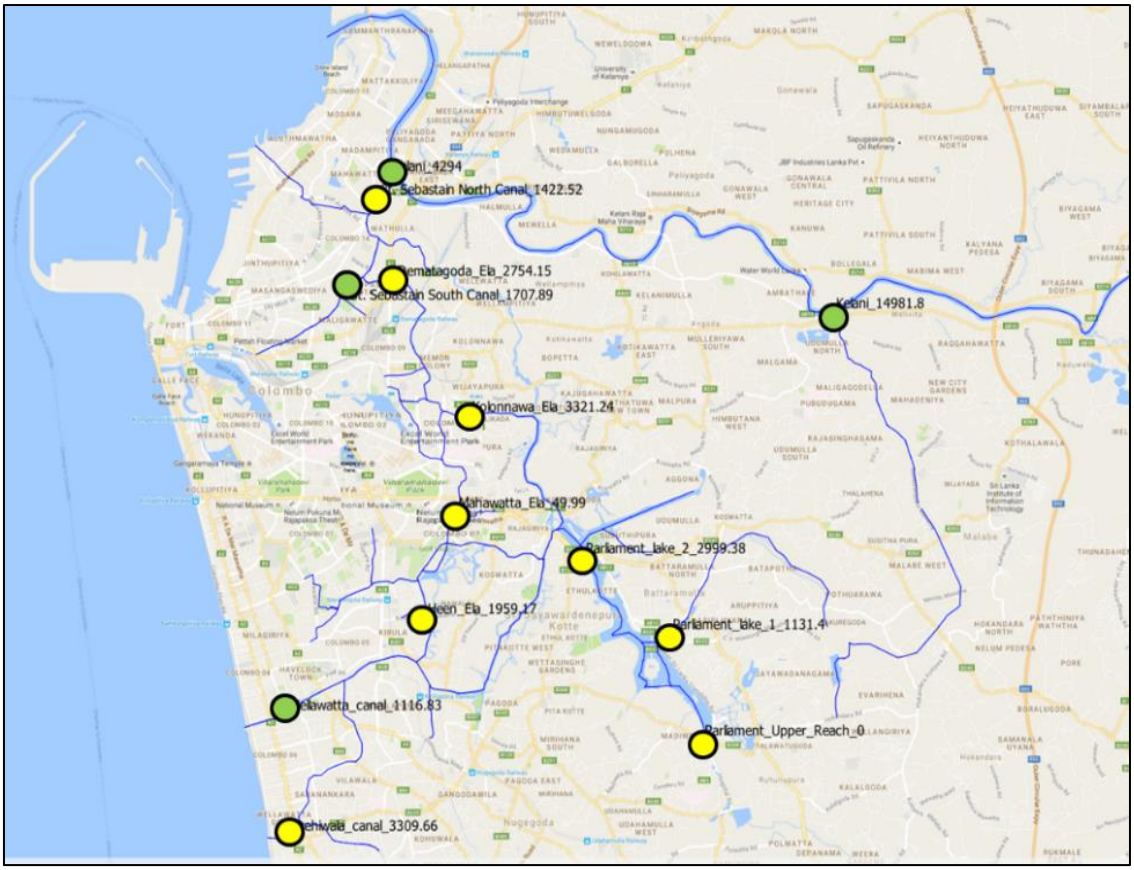


Figure 6.4 Locations of Canal and River Water Level Collection

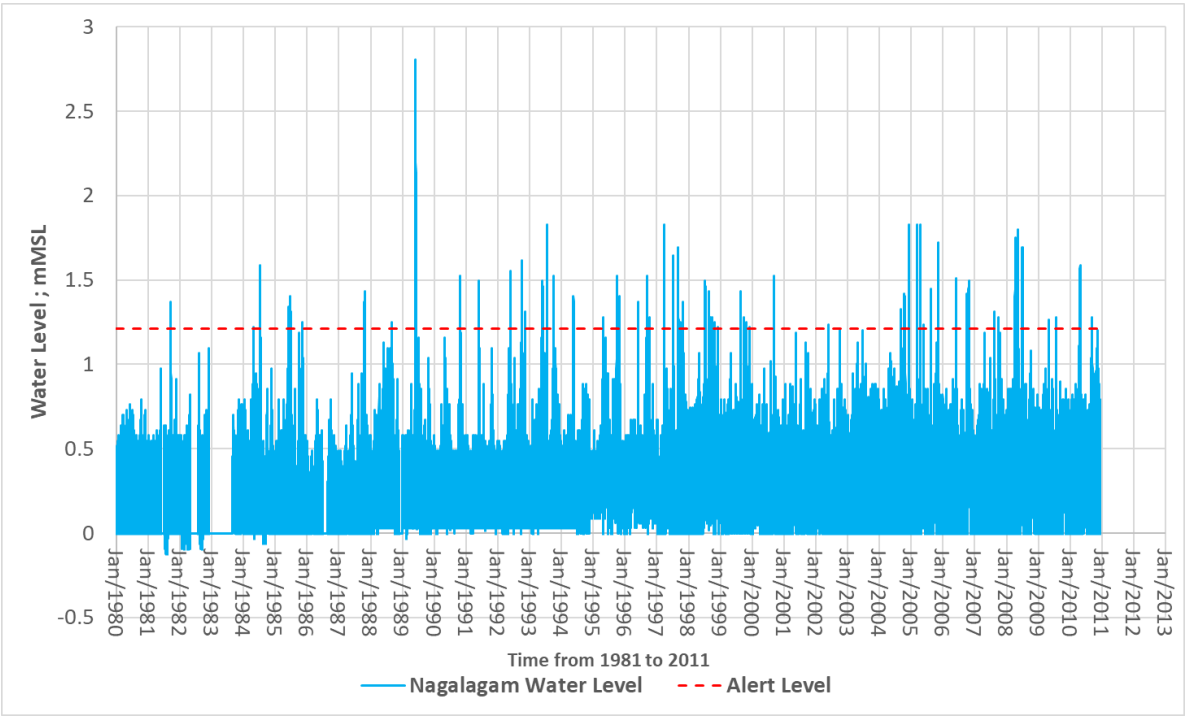


Figure 6.5 Observed Water Levels of Kelani River at Nagalagam Street from 1981 – 2010

6.3.3. Tidal Data

The Colombo canal system consists of several sea outlets and therefore, tidal level can be identified as a forcing factor for the flood status within the Colombo canal system.

Accordingly, the hourly tidal data of Colombo harbor were collected for a period of 30 years (1981-2010). The tidal constituent and the non-tidal constituents were separated from the observed levels and thereafter, a frequency analysis was carried out for non-tidal constituent. The tidal constituents were then added to the statistical non-tidal constituent and obtained statistical tidal levels with a frequency. The tidal variation at Colombo harbor is from -0.2 m MSL to 0.6 m MSL

These tidal levels were used at boundary points of the sea outlets in the model.

6.3.4. Discharge of Kelani River (Rating Curves)

The discharge of Kelani river is a direct variable which defines whether the river is at a flood status or not. Since the Colombo canal network consists of major two river outfalls (Nagalagam Street and Ambathale), the flood status in Kelani river directly affects the flood status within the Colombo canal system.

On the other hand, the upper Kelani river boundary of the hydrological study has been defined as at Hanwella located 36 km upstream of outfall. Therefore, river discharge at Hanwella is a major input parameter of the hydrological models. Therefore, observed rated river discharges at Hanwella were obtained from Department of Irrigation for the period of 30 years (1981 – 2010). An additional frequency analysis has additionally been carried out for the discharge at Hanwella to obtain statistical discharges.

6.3.5. Traffic Surveys

Traffic surveys were carried out for the sub-project "Rehabilitation of Galle Road and R. A. De Mel Mawatha". Level of service was calculated based on these survey outputs and the traffic data available at CMC. It was found that reducing the number of lanes for R. A. De Mel Mawatha (from 4 to 3) can provide the same level of service by utilizing the remaining space for bus bays and parking bays.

6.3.6. LiDAR Survey

Light Detection and Ranging (LiDAR) is a surveying method where light is used to scan the ground surface and obtain Digital Elevation Models (DEM) and Digital Surface Models (DSM).

A LiDAR survey was carried out for the Metro Colombo water basin and obtained raster images of both DEM and a DSM. The resolution of the survey was 1m x 1m and the vertical accuracy as verified by Department of Survey was 15-20 cm.

The DEM obtained from LiDAR survey was used to delineate the flood plain details within the hydrological model. The 1D hydraulic models set up initially were upgraded as 1D-2D models and the DEM of LiDAR survey was used for 2D modeling and inundation mapping and subsequent GIS works for the interpretation of results.

6.3.7. Physical surveys of drainage network

The cross sections of the Colombo canal system including relevant secondary canals were obtained from a comprehensive topographical survey.

6.3.8. Land Use Analysis

The percentage of imperviousness of each sub-catchments is an important parameter which define the amount of runoff from each sub-catchment. Therefore, a GIS database of all land use files were collected and estimated percentage of imperviousness of each and every sub-catchment.

Land use map for CWB is shown in Figure 6.6.

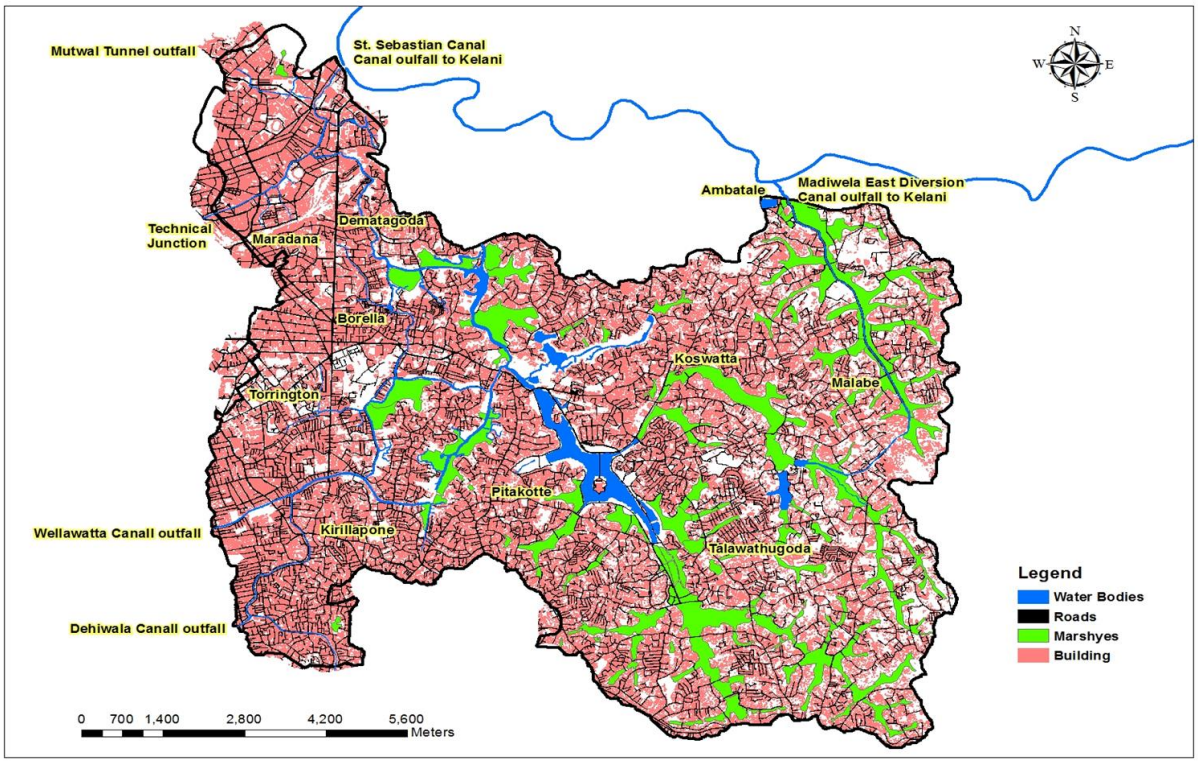


Figure 6.6 Land Use Map for Colombo Water Basin

6.4. Modeling Works

Once the data collection was completed, a complete hydrological and hydraulic model of the Colombo canal network was set up using MIKE 11 software, while it was coupled with MIKE 21 and MIKE FLOOD for 2D modeling.

NAM (Nedbør-Afstrømnings model) of MIKE 11 was used for rainfall runoff modelling. Model set up for macro-drainage system is shown in Figure 6.7.

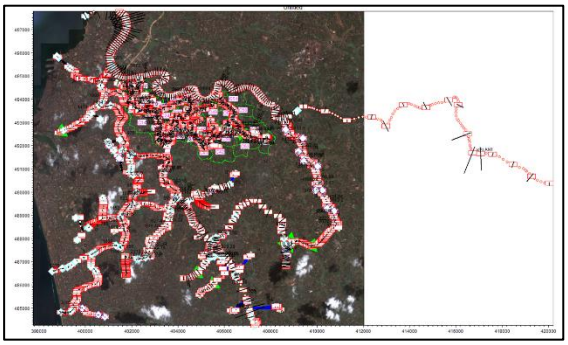


Figure 6.7 MIKE 11 model set up for macro-drainage system of the Metro Colombo water basin.

The calibrated model was used for simulations with statistical events and once in 50 years daily rainfall was used as the design rainfall to achieve the flood safety level.

Apart from the rainfall, boundary conditions (tidal level and river discharge at Hanwella) and pre-storm initial conditions were identified as major factors defining flood status in the Canal system.

Similar to NAM in the macro model, the hydrological model (rainfall runoff) used in micro model is the SCS curve number model developed by US Army Corps of Engineers, which is widely-used and efficient method for determining the approximate amount of runoff from a rainfall event in a particular area.

6.4.1. Boundary Conditions of Kelani River

The flow in Hanwella of Kelani river and the tidal level at sea outlets are the important boundary conditions which governs the hydraulics in the Colombo canal network. Initially, it was decided to use 10-year boundary condition together with the 50-year rainfall for the Colombo canal system. However, there are three (3) clear states of Kelani which influence to the Metro Colombo water basin in two different ways:

I. Low Kelani condition
   - *the river water level at Nagalagam Street is mainly defined by the tide level and not by the river discharge. At this condition, flood gates are kept fully open, in order to facilitate gravity flow.*

II. Intermediate Kelani condition –
   - *when the water level of Kelani river at Nagalagam Street is defined predominantly by its discharge and still the water level is lower than the 5ft MSL, the state of Kelani river could be considered as "intermediate". The gravity discharge through flood gates is lesser than that of low Kelani condition.*

III. High Kelani condition
   - *once its water level at Nagalagam Street goes beyond minor flood level, i.e., 5ft MSL. The water level at Nagalagam Street is predominantly defined by the discharge of Kelani River more than the boundary conditions during the high Kelani conditions.*

The system behaves extremely different to high Kelani conditions than to low Kelani conditions. The reason for this is one existing river outfall (St. Sebastian North Canal) goes out of function at high Kelani conditions. The classification of the Kelani river flood levels as per the gauge at Nagalagam Street can be stated as follows:

- Minor flood > 5 ft. (1.32 m MSL)
- Major flood > 7 ft. (2.13 m MSL)
- Dangerous flood > 9 ft. (2.74 m MSL)
- Critical flood > 12 ft. (3.45 m MSL)

6.4.2. Tidal Boundary Conditions

Several simulations were carried out applying a high spring tide and a low neap tide as the tidal boundary condition. Monthly spring and neap tide variations at Colombo harbor are shown in Figure 6.8. However, it was examined that the effect due to the tide is minimal during a major flood such as a 50-year flood for the Colombo basin (i.e., 529mm daily rainfall) and therefore it was decided to use an average spring tide boundary condition.

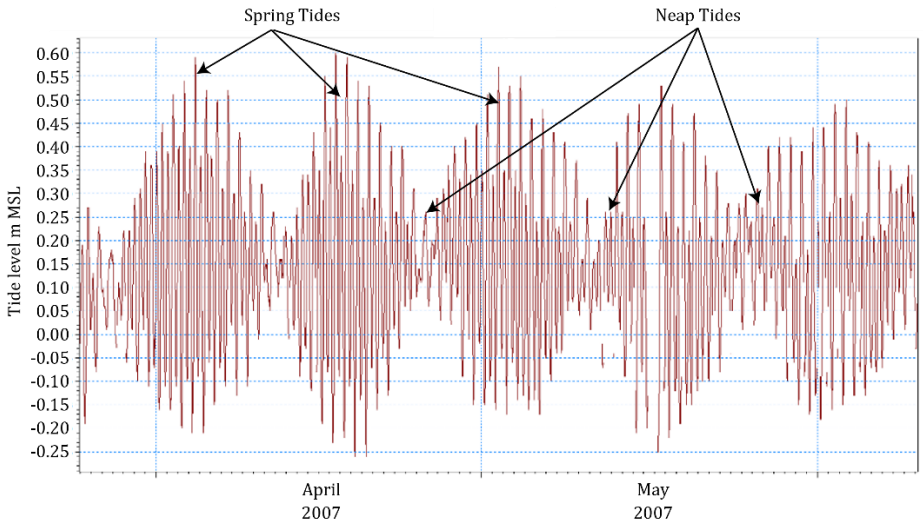


Figure 6.8 Monthly Spring Tides and Neap Tides Variation at Colombo Harbor

6.4.3. Initial Conditions

Initial Conditions for Rainfall – Runoff model (NAM) are very sensitive to the generated water levels within the system for a given storm event. The degree of saturation of the soil prior to a storm event determines the amount of water infiltrated and thereby has a major effect to the runoff volume. Accordingly, two conditions were identified as Dry Soil Condition and Wet Soil Condition

It is evident that the generated water levels within the system for a particular storm event vary according to the applied boundary conditions and initial conditions. Therefore, for simplicity, the following two extreme conditions were derived by combining both initial conditions and boundary conditions:

a) Favorable Condition ; Low Kelani & Dry Soil condition
b) Worst Condition ; High Kelani & Wet Soil condition

It is understood that the maximum water level generated for a given rainfall has a certain range according to applied initial conditions and boundary conditions. The "Favorable condition" defines the lower bound of this range while "Worst condition" defines the upper bound and once these two values are known, the behavior of the system for that particular storm event is well understood.

The model simulations for different design rainfalls defined in subsequent chapters always define two conditions for each storm event namely "Favorable condition" and "Worst condition" and it should be understood that these two extreme values define the range of the number of different water level possibilities that could be expected for a given rainfall.

6.4.4. Test Simulations for Existing Drainage System

The existing system was simulated for different statistical rainfalls under different hydrological conditions. The assessment of the 50-year runoff distribution to the system (shown in Figure 6.9) is such that approximately one third of the total generated runoff is discharged via outfalls and another one third is retained in the available wetlands. The balance one third of the runoff causes the floods in the system.

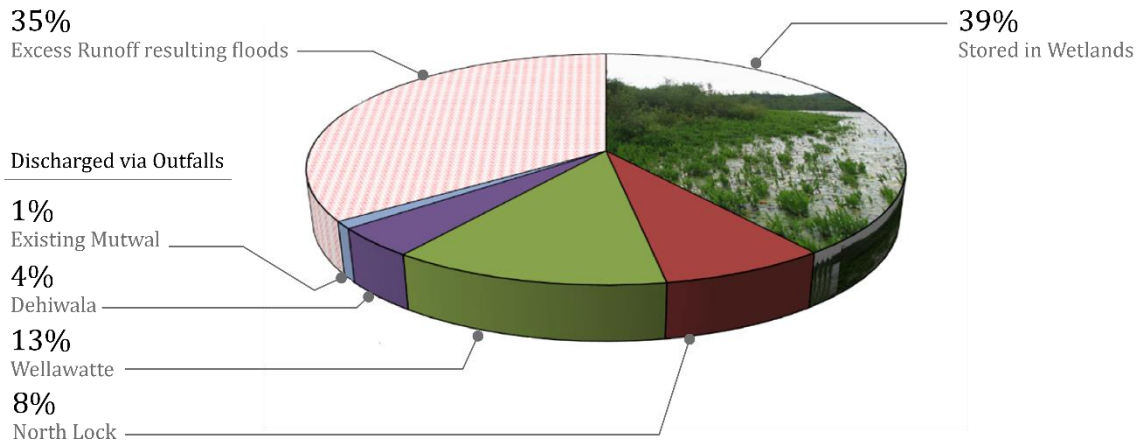


Figure 6.9 Runoff distribution for the existing system for 50-year rainfall under favorable hydrological conditions

It is evident that the percentage excess runoff increases for the worst hydrological conditions as the functionality of North Lock outfall is hindered due to high Kelani river conditions.

6.4.5. Test Simulations for Proposed Interventions

The approach on testing the effectiveness of proposed interventions therefore was based on increasing of either outfall capacity or storage capacity for addressing the excess runoff. However, during initial investigations and simulations, it was found out that the increasing of further storage capacity was almost

impossible due to rapid urbanization and thereafter the approach was modified to "increasing of outfall capacities with available storage capacity".

Accordingly, many outfall improvement interventions were simulated and excess runoff was able to be significantly reduced with proposed condition, as shown in Figure 6.10.

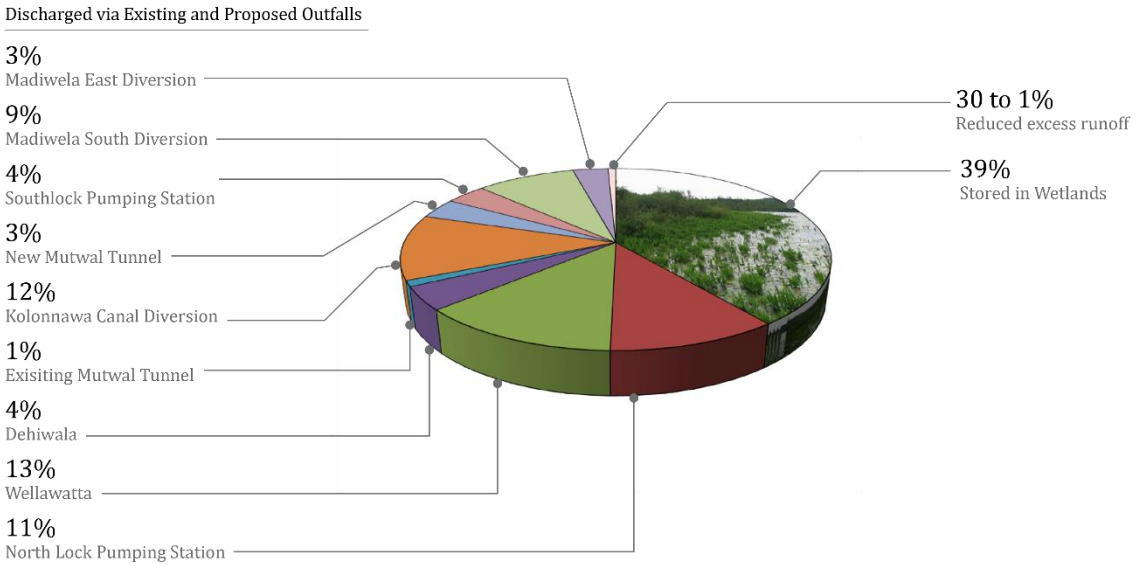


Figure 6.10 Runoff distribution for the proposed system for 50-year rainfall under favorable hydrological conditions

The model was thereafter simulated for a number of test scenarios with different combinations of interventions and the effectiveness of individual proposed interventions can be summarized as shown in Table 6.2.

Table 6.2 Effectiveness of individual interventions

Intervention	Outflow Capacity (m^3/s)	Reduction in water level for 50 Year Rain (cm) ***		Average Score	Rank on Performance
		Center of the System	Locally		
1. Madiwela East Diversion **	10	2	30	0.8	7
2. Kolonnawa Diversion	45	17	25	3.5	2
3. North Lock Widening	42	3	21	2.3	5
4. North Lock Pumping	30	9	37	2.8	3
5. New Mutwal Tunnel	14	5	48	2.4	4
6. St. Sebastian South Pumping	10	5	26	1.7	6
7. Madiwela South Diversion **	50	24	-	4.9	1

**-: These interventions are not outfalls, but inflow reductions to Colombo basin. Therefore, the amount of inflow reduction from these two interventions will depend on the applied storm event.

*** -: These water level reductions are values averaged after simulating both favorable and worst scenarios.

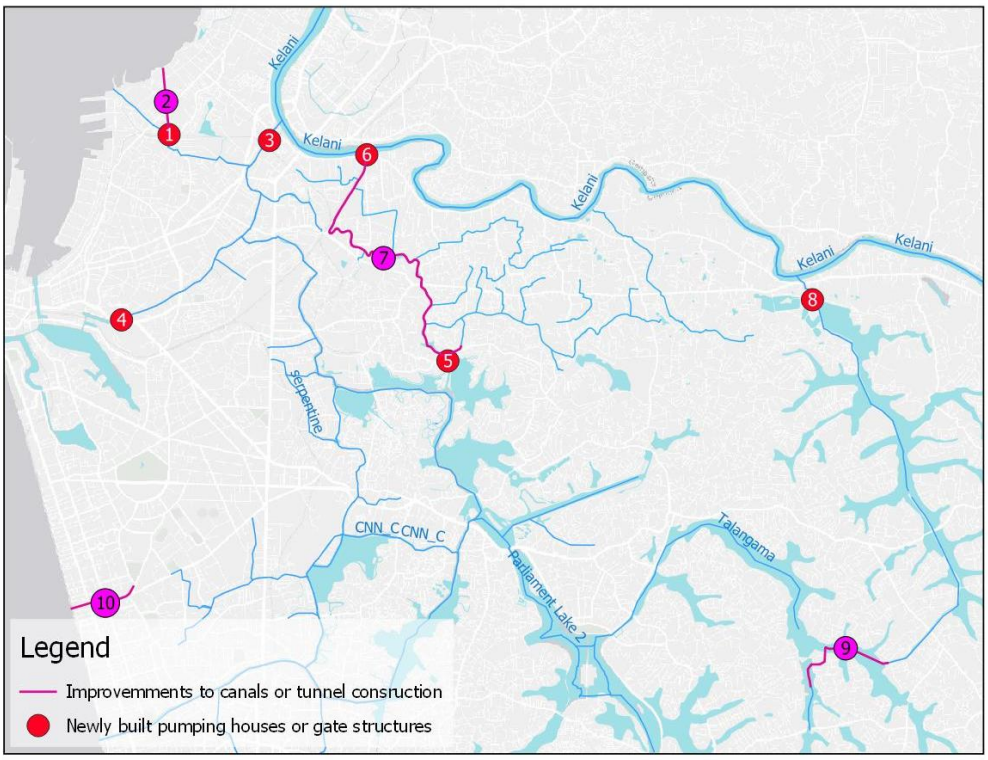
Effectiveness of each intervention can be assessed based on three (3) parameters:

1. Outflow capacity enhancement
   A score of "1" is assigned for each 10m^3/s of outflow capacity enhancement.
2. Water level reduction at the center of the overall drainage system
   A score of "1" is assigned for each 5cm of water level reduction at the center. Parliament Lake is considered as the center of the drainage system.
3. Water level reduction in the area benefitted by each intervention (local water level reduction)
   A score of "1" is assigned for each 10cm of local water level reduction

For Madiwela East Diversion (MED) Scheme, which is a trans-basin diversion having an indirect effect on the main drainage system, a score of 1 is assigned for each 30cm of local water level reduction.

For each intervention, a combined score is derived by averaging the three (3) scores assigned as above.

The result of the extensive simulation effort with a large number of combinations, can be summarized as shown in Figure 6.12, which can be considered as the essence of the entire study where it revealed that although implementation of all the interventions would significantly drawdown the flood level of Parliament Lake – the center of the system, still some amount of flooding could be expected at 50-year worst conditions. However, the duration of flooding is significantly reduced.



Newly built structures

Id	Name
1	New Mutwal Tunnel Inlet
3	North Lock Pumping Station
4	South Lock Pumping Station
5	Kolonnawa Canal Diversion Gates at Gothatuwa Bund
6	Kolonnawa Canal Diversion Gates at Kalupalama
8	Ambatale Pumping Station

Canal improvements or tunnel constructions

id	Name
2	New Mutwal Tunnel
7	Kolonnawa Canal Diversion
9	Improvements to Madiwela East Diversion
10	Torrington Tunnel

Figure 6.11 List of Major interventions- Macro Drainage

It is to be noted that some of these interventions were further divided into several sub-projects, for ease of implementation, e.g., Kolonnawa Canal Diversion consists of four (4) sub-projects and Madiwela East Diversion consists of four (4) sub-projects, including Ambathale Pumping Station, which is essential to cater for the increased discharge requirement due to upstream developments. In addition, several other sub-projects were undertaken to improve conveyance capacity towards the respective outfalls. A complete list of sub-projects is given in section 7.1 of this report.

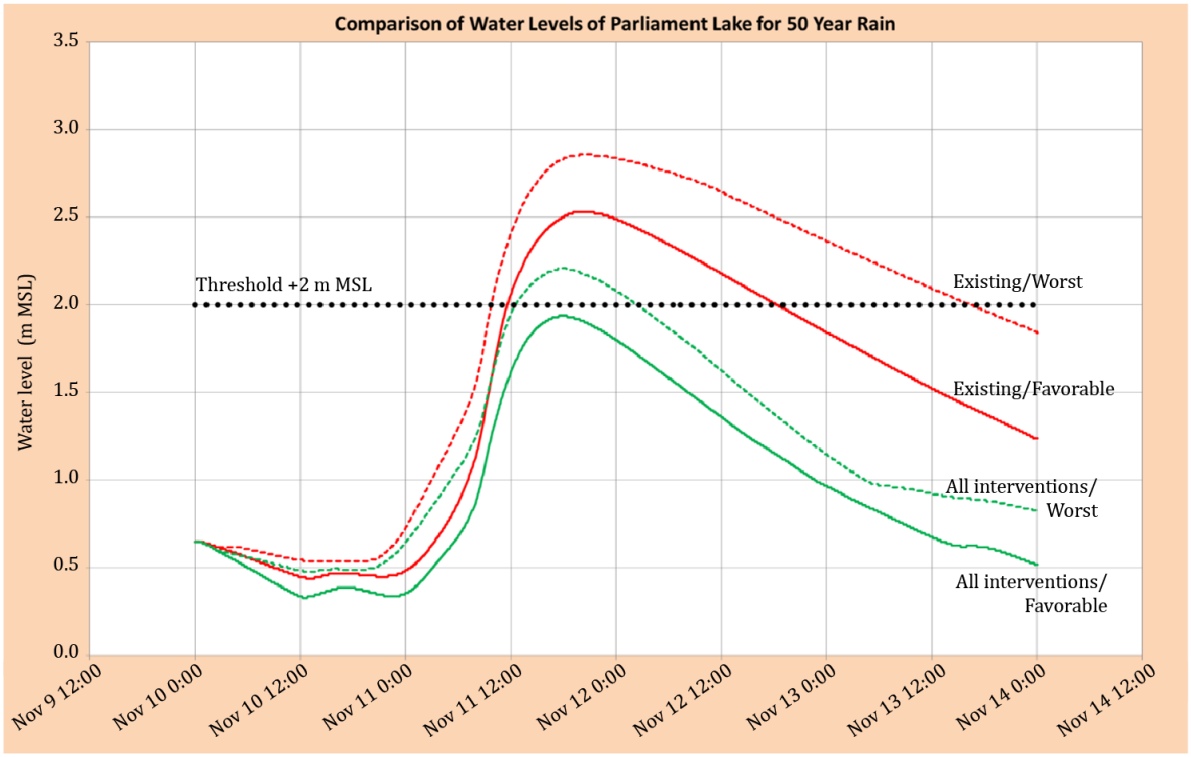


Figure 6.12 Water level variation of Parliament Lake for once in 50-year storm

For the micro-drainage system of CMC, a selected sub-catchment with observed localized floods was selected to be studied under MCUDP. The hydrological models were set up accordingly and boundary conditions were obtained from main canal models wherever necessary.

6.5. Flood Risk Assessment

A risk-based flood risk assessment was carried out for the Metro Colombo water basin (during 2016-2017) under a Japan Policy and Human Resources Development (PHRD) Grant, and Deltares from the Netherlands was the Consultant. A comprehensive probabilistic analysis was carried out with assigning frequencies of each forcing factor (i.e., rainfall, Kelani discharge, tide, initial conditions) and eventually, 88 scenarios with a combined probability were shortlisted to be simulated, as shown in Table 6.3.

Table 6.3 Scenarios to be simulated for different combinations of forcing factors

Tide (m+MSL)	Discharge (m^3/s)	Rain (mm)	Initial conditions
0.4	300	20	wet
0.6	800	155 (T=2)	dry
	1500	255 (T=10)	
	2500	370 (T=25)	
		480 (T=50)	
		635 (T=100)	
2*4*6*2 = 96 simulations. 8 not important -> 88 simulations			

Once the inundation maps are created, they were converted to damage maps using land use maps and vulnerability curves and finally, the Expected Annual Damage (EAD) was calculated integrating the damage vs probability curve, as shown in Figure 6.13.

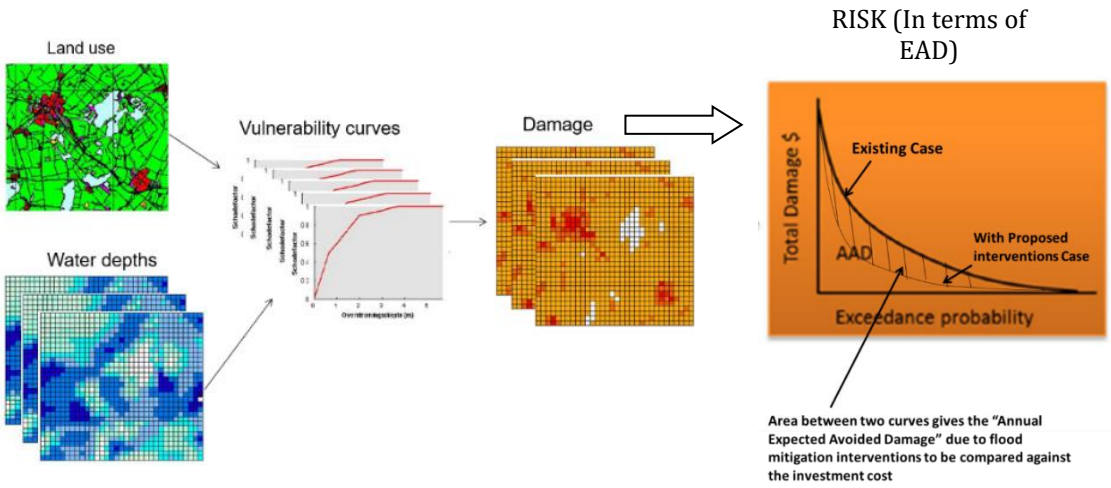


Figure 6.13 Risk evaluation methodology

Since the Metro Colombo water basin is the most urbanized and rapidly growing area in the country, the future Gross Domestic Product (GDP) growth has also been considered for extrapolating the existing risk for future damage using the GDP growth projections proposed by Shared Socioeconomic Pathways (SSP, 2017) for the entire world and considered 05 SSP scenarios based on different GDP projections. As the risk calculation only includes direct tangible damages, an allowance has also been made for indirect, intangible damages.

It has been estimated that the Expected Annual Damage (EAD) due to floods in the CM area is around LKR 2,300 million (USD 11.22 million as at December 2021, assuming an exchange rate of 1 USD = 250 LKR).

6.6. Wetland Management Strategy

6.6.1. Introduction

The wetlands in Metro Colombo water basin offers many ecosystem values ranging from flood storage and ecological significance to eco-tourism and climate regulation. A detailed ecosystem service analysis of the Colombo wetlands had been carried out under the "Metro Colombo Wetland Management Strategy" by Signes of France in January 2016 carried out as part of Metro Colombo Urban Development Project (MCUDP) with the objective of formulating a strategy on conservation and effective usage of Colombo wetlands.

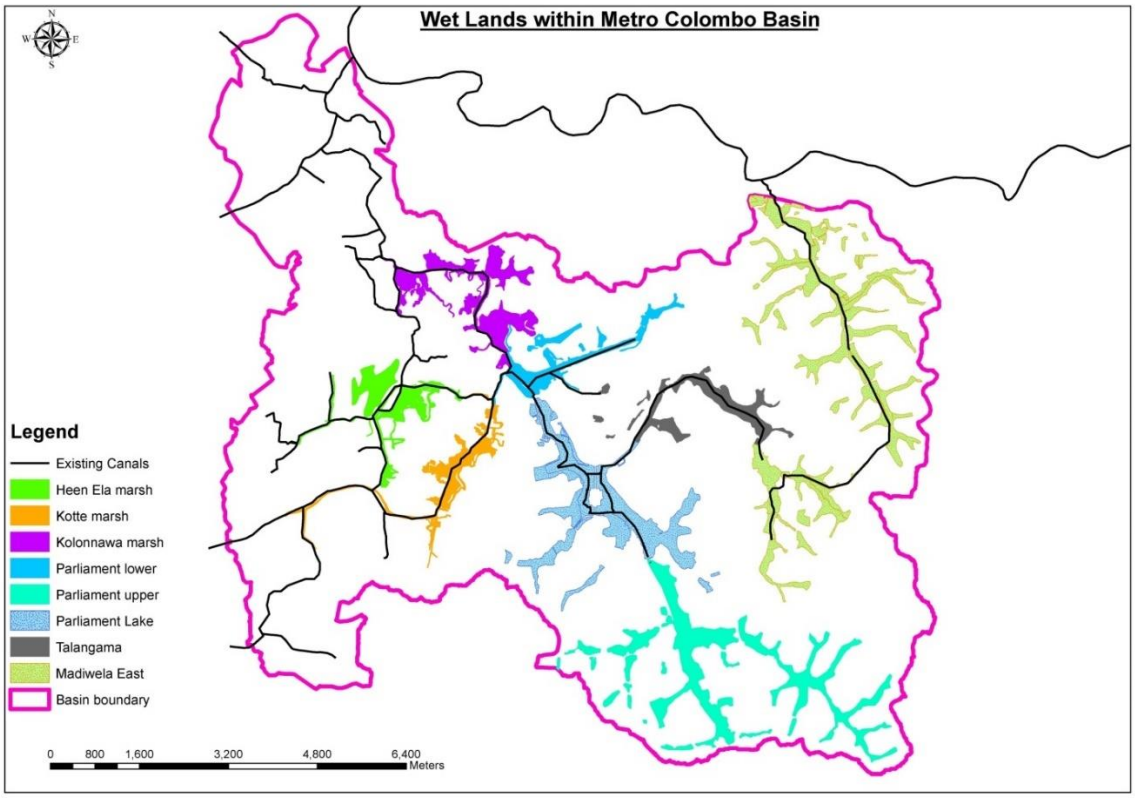


Figure 6.14 Wetlands and Canals in Metro Colombo Water Basin

6.6.2. Effect of wetlands in terms of flood water storage

The drainage assessment for Metro Colombo water basin under MCUDP indicates that approximately one third of the runoff generated during extreme rainfall events gets stored in existing wetlands. Therefore, it was emphasized that the present flood investments must be combined with preservation of wetlands for a flood free city and outfall enhancements alone would not be adequate.

Further, it was further established the importance of the Colombo wetlands considering the future flood damage combined with climate change.

In this analysis, No. of existing scenarios were simulated under future climate with loss of wetlands and the economic value of the flood damage of each scenario was calculated in terms of monetary values. The conclusions of this study can be outlined as follows.

- The existed floods in the Metro Colombo water basin were mitigated through MCUDP interventions and flood levels were reduced. However, if wetlands were reduced, the water levels for these scenarios may go beyond safety levels and the effect of MCUDP interventions may not be enough to achieve the flood safety. If there is a significant wetland loss, the water levels rise even higher than the pre-MCUDP condition and therefore wetlands must be protected for the flood safety of the basin.
- The economic damage of each future scenarios was calculated with wetland loss. It is evident that an economic benefit can also be gained by developing existing wetlands. However, when the economic tradeoff between these two is concerned, the future flood damage in monitory terms is much higher than the present development benefit and therefore, wetlands must be preserved.

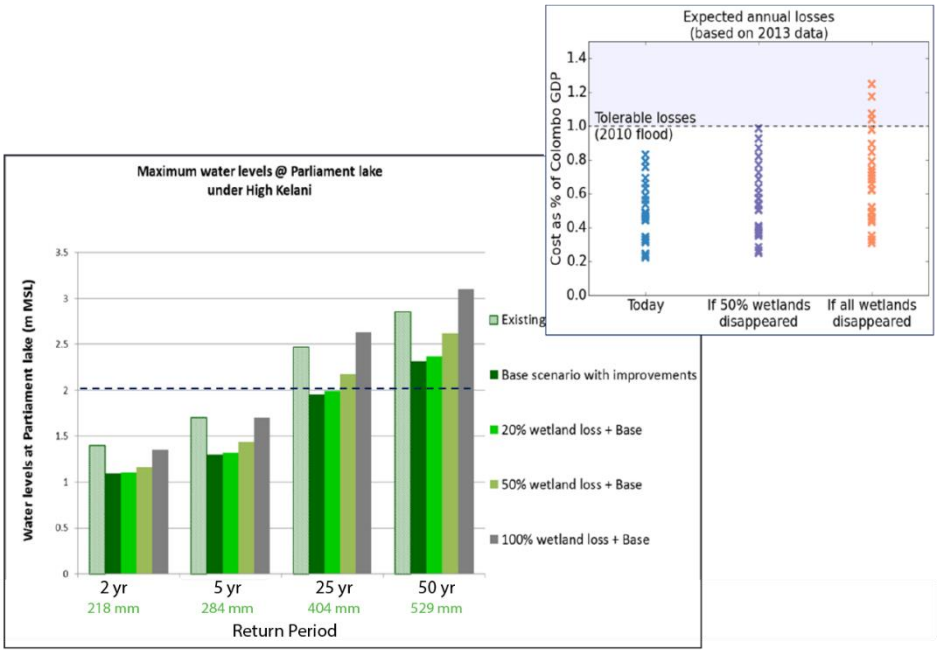


Figure 6.15 Estimation of Significance of wetlands for flood storage with future climate change (Source: Julie Rozenberg et al, 2015)

This study has been conducted only considering the benefit of wetlands for flood mitigation. However, there are many more other eco – system values are provided by Colombo wetlands in addition to the flood mitigation which further justify the preservation of existing wetlands.

A comprehensive analysis on all the ecosystem values of Colombo wetlands were carried out under "Colombo Wetland Management Strategy Project" and a mechanism for the sustainability of Colombo wetlands were formulated.

6.6.3. Wetland Management Strategy (WMS)

The WMS developed under Colombo wetland management strategy project was rested on five strategic objectives to achieve WMS goal. Numerous initiatives were recommended achieve those strategic objectives.

Figure 6.16 Strategic Objectives for wise use of Colombo Wetlands (Source: Metro Colombo Wetland Management Strategy by Signes, 2016)

7. Methodology of Selecting Sub-projects

This section describes the rationale behind the selection of each intervention that was implemented as a sub-project of MCUDP.

To respond to the issues and challenges discussed in preceding chapters, a series of flood mitigation measures were implemented under Component 1 of MCUDP, in order to reduce the area under risk of flooding (50-year return period) by 3 km^2, while meeting the Intermediate Result Indicators.

Under Component 2, main PDO was set to assess the quality of the roads maintained by the four PLAs, taking improvements done by the project as a demonstration.

7.1. Sub-component 1.1: Interventions on Macro-drainage

An initial list of sub-projects is given in the Project Appraisal Document (page Nos. 25 and 26). Consequent to the detailed study as described in Chapter 6 of this report, this list was further refined and a prioritized list of sub-projects was agreed upon for implementation. Meeting the PDOs and intermediate results indicators and managing the cost within the allocation for this sub-component were important considerations in finalizing the list. Certain schemes were subdivided into several contract packages for easy implementation. Annex 1: explains the rationale behind the changes from the PAD list to the final list which was implemented. Table 7.1 contains the final list of implemented sub-projects and the location map is given in Figure 7.1.

As mentioned in section 6.4.5, Madiwela South Diversion is the highest ranked intervention in terms of outflow enhancement and flood level reduction. However, according to the Aide Memoire of Mid Term Review (Nov-Dec 2014), this intervention was supposed to be implemented as part of another development project, i.e., Weras Ganga Project, which has been undertaken separately by SLLDC.

Table 7.1 List of Sub-projects Implemented under Sub-component 1.1

No.	Sub-project ID	Sub-project
1	SLLRDC/W/01	Canal bank protection work of Dehiwala Canal
2	SLLRDC/W/02	Aluth Mawatha Culvert, Mutwal Box Drain and Ext. Mutwal outfall
3	SLLRDC/W/03-A	Rehabilitation of St. Sebastian South Canal
4	SLLRDC/W/05	Improvements to Madiwela East Diversion Scheme - I
5	SLLRDC/W/07-A	Conveyance improvements to Wellawatta Canal at Galle Rd Bridge
6	SLLRDC/W/09	Construction of Bank Protection works of St. Sebastian North Canal.
7	SLLRDC/W/11	Improvements to Madiwela East Diversion Scheme - II
8	SLLRDC/W/12	Design & building of St. Sebastian North Lock Gates & Pumping Station
9	SLLRDC/W/13	Design & Building of St. Sebastian South Stormwater Pumping Station
10	SLLRDC/W/14	Design & Building of New Mutwal & Torrington Tunnels
11	SLLRDC/W/16-A	Kolonnawa Canal Diversion Scheme Stage - I
12	SLLRDC/W/16-B	Kolonnawa Canal Diversion Scheme Stage - II
13	SLLRDC/W/16-C	Kolonnawa Canal Diversion Scheme Stage - III
14	SLLRDC/W/16-D	Kolonnawa Canal Diversion Scheme Stage - IV
15	SLLRDC/W/19	Improvements to Madiwela East Diversion Scheme - III
16	SLLRDC/W/20	Installation of Flushing Gates for Water Quality Improvement
17	SLLRDC/W/23	Dredging of Thalangama Tank
18	SLLRDC/W/24	Design & Building of Ambathale Stormwater Pumping Station
19	PMU/W/01	Construction of Flood gate at Thalangama tank and culvert at Bauddhaloka Mawatha
20	CMC/W/SD/01	Improvement to distributed sewerage network around Beira Lake

Sub project No. 16 – (W/20) Installation of Flushing gates mostly comes under sub component 1.3 as it contributes to water quality improvement in the canal system and it is explained under 7.3

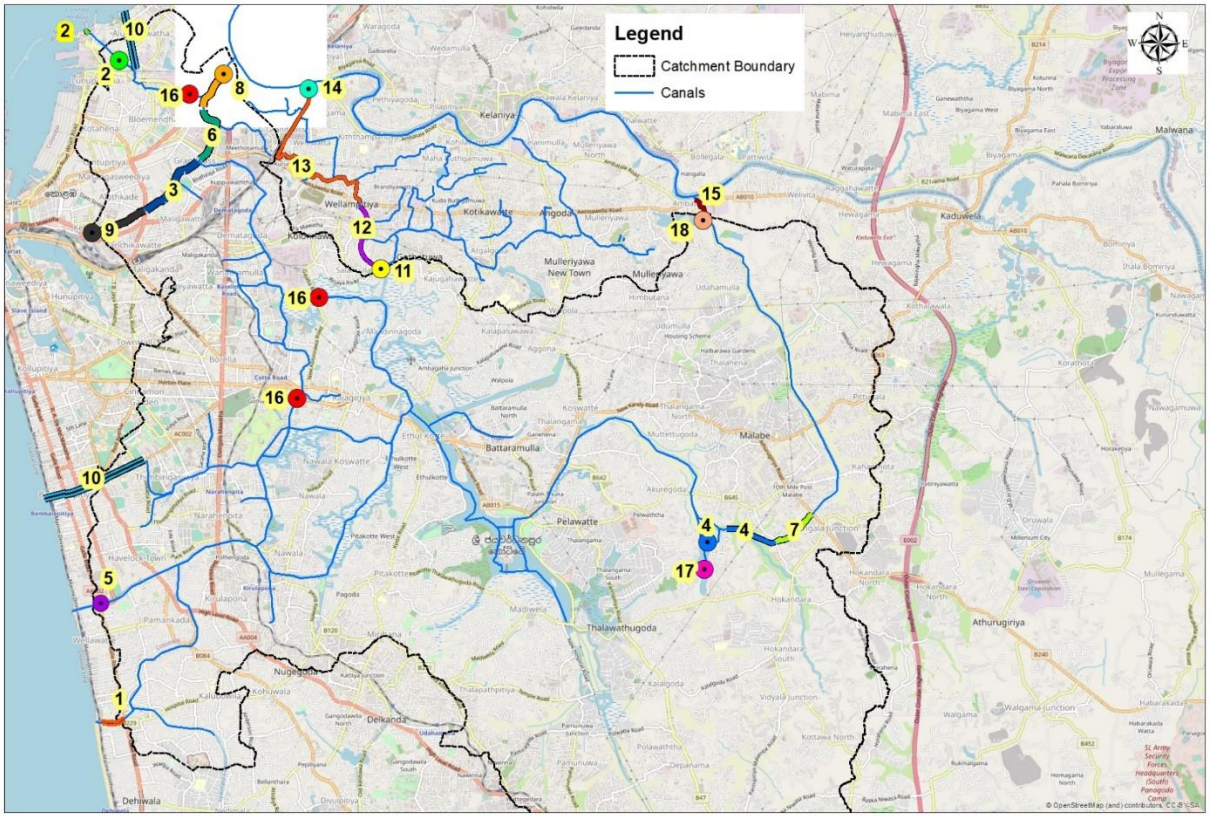


Figure 7.1 Location Map of Intervention Packages for Macro-drainage System

7.2. Sub-component 1.2: Interventions on Micro-drainage

A number of areas in which localized flooding to be addressed have been identified in the PAD, based on the proposals submitted by the government via the report titled "Proposed Remedial Measures for Floods in the Colombo City (March 2011)". From these areas, improvements to drainage in Marine Drive was implemented as a front-runner project. During the Mid-Term Review, the other areas were revisited and ranked after evaluating several aspects such as extent of flooding, expected damage, implementation of social management framework, progress in design, estimated cost, unforeseen utility issues and timeline of implementation. In addition, Kynsey Road junction and Devi Balika junction along Parliament Road were added to the originally selected schemes in order to provide flood free access to the Parliament area.

CMC was the PIA for this sub-component (1.2), and sub-projects listed in Table 7.2 have been identified for the upgrading of the micro drainage system. Location map is given in Figure 7.2.

Table 7.2 List of Sub-projects Implemented under Sub-component 1.2

No.	Sub-project ID	Sub-project
21	CMC/W/MD/02	Improvements to storm water drains in catchment 2 & 3 (revised package) of Marine Drive
22	CMC/W/MD/03	Rehabilitation of Gregory's Canal
23	CMC/W/MD/04-B	Improvements to Norris Canal
24	CMC/W/MD/12	Improvements to Kinsey Rd Drain
25	CMC/W/MD/13	Improvements to Devi Balika Drain
	SLLRDC/W/14	Torrington tunnel network in sub-project "Design & Building of New Mutwal & Torrington Tunnels"

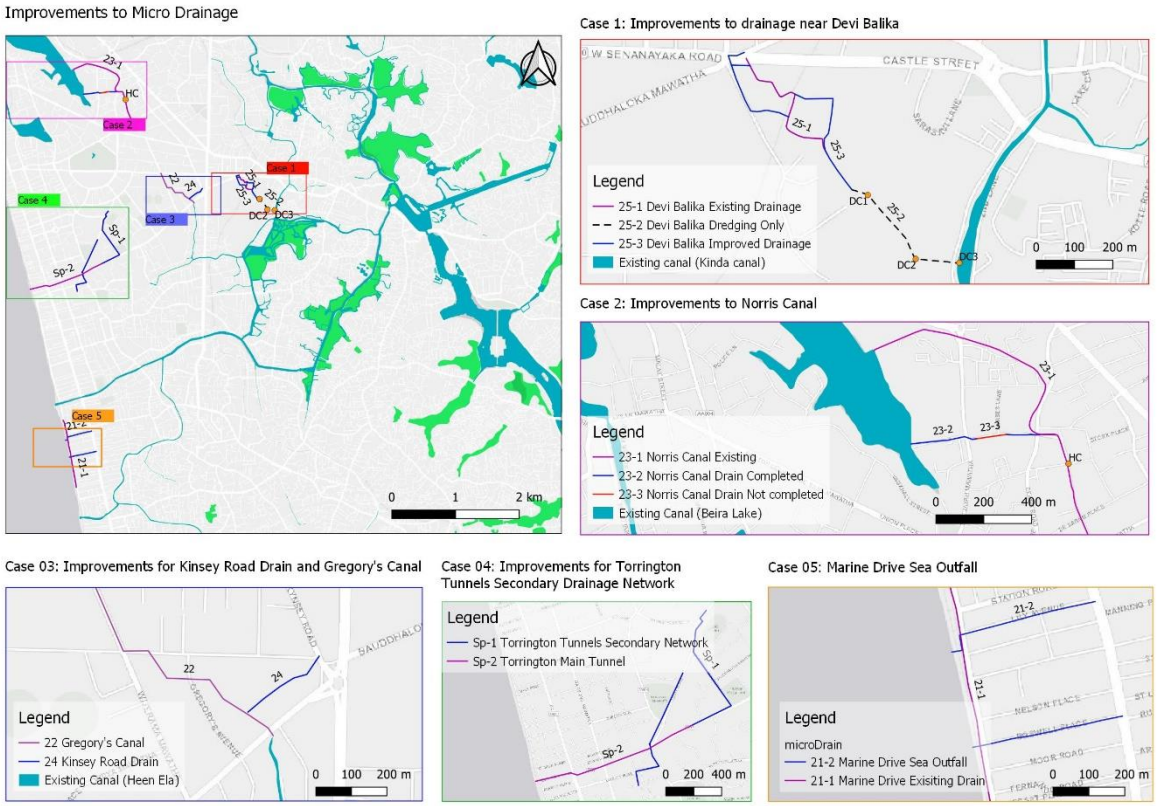


Figure 7.2 Location Map of Intervention Packages for Micro-drainage System

Note on Saunders

MCUDP planned to construct an underground stormwater retaining structure below the Saunders playground with the improvement to the existing drainage as a solution to the flooding near Pettah bus stand and surrounding areas. The ground is used as a football playground. Saunders Sports Club was identified as the main group affected for the duration of the construction. MCUDP proposed to allocate an alternative ground for the sports club to continue their practices during the construction. MCUDP also agreed to upgrade the playground into an international standard with a subsurface drainage system through the same subproject. Sports club agreed to the alternative arrangement initially, however later came up with a strong objection in writing before awarding the contract. Their concern was that, the players may demotivate and may face social issues by moving into an alternative ground and hence came up with the objection.

The status of the project was discussed at a special meeting held at Ministry of Finance & Mass Media with World Bank on 31st January 2019. The following points were discussed:

- Having agreed earlier the Saunders Sports Club brought up objections recently mentioning that they are unable to practice during the construction period.
- Further they refused to move to an alternative ground during the construction. (Their opinion was that the players may demotivate and may face social issues by moving into an alternative ground).

Considering the above facts and total time requirement to renegotiate with them and complete the construction, World Bank and the Ministry of Finance & Mass Media together with the MMWD decided to cancel the subproject.

7.3. Sub-component 1.3: Capacity Enhancement for Flood and Drainage Management

Establishment of Integrated Flood Management System (IFMS)

IFMS is established as a state-of-the-art flood control and water management center in the Metro Colombo to operationalize the flood control structures such as stormwater pumping stations, flood control gates and other water storages. The objectives of the IFMS are:

1. To monitor and control flood control interventions
2. To establish a flood early warning system
3. To implement a hydro-meteorological monitoring system
4. To disseminate information to public and stakeholders

For this purpose, a Real Time Control Center (RTC) was formed, and its main functions and operations can be categorized into the following core components.

1. Component A: Building and maintaining the main physical infrastructure of the RTC
2. Component B: Establishing the computing and analysis infrastructure
3. Component C: Preparation of forecasting, risk assessment and operational guidance system
4. Component D: Integrating the monitoring (rainfall, water levels) and control (gates and pumps) functionalities to the RTC
5. Component E: Working on stakeholder collaboration, information sharing and real-time information assimilation

Under the above components, the RTC now has 50 weather monitoring stations, 40 of those situated within the Kelani River Basin or in the Metro Colombo area, while the remaining 10 are situated spread over the country. At the same time, 33 water level gauges are placed to monitor the water level in canals in Colombo, as well as the water level of the Kelani River at selected locations. These telemetric stations report their respective data to the center owned cloud hosted databases in real-time.

Simultaneously, the center runs automated real time forecasts of the water levels of the canals and the rivers, making it possible to provide necessary early warnings and recommendations to the relevant stakeholders, especially for the flood control interventions to optimize their controlling strategies. The center staff will also be engaged in doing manual forecasts, as a part of verification of the forecasts at critical events. The center will also engage in the integrations of the operation and monitoring activities of the flood controlling interventions. The center is also equipped to provide necessary damage assessments, do flood surveillance, and flow measurements in the canal system using state of the art tools and equipment available at the center.

Purchase of machinery and equipment to SLLDC for maintenance of main drainage system

Details of machinery and equipment procured for SLLDC are given in Table 7.3.

Table 7.3 Details of Machinery and Equipment Procured for SLLDC

Ref. No.	Description
SLLRDC/G/01	Procurement of Dredging Equipment
SLLRDC/G/02 & 02A	Procurement of Transport and Utility Vehicles
SLLRDC/G/03 & 03A	Procurement of Testing Equipment and Instrument
SLLRDC/G/04 & 04A	Procurement of Construction Equipment
SLLRDC/G/06	Procurement of Workshop Tools
SLLRDC/G/08	Procurement of Equipment for Development of RTC System

In addition, several Engineering software including hydrology and hydraulic modeling software (MIKE 11, MIKE URBAN and MIKE 2D) were also procured under this sub-component.

Installation of Flushing Gates in the Macro Drainage System

Table 7.4 Installation of Flushing Gates in the Macro Drainage System

No.	Sub project ID	Sub Project
16	SLLRDC/W/20	Installation of Flushing Gates for Water Quality Improvement

Most of the canals in the northern section of Colombo canal system are heavily polluted, mainly during the dry season, and thus a cleaning process is required. Therefore, it was proposed to construct flow control gates at three (3) identified locations to isolate the polluted canals, pump fresh water from Kelani River into the canal system (up to 1.2m MSL) using reverse pumping at North Lock Pumping Station, and flush the system to the sea by opening the gate at Port Access Road. Locations proposed for installation of such gates are shown in Figure 7.3.

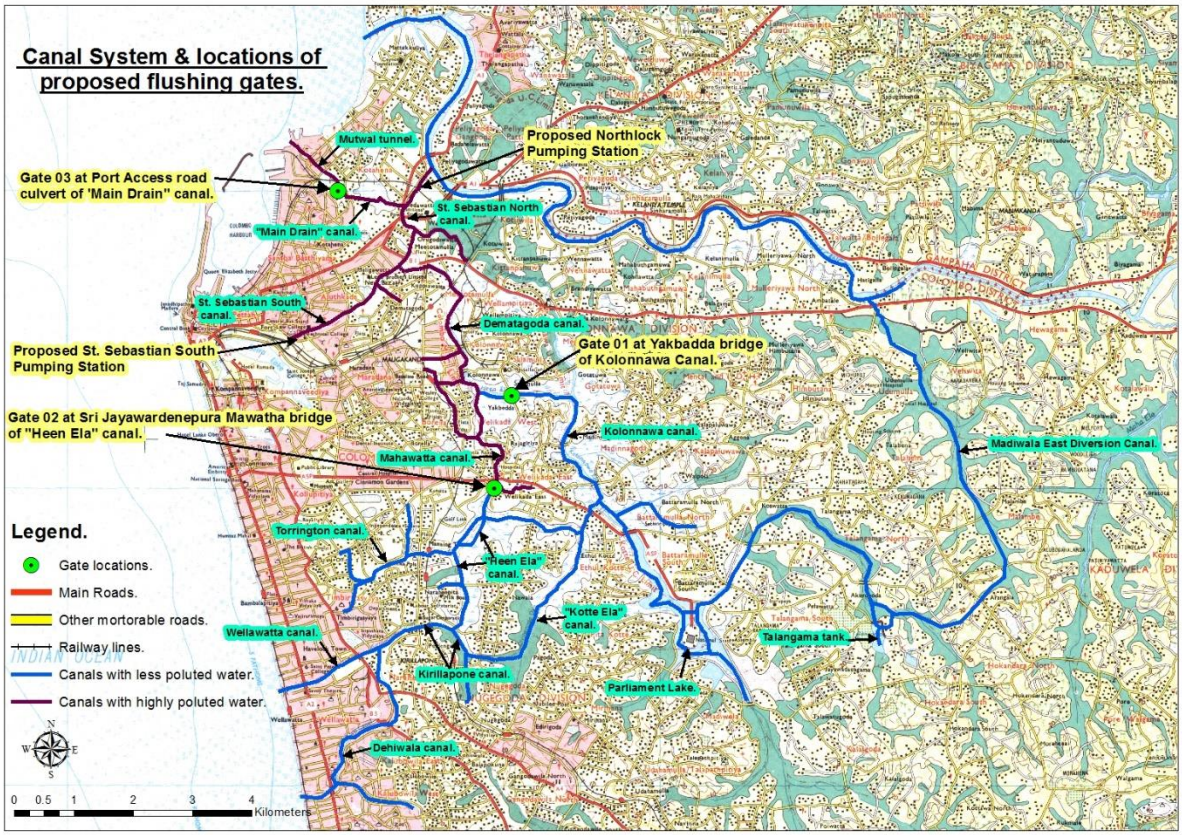


Figure 7.3 Locations of Flushing Gates

7.4. Sub-component 1.4: Beira Lake Linear Park and Beddagana Park

This sub-component aimed at complementing the flood reduction measures undertaken under Component 1 by providing opportunities for urban regeneration along Beira Lake waterfronts with public access to the lake along a linear park, and ensuring the protection of Beddagana wetland sanctuary and Kotte Ramparts from encroachments, enabling it to function as a flood retention area and protecting historic areas in the vicinity while providing opportunities for recreational and eco-tourism activities. The interventions under this sub-component were selected and planned considering the findings of the baseline user satisfaction survey.

Table 7.5 contains the final list of implemented sub-projects.

Table 7.5 List of sub-projects implemented under sub-component 1.4

No.	Sub-project ID	Sub-project
26	UDA/W/01-A	Development of Beddagana Bio-diversity Park
27	UDA/W/01-B	Development of Bio-diversity Park at Kotte Rampart
28	UDA/W/01-C	Construction of Cycle Track and Jogging Trail at Nippon Mawatha
29	UDA/W/02	Development of McCallum Entrance Park
30	UDA/W/03-A	Construction of Bank Protection of Eastern Bank of East Beira Lake – 1.2km
31	UDA/W/03-B	Construction of Bank Protection of Western Bank of West Beira Lake – 1.05km
32	UDA/W/03-C	Construction of Bank Protection of Eastern Bank of West Beira Lake – 1.2km
33	UDA/W/04-A	Construction of Linear Park along Beira Lake – Stage I
34	UDA/W/04-C	Construction of Linear Park along Beira Lake – Stage II
35	UDA/W/04-D	Construction of Linear Park along Beira Lake – Stage III

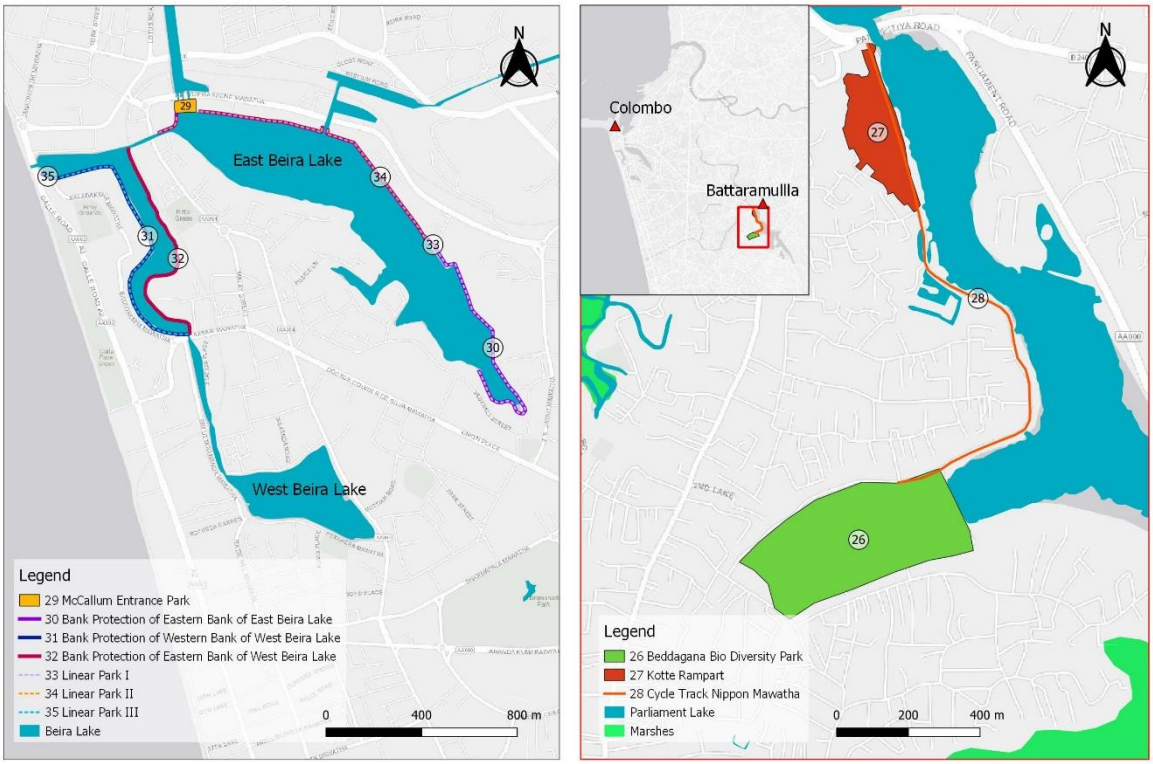


Figure 7.4 Location Map of Intervention Packages for Sub-component 1.4

7.5. Sub-component 2.1: Investment Support to Local Authorities

Under sub-component 2.1, it was aimed to support the rehabilitation, improvement and management of local infrastructure services of the four (4) Project Local Authorities (PLAs). The priority investments had been identified upfront by the PLAs. The planned developments targeted improving the recreational facilities, enhancing public services and strengthening the capacity of the local government authorities through selected demonstration projects.

Walkability Improvement and Rehabilitation of Roads

One of the main tasks of component 2.1 was to upgrade the road network to international standards, which also included comfortable pedestrian foot paths at either side of the road to improve walkability. Roads interconnecting recreational facilities were also selected for upgrading, in order to improve accessibility of these recreational facilities to the general public, facilitating cycling, promoting greener transportation and

healthy physical activities, and attracting tourists who enjoy cycling. Parks have been selected to be upgraded for the residents and the visitors to escape from the stressful lifestyle.

At the initial stage, many roads were proposed to rehabilitate under MCUDP. For the final selection of roads, main parameters such as Roughness value of the existing road, Traffic volume and Connectivity to public places developed under MCUDP were considered
The following are some special features of improvements:

- Galle Road and R. A. De Mel Mawatha were selected due to being main arteries within the city near the coastal line
- The roads were made one-way, and new traffic diversion plan was introduced
- Pelican crossings with synchronization were introduced
- Signalized roundabouts with latest technology were introduced, e.g., Lake House and Slave Island

Improvement of Public Convenience Facilities

A survey was done for all existing public toilet locations within the Colombo city and to identify the need of new locations, based on usage, in order to provide clean hygienic sanitation facilities to the general public who visit the Colombo city for various needs. The final locations were selected based on the results of the above survey. Parameters considered for the selection were; number of people using, unavailability of toilets, proximity to public places, etc. Accordingly, Public convenience complexes with all necessary facilities have been planned where needed and existing facilities have been selected for improvement.

List of sub-projects under this sub-component is given in Table 7.5.

Table 7.6 List of sub-projects implemented under sub-component 2.1

No.	Sub-project ID	Sub-project
36	CMC/W/01	Improvement to Public Convenience – Package I
37	CMC/W/02	Walkability Improvement & Asphalt Overlaying – Package I
38	CMC/W/03	Improvement to Public Convenience – Package II
39	CMC/W/03-A	Improvement to Public Convenience – Package III
40	CMC/W/04	Walkability Improvement & Asphalt Overlaying – Package II
41	CMC/W/06	Model Zone Development in Town Hall – Package II
42	CMC/W/07	Model Zone Development in Town Hall – Package III
43	CMC/W/08	Walkability Improvement & Asphalt Overlaying – Package III
44	CMC/W/09	Model Zone Development in Town Hall – Package I
45	CMC/W/12-A	Rehabilitation of Galle Road and R. A. De Mel Mawatha – Package A
46	CMC/W/12-B	Rehabilitation of Galle Road and R. A. De Mel Mawatha – Package B
47	CMC/W/12-C	Rehabilitation of Galle Road and R. A. De Mel Mawatha – Package C
48	CMC/W/13-A	Construction of Beach Park at Crow Island
49	DMMC/W/01	Infrastructure Development in DMMC – Package I (Roads development)
50	DMMC/W/02	Infrastructure Development in DMMC – Package II (Roads development)
51	DMMC/W/03	Infrastructure Development in DMMC – Package III (Building & vehicle hangar)
52	KUC/W/01	Infrastructure Development in KUC – Package I
53	SJKMC/W/01	Infrastructure Development in SJKMC – Package I (Roads development)
54	SJKMC/W/02	Infrastructure Development in SJKMC – Package II
55	SJKMC/W/03	Infrastructure Development in SJKMC – Package III

Pedestrian Overhead Bridges at Kollupitiya & Bambalapitiya Intersections with Galle Road

Intention of the planned developments was to facilitate ease and safe movement between the railway stations and bus terminals. The designs were completed for the two pedestrian overhead bridges through a consultancy firm. With the change of government, the Megapolis concept was introduced for Colombo and new development plans emerged. The LRT (Light Rail Track) resurfaced as a priority. However, the

footprint of LRT was not finalized at that time. Due to the possible collision of development plans, the two bridges (which are permanent structures) were not constructed.

Marine Drive Promenade with Beach Front Leisure Park

Conceptual designs were completed for the Marine Drive Promenade with Beach Front Leisure Park. However, it was not developed due to the accessibility issue and funding limitations. Construction of the access to the anticipated park on the other side of the railway line was expensive.

Further to that, PLAs also identified required machinery and equipment for street and drainage maintenance works and for solid waste collection.

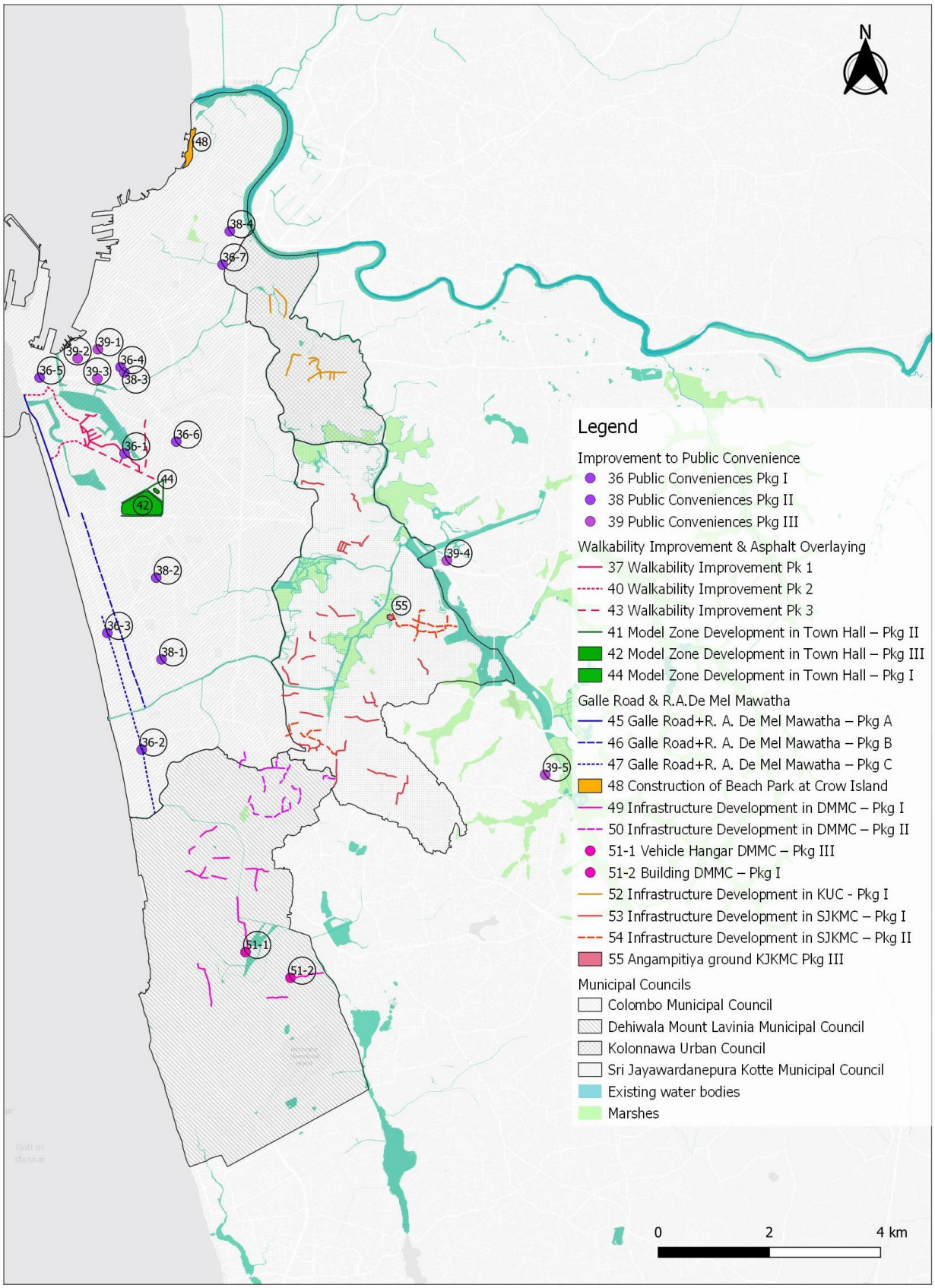


Figure 7.5 Location Map of Intervention Packages for Sub-component 2.1

7.6. Sub-component 2.2: Institutional Strengthening and Capacity Building for Local Authorities

Following activities were proposed in the PAD under this sub-component.

Urban road asset management

Developing and operating an urban road asset management system was identified as a priority under sub-component 2.2. The procurement process was started for the selection of a suitable consultancy firm for this purpose. It was also identified that without a trained dedicated team, the PLAs will not be able to make use of the urban road asset management system created by the consultancy firm. The requirement of a separate team with professionals with required competencies was also identified and this team should have been trained (including on the job training) by the consultant in parallel to the developing of the system. The efforts both the CMC and the MoMWD taken to obtain approval to the additional cadre provision for the Urban Road Asset Management unit at CMC, (from the Department of Management Services) was not successful. The team should have been onboard before the Consultant initiate the development of the asset management system. However, no approval was received and CMC could not establish a team for this task. Without a trained dedicated team, a developed system would become a waste, not being able to make use of it. Considering the lack of readiness, and after discussing with the World bank team and the National Steering committee for MCUDP, the decision was made not to proceed with the recruitment of the consultancy firm, which was already at the last stage of the procurement process.

Integrated metro-level GIS platform

"Integrated Metro-level GIS Platform" was planned to develop an integrated GIS platform targeting cadastre management as a revenue enhancement tool and sharing of data across local authorities and central agencies. "Supporting Metropolitan Development Strategies and Planning" was aimed at development of strategies, master plans and relevant detailed studies. It planned development of a "Metropolitan Colombo City Development Strategy (MCCDS)", "Development of an integrated Master Plan for the (CMR)", "Development of a Solid Management (SWM) strategy and relevant detailed studies.

However, these changed with the "Metro Colombo Transformation Platform (MCTP)" initiative of the Ministry of Megapolis and Western Development (MoMWD). The MoMWD was formed in September 2015 with the mission "to accomplish economic prosperity and enhance quality of life" which became the line ministry for MCUDP since it was formed.

The GoSL requested the Bank support to develop a programmatic platform for an integrated view of policy reforms and investment, and to prioritize and sequence interventions for the sustainable development of Metro Colombo. As a result, a World Bank mission visited Sri Lanka in August and then in November 2017 for the proposed Metro Colombo Transformation Platform (MCTP), which is a technical support program. The MoMWD was the main counterpart and facilitated these missions. MCTP was a separate initiative than MCUDP though facilitated by the same ministry.

The mission activities in November 2017 included: CityNet Congress, Stakeholder Outreach and Roundtable Discussions, Institutional Architecture Study, Data Platform and Capital Investment Plan. Regarding the Data Platform, mission held a workshop on Megapolis Spatial Data Platform (MSDP) which was agreed as a key priority during the MCTP mission in August 2017 which also aligns with the Strategy and roadmap of the Sri Lanka Spatial Data Infrastructure (SLSDI). MCTP mission met with a much wider group than MCUDP consisted with high-ranking officials from Ministry of Megapolis and Western Development, Colombo Municipal Council, Department of National Planning, External Resources Department, Kotte Municipal Council, Ministry of Land, Ministry of Provincial Council & Local Government,

National Water Supply & Drainage Board, Roads Development Authority, Sri Lanka Land Reclamation Development Corporation and Urban Development Authority.

(Source: Aide Memoire, Metro Colombo Transformation Platform, November 1-17,2017)

This initiative overshadowed and overtook the scope planned under "Integrated Metro-level GIS Platform" and "Supporting Metropolitan Development Strategies and Planning" within sub-component 2.2.

Solid waste management strategy - feasibility and action plan

One of the most critical problems emerging from rapid urban expansion in Colombo and its suburbs is the unavailability of an environmentally acceptable disposal system for Municipal Solid Waste (MSW). Using open dumping of MSW could cause contamination of soil and groundwater and threaten human health directly and indirectly. Thus, Government of Sri Lanka (GOSL) and Metro Colombo Urban Development Project (MCUDP) have concurred that a sanitary landfill is the most appropriate (environmentally and economically) long-term solution for the management of MSW generated in the MCR after considering various MSW management options.

A consultancy firm was hired under MCUDP for the **"***Feasibility Study for a Municipal Solid Waste Disposal System Including Sanitary Landfill, Transfer Station, Rail Transportation Improvements and Preparation of Tender Documents for a Design & Build Contract***"**.

The scope of the feasibility study consists of two phases. The first phase has six (6) different parts conducted in parallel and in an iterative manner as follows:

1. Overview of the current SWM situation in the MCR, waste characteristics and potential waste treatment options
2. Feasibility and preliminary design for the transfer station
3. Waste transportation
4. Field investigations to verify the suitability as the disposal site and conduct preliminary design for sanitary landfill
5. Public perception management
6. Overall project cost estimates and operation costs

The feasibility study report submitted by the consultant consists of three volumes;

- Volume 1: Feasibility Study Report (Main Report)
- Volume 2: Conceptual Design Drawings
- Volume 3: Results of Site Surveys

The required Environmental Impact Assessment (EIA) for the project was also carried out.

By letter dated 27th December 2016, above documents prepared under Metro Colombo Urban Development Project were officially handed over to Metro Colombo Solid Waste Management Project under the Ministry of Megapolis and Western Development (same line ministry).

8. Preliminary and Detailed Designs

Stormwater Pumping Stations

Once the decision of implementation of pumping stations has been taken, the basin scale flood model provided the required design capacities. St. Sebastian North Lock pumping station (capacity: 30m^3/s) and Ambathale pumping station (capacity: 20m^3/s) were the two initial pumping stations decided to be proceeded with preliminary designs.

Since the flood model only determined the required capacity, a preliminary design of such a large-scale pumping station was required prior to the detailed designs in order to finalize the basic design parameters for the implementation contractor.

Kunhwa Engineering and Consulting Co., Ltd., of Korea was appointed as the consultant during the period of 2014-2015, for the preliminary design works of the above two pumping stations and their work scope included carrying out an option study and finalize the basic general layout of the pumping station inclusive of the number of pumps and capacity per pump, Determination of required pump heads, initial pump selection and verify the structural sizing, general orientation of civil structures, Detailing of Mechanical and Electrical items and Preparation of tender documents for selection of a "Design and Build" Contractor.

During the latter stages, another pumping station, i.e., St. Sebastian South Pumping Station (capacity: 10m^3/s) was also added to the list of interventions. For this, preliminary design and preparation of tender documents were carried out by SLLDC in-house technical team, making use of the knowledge and experience obtained in working together with the consultant (as described above) for the other two pumping stations.

Stormwater Tunnels

Geodata S.p.A. of Italy was appointed during 2015 to carry out a review of the bidding document prepared for tunneling works, and their work scope included; Carrying out a review of all documents, studies, conceptual designs, etc., prepared by the former individual consultant and the team assigned to him, and preparing an Information Review Report for each tunnel, carrying out geotechnical investigations and preparing a Geotechnical Baseline Report (GBR) for each tunnel, preparation of a Risk Management Strategy for each tunnel and review and finalize tender documents for both tunnels to be constructed on "Design and Build" basis under one contract package.

Other Interventions under Macro-Drainage

Except for the Flushing Gates sub-project, all conceptual, preliminary and detailed designs of all other macro-drainage interventions were carried out by in-house Engineers of SLLDC who had been seconded to MCUDP on full-time basis. For the structural design of some of the major structures, service of a local Structural Design Consultant on part time basis was obtained. In addition to the designs, preparation of specifications, procurement documents and tender drawings was also done by SLLDC in-house technical team. Construction supervision and contract management of all those interventions, except for three (3) sub-projects coming under Kolonnawa Canal Diversion (KCD) Scheme, was also carried out by SLLDC technical team. A Consultant was hired for the Construction Supervision of above three (3) sub projects as many projects were implemented parallelly and inhouse technical team was not adequate to do direct Construction Supervision.

For the Flushing Gates sub-project, a consultancy firm was hired for detailed design and construction supervision.

Micro-Drainage

All conceptual, preliminary and detailed designs of all micro-drainage interventions were carried out by in-house Engineers of CMC who had been seconded to MCUDP on part-time basis. In addition to the designs, preparation of specifications, procurement documents and tender drawings was also done by CMC in-house technical team with the support of PMU. Services of local individual consultants (part time basis) were obtained for aspects such as hydrological modeling, drainage designs and structural design.

Construction supervision and contract management of Marine Drive Drainage, Gregory's road drainage were carried out by CMC technical team with the support of PMU while two (2) Consultancy firms were hired for Devi Balika, Kinsey and Norris sub projects.

Integrated Flood Management System (IFMS)

Services of an external consultant was obtained for the formulation of the Integrated Flood Management System (IFMS). Two (2) SLLDC Engineers were released on full-time basis to support the consultant, and a team of young Engineers specialized in areas such as hydrological modeling, electronics and telecommunication engineering, computer engineering, information technology, etc., were hired on contract basis to support the design and implementation of IFMS. During the final stage of MCUDP, several of those Engineers were absorbed into SLLDC permanent cadre, in order to facilitate the effective transfer of project outcomes into routine operations of SLLDC.

Waterfront Development (Beira Lake) and Wetland Park Development

Concept and the architectural and landscape designs of Beira Lake Linear Park, Beddagana Wetland Park and Kotte Ramparts Wetland Park were carried out by UDA, in accordance with design guidelines and considering the inputs provided by the wetland expert (Dr. Mathew Simpson), whose service were facilitated by the World Bank. SLLDC provided structural engineering inputs for the linear parks.

Sub-projects under Component 2

Relevant PLAs, i.e., CMC, SJKMC, DMMC and KUC were responsible for design and implementation of sub-projects under Component 2. CMC had started formulating the sub-projects in 2011, before the official kick off of MCUDP in 2012. Detailed designs of most of the sub-projects (both structural and architectural) except for "Rehabilitation of Galle Road and R. A. De Mel Mawatha" have been carried out by CMC staff. Support from UDA has been received for the architectural designs of Crow Island Beach Park.

Service of a consultancy firm was obtained for the design and construction supervision of the three packages for "Rehabilitation of Galle Road and R. A. De Mel Mawatha". In addition, three (3) more consultancy firms have been hired for the other 3 PLAs, for designing and construction supervision of the sub-projects under the respective PLAs. These consultants completed designs, prepared contract documents and supervised construction activities of the relevant sub-projects under the 3 PLAs.

The following software packages were used for the design and studying of traffic conditions of the roads:

1. Civil 3D – for the design of roads
   Earlier, all road designs were done manually. This was the first-time software was used by CMC staff for road design.
2. Traffic simulation software for traffic studies

Two consultancy contracts had been awarded for designing of two pedestrian overhead bridges at Kollupitiya and Bambalapitiya, through a design competition. The detailed designs were completed by the consultancy firm. However, due to the reasons described under section 7.5, the two bridges were not constructed.

Part IV - Project Implementation

9. Project Implementation Framework

9.1. Implementation Arrangement

A Project Management Unit (PMU) headed by a Project Director was entrusted with the overall implementation responsibility of MCUDP, subject to relevant administrative, financial and procurement regulations and procedures, which were under the purview of the line ministry. PMU handled all fiduciary, procurement, monitoring & evaluation and reporting, and also played a critical role in coordinating the agencies involved in project implementation to ensure overall quality of investments, achieving PDOs and monitoring compliance with environmental and social safeguards.

A Project Steering Committee chaired by the Secretary to the line ministry has overseen the functions of the PMU as per the Management Services Circular issued by Ministry of Finance on Management of Projects. The implementation arrangement proposed in the PAD is shown in Figure 9.1.

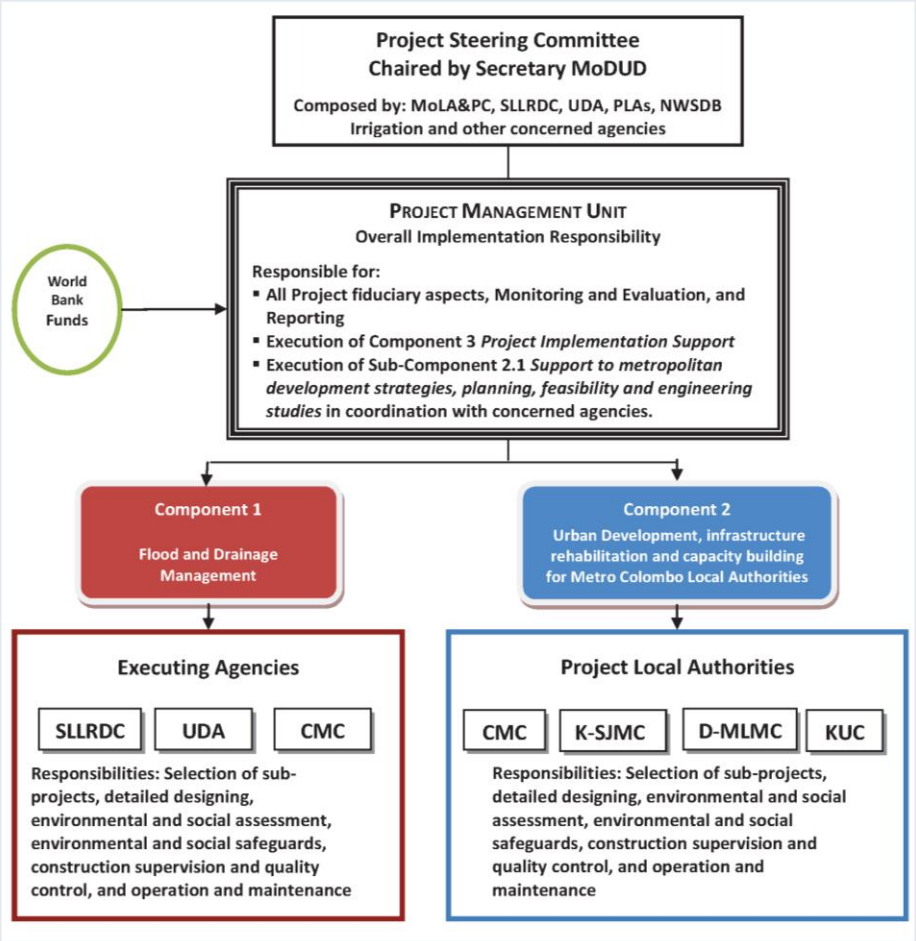


Figure 9.1 Implementation Arrangement as per PAD

The World Bank provided continuous support through regular Implementation Support Missions, in addition to frequent assistance and monitoring from the resident experts at the country office. The Project Implementing Agencies (PIAs) prepared the tender-ready detailed designs and supervised the implementation of sub-projects and reported the quality and progress to the PMU. PIAs are also responsible

for compliance with environmental and social safeguards and monitoring and evaluation functions at the sub-project level. Further, PIAs have taken over the developed facilities and will operate and maintain these facilities.

The Project Local Authorities (PLAs) played a similar role in implementation of the sub-projects under their purview.

9.2. Line Ministry

Role of the line ministry (Secretary) with regard to MCUDP was defined in accordance with the prevailing regulations and guidelines, and includes the following:

1. Correspondence with Secretary, Ministry of Finance, in respect of budgetary allocations and approvals, and ensuring availability of necessary budgetary provisions
2. Responsibility on procurement actions as vested with the Secretary who is deemed to be the Chief Accounting Officer
3. Signing agreements with contractors / consultants in respect of large contracts, as the Employer for that particular sub-project
4. Approving variations (above 10%) and claims of contracts, where required
5. Appointing Project Director and required staff for PMU

9.2.1. Changes to Line Ministry

In line with the administrative changes that took place in the government during the course of the project, the line ministry responsible for MCUDP changed several times, as shown in Table 9.1.

Table 9.1 Changes to Line Ministry

Ministry	With Effect from
Ministry of Defence and Urban Development	2012 (from inception)
Ministry of Urban Development and Water Supply	January 2015
Ministry of Megapolis and Western Development	August 2015
Ministry of Urban Development, Water Supply and Housing	November 2019
Ministry of Urban Development and Housing	August 2020

The change in ministries also introduced new faces to the higher management of the ministry and the PIAs. The project implementation became difficult as the new officers lacked the background knowledge of the project.

9.3. Project Management Unit

A self-standing Project Management Unit (PMU) headed by a Project Director was set up under the line ministry, in accordance with the government's framework for implementing and managing infrastructure development projects. The PMU consisted of thematic units headed by specialists, such as Procurement Specialist, Social Specialist, Environmental Specialist, Monitoring and Evaluation (M&E) Specialist and Finance Manager. A set of Senior Engineers handled different technical aspects such as implementation, contract administration, etc. In addition, individual experts (Engineering Consultants) were hired from time to time depending on the specific project requirements.

9.4. Project Implementing Agencies and Project Local Authorities

The following are the Project Implementing Agencies (PIAs) and Project Local Authorities (PLAs), as per the PAD:

- Project Implementing Agencies
  - Sri Lanka Land Development Corporation (SLLDC)
  - Urban Development Authority (UDA)
  - Colombo Municipal Council (CMC)
- Project Local Authorities
  - Colombo Municipal Council (CMC)
  - Sri Jayewardenepura – Kotte Municipal Council (SJKMC)
  - Dehiwala – Mount Lavinia Municipal Council (DMMC)
  - Kolonnawa Urban Council (KUC)

9.5. Management of Sub-projects

9.5.1. Sub-projects Directly Managed by PIAs

For most of the sub-projects, mainly those with less technical complexity, implementation was managed by the respective PIAs. PIAs released their staff for the project. While SLLDC staff were released in full-time basis, UDA and CMC released staff on part-time basis. Each PIA had a Senior Project Manager and a dedicated implementation unit headed by a Project Manager.

For the construction phase, a Project Engineer was appointed to each sub-project and continuous site supervision and quality assurance was ensured by assigning a full-time Engineering Assistant or Technical Officer. A Quantity Surveyor, supported by Assistant Quantity Surveyors, handled the checking and certification of payment until Final Payment Certificate. The Design Engineer who was responsible for the overall design would continue to provide support, including design revisions where necessary, until completion of the particular sub-project.

For sub-projects managed by UDA and CMC, necessary technical support was provided by contract basis staff recruited through PMU in accordance with the MSD circular of the ministry of finance. In addition, safeguards teams for the implementation of all sub-projects were also hired through PMU.

9.5.2. Hiring of Individual and Supervision Consultants

When the project moved towards more technically complex sub-projects such as stormwater tunnels and pumping stations, the sub-projects were grouped into several clusters, each functioning under a local individual expert (Engineering Consultant hired to PMU) in the particular field. Engineers and other technical and supporting staff were assigned to support each expert.

For certain technically complex sub-projects, a dedicated design review and construction supervision consultant was hired. The consultants thus hired for “Design and Build” type sub-projects played the role of “Project Manager”, while for the others, the consultant played the role of “Engineer to the Project”, according to the provisions of the relevant contracts.

For the “Design and Build” type sub-projects, the consultant’s team included foreign experts as Team Leader and Deputy Team Leaders, and several local experts to handle different areas, e.g., Site Engineer, Materials Engineer, Quantity Surveyor, etc. Site supervision and quality assurance were primarily the responsibility of the respective supervision consultant, who was continuously supported and overseen by the technical staff of the respective cluster.

9.6. Transfer to SLLDC

As per a decision taken by the line ministry in December 2020, all assets and liabilities of MCUDP were transferred to SLLDC, with effect from 9th December 2020. As a result, the implementation arrangement was modified. The implementation arrangement indicated in the Aide Memoire (16th Feb – 2nd Mar 2021) and the Management Letter dated 21.03.2021 is as shown in Figure 9.2.

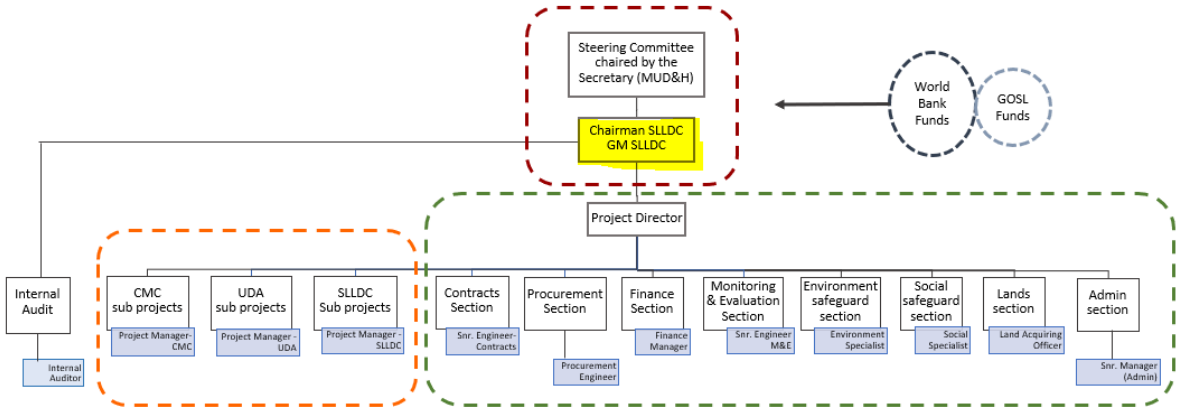


Figure 9.2 Implementation Arrangement as per Aide Memoire (16th Feb – 02nd March 2021)

9.7. Impact of Covid-19

Colombo started feeling the impact of Covid-19 pandemic with identification of an infected foreigner in January 2020. Gradually, Sri Lankans started testing positive for coronavirus since March 2020. Currently Sri Lanka has experienced multiple waves of Covid-19 pandemic and the next wave is at the verge.

The country was locked down for a long period during the Covid pandemic and strict quarantine curfew and restrictions were imposed for a long period. During the 1st wave from March to May 2020, sites were shut down as they were located in high-risk areas. During the second wave from October to December 2020, work continued with minimum workforce under special permission from police adhering to strict health guidelines. The direct time lost was nearly 7 months.

The situation in the country restricted and discouraged workforce travelling to work places and globally travel restrictions and limited export and imports led to material scarcity. The major plant and equipment, manufactured and delivered from abroad were delayed. The staff and families of the contractors, consultants and the client were infected and had to undergo quarantine for weeks. All 3 major factors in engineering construction: labor, material and time, has drastically disturbed. However, World Bank did not agree to grant a time extension to compensate for the above time lost.

While all the ongoing subprojects were affected, design and build of Torrington tunnel subproject was affected the most. Working underground in a confined area poses a high risk of spreading the disease. Further, the tunnelling crew of the international tunnelling contractor was not able to come to Sri Lanka from February 2020 for many months, delayed the construction progress by several months.

Among all these adverse impacts, MCUDP strategically made one advantage of the situation by completing the railway bridge underpass of the Torrington tunnel, during a break in train operation.

9.8. Implementation Timeline

The project starting date was 10th July 2012, and the original project closure date was 31st December 2017. The revised project closure date was 31st December 2021, after granting two (2) time extensions as follows:

1st extension up to 30th June 2020 based on the following:

Time taken for:

- Feasibility studies,
- Raw data collection and processing (including LiDAR survey and Digital Elevation Model),
- Setting up hydrological and hydrodynamic models, selection of subprojects for flood mitigation measures after modelling exercise,
- Finalization of "Design & Build" procurement documents in accordance with World Bank standards,
- Identification of land acquisition and resettlement requirements after finalizing conceptual designs and following the lengthy process for acquisition, and unavoidable administration changes.

Most of the above points have been observed and recorded by the World Bank Mission as quoted below from paragraph 29, Aide-Memoire of the implementation support mission (August 22 – October 30, 2019).

"29. Technically complex project. The Project was prepared as a framework approach and spent the first 2.5 years carrying out data collection, technical modeling, and technical analyses to identify and prioritize sub-projects for Component 1. This involved extensive technical review and discussion, along with intense communication and citizen engagement efforts due to its highly visible impacts during project implementation. The design and build contracts for the Tunnels and the Pumping Stations Projects are the first of their kind in Sri Lanka and the Project has learnt from anticipated timeframes from the preparation of the design, the bidding documents, and the implementation."

2nd extension up to 31st December 2021 based on the following:

- Exceptionally adverse climate conditions (alarming us on Climate Change Effect) in 2019 and 2020 and inundation of sites caused by high precipitation within short period and consequent high spate of Kelani river as most of the developed facilities are situated in the flood plain.
- Restrictions on operation time, material and labor shortages, stringent security measures due to Force Majeure event: Easter Sunday bomb attack in 2019.
- Unavoidable administration changes after presidential and general elections.

The first point above has been observed and recorded by the World Bank Mission as quoted below from paragraph 30, Aide-Memoire of the implementation support mission (August 22 – October 30, 2019).

"30. Scheduling, timeframes and completion of physical construction. The Project has learnt that time estimates for implementation of the Component 1 sub-projects, which are related to drainage and flood mitigation, have generally been too optimistic and based on best case scenarios. The effect of flooding which has been factored into timeframes to an extent, has been underestimated and this includes both the requirements on PMU staff who must respond to flooding events, as well as the requirements for contractors to manage sites (e.g., de-watering requirements) to enable work to proceed. There has also been flooding that has gone beyond reasonable predictions resulting in force majeure claims from

contractors (e.g., August-October 2019). Alongside the delays caused by weather, the uncertain location and state of underground utilities and the coordination required for shifting with each responsible authority have contributed to delays. The Project has also been focused on the physical completion of the sub-projects and, whilst this is an acceptable mode of operating for the Works Contracts, the Design and Build contracts need to factor in commissioning and hand-over time. The Project has learnt from this lesson with regards to scheduling and timeframes for implementation."

Request for a time extension due to effect of Covid-19 Pandemic:

At the time of granting the 2nd extension, in June 2020, both the GOSL and the Bank were in a clear agreement that more time may be required beyond the project closure anticipated by that time, in order to complete the ongoing sub-projects due to the unforeseen impact of Covid-19 pandemic. It was agreed to consider Covid-19 impact later, after ascertaining the correct time requirement. This was agreed at the wrap-up meeting and is documented in the paragraph 2 of the Aide Memoire of World Bank implementation support mission (February 17 to March 13 2020) as quoted below.

"2. The agreed action plan summarized in the Aide Memoire was discussed at the wrap-up meeting on March 13, 2020 with the Secretary, Ministry of Urban Development, Water Supply, and Housing Facilities as the chair. It was agreed during the wrap-up meeting that the Bank will proceed with a project closing date extension of 18 months from June 30, 2020 to December 31, 2021, based on a request letter sent by the government dated December 27, 2019. This request didn't consider the current unforeseen pandemic (Covid-19). It was also agreed during the wrap-up meeting, that due to the unforeseen impact of Covid-19, the government will revisit and reassess the feasibility of estimated completion date for ongoing sub-projects, especially tunnels and pumping stations. There may be a possibility for an additional time needed to complete the tunnels and pumping stations beyond 18-months due to Covid-19. It was agreed that the PMU and the Bank will closely monitor this possibility in the next few months."

The project implementation was badly affected by the Covid-19 pandemic situation during the years of 2020 and 2021, and sites had to be shut down several times during this period. More than seven (7) months of time had been almost completely lost due to curfew and restrictions imposed due to Covid-19 pandemic.

However, despite the project having been severely affected by the Covid-19 pandemic (to the effect of about two years), the impact of this period of delay was not considered at all.

Part V - Environmental and Social Safeguards Management

10. Environmental Safeguards

Environmental Health and Safety (EHS) aspects of the MCUDP were implemented in accordance with the guidelines set out in the Environmental Management Framework (EMF). In addition, existing policies, laws, rules and regulations and guidelines issued by the Government of Sri Lanka (GOSL) and the World Bank ESH measures were implemented throughout the project period and the issues were handled very successfully.

In the Environmental Management Framework (EMF) sub projects were categorized according to anticipated environmental outcomes. The safeguard categories were decided according to World Bank Operational Policy No 4.01 (OP4.01). Category A is when the environmental impacts are significant and irreversible, category B is when the significance of impacts vary, mitigatable and not irreversible and category C is when there is no impact on the environment. Accordingly type of environmental analysis were recommended. Though most of the projects were categorized B and required only an EMP, Environmental Screenings were carried out for majority of them.

Table 10.1 Environmental Assessment category

Category	Type of Environmental Assessment	Number of Sub-Projects
A	Environmental Assessment	02
	Initial Environmental Assessment	01
B	Environmental Screening	31
	Environmental Management Plan	21

In all sub-projects, environmental safeguards were implemented and managed according to the EMAP, prepared based on the EMP included in the respective environmental assessments.

The awareness and required trainings were given to the project staff at project sites frequently and their performances continuously monitored. During the project period there were no fatal accidents recorded even though all the project sites were located in densely populated metro Colombo area because the workforce had adhered to the implemented EHS measures. The main focus of the project was to control noise, pollution, vibration and damage to trees, especially religious trees, and planted trees along roadsides. The mitigatory measures were implemented and monitored using the prepared Environmental Management Plans and Environmental Management Actions Plans.

In addition, if the issues arose the best practices were implemented in consultation with the professionals and expert in the relevant fields. These issues can be considered as the case studies on implementing the best practices throughout project period.

Environmental assessment was conducted for the **Madiwela East Diversion Scheme – Improvements to Thalangama and Averihena Tanks**. Invasive plant *Anona glabra* was removed which reduced the retention capacity of the Thalangama tank and dredging was done to increase the retention capacity of the tank to handle excessive rainfall. This activity was done while preserving the roosting habitats of migratory avi-fauna and wetland grass patches and mangroves which increased the ecological importance of the site. The activities were scheduled during the period when there are no migratory birds are nesting. Dredging was done to aid the increase of fish habitats such as maintaining uneven surface without a smooth terrain as instructed by World Bank experts.

Under the environmental management a habitat improvement programme was conducted planting native plants along the roadsides and canal banks at the project sites where necessary. This will also help to improve the greenery appearance, canal bank protection and fix the carbon emissions in Colombo Metropolitan area acting as carbon sinks.

Kotte Rampart is an ecologically and culturally highly sensitive area. Therefore, special attention was given for environmental protection and archaeological monument protection. During the construction period only the wetland weeds i.e *Anona glabra* trees/shrubs were removed manually without disturbing the native tree species in the surrounding. All the tree species were not removed at once to ensure the availability of roosting sites and habitats for the wetland species and avifauna. A tree planting programme was conducted along the bank of canals which connect with Diyawanna Oya. This is a habitat improvement programme. The planted tree species were kumbuk (*Terminalia arjuna*), Mee (*Madhuca indica*), Ehela (*Cassia fistula*), and Magul Karanda (*Pongaima pinnata*).

Kotte Rampart site is an archaeologically important area found in the Colombo Metropolitan area. An archaeological monument (a pole used to tie a horse in the ancient kingdom) was found and that was reported to the Archaeological Department. Accordingly, the project construction activities were stopped for a certain period for obtaining the consent of Archaeological Department to continue the construction activities. The found archaeological monument was protected under the guidance of Archaeological Department.

Special attention was given for tunnelling projects of MCUDP because they would cause significant environment, health and safety issues due to project activities. Initial Environmental Examination was conducted for the **Mutwal and Torrington Tunnel Construction Project**. In the **Torrington Tunnel Construction project a**ccording to the micro tunnel specifications, the tunnel was excavated 15 fts deep from the ground level applying pipe jacking system. Some parts of the tunnel trace are along iconic tree lined streets of the Metro Colombo are. Tunnel excavation was done more than 1m away from each tree. Therefore, we believed that the root systems of said trees were not damaged due to excavation activities.

The expert opinion was obtained in consultation with botanists from Peradeniya Botanical Gardens. The Environmental Division of the PMU closely monitored the health of the trees along the tunnel and monitored the presence of damaged roots in the excavated soil. The contractor and the consulting firm have successfully completed the contract without damaging the historic trees along Bauddhoka Road.

The Sea outfall of **New Mutwal tunnel** had to be constructed through a hard rock formation. According to the approved environmental management plan, the existing sea outfall should have been blasted manually with chemicals and vibrators. The contractor and consulting firm of New Mutwal noted and informed the difficulty of the manual blasting. The Environment Division of PMU therefore raised this issue during a World Bank mission's site visit and obtained approval for control blasting. The relevant permits were obtained by the contractor and the blast was successfully completed coordinating with all relevant agencies. That activity was closely monitored by the PMU staff. During the underground machinery excavation for tunnel construction the vibration level and noise level on the ground surface were closely monitored and maintained up to the standards gazette by Central Environmental Authority. Accordingly, the complaints and grievances were handled successfully.

A tree planting programme was conducted at Ambathale pumping station during the construction period since some of trees were removed for construction activities. In the tree planting programme more than 30 native tree species were planted along the banks of stream and other cleared areas in order to increase the green cover and soil stabilization. For wetland creation a lowland area at the Ambathale pumping station premises was converted into a seasonal wetland and maintained as it is.

It was found that non-native and home garden species have been proposed in the contract document for planting along the canal which connects the **Thalangama lake in Madiwela East Diversion Scheme**

project (MED). The tree species to be planted were reviewed and some tree species were removed from the list and new native species were suggested at the same price. Although, the contractor of the above project planted the recommended tree saplings at the project site, some of tree saplings were not maintained well. Accordingly, the contractor was instructed to replace the dead plants and unhealthy plants before their payments.

Under the Environment, Health and Safety aspects of the project, we found that some of environmental issues would be ended as a social issue. One of such issue was recorded at Kolonnawa Canal Diversion Project (KCD I) site. The contractor's workers damaged several lateral roots of the religious tree (Bo) located at the end point of Kiththamphuwa canal at Haward Bund Bridge. That incident was reported by the supervision consultant to the Project Management Unit (PMU) in early August 2020. The PMU found that it would be developed as an environmental issue as well as a social issue at the project site area. Accordingly, PMU consulted the former Secretary of Ministry of Botanical Gardens to obtain an opinion to treat the tree. Meanwhile, the supervision consultant and contractor hired a Botanist from the Botanic Gardens at Peradeniya. The botanist treated the damaged lateral roots. At present the Bo tree is healthy and has fresh leaves.

The importance of implementation of safety measures in construction was demonstrated at Norris Canal project site. Further, importance of having inter agency coordination in working in highly congested urban set up was shown by some of incidents. For example, in front of the Fire Service Department, a large number of utility lines are found and among them some of utility lines were high voltage (132 kV) utility lines. These lines and their locations were not clearly identified during the design phase. The utility shifting was very difficult and not a practicable solution. The contractor's staff took more precautionary measures and completed the task coordinating with relevant agencies.

Further, importance of having inter agency coordination in working in highly congested urban set up was shown by some of incidents. For example, two main roads junctions at T. B. Jaya Mawatha & Deens Road consisted with a large number of utility lines and among them some of utility lines are high tension voltage (132 kV) lines, main water supply, telephone and main sewer lines.

These utility lines and their locations were clearly identified at the planning stage but practical difficulties were encountered during construction. Engineer and the Implementing Agency well-coordinated the relevant utility agencies and directed Contractor for making maximum precautionary measures on safety of people and the utility lines.

The Environment Division of PMU was able to implement the good practices, if the provisions are not mentioned in the contract documents. For example, the PMU has identified the importance of preventing soil erosion at **South Pumping Station** project site, the contractor and consultancy firm were requested to plant native trees along the left bank of the project site to minimize soil erosion, if there is no any provision available in the contract documents.

There was no provision in the contract document to construct a footbridge over the existing canal **at Bauddhaloka Mawatha Project Site in front of Central Engineering Construction Bureau.** The road was damaged due to construction work and it was difficult for pedestrians to move. This was discussed at the progress review meetings and emphasized the importance of having a temporary sidewalk at the site for the safety of pedestrians. The contractor agreed to our request and established a footbridge spending his own money.

Less than four significant grievances, mainly due to the impact of the vibration effect have been received and resolved them satisfactorily. One such example is: Due to the construction activities of North Pumping Station project cracks were reported in some of houses located at the boundary of St. Sebastian North Lock Pumping Station. One house was damaged due those construction activities. It was also found that the said

house had been constructed in the unstable soil and due to the vibration effects of the project site, that house was damaged. The affected person requested a compensation for the damaged property even though the house was built in the unstable substratum.

The case has now been settled after a series of discussions and negotiations between affected party and the contractor. Compensations were paid by the Insurance company.

All the project sites were located in the congested and highly populated urban setup in Metro Colombo area. Environmental protection, pollution control and traffic management were not easy throughout the project period. Therefore, more attention was given for these aspects and in our Environmental management plans precautionary and mitigatory measures were clearly mentioned. Accordingly, precautionary and mitigatory measures were successfully implemented. Few complaints and grievances were received from the adjacent community and they were attended and resolved within a short period of time.

Three linear parks along the Beira Lake and two wetland parks i.e. Kotte Rampart and Beddagana were established under MCUDP. The recent research has shown that the established linear parks and wetland parks improve the mental wellbeing of Colombo residents. The project is primarily designed for flood control in the Colombo Metro area and wetland management was a key component of the project. Therefore, the Wetland Management Unit of the Sri Lanka Land Development Corporation was established to sustainably conserve, regulate and manage the Colombo Wetlands. Wetland water quality is measured periodically and the data obtained are used in decision making. The declaration of the Colombo Metro Colombo area as a Ramsar Wetland City was a commendable achievement during the project period.

According to a checklist prepared by the PMU, all project sites were taken over by the Project Management Unit (PMU) and operational level management plans and emergency plans/contingency plans were prepared for all project sites for the EHS aspects of each project site. The Norris Canal project has not yet been completed as at the end of the Project. Potential impacts and mitigation measures have been identified for the remaining 126m drain development segment and documented with a contingency plan.

11. Social Safeguards

11.1. Background

MCUDP adopts a social safeguards management framework in project implementation in 3 stages, as given below:

- Social assessment on overall project to study potential risk and impact
- Implementation of social safeguards during feasibility stage
- Implementation of social safeguards during construction and post construction stages

A social assessment (SA) for MCUDP was carried out to study the potential risks and impacts during the planning stage of the project. The Social Assessment has indicated that a significant positive social impact is expected through the proposed interventions in flood and drainage management and infrastructure development by way of improving the urban environment and liveability of CMA, at the completion of the project.

Moreover, the SA indicated that during the implementation there can be negative social impacts such as temporary risks relating to access, mobility, health, and safety. As MCUDP interventions require acquisition of private lands, recovery of state lands occupied by squatter households, and the relocation and resettlement of project-affected households (PAHs) and the non-titleholding squatter families live along the canal banks, proper management of social safeguard has been identified as a compulsory need. On the other hand, by involving in above resettlement, expected major positive impact will be the improvement in

living standard / condition of households in identified under-served settlement in flood-prone low-lying areas to secure housing.

In the PAD, MCUDP overall project risk is rated high, considering the high-risk rating for the Social and Environmental Safeguards. This is the first large-scale urban development project that the World Bank has supported in Sri Lanka. In order to identify short-term and long-term adverse impacts of each subproject, a Social Screening has been conducted.

Based on the results of SA, World Bank Operations Policy 4.12 on Involuntary Resettlement has been triggered for the project. In addition to the World Bank policies, following Sri Lankan acts, laws and regulations also applied on implementation of Social Safeguards in MCUDP.

1) National Involuntary resettlement policy in Sri Lanka.
2) Land Acquisition Act and 2013 regulations.

The project collected all necessary data of likely to be affected households and business entities, assessed feedback from local communities of each sub-project sites to ascertain the potential socio-economic impacts on the project interventions. The data collected and its subsequent analysis confirms that this process has fully complied with the relevant social safeguard principles. MCUDP produced Social Impact Assessment reports (SIA) for each sub-project, identifying the possible impacts. The SIAs and Social Screening Reports (SSRs) were developed for the sub-projects to meet the requirements for preparing the social safeguards instruments as follows;

1. Social Screening Report (SSR)/ Due Diligence Report (DDR) – for subprojects with temporary adverse impacts only.
2. Abbreviated Resettlement Action Plan (ARAPs,) – for subprojects with Middle level Adverse Social Impacts
3. Resettlement Action Plan (RAPs) – for subprojects with Higher Level Adverse Social Impacts

To mitigate the negative social impacts that had been identified, the following Social Safeguards Instruments have been prepared, and World Bank Clearance/ consent has been obtained before commencement of construction works.

Table 11.1 Social Assessment Category

Category of Sub project based on scale of impact	Relevant Social Instrument	No. of Sub Projects		World Bank Clearance obtained
		Component 1	Component 2	
A	RAP	06	-	06
B	ARAP	04	-	04
C	SSR/ DDR	25	20	45
Total		**35**	**20**	**55**

Following the assessment of the potential impacts of each project, project alternatives were considered, and possible changes to the technical designs were made in order to avoid/ minimize the adverse Social Impacts such as; acquisition of lands with permanent structures, resettlement and livelihood displacement.

Out of 35 sub-projects on Component 01: flood and drainage management, 10 required land acquisition and acquisition of servitude rights and 901 lots of lands (8.736 hectares) and 98 lots of servitude rights (0.939 hectares) were acquired. Land acquisitions and the recovery of state land affected both the titleholders as well as non-titleholders in the form of permanent, temporary, or full or partial loss of either their residential dwellings, or their commercial business units or both, and associated livelihoods. Altogether, 652 households had been affected by the project.

195 squatter households were resettled in condominiums constructed by Urban Development Authority, individual apartment therein valued at LKR 3 - 5 million, and fully paid by the project, and a range of resettlement and rehabilitation assistance including support for the restoration of their affected livelihoods were provided. The total resettlement cost of the non-titleholder households was approximately LKR 723 million. The title deeds for the flats were issued in the joint name of spouses, and the name of the mother in case of a deceased husband/son.

Meanwhile, the titleholder households affected by the project were provided with cash compensation at replacement cost as determined by the Land Acquisition and Resettlement Committees (LARC) established for the project under the Land Acquisition Regulations (LAR) of 2013. Altogether, 437 households had received cash compensation for the land acquired at a total value of over LKR 1.1 billion. Additionally, special cash grants were provided to support the vulnerable households comprised of households headed by women, by disabled persons, and by elderly persons. Around 107 vulnerable households had received the cash grants each valued at LKR 15,000. Moreover, 33 households had received livelihood restoration grants with a total value of LKR 12.3 million. Compensation payments that could not be addressed by LARC under LAR 2013 were determined by the Entitlement Assessment Committee (EAC) established for the project with the special provisions given in the Social Management Framework (SMF).

The lands acquired also included the space required for the maintenance of the canals which is within the limits of the reservation which were not acquired before the project. Only the required strip of land was acquired without acquiring the entire reservation.

11.2. Implementation of Social Safeguards during Construction

The project also required the temporary relocation of around 101 households to ensure their safety during civil construction works, to whom rental allowances were paid until such time as they were able to return to the place of residence that they had been required to leave whilst the work was in progress. The rental allowances paid by the project amounted to around LKR 38.4 million. Of the temporary relocated households, 89 returned to their original dwellings. The remaining 12 HHs will be resettled on completion of the civil works. The project reported 413 cases of damages to buildings and structures, of which 400 cases 97% have been rectified, or compensated by the contractor, with the acceptable amount to the PAPs. The rest remaining damages will be restored by the respective contractors on completion of the civil works, and the project will take responsibility for ensuring the permanent resettlement of those previously affected households.

The project engaged the affected parties, and other key stakeholders in a rigorous and continuous process of consultation and information sharing throughout the project cycle. This included consultations and awareness raising programs conducted at group and individual levels. Written materials printed in local languages containing project related information including entitlements of affected parties and grievance redress procedures were also disseminated the project operated a four-tier grievance redress mechanism (GRM) (accessible through https://social.mcudp.lk/administration/dashboard.php) across all its sub-projects, which together reported 423 grievances. Of the grievances, 95% (402) have been resolved, and the rest, largely related to compensation for construction related damages, will be resolved through the contractors and their respective insurance service providers.

11.3. Challenges and How They were Overcome

The Norris Canal Improvement Project required the relocation and resettlement of 24 households occupying an old housing scheme, belonging to the Colombo Municipal Council (CMC), whose identified structural weaknesses made it unable to withstand the required deep excavation works. Thus, the housing scheme located along Arnold Rathnayaka Mawatha, bordering the canal, require its complete demolition.

The 24 affected households comprised 16 tenants, and 08 legal owners who enjoyed unencumbered freehold interest for their housing units under a deed granted by CMC. Of the 24 households, 12 households (08 tenants and 04 legal owners) vacated their housing units and opted for relocation in the housing units of the condominium provided by CMC free of charge. The remaining 12 PAPs (08 tenants and 04 legal owners) refused their relocation, demanding either better housing units or higher compensation. CMC cancelled the tenancy agreements and instituted legal action at Magistrate's Courts (MC) for the eviction of the tenants. However, the tenants appealed to the Court of Appeal and thereafter to the Supreme Court against any possible eviction order, and both of these appeals were rejected. The case, temporarily suspended by MC pending the appeals to higher courts by the tenants were taken up again by the Magistrate Court, and the decision of issuing the eviction order to the tenants were reconfirmed on 28.11.2022. CMC is in the process of evacuating them from the building. Under the Land Acquisition Act, the CMC moved to acquire properties belonging to the 4 legal owners, with the process being in its early stages. CMC is in the process to issue the Section 38a to obtain the possession of land.

The prolonged delays to accomplish the resettlement process have adversely affected the timely completion of a 126m section of the Norris Canal.

The acquisition of servitude rights of 54 land lots for the construction of the New Mutwal Tunnel (NMT) affected 95 PAPs. Of those 95, 55 filed a Writ Application in the Court of Appeal in 2017, to demand higher compensation for the servitude rights acquired in view of the devaluation of their land, the insecurity caused to their lives due to the tunnel been constructed underneath their residential dwellings, and the possible rejection of their title deeds by the commercial banks in the event that they want to mortgage their lands. The project obtained special approval from the Cabinet of Ministers to enhance the statutory compensation payable to the PAPs. Moreover, it provided a long-term insurance cover with a commitment on the government to bear the full responsibility for any future property damages and accidents for PAPs during the life-time of the tunnel, and reached agreement with the State Banks to recognize the title deeds of APs for mortgage purposes. Having responded fully to the claims made by the PAPs in their Writ Application, the project facilitated the signing of a memorandum of understanding (MoU) between the Ministry of Urban Development and Housing and the PAPs which stipulated the commitments and provisions by the GoSL, and the PAPs' agreement to the conditions laid therein. Despite the PAPS receiving a higher level of compensation in full, and signing of the MoU by 45 of 55 PAPs, the Writ application has not yet been withdrawn, as they 10 PAPs are seeking a higher level of compensation than that was already given. Remaining petitioners requested letter of comfort to make sure their ownership of land has not been transferred to the SLLDC/ GoSL due to the acquisition of servitude right. Draft letter of comfort has been prepared and shared with petitioners' lawyer through Attorney General's Department. Both parties are in a process to come for an amicable solution before next court date in July 2022.

11.4. Gender and Vulnerability Considerations

Specific gender considerations in the SMF include: (a) provision of the title of the alternative house in the joint name of spouses, and the name of the mother in the case of the deceased husband/son; (b) particular support for women headed households with livelihood restoration support; (c) equal provision of employment training opportunities for male and female youth; (d) gender-sensitive provision of facilities in resettlement sites including centres for women and day care; (e) and ensuring women's participation in the condominium management process. The objective of this gender strategy is to ensure equity in the resettlement process, enabling women to be economically and socially active by contributing to the livelihood activities, and participate effectively in the condominium management activities.

The SMF further illustrates that Samurdhi Recipients are considered to be amongst the poorest families in the settlement, and special attention has been given to them in the new locations; with Samurdhi payments continuing for them in the new locations. Further, RAPs identified vulnerable households among the PAHs. During the compensation process, these vulnerable households were further identified, and an allowance

of Rs. 15,000 was paid to each vulnerable member in the household. Accordingly, the following table depicts vulnerability allowances paid by the project under different sub-projects.

Table 11.2 Number of vulnerable households paid with a vulnerability allowance

Sub-project	No. of Vulnerable HHs affected			
	Women Headed HHs	Elderly Persons	Persons with Disability	Total
St. Sebastian South Canal Rehabilitation	11	6	1	18
St. Sebastian North Canal Rehabilitation	14	11	-	25
St. Sebastian North Pumping Station	9	5	-	14
New Mutwal Tunnel	7	8	2	17
Kolonnawa Canal Diversion Scheme	14	11	2	27
Ambathale Pumping Station	-	3	-	3
Madiwela East Diversion Scheme (Stage III)	1	2	-	3
Total	56	46	5	107

11.5. Special Attention Given to Vulnerable Households

The project has taken deliberate efforts to identify vulnerable beneficiaries and provided assistance depending on each beneficiary's requirement. Vulnerable people are recognised as being elderly people, women of poor households, women-headed households, and children. The following specific assistances were provided for such families.

1. Vulnerability allowances provided through LRAC & SLARC system; Around LKR 1.2 million cash compensation paid under this category.

2. Livelihood allowances provided to re-start/ improve the livelihood activity of women headed HHs; LKR 330,000/= cash compensation paid under this category.

3. New housing units at Ground or preferred floor of the Condominium (on the request of sick persons); 5 families were benefited under this category.

11.6. Gender-Sensitive Provision of Facilities at Resettlement Sites

The lack of day care facilities acts as a barrier for women to engage in economic activities outside of their homes. Participants also pointed out that it is important for them to have a proper place to conduct funerals, special functions, and a place for religious observances within the condominium. At Siyasetha Sevana, dwellers usually remove their front window in order to get a coffin in and out. Dwellers at the Muwadora Uyana are able to utilize the balcony area for this purpose.

11.7. Women's Participation in the Condominium Management Process

Three condominiums, C and D Blocks of Methsanda Sevana, and Siyasetha Sevana each have a management committee to oversee and deliberate on the day-to-day management issues of the Condominium. C Block

of Methsanda Sevana has a management committee with 26 office bearers, including 2 members to represent each floor. Out of 5 key positions, 4 are occupied by women, whilst the position of vice-president is occupied by a man. The management committee of the D Block of Methsanda Sevana is comprised of 28 members and 6 office bearers. Out of 28 members, 13 are women and among the 6 office bearers, the secretary is a woman. Siyasetha Sevana's management committee includes 6 office bearers and 14 members representing 14 floors. Out of 6 office bearers, 4 are women while among the members, 12 are women: the president is a man and the secretary is a woman.

11.8. Social Safeguards Monitoring System

Social Safeguards monitoring has been done both internally and externally. Internal monitoring has been done by the PMU at the project level and by the PIA at the sub-project level. The Social Development Specialist played key role at the PMU level whereas the SDOs/CDOs played an active role at the sub-project levels. Internal monitoring was focused on timely execution of safeguard activities in line with the SMF including screening, survey, mitigation planning, RAP preparation/ implementation, scheduling with civil works, monitoring the role of contractors, managing safeguards consultants and their outputs, documentation of progress with regard to eligibility list preparation, disclosure and consultation, grievance registration and resolution, disbursement of entitlements, day-to-day relocation support, etc.

MCUDP engaged an external monitoring agency for independent review of the safeguard implementation program to determine whether intended goals are being achieved, and if not, what corrective actions are needed. External monitoring had two objectives.

i) Verify if the safeguard program is being implemented in accordance with the approved framework.

ii) Verify whether affected persons, households and communities are able to address negative impacts and restore their livelihoods and living standards.

External Monitoring was supposed to: a) Verify that the RAP has been implemented in accordance with the approved plans and procedures. b) Assess that the objectives of the RAP have been achieved. c) Determine that APs livelihood and living standards have been restored or improved and if not suggesting ways and means of improving performance. d) Obtain views of the APs on their relocation, entitlements and performance of the GRM. e) Evaluate the performance of the all implementing Agencies including PMU and PPAs. f) Prepare and submit safeguard compliance report quarterly and annually to the PMU and the World Bank.

MCUDP deployed Institute for Participatory Interaction in Development (IPID) as the external monitoring agency to monitor the social safeguards implementation. As per the consultancy contract, IPID appointed well experienced professionals and done the deep review of safeguard implementation at individual level, Sub-project level and PMU level. Based on the findings IPID was prepared and submitted the Quarterly, Annually and Final safeguard review report to the PMU and the World Bank with their recommendations.

Part VI - Project Outcomes

12. Project Outcomes

12.1. Component 1

12.1.1. Integrated Outcome of Component 1

As defined in the PDOs, the target of Component 1 is to reduce the flood inundation by 3 km^2 for a design rainfall event of a return period of 50 years (design rainfall of 477 mm/day). Therefore, as shown by the 2D flood inundation model results, it can be shown that the PDO is achieved to reduce the flood inundated area by 3.03 km^2 (as shown in Table 12.1), and this is achieved without implementing the Madiwela South Diversion. With Madiwela South Diversion, the reduction in flood inundation area increases up to 4.33 km^2.

Table 12.1 Achievement of PDO Level Results Indicator – Component 1

PDO Level Results Indicator	Target	Achievement
Reduction in the area under risk of flooding (50-year return period) in the project area.	3.0 km^2	3.03 km^2

Note: This reduction is excluding the contribution from the micro-drainage improvements.

It should be noted that this reduction is only for the useable land, meaning that the inundated area in water bodies and marshes are not included within the achieved 3.03 km^2 reduction. Further, this 3.03 km^2 is exclusive of the area that is made flood-free for frequently occurring high intensity short-term rainfall through the implementation of micro drainage improvements (6 sub-projects covering 8 flood locations) done under MCUDP. For an example, Torrington tunnel network implemented to mitigate frequent flooding in one of the busiest areas in the city protects an area of 0.54 km^2 from floods, in addition to the above 3.03 km^2. Other five (5) micro-drainage sub-projects also contribute similarly.

Further, it should also be noted that the duration of inundation is significantly reduced, reducing the damage and compensation expenditure the government has to spend in relief work to a great extent (further information is given in Part VII – Economic Analysis).

As a further insight to Figure 12.1, cases 1 and 2 show that still there are inundated areas indicated by blue colour patches even though PDOs are achieved. However, it should be noted that ground elevations at these locations are well below 1.5 m MSL (localized depressions) and it makes very difficult to reduce flood inundations, because overall flood safety level in the area is set as 2 m MSL. Figure 12.2 further shows that the adjacent land uses are marshy areas and even though the inundated areas are having elevations less than 1.5 m MSL, those areas are utilised for residential land uses. This means that majority of the affected buildings would have been built in very low-lying areas, which may also be defined as the flood plain.

Case 3 shows the flood reduction near North Lock Pumping Station, where the flood freed areas are shown as red patches. If looked closely, it can be seen that the flood freed areas are densely populated with many industrial and residential land uses, including Kelanitissa Power Plant. Also, it is evident that some of the accessibility limitations during a flood are mitigated from the operation of flood mitigation interventions, as some roads are not blocked due to floods, which can be seen as a great contribution to the indirect economic benefits gained through the project, in addition to the directly identified project benefits.

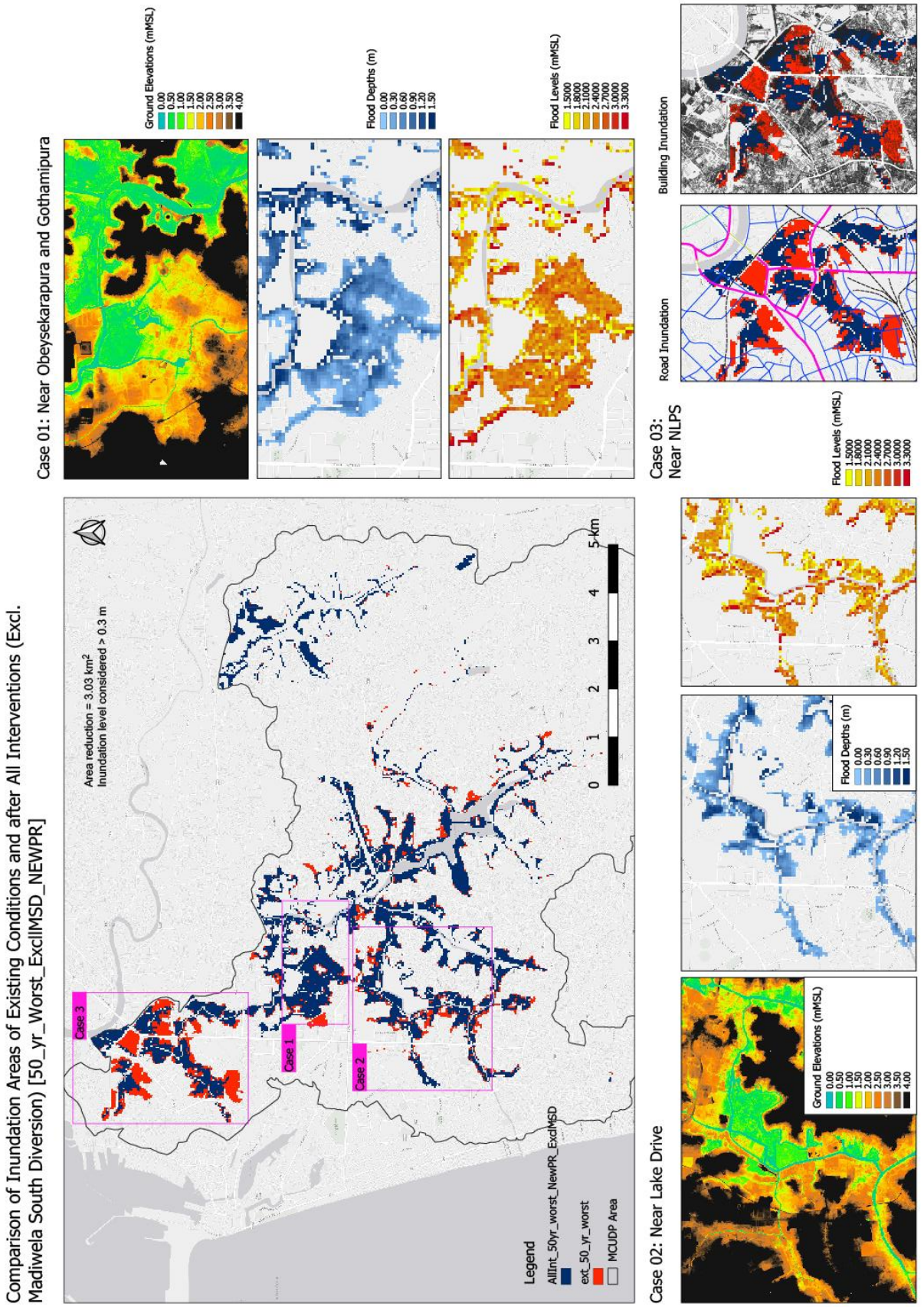


Figure 12.1 Simulation Results of MCUDP Macro-drainage Interventions for a 50-year Rainfall Event

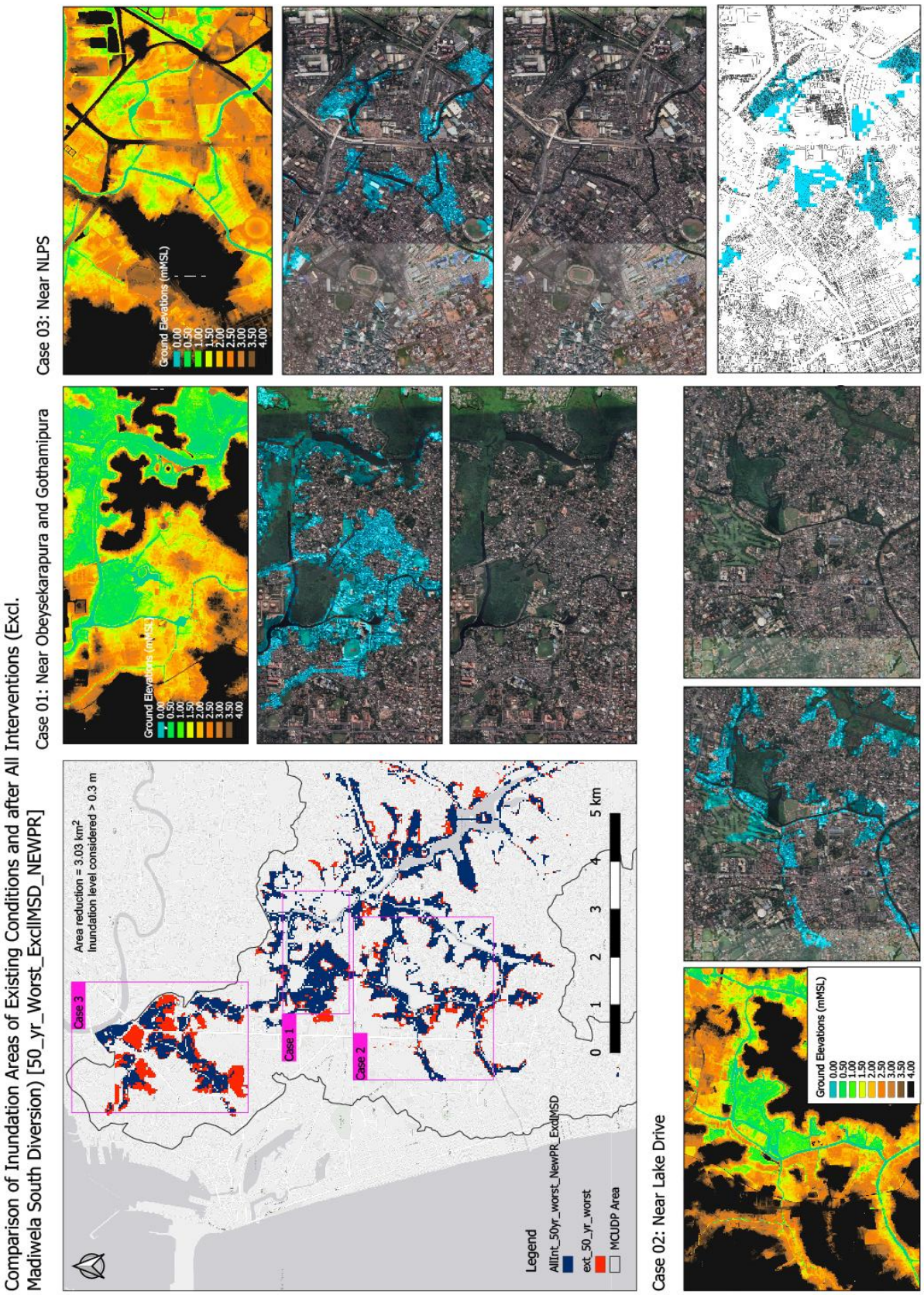


Figure 12.2 Simulation Results of MCUDP Macro-drainage Interventions for a 50-year Rainfall Event with Land Use

12.1.2. Sub-component 1.1

Table 12.2 Achievement of Intermediate Results Indicators – Sub-component 1.1

#	Intermediate Results Indicator	Target	Achievement
1.1	Length of primary canals improved by the project	9.2 km	10.62 km
	Refer Table 12.3 for the detail of the primary canals improved		
1.2	Increase in drainage capacity (gravity system)	185 m^3/s	220 m^3/s
	Refer Table 12.4 for the detail on contribution of each intervention on improvement of drainage capacity (gravity system)		
1.3	Increase in drainage capacity (pumping system) subject to the results of the hydrological model)	25m^3/s	60m^3/s
	Refer Table 12.4 for the detail of pumping introduced to the system		

Summary of Drainage system improvement:

Canal conveyance improvements

Conveyance of several primary canals were improved under MCUDP as shown in Table 12.3, to increase the outflow capacity of the system.

Table 12.3 Primary canals improved under MCUDP for conveyance improvements

No.	Primary Canal	Length (m)
1	Main Drain	1,650
2	Dehiwala Canal	415
3	Wellawatte Canal	50
4	St. Sebastian North Canal Construction of bank protection works (620m) North Lock pumping station (300m)	920
5	St. Sebastian South Canal Construction of bank protection works (855m) South Lock pumping station (400m)	1,255
6	Madiwela East Diversion Scheme Stage I (800m) Stage II (290m) Stage III (300m) Ambathale Pumping Station (140m)	1,530
7	Kittampahuwa Canal KCD-Stage I (270m) KCD-Stage II (1,230m) KCD-Stage III (2,300m) KCD-Stage IV (1,000m)	4,800

A total of 10.62 km length of primary canals has thus been improved with methods such as gabions, steel sheet piles, reinforced concrete walls, etc., as appropriate, depending on the site conditions and flow

requirements. A number of culverts/bridges were also either newly built or rehabilitated under the respective contracts.

In addition, two (2) new flood control gates were constructed under stages I and IV of Kolonnawa Canal Diversion Scheme and one (1) flood gate at Thalangama Tank under Madiwela East Diversion Scheme.

Outflow capacity enhancement

Table 12.4 Outflow capacity improvements under MCUDP - Gravity and Pumping

Intervention	Outflow (m^3/s)		Contribution	
	Before Project	After Project	To favorable scenario (Low Kelani)	To worst scenario (High Kelani)
1. North Lock gravity	30	42	√	
2. North Lock pumping	-	30		√
3. Wellawatta	50	50	√	√
4. Dehiwala	16	16	√	√
5. Existing Mutwal Tunnel	4	4	√	√
6. Kolonnawa Canal Diversion	-	55	√	
7. New Mutwal Tunnel	-	15	√	√
8. Torrington Tunnel *	-	28	√	√
9. South Pumping **	3.5	10	√	√
10. Madiwela East Diversion	-	10	√	√
11. Ambatale Pumping	-	20		√
Total gravity capacity	100	**220**		
Total pumping Capacity	3.5	**60**		

* - While Torrington Tunnel enhances the outflow capacity by $28m^3/s$, it contributes to micro-drainage system through secondary tunnel network.

** - Though $3.5m^3/s$ pumps were at old pump house, those were not functional for a long period.

With the above interventions, the outflow capacity under gravity was improved from 100 m^3/s to up to 220 m^3/s while 60 m^3/s pump capacity was introduced to the system.

Stormwater pumping stations

The following three (3) stormwater pumping stations were constructed under MCUDP:

1. St. Sebastian North Lock Gates and Pumping Station
    - Maximum capacity: 30m^3/s
    - Reverse pumping capacity: 12m^3/s (for water quality improvement)
2. Ambathale Stormwater Pumping Station
    - Maximum capacity: 20m^3/s
3. St. Sebastian South Pumping Station
    - Maximum capacity: 10m^3/s

All necessary electro-mechanical equipment such as stormwater pumps, gates, trash screens and conveyors, generators, electrical panels, SCADA systems, etc., were installed. Operation and Maintenance (O&M) manuals were prepared and training was provided to SLLDC O&M team. In addition, upstream and downstream (where relevant) canal improvement works were also carried out under the respective contracts.

By constructing these three pumping stations, outflow capacity of 60m^3/s was added to the system by pumping.

Stormwater tunnels

The following two (2) stormwater tunnels were constructed as new diversions under MCUDP:

1. New Mutwal Tunnel (length: 777 m; internal diameter: 3 m)
2. Torrington Tunnel (main tunnel – length: 1100 m; internal diameter: 3 m / spine and lateral tunnels – length: 2400 m; internal diameter: 1.2 m to 2 m)

Operation and Maintenance (O&M) manuals were prepared, and training was provided to SLLDC and CMC O&M teams.

Diversions

The following canal diversions were constructed/improved:

1. Madiwela East Diversion Scheme (3 stages) – improved
2. Kolonnawa Canal Diversion Scheme (4 stages) – new connection introduced

12.1.3. Sub-component 1.2

Table 12.5 Achievement of Intermediate Results Indicators – Sub-component 1.2

#	Intermediate Results Indicator	Target	Achievement
1.4	Micro-drainage sub-projects implemented under the Project that reduce risk of flooding in localized areas (10-year return period)	6 Nos.	5 Nos. completed + 1 No. partly completed
5 sub-projects covering several isolated flooding locations has been fully completed. *1 sub-project (Norris canal improvement) is 85% completed. Refer "Note on Norris Canal" below for details.*			

By implementing the selected sub-projects mentioned under 7.2, the issue of frequent flooding in the following areas was solved:

Table 12.6 Implementation of selected sub-projects

Sub-project	**Flood locations addressed**
Drainage Improvements in Marine Drive - (Catchments 2 & 3)	Boswell Place & Moor's Road – through catchment 2, Lily Avenue & Collingwood Place – through catchment 3
Rehabilitation of Gregory's Canal	Wijerama, Horton Place
Improvements to Kinsey Road Drainage	Kinsey Road – Kanatta Junction
Improvements to Devi Balika Drainage	Devi Balika Junction, Golf ground & Model Farm Watta
Improvements to Norris Canal	National Hospital premises, Hedges Court, Deans Road and Vipulasena Mawatha
Torrington Tunnel Network	University of Colombo area, Race Course area, Thummulla Junction

Note on Norris Canal:

Implementation of Norris Canal sub-project could not be fully completed by 30.06.2022, due to delays in providing site possession for 126 m of canal length. The prolonged delays in accomplishing the resettlement process by CMC due to unreasonable demands by PAPs have caused the above delay.
Before improvements under MCUDP, there were only tertiary drains along Arnold Rathnayake Mawatha (ARM), connecting to Norris Canal and directly to Beira Lake at the two ends. The following improvements were done under MCUDP:

- Removed bottleneck of the existing Norris Canal
- Constructed new diversion from Norris Canal, starting from Deans Road junction leading to Beira Lake (not fully completed by 31.12.2021)
- Lateral drains were connected to the already constructed diversion channel

However, existing tertiary drainage along the incomplete 126 m stretch is still functioning, as it is connected to the already completed downstream portion of the new diversion, which is connected to Beira Lake.

Further, although the bed slope of box drain of the new diversion is towards Beira Lake, during rain events, flow from the already completed upstream portion of the new diversion will take place to the head gradient. towards the existing Norris Canal (Refer Figure 12.3 for the layout map).

Therefore, as of the present situation, though the expected benefits cannot be fully achieved, there is no adverse impact due to this incomplete section, as the drainage pattern continues as described above. And with the improvements done to existing Norris Canal and the two ends of the new diversion path, a reasonable improvement in the drainage condition is expected, which has already been practically witnessed during the recent rain events.

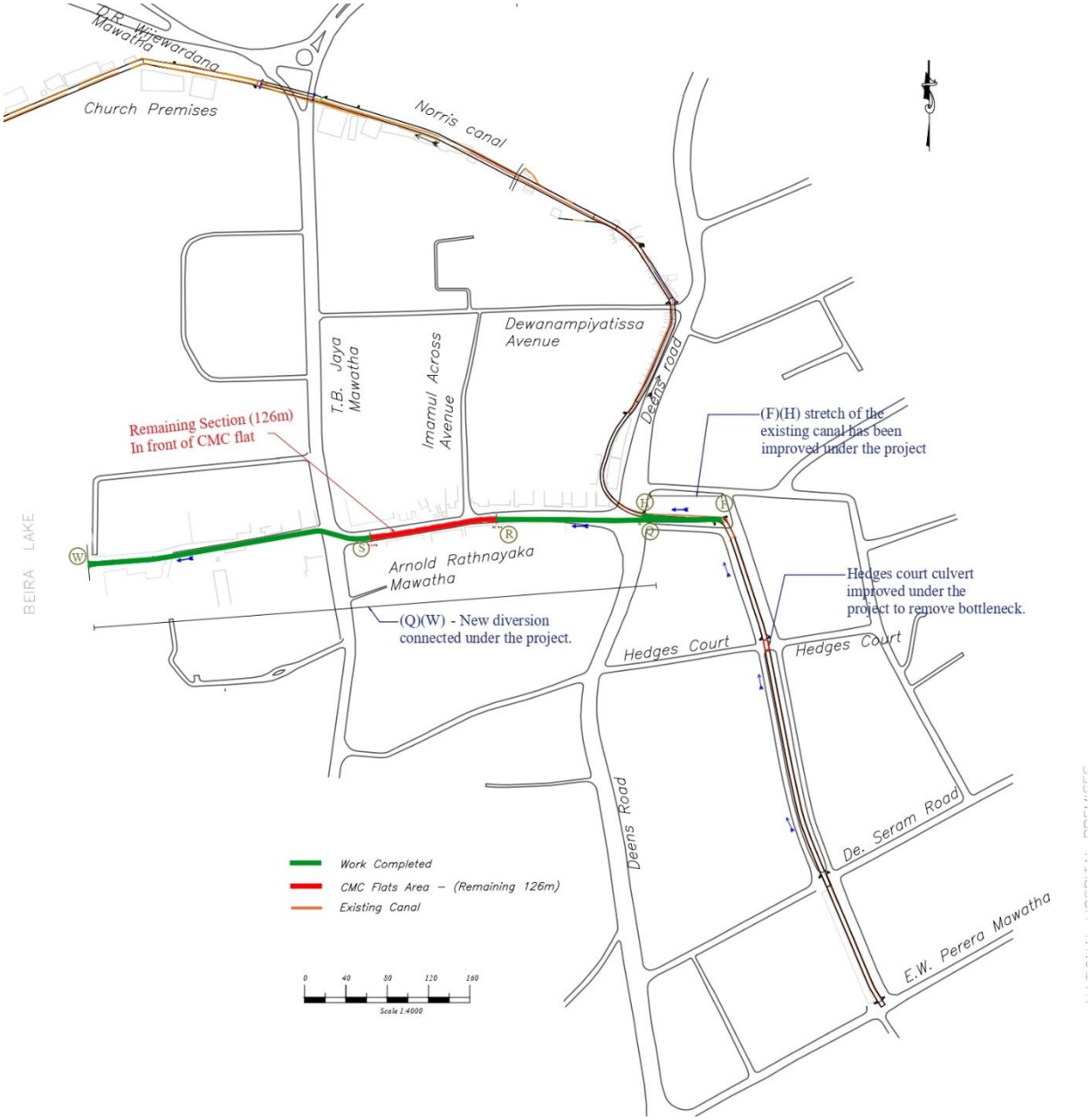


Figure 12.3 Layout map on Norris Canal

12.1.4. Sub-component 1.3

Table 12.7 Achievement of Intermediate Results Indicator – Subcomponent 1.3

#	Intermediate Results Indicator	Target	Achievement
1.5	RTC developed and integrated into SLLRDC's operation	Yes	Yes

The outcomes of IFMS under the sub-component 1.3 and their integration can be summarized as shown in Figure 12.4.

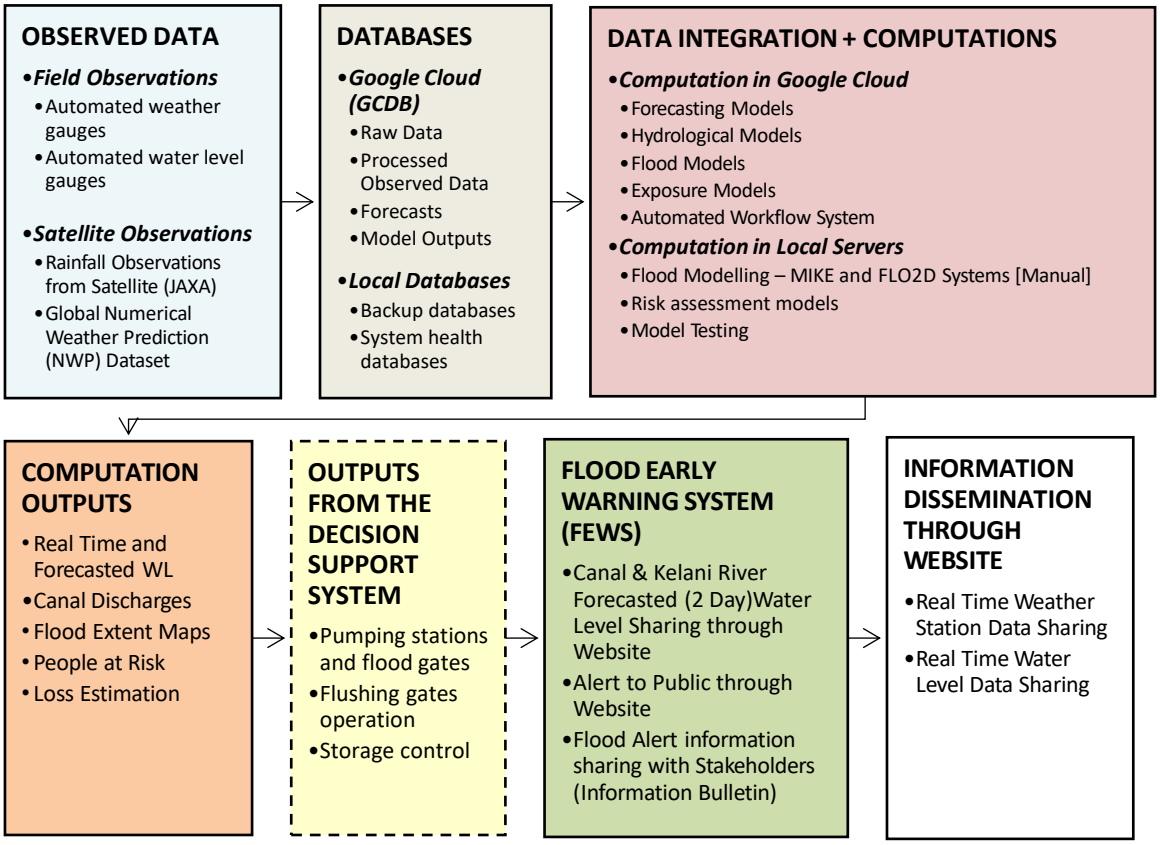


Figure 12.4 Outcomes of IFMS

Most of the above functions are integrated with cloud-based systems, and the local system are utilized to act as the backup options and often as test cases before deployment to the cloud system. All the generated information including the observed weather and water levels is disseminated through the http://pub.curwsl.org/ website, to the specific stakeholders and to the general public. For above system to sustain and function, carry out the operations and to maintain the system, necessary staff has been recruited in a permanent basis to the SLLDC.

The decision support system is yet to be finalized with its final system integration component, which is the Central SCADA – central supervisory control and data acquisition system which will allow to control and monitor the flood control interventions (pump stations and flood gate facilities) from a central location. When this system is established, the central location will have the capability of monitoring and remotely operating the flood control interventions even at emergency situations where the interventions accessibility is seriously limited. It will also act as a redundant mode to collect the critical monitoring information such as water levels, pump and gate status in addition to the automated telemetry (weather stations and water level gauges) system. Refer Annex 2: for further details.

- Machinery and equipment worth of USD 7.38 million were procured and handed over to SLLDC for maintenance of the macro drainage system. In addition to that USD 0.38 million worth of computer software for designing and operations of Macro Drainage System and office equipment for setting up of Integrated Flood Management System also were handed over to SLLDC. Refer to Annex 3:.

- Specifically, during dry season water quality of the canals get worsen. By analyzing the pollution level using measured water quality parameters, especially Biochemical Oxygen Demand (BOD) will be

diluted using six (6) or seven (7) cycles of flushing and water quality of the canal system can be improved to an acceptable level (up to 80% of the river water quality). Operational functions of flushing gates have connection to SCADA system.
The time duration needed per one cycle, including filling the northern part of canal system by reverse pumping and releasing water through the gate at Port Access Road is approximately 12 hours.

12.1.5. Sub-component 1.4

Table 12.8 Achievement of Intermediate Results Indicator – Sub-component 1.4

#	Intermediate Results Indicator	Target	Achievement
1.6	User's satisfaction with the condition of Beira Lake and Beddagana and Rampart Park	70%	83.26%
	Refer note on User Satisfaction Survey carried out at the completion of the project given at the end of this chapter.		

Beira lake bank protection and linear park

Bank protection work has been completed for 3.45 km while establishing boundaries and demarcating the reservation of the Beira Lake. A clean environment has been created by reducing erosion, water pollution, preventing unwanted sewage entering the lake. Provisions have been made for the stormwater drainage.

Linear Park of 3.45 km together with McCallum entrance park has been developed. Banks of Beira has been converted into a safe space for urban regeneration assuring protection of users with handrails fixed at the lake side and street lighting. Soft landscaping has been used to create an attractive environment. Decks has been built and street furniture has been provided for the comfort of the users. Underpass has been provided to access the McCallum entrance park.

Beddagana and Kotte Rampart wetland parks

Beddagana wetland park and its second phase biodiversity park at Kotte Rampart together with a cycle and jogging track along Nippon Mawatha joining the two parks have been successfully completed. The wetlands have been protected from encroachment, creating a sanctuary for native flora and fauna providing ecosystem services preventing floods by retaining stormwater during heavy rains. Both parks are good bird watching sites including for migratory birds and in addition Beddagana is a habitat for variety of butterflies. Invasive plants have been removed and endemic plants have been introduced into the parks to enhance bird habitats. Parking area, orientation center, resting place, open decks, bird watching hides and towers, broad walk, entrance porch, timber bridge, forest paths, shallow ponds, bird scrapers, reed beds, visual barrier and dry weather playground are the main features in Beddagana wetland park. The Kotte Rampart bio-diversity park designed to be a knowledge hub for wetland education, features entrance building, broad walk, discovery center, classrooms, conference hall, restaurant, washroom facilities, reflexology area, swing walk, canopy walk, observation tower, natural trails and adventure park for children. The parks in the heart of the city provide recreational facilities for the general public and learning center for the students and environmentalists generating an income to the authorities.

User satisfaction survey

User satisfaction survey has been completed as per the directive given in the PAD (Source: Results framework, Annex 1, Page 21-22) to understand the user satisfaction level of the parks and area-based demonstration projects under subcomponent 1.4 Beira Lake, Linear Park and Beddagana Park (water front development) and subcomponent 2.1 Investment support to local authorities. A well experienced consultancy firm was given to conduct this participatory assessment. Information was gathered using Key Informant Interviews (KII), Focus Group Discussions (FGD), and by interviewing the users. The questioner prepared was slightly changed to adopt to the features developed and improved in different places. The findings of the study shows that users are highly satisfied with the current conditions of the parks. Users' satisfaction level for the condition of Beira Lake and Beddagana & Rampart parks was 83.26% and for the area-based demonstration projects in Colombo city - Vihara Mahadevi and Crow Island parks was 78.21%.

12.2. Component 2

Outcome of Component 2 was set to measure using the 2nd Indicator of the results framework "Percentage of total urban roads maintained by PLAs that are in good and fair condition in the 4PLAs". In addition, 6 intermediate results indicators have been introduced in the project appraisal document as well as the loan agreement. However, with the changes done to the intermediate results indicators in the restructuring in 2017 and following the implementation support mission in August- October 2019, currently the component 2 has 4 intermediate results indicators.

At the project closure on 31st December 2021, all the intermediate results indicators have been achieved.

Table 12.9 Achievement of PDO Level Results Indicator

PDO Level Results Indicator	Target	Achievement
Increase in percentage of total urban roads maintained by the four PLAs that are in good and fair condition in the 4 PLAs	70%	> 70% Achieved

A survey has been conducted by the University of Moratuwa to measure the International Roughness Index (IRI), which has been used as a standard to quantify road surface roughness.

Figure 12.5 illustrates the overall condition of the road network and less than 5% of the roads are in poor condition. Roads that have IRI between 4 to 6 (around 20%), is likely to have isolated distresses that have increased the average section IRI. Roads with an IRI value less than 7 are considered to be in good condition, therefore 94% of the roads are in good condition even after 5 years after completion exceeding the target. Overall, it can be concluded that more than 70% roads segments are in good/excellent condition.

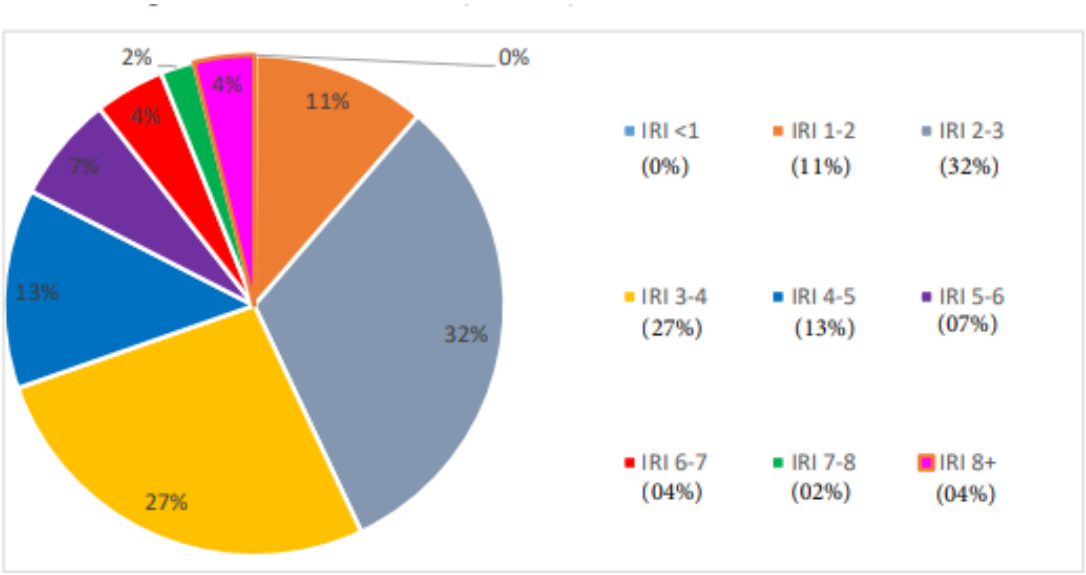


Figure 12.5 IRI distribution among road segments

Figure 12.6 illustrates the distribution of road segments with IRI (number of road segments with the given IRI range). A road segment is 100m long.

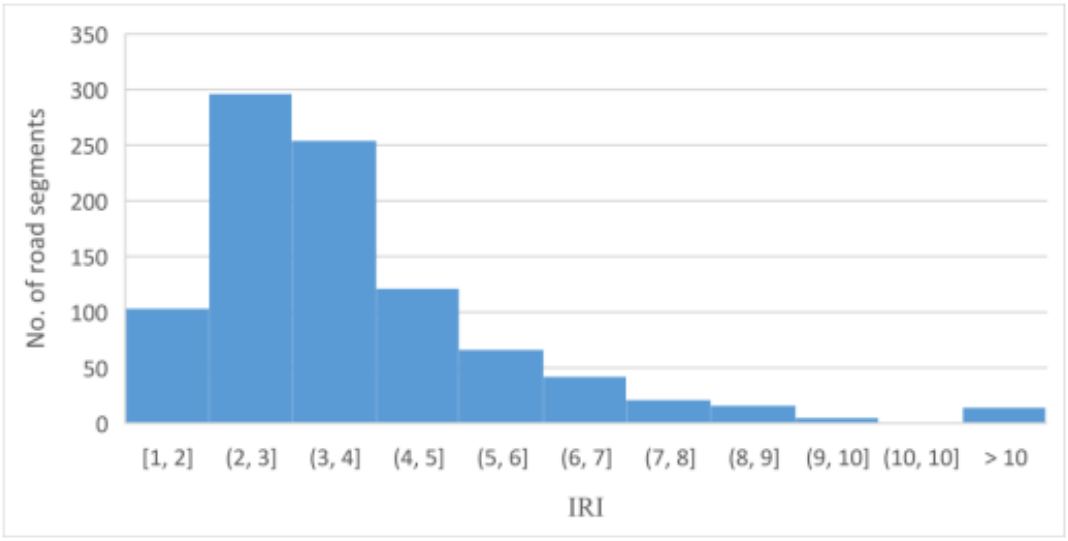


Figure 12.6 Distribution of road segments with IRI

Table 12.10 Achievement of Intermediate Results Indicators – Sub-component 2.1

Intermediate Results Indicator	Target	Achievement
2.1: Kilometers of road /drainage built / rehabilitated based on prescribed standards	45 km	47 km, Target has been achieved
Refer Table 12.11 for Names of Roads		
2.2: Users satisfied with area-based demonstration projects in Colombo City	70%	78.21%, Target has been achieved
Refer chapter 12.1.5 for the detail on User satisfactory survey results		
2.3: Number of public spaces/parks upgraded and revitalized by the project	3 Nos.	3 Nos. Target has been achieved
Vihara Maha Devi Park, Crow Island Beach Park, Angampitiya playground - Refer Figure 7.4		
2.4: Number of public convenience complexes maintained by PLAs that are in good & fair condition.	16 Nos.	16 Nos. Target has been achieved
Refer Figure 7.4 *for locations*		

Table 12.11 Length of Roads Rehabilitated under MCUDP

PIA	Project	Length (m)	Length (km)
SJKMC	Infrastructure Development in SJKMC/ PKG 1	8,658	12.84
	Infrastructure Development in SJKMC/ PKG 2	4,185	
DMMC	Infrastructure Development in DMMC / PKG 1	5,950	10.97
	Infrastructure Development in DMMC/ PKG 2	5,023	
KUC	Infrastructure Development in KUM / PKG 1	3,499	3.50
CMC	Walkability PKG I	2,687	7.72
	Walkability PKG II	2,056	
	Walkability PKG III	2,982	
	Town Hall PKG II	2,362	2.36
	Galle Road PKG A	2,334	9.72
	Galle Road PKG B	3,660	
	Galle Road PKG C	3,730	
Total			**47.11**

Project Interventions Impact Survey

A project intervention impact survey was done by an independent consultant hired by the World Bank and the results of the survey showed that a considerable majority (81.49%) of beneficiaries were found to be confident and in good impression that flood risk has been declined as a result of interventions under MCUDP.

13. Mitigation of Recent Floods

During the closing phase of MCUDP, the CM area experienced two (2) significant rain events, i.e., in May/June 2021 and November 2021. Since most of the interventions under MCUDP had either been completed or were approaching "Completion" contractually (substantially completed), those could be operated to successfully mitigate the said flood events. This chapter discusses event summaries, and how the flood control interventions tackled the flood situations.

13.1. Event in May / June 2021

Heavy rainfall occurred within Colombo and Kelani catchments at the end of May and beginning of June 2021. Real time weather information obtained during the event by IFMS/RTC from automated weather stations in monitoring stations in Colombo and Kelani catchments are shown in Table 13.1, while rainfall patterns observed at selected stations are shown in Figure 13.1. Battaramulla weather station recorded the 24-hr maximum rainfall of 236 mm.

Table 13.1 Rainfall Summary of May/June 2021 Event

		Rainfall mm				
From	To	Battaramulla	Jalthara	Kithulgala	Dickoya	Mawaramandiya
2021-06-02 0:00	2021-06-03 0:00	2.8	66.6	16	1.8	7
2021-06-03 0:00	2021-06-04 0:00	220.4	280.8	40	4.4	384.6
2021-06-04 0:00	2021-06-05 0:00	35.8	97.2	99.8	22.8	54.2
2021-06-05 0:00	2021-06-06 0:00	19.6	66	107.6	39.2	50
2021-06-06 0:00	2021-06-07 0:00	3.8	4	7	6.4	5.8
Total Rain		282.4	514.6	270.4	74.6	501.6

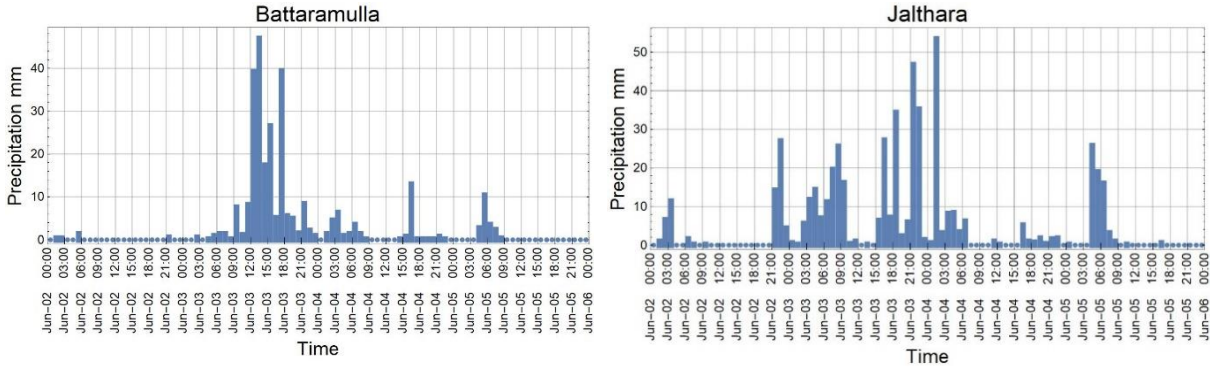


Figure 13.1 Rainfall Patterns Observed at Selected Stations during May/June 2021 Event – left: Colombo catchment, right: Kelani catchment

Observations of Colombo canals and Kelani River water level monitoring stations shown in Figure 13.2.

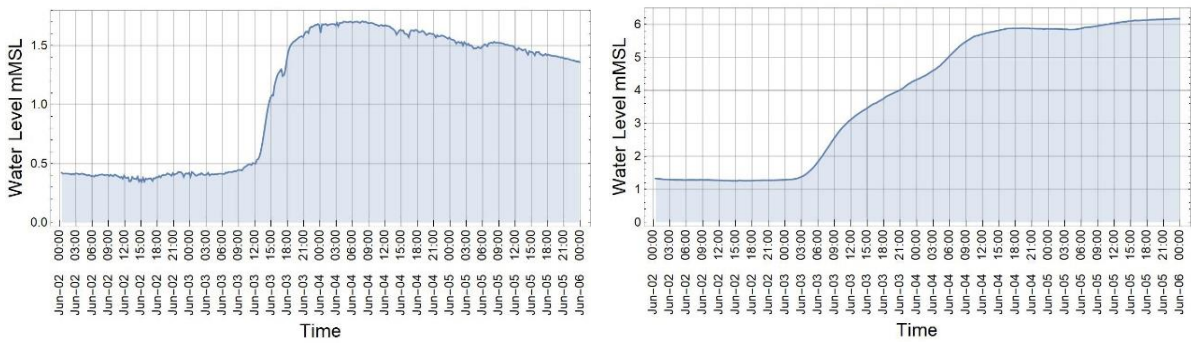


Figure 13.2 Observed water levels at Colombo canal system and Kelani River

Operation of Pumping Stations

In order to reduce the adverse effects of floods, pumps were operated at three pumping stations; Ambathale, North Lock and South Lock. Summary of pumping operation is given in Table 13.2, Table 13.3 and Table 13.4 for the above three pumping stations, respectively. However, it was not the standard operational sequence of pumping as the project was not fully completed by that time to do so. This was done as a testing of operation of developed facilities by MCUDP.

Table 13.2 Operation of Ambathale Pumping Station

Time	Discharge (m^3/s)
6/5/2021 12:05:00AM	8
6/5/2021 1:00:00PM	8
6/5/2021 1:05:00PM	20
6/8/2021 12:00:00AM	20

Table 13.3 Operation of South Lock Pumping Station

Time	Discharge (m^3/s)
6/4/2021 8:55:00AM	5
6/8/2021 12:00:00AM	5

Table 13.4 Operation of North Lock Pumping Station

Time	Discharge (m^3/s)
6/3/2021 3:40:00PM	12
6/3/2021 3:50:00PM	18
6/3/2021 4:05:00PM	12
6/3/2021 4:25:00PM	12
6/3/2021 4:40:00PM	18
6/5/2021 5:25:00AM	18
6/5/2021 5:30:00AM	24
6/5/2021 6:00:00AM	24
6/5/2021 6:05:00AM	18
6/5/2021 8:00:00AM	18
6/5/2021 8:05:00AM	12
6/8/2021 12:00:00AM	12

Peak water level of Kelani River has reached minor flood level and simultaneously Colombo catchment received nearly 300 mm rainfall. With the operation of pumps as above, peak water level of Parliament Lake could be managed at 1.71 m MSL, within the flood safety region.

In addition, the gates at Gothatuwa Flood Bund (KCD I) were opened to reduce the impact to Kolonnawa basin from river overflow / back water, and water from Kolonnawa basin was diverted back to Kelani River via North Lock Pumping Station.

13.2. Event in November 2021

By November 2021, almost all the flood control facilities are completed / substantially completed. During the period from November 6th to 11th, both Kelani and Colombo catchments received rainfall and. Kelani River reached its minor flood level. Flood mitigation operations could be carried out to lower the Colombo water levels before peak comes and Water level at center of the macro drainage system (Parliament Lake) could be managed below +1.15 m MSL: a quite safe level.

Operation of Pumping Stations

In order to reduce the adverse effects of floods, pumps were operated at two pumping stations; Ambathale and North Lock. Operation of pumps at Ambatale pumping station and water level comparison at Ambathale (with and without pumping operation) during this event is given in Figure 13.3 and Figure 13.4 respectively.

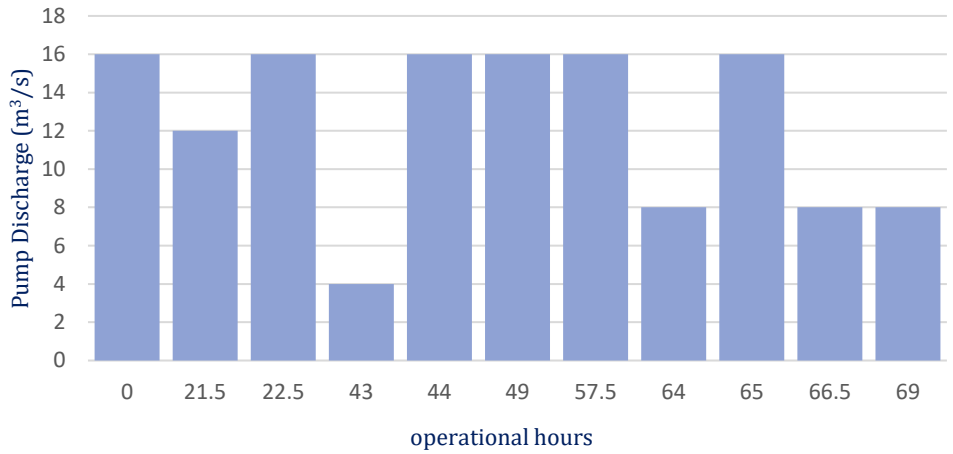


Figure 13.3 Operation of Ambathale pumps during flood event: Nov 2021

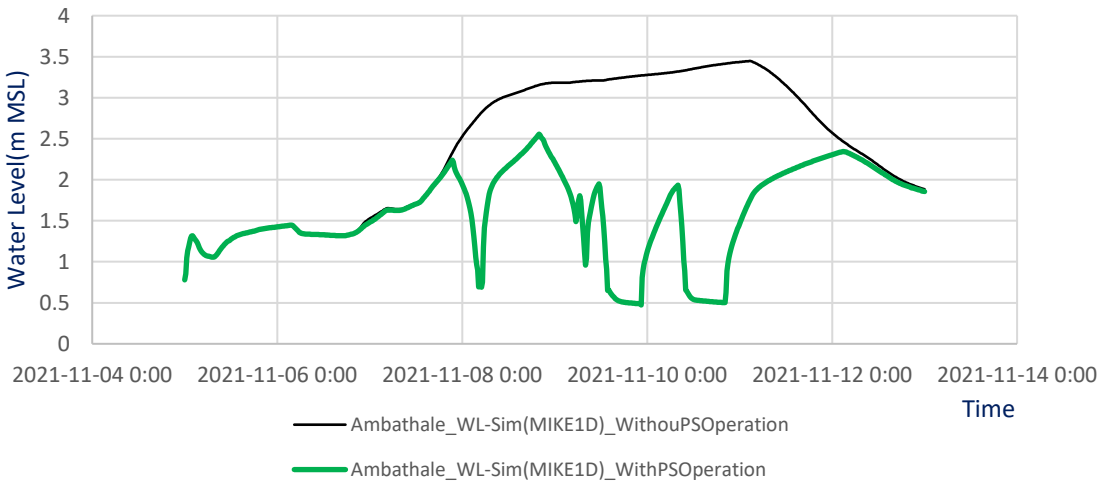


Figure 13.4 Water Level Comparison at Ambathale (with and without Pumping Operation) during November 2021 Event

This exercise has been used as a testing event, and the practical experience has been used to fine tune the pumping operating sequences for better mitigation of floods.

Part VII - Economic Analysis

14. Economic Analysis

The cost benefit analysis includes the Financial Internal Rate of Return (FIRR) calculations, and also the Economic Internal Rate of Return (EIRR) calculations, including a sensitivity analysis as well. However, since the MCUDP is seen as an economic benefit generating project rather than as a revenue generating project, for the purpose of this report, only an EIRR calculation and related analysis are done. It wholistically represents the economic impact of the project.

The methodology used to calculate the current ENPV and the EIRR values is explained below.

14.1. Key Considerations

For the project economic evaluation, following are taken into consideration:

- The economic analysis is conducted aiming flood and drainage management considering the subcomponents 1.1, 1.2 and 1.3
- Economic analysis was developed using cost and financial parameters derived from the project design where benefits, both direct and indirect were taken into consideration. It is done for the project implementation period, and the 30 years of operation.
- The financial figures are presented in LKR or US$ as appropriate.
- Project expenditure as per the financial reports has been considered in the analysis.
- Operation and Maintenance cost and project benefits have been derived based on several analysis which are annexed to this report. Analysis period is 30 years and are considered operational years.
- To adjust the financial values into economic values, the conversion factor is taken as 99.67% to exclude transfer payments such as taxes, import duties etc. Please refer section 14.2.1 MCUDP - Ascertaining Economic Costs for workings.
- Benefit estimates for projects are based on the existing market condition including demand, supply and logistic factors.
- An annual increment of 5% for costs are assumed, which is similar to the assumption for the annual increment for costs in the PAD.
- For component 1.4, the PAD presents a calculated EIRR of 28% with an NPV of USD 18.3 million, which is based on a business development plan proposed/intended to be implemented after improvements to the Beira Lake under MCUDP. Even though the MCUDP interventions are completed, a separate analysis on the economic benefits for this component could not be carried out as the proposed/intended business development plan was not implemented yet.

14.2. Economic Analysis / Cost Benefit Analysis Results

Projects are considered economically viable when projects EIRR exceeds Economic Opportunity Cost of Capital (EOCC) which is assumed as 10%. The EIRR is the discount rate at which the present value of incremental projects costs equalizes the present value of incremental benefits in economic term over the projects life.

14.2.1. Economic costs

These are the financial costs, converted to the economic costs, and a resultant economic expenditure of LKR 25,186,102,892 for a financial expenditure of LKR 25,268,870,362 is obtained. The conversion factor derivation and the relevant other computations are shown below.

MCUDP - Ascertaining Economic Costs

Table 14.1 Ascertaining economic costs

Item	Financial Cost Total	Foreign Cost	Local Cost	Unskilled Labor 30%	Balance Local Cost	Other Local Cost	Foreign x SERF 1.033	Unskilled x SWRF 0.82	Other x SCF 1.00	Economic Project Cost
Works	18,295,116,131	9,096,249,060	9,198,867,070	2,759,660,121	6,439,206,949	6,439,206,949	9,396,425,279	2,262,921,299	6,439,206,949	18,098,553,528
Consultancies	2,665,866,082	1,454,271,931	1,211,594,151	-	1,211,594,151	1,211,594,151	1,502,262,905	-	1,211,594,151	2,713,857,056
Goods	1,116,261,415	934,950,099	216,262,122	-	216,262,122	216,262,122	965,803,453	-	216,262,122	1,182,065,574
Social Safeguard (Land acquisition)	1,958,061,053	-	1,958,061,053	-	1,958,061,053	1,958,061,053	-	-	1,958,061,053	1,958,061,053
Project Overhead Expenditure+ PMU+ Other	1,233,565,681	-	1,233,565,681	-	1,233,565,681	1,233,565,681	-		1,233,565,681	1,233,565,681
Total Cost	25,268,870,362	-	-	-	-	-	-	-	-	25,186,102,892

SERF = shadow exchange rate factor; SWRF = shadow wage rate factor; SCF = standard conversion factor

Notes:

- Taxes are not included in the calculation; hence a relatively large value is obtained for the conversion factor (99.67%).
- It is assumed that the unskilled labor percentage is 30%, SERF is 1.033 and the SWRF is 0.82, according to the recommendations by (Asian Development Bank, 2017) considering the country contexts.

14.2.2. Economic Benefits

An average annual benefit of LKR 2,190 million has been computed for the project forecasted benefit (please refer Annex 4: for the workings), and the sectorial breakdown is shown below. All these values are identified to avoiding costs, due to not experiencing floods in MCR. The benefit analysis table shown below is applicable at the end of the year 31st December 2021. The enhance value of benefits for 2022 would be LKR 2,300 million, after accounting for a 5% average annual increment in costs and benefits.

Table 14.2. Sectorial breakdown of benefits

Sector	Benefit LKR Millions	Ratios
Social		
Housing, Land, and settlements	2,044.03	93.33%
Health and Nutrition	21.49	0.98%
Education	8.60	0.39%
Productive sectors		
Food Security, Agri and Livestock, Fisheries	0.27	0.01%
Industry and Commerce	0.27	0.01%
Infrastructure		
Irrigation	0.19	0.01%
Water and Sanitation	3.06	0.14%
Transport	22.00	1.00%
Power Supply	1.66	0.08%
Cross cutting issues		
Environment	1.05	0.05%
Disaster Risk Reduction	1.46	0.07%
Employment and Livelihoods	85.39	3.90%
Gender and Social inclusion	0.53	0.02%
Total	**2,190.00***	**100.00%**

**This value has been derived for the year 2021, and after accounting for the annual 5% increment, the equivalent benefit for 2022 will be LKR 2,300 million.*

14.3. EIRR and Sensitivity Analysis

A combined analysis of Component 1.1-1.3 to assess the overall economic viability of projects completed was carried out. In this analysis resulting all completed projects EIRR as combined is assessed at 26.31%. This exceeds the estimated opportunity cost of capital 10.00%. A sensitivity analysis, undertaken to further test economic viability showed that ENPV assessed is LKR 19,955.28 million which shows the potential economic viability of the projects completed were satisfactorily.

14.3.1. Cost Benefit Analysis

The result of cost benefit analysis and Economic Internal Rate of Return (EIRR) including sensitivity analysis are provided herein. All costs are in LKR.

Table 14.3 Summary of the costs and benefits

Investment Cost	O&M	Benefits	Land value appreciation
25,186,102,892 *One time cost only in 2021*	105,000,000 *Annual cost starting from 2022* 3,438,000,000 *After 20 years (2042), one time cost accounting for major replacement cost*	2,300,000,000 *Annual cost starting from 2022*	20,287,000,000 *One time cost only in 2022*

Notes:

1. Workings on Land value appreciation has been provided in the Annex 4:
2. Expected replacement (capital cost) for major mechanical parts in 2042, LKR 3,438 million (after 20 years), before accounting for 5% annual increment. After accounting for the annual increment of 5%, the value would be LKR 9,122.04 million.

14.3.2. Summary of Economic Evaluation and Sensitivity Analysis - Component 1.1-1.3 Flood and Drainage Management

The conventional EIRR is analyzed as the base case, and in addition, three more scenarios are conducted to assess the sensitivity of the benefits of the project. The selected cases are committed to the base case as follows.

A. Increment of operation and maintenance (O&M) cost by 10%
B. One year delay in benefits
C. Increment of operation and maintenance (O&M) cost by 10% plus one-year delay in benefits

Table 14.4 Selected scenarios to analyze benefits

	Base case	Case A	Case B	Case C
EIRR	26.31%	26.22%	22.98%	20.56%
ENPV (LKR million)	19,955.28	19,811.66	17,770.26	14,578.51

14.3.3. Detailed economic analysis: Component 1.1-1.3 Flood and Drainage Management

Table 14.5 Detailed economic analysis

Year	Benefits	Land Value Increase	O&M	Investment	Written Down Value	Base Case	Case A	Case B	Case C
2021				25,186.10		-25186.10	-25186.10	-25186.10	-27704.71
2022	2070.00	20287.00	105.00			22252.00	22241.50	20182.00	22034.50
2023	2173.50		110.25			2063.25	2052.23	1959.75	1834.88
2024	2282.18		115.76			2166.41	2154.84	2057.74	1926.62
2025	2396.28		121.55			2274.73	2262.58	2160.62	2022.95
2026	2516.10		127.63			2388.47	2375.71	2268.66	2124.10
2027	2641.90		134.01			2507.89	2494.49	2382.09	2230.30
2028	2774.00		140.71			2633.29	2619.22	2501.19	2341.82
2029	2912.70		147.75			2764.95	2750.18	2626.25	2458.91
2030	3058.33		155.13			2903.20	2887.69	2757.57	2581.85
2031	3211.25		162.89			3048.36	3032.07	2895.44	2710.95
2032	3371.81		171.03			3200.78	3183.67	3040.22	2846.49
2033	3540.40		179.59			3360.82	3342.86	3192.23	2988.82
2034	3717.42		188.56			3528.86	3510.00	3351.84	3138.26
2035	3903.29		197.99			3705.30	3685.50	3519.43	3295.17
2036	4098.46		207.89			3890.57	3869.78	3695.40	3459.93
2037	4303.38		218.29			4085.09	4063.27	3880.17	3632.93
2038	4518.55		229.20			4289.35	4266.43	4074.18	3814.57
2039	4744.48		240.66			4503.82	4479.75	4277.89	4005.30
2040	4981.70		252.70			4729.01	4703.74	4491.78	4205.57
2041	5230.79		265.33			4965.46	4938.92	4716.37	4415.85
2042	5492.33		278.60	9,122.04		-3908.31	-3936.17	4952.19	-5397.60
2043	5766.94		292.53			5474.42	5445.16	5199.80	4868.47
2044	6055.29		307.15			5748.14	5717.42	5459.79	5111.89
2045	6358.05		322.51			6035.54	6003.29	5732.78	5367.49
2046	6675.96		338.64			6337.32	6303.46	6019.42	5635.86
2047	7009.75		355.57			6654.19	6618.63	6320.39	5917.66
2048	7360.24		373.35			6986.90	6949.56	6636.41	6213.54
2049	7728.25		392.01			7336.24	7297.04	6968.23	6524.21
2050	8114.67		411.61			7703.05	7661.89	7316.64	6850.43
2051	8520.40		432.19		6,296.53	14384.73	14341.51	7682.47	13489.47
NPV						19955.28	19811.66	17770.26	14578.51
EIRR						26.31%	26.22%	22.98%	20.56%

Notes:

1. Life of asset is considered as 40 years
2. Assessment period is considered as 30 years
3. Capital / investment cost ascertained at 100% upon completion.
4. Benefits (Direct) increased by 5% annually.
5. O&M cost also increased by 5% annually.
6. Capital / financial cost analysis has been provided.
7. Cost apportioning - Goods, Consultancies, Social Safeguard and Project Overheads - PMU and others are shown in the analysis.
8. Expected replacement (capital cost) for major mechanical parts in 2042, LKR 3,438 million. (After 20 years), after accounting for 5% annual increment.

Part VIII - Procurement, Contract and Finance Management

15. Procurement

Procurement procedure adopted including guidelines, process, challenges and achievements are explained under the procurement management.

The following procurement guidelines of World Bank and Government of Sri Lanka were applied in respect of procuring Works, Goods & Services, and Consulting & non-Consulting services of MCUDP implementation.

15.1. Guidelines for Procurement Process / Procedures adopted

- Procurement of Goods, Works, and Non-Consultancy Services Under IBRD Loans and IDA Credits & Grants by World Bank Borrowers.
  WB Guidelines issued in 2011 and revised in July 2014 & 2017 and National Procurement Guidelines issued in 2006 along with the Procurement Manual (2006) & respective Supplements to the Procurement Manual were applied in the procurement process.
- Guidelines for selection of employment consultants Under IBRD Loans and IDA Credits & Grants by World Bank Borrowers.
- WB Guidelines issued in 2011 and revised in July 2014 & 2017 and National Procurement Guidelines issued in 2007 along with the Procurement Manual (2007) were applied in the procurement process.

15.2. Procurement Methods

The method of procurement of goods, works and consultant services were decided based on the initial and revised estimated contract value (threshold) provided by the WB in the PAD/agreement. The used procurement methods are,

- Goods, Works & Non-consulting Services
  - Request for Bids (International & National Competitive Bidding)
  - Request for Quotations (International & National)
  - Direct Selection (International & National)

- Consultant Services
  - Quality and Cost-Based Selection (International & National Competitive Bidding)
  - Direct Selection (International & National)
  - Individual Consultant Selection (International & National)

With the identified procurement method and estimated contract value, the procurement processes were carried out upon the decision of the respective Procurement Committees (PC) and the approval of the relevant approving authority stipulated in the national procurement guidelines.

The MCUDP adopted all relevant & required procurement guidelines, methodologies in the selection process and are documented in the prescribed manner for reporting purpose. Accordingly, the MCUDP was able to complete the procurement processes of 55 nos. of contracts for Works, 38 nos. of intending for

Goods, 36 nos. of Consultancy services and also for 2 non-consultancy services. All together the procurement process completed for 131 nos. of activities successfully. List of sub projects by the project closure and the summary is tabulated as below. The details of the sub projects and the procurement processes are tabulated as Annex 5:.

Table 15.1 Details of Procurement packages

Procurement Category	Procurement Method	No. of packages	Total No. of packages
Works	Request for Bids		55
	ICB	06	
	NCB	48	
	Direct Selection		
	Force Account	01	
Goods	Request for Bids		38
	ICB	05	
	NCB	12	
	Request for Quotation	08	
	Direct Selection	13	
Consultant Services	Quality & Cost-Based Selection	18	36
	Direct Selection	02	
	Individual Consultant Selection	16	
Non-consulting Services	Request for Quotations	01	02
	Direct Selection	01	

15.3. Reporting and Monitoring of the Procurement Processes.

An online system called "Strategic Tracking of Exchanges in Procurement" (STEP) was introduced by the WB in order to help the World Bank and borrowers plan and track all the procurement activities from commencement to completion under Bank-financed projects. The system provided ways to transform all procurement related data into knowledge, speeds up the procurement process, and improves accountability and transparency – driving results for development. Reporting & monitoring of procurement processes were easily traced by both borrower and the WB at any convenience time by accessing the STEP system.

STEP system automatically published all approved procurement plan, publication notices and contract award information of sub projects of MCUDP in the Bank's external website, UNDB online.

15.3.1. Delays in the Procurement Process

The procurement process of MCUDP often delayed for different reasons caused by both WB and implementing agency. Due to such delays, some of the contracts could not be awarded as scheduled and this contributed to delays in completion of MCUDP.

The following were the causes of delay in the MCUDP procurement process.

Delay in finalizing Standard Procurement Document for Design & Build Contracts

MCUDP consists of four (04) nos. of Design & Build contracts which were procured following the ICB method of procurement (single stage two envelope). World Bank was unable to share a standard

procurement document for design and building of stormwater pumping stations and underground stormwater tunnels. It took a long time to modify the World Bank standard document "Standard Bidding Document for Procurement of Plant Design, Supply and Installation" in accordance with the scope of the pumping stations and the tunnels.

Extension of Bid or Proposal Submission Date

Extensions has to be given for longer periods due to following reasons:

- Considerable time was taken to provide responses for request for clarification (particularly for design and build procurements) resulted in amendments to the solicitation documents.
- Bid and proposal opening was postponed due to the unforeseen event of Easter Sunday bomb attack occurred in 2019.
- Due to the Covid 19 pandemic in 2020 followed by frequent lockdown and travel restrictions all over the island, invitation for bids and bid opening of several procurement of goods related to RTC were postponed by several weeks/months.

The above caused considerable delay in awarding contracts.

Delay in Completing the Evaluation Process

The MCUDP organized the evaluation process, but bids and proposals were evaluated by an independent panel of three or more individuals from various public organizations. Therefore, the duration of the evaluation process was not under the control of the Procuring Entity and the time taken for evaluation of bids/proposals for procurements such as design & build contracts, consultancy contracts following QCBS method etc. was more than the planned duration and this delay in evaluation caused delays in awarding the contract.

Further, for some large contracts such as design and built contracts, additional support of technical experts in that speciality has to be obtained for Technical Evaluation Committees of contracts which require specific technical knowledge for evaluation process, upon the request of Technical Evaluation Committee.

Delays during the Approval Process

Approval was required at various stages in the procurement process depending on the monetary value of the procurement requirement as stipulated in the respective national procurement guidelines.

The time taken for determination on contract award of procurement committees was out of control from the planned time schedule by MCUDP. The same delay was experienced when obtaining the approval for contract award for the large procurements from the relevant approving authorities such as Secretary of the line ministry and the Cabinet of Ministers.

Specially, the process of obtaining approval from cabinet & the Secretary of line ministry at various stages of procurement process of some large-scale contracts were delayed largely after the government changes during the years 2015 & 2018.

Challenging the Determination on Contract Award

National Procurement Guidelines permits the unsuccessful bidders to make their representations against the recommendation of Cabinet Appointed Procurement Committee (CAPC) for the intention to award the contract to the successful bidder to the Procurement Appeal Board (PAB). Accordingly, most of the procurements under the level of CAPC were addressed to the PAB and it took almost 3-4 weeks to obtain PAB for the intention to award.

But, in the case of Ambathale Pumping Station, initially the PAB decision was in favour of the unsuccessful bidder and thus, the bids were re-evaluated by an enhanced TEC with the guidance of WB & National Procurement Commission of SL. Then, after repeating from beginning and following all guidelines & procedures including PAB, the contract was awarded to the same bidder who was initially recommended by the previous TEC.

This caused a huge delay of additional 07 months to award the contract.

In summary most of the sub projects under MCUDP got delayed in the various stages in the procurement process and finally the contract award was delayed by considerable time period in addition to the planned duration. The common time flow chart to follow the procurement processes under the level of CAPC Level procurement (Single Stage Two Envelope) is shown in Annex 6:.

15.4. Procurement Review and Assessment (as per the PAD)

Procurement Post Reviews (PPR) of MCUDP for each financial year were conducted by the WB team to ascertain the compliance to (i) the agreed procurement procedures, (ii) all documents related to the procurements are retained by the MCUDP, and (iii) the procurement documents are readily accessible.

Further, the WB conducted missions in time to time normally two times in a year to ascertain the procurement processes are in line with approved procurement plan, reviewing current procurement plan and make necessary clearance and evaluate the overall compliance of the procurement.

15.5. Overall Procurement Process

The Project Steering Committee and the PMU with other relevant authorities has been able to successfully complete the procurement process throughout the period ensuring that all contracts awarded for Works, Contracts for Consultancies, and Procurement of Goods for PIAs and PLAs have been satisfactorily completed.

Further, the procurement review and assessment carried out by Word Bank mission endorsed that procurement procedure has been satisfactorily carried out.

16. Contract Administration

The sub-projects undertaken by the MCUDP, Capital Works and construction, renovation, etc. for flood and drainage management, 55 projects, Consultancy Services for 39 projects on same Capital Works and Procurement for 37 indents for Supply of Goods including equipment and machinery to those Project Implementing Agencies (PIAs) and Project Local Authorities (PLAs) have been completed. The contract management process has been duly implemented by the PMU for undertaking, execution and completion of projects throughout the period.

The PMU initiated action and formal arrangements have been made for proper handing over of projects completed and Goods supplied for those PLAs for operation and maintenance ensuring the continuation of project activities. Accordingly, the completed projects are considered satisfactory in respect of achieving the PDOs and also providing the necessary infrastructure facilities and logistic requirements.

As shown under the Procurement Section, all 55 subprojects have been implemented awarding separate contracts as per the prevailing World Bank guidelines, through ICB/ NCB method based on Employer's requirement and/or considering World Bank's threshold limits. Out of the 55 subprojects, 4 are design & build contracts and the rest are general works contracts. All these contracts were managed with the Conditions of Contracts (COC) stipulated in the world bank guidelines. The COC for general works contracts is based on the FIDIC Red Book while the COC for Design & Build (D&B) have been formed based on the conditions of contract of the Model Form of International Contract for Process Plant Construction published by the Engineering Advancement Association of Japan (ENAA)

Except for four D&B contracts, the rest of contractors are local contractors, although few general works subprojects are procured through ICB procurement method in addition to four D&B subprojects.

The engineering supervision, project management and contract administration work in four D&B contracts and few identified works contracts were done by team of Consultants/ Engineers selected through the standard procurement process. The engineering supervision in rest of the subproject contracts were directly handle by the team of technical/ engineering staff of the relevant Project Implementing Agencies (PIAs) such as SLLDC, UDA and CMC.

Challenges encountered by the PMU under contract management process is summarized for all categories below.

1) ***Implementation of project task within the WB approved time period despite of Covid-19 situation although no extension was received from the Funding Agency considering the Covid-19 affected period.***

   Although several requests were made to get the project extensions from the Funding Agency considering the various disturbances due to COVID-19 pandemic situation, it was not favorably considered. Accordingly, in order to complete the implementation works on all subprojects at the last stage extra effort had to be made. Finally, except for works in 2 subprojects and IFMS system all the other subprojects were able to be completed.

2) ***Facing two Arbitration cases filed by the Consultant of Consultancy contract for Design and Supervision of Pedestrian Bridges at Kollupitiya and Bambalapitiya***

   These consultancy contracts which have been awarded in the year 2013 had not been continued subsequent to the change in the Government in January, 2015. Since the consultancy contracts have not been contractually terminated and due to additionally implemented works and incurred additional expenditure prior to stoppage, Consultants have submitted a claim. Finally, the matter was resolved through the arbitration process.

3) Dispute against the payment method with the contractor for Gall Road Improvement Projects.

In the three Road Rehabilitation Contracts awarded to this contractor, 13 disputed cases have been referred to the sole adjudicator and the award has been received with 10 cases in favour of the Contractor. The dispute was due to the non-payment / under payment for certain items as interpreted by the Engineers of PIA. Contractor had claimed interest as well in line with the Adjudicator's Award. Finally, Employer was able to come to an amicable settlement with the Contractor and the finally agreed amount is around 60% of the previous claimed amount with interest.

4) Handling the claim submitted by the contractor for New Mutwal Tunnel & Torrington Tunnel subproject due to change in geological condition of the project.
Details

Contractor has submitted a claim quoting the change of actually encountered engineering geological condition against the information provided at the bidding stage. While making timely arrangements to smoothen Contractor's affected cash flow for importing additional boring/cutting tools etc., required compensation was made to the Contractor. The evaluated additional amount is around 15% of the claim value submitted by the Contractor.

5) Making remuneration payments for the staff during the lockdown period due to Covid-19 pandemic.

During the lockdown period as a result of pandemic situation, government allowed work from home arrangements as well. Implementation works of subprojects were functioned on and off based on the site/location situation. The payment for supervisory consultants which had to be done on time-based method was not clearly defined in the contract documents under such a scenario. A reasonable mechanism was developed considering both the attendance as well as implementation of work from home also.

6) Handling poorly progressed contractor for subprojects Madiwela East Diversion-I and Improvements to Kinsey Road Drain and continuing balance work.

Contractor was a semi-governmental organization and his progress was very poor after implementing substantial portion of the work. Instead of terminating the contracts, identified portions of the work scope were reduced as an amicable settlement. Subsequently, new contract was formed with these two work portions and implemented the work through a separate procurement. By this way we were able to manage the situation, otherwise, various implication would have occurred if contracts were terminated.

17. Finance

17.1. Guidelines, Disbursement including Contractual Obligations, Management of Funds

Financial Management process of the MCUDP including Financial Management, Financial Reporting and Auditing have been carried out in compliance with the World Bank requirements. The reporting requirement stipulated in the Loan Agreement and PAD, has been complied to the satisfaction of the World Bank and other reporting agencies.

Further, the borrower maintained a Financial Management System in accordance with the provision of section 5.09 of the General Condition of IBRD. This condition has been complied in total as per the financial and other reports furnished to the IBRD throughout the project period which includes interim unaudited financial reports covering made by each quarter and annual audited financial statements.

According to the World Bank Implementation Support Mission 2021, Financial management and fund utilization process carried out satisfactorily. The following completion task of the project highlighted including the way forward action plan for the project completion which was schedule for 30 June 2022 have also been completed.

- The WB mission states that need of preparing unaudited financial reports for the balance period from 1st January 2022 to 30th June 2022,
- Refunding of unutilized funds after the project is physically completed.

17.1.1. Audit of Project Financial Statements and Internal Audit

Audit of financial statements and results framework. This includes audit of project accounts up to 2021 and audit opinion expressed together with responses for management report.

17.1.2. Audit of Project Financial Statements by Auditor General of Government of Sri Lanka for 2020 and 2021

Compliance of governance regulations in respect of financial reporting, audit related issues together with GoSL reporting requirements fulfilling the concept of accountability. This process has been carried out satisfactorily.

Report of the Auditor General on the financial statements of the MCUDP for the year ended 31st December 2020, issued on 17th August 2021. The Auditor General has expressed an unmodified opinion to the effect that financial statements give a true and fair view of the financial position of the Project as at 31st December 2020 and its cash flows for the year ended in accordance with Generally Accepted Accounting Principles.

The Auditor General has carried out the audit in pursuance of provisions in article 154 (1) of the constitution of the Democratic Socialist Republic of Sri Lanka and the opinion of the Auditor General has been shared with World Bank as per the schedule 2 - section II B .3 of the Loan Agreement No. 8145-LK dated 18th May 2012.

The Auditor General states in the report on other requirements of the Lending Agency that MCUDP has satisfactorily completed the necessary steps with regards to,

a. Funds provided had been utilized for the purposes for which they were provided,
b. Statements of Expenditure (SOE) submitted could be fairly relied upon to support the applications for reimbursement in accordance with the requirements specified in the Loan Agreement.
c. Opening and closing balances, withdrawals from and replenishments to the Special (Dollar) Account had been truly and fairly disclosed in the books and records maintained by the Project and the balance as at 31st December 2020 had been satisfactorily reconciled with the accounting records of the Central Bank of Sri Lanka as at that date, and
d. The financial covenants laid down in the Loan Agreement had been complied with.

The financial statements for the year ended 31st December 2021, have been prepared and presented on the 28th February 2022, as required by the Government of Sri Lanka complying with the Generally Accepted Accounting Principles.

Audit Management Report of the Auditor General on the financial statements of the MCUDP for the year ended 31st December 2021 is due on 31 August 2022.

17.2. Project Financing

17.2.1. Lending Instrument

The lending instrument is Specific Investment Loan (SIL). The GoSL selected a Fixed-Spread Loan (FSL) with commitment-based level repayments because of the embedded flexibility that it offers for better management of the country's sovereign debt. The loan has a 25-year maturity, including a five-year grace period. The Loan has been denominated in US Dollars.

17.2.2. Financial allocations

As per the loan agreement and the PAD, the following financial allocations have been made for the project implementation and the percentage of source of funding are shown below.

Table 17.1 Percentage of source funding

Source of Fund	Percentage	Initial Allocation as per Loan Agreement US$ Million
IBRD _ WB	66%	213.0
GOSL	34%	108.0
Total		**321.0**

17.2.3. Revised withdrawal and the actual utilization of the IBRD funds

The following table shows the summary of the loan account, including allocated amounts of funds, according to the section IV-A-2 of schedule 2 in the amendment to the loan agreement in 2017 and the actual utilization for IBRD funds.

Table 17.2. Revised withdrawal table

Category	Amount of the Loan Allocated (USD)	Actual utilization (USD)
Goods, works, non-consulting services and consultants' services, under Parts 1 and 2.1 of the Project	211,467,500.00	198,443,970.44
Front end Fee	532,500.00	532,500.00
Interest Rate Cap or Interest Rate Collar premium	-	-
Project Management, Training (Capacity building) and Implementation of Strategic Communication Plan under part 3 of the Project	1,000,000.00	82,647.04
Total amount	**213,000,000.00**	**199,059,117.48**

17.2.4. Utilization of the GOSL fund

The following table shows the fund allocation and the actual utilization of the GOSL component of the fund, according to the revised cost estimate and financing table (Aide Memoire Apr 28th _ May 05th 2017).

Table 17.3. Utilization of the GOSL component of the fund

Cost component	Allocated amount (USD million)	Utilized amount (USD million) up to 30th June 2022
2.2 Institutional strengthening and capacity building for Metro Colombo Local Authorities	5.6	0.6
3 Implementation support	20.0	12.6
Taxes and duties	45.0	28.0
Implementation of the Resettlement Policy Framework	37.4	12.9
Borrower's contribution	108.0	54.1

17.2.5. Reasons for under-utilization of the fund

It is observed that a balance of USD 13.9 million worth of funds were cancelled as of July 6th 2022, and the following insights can be drawn to see the reasoning behind the under-utilization of the funds.

The exchange rate of USD to LKR was suddenly increased with the economic crisis Sri Lanka was facing, starting in February 2022 from LKR 201 per USD to LKR 360 per USD in May 2022 (refer Figure 17.1). This abrupt change in exchange rate realized more LKR currency in exchanging processes, as most of the project payments were done in LKR and a less amount of USDs were drawn for the same planned amount of work. It should be noted that this underutilization of funds does not mean a partial completion or an incompletion state of the project status, as the PDOs are completely achieved as mentioned in 54 Part VI - 12.

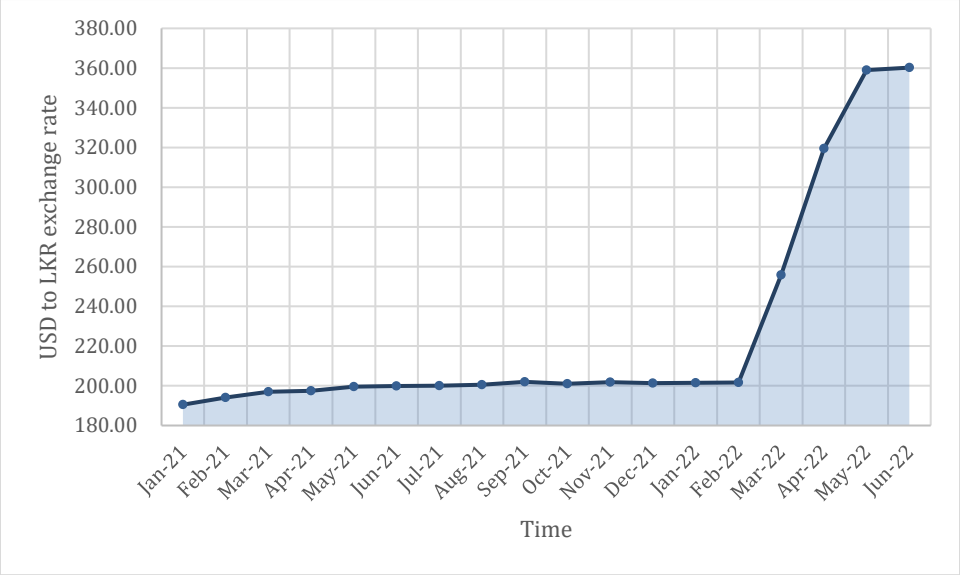


Figure 17.1. Change of USD to LKR exchange rate over time

The project – MCUDP has concluded the reporting process successfully ensuring proper accounting reports and obtaining unmodified audit opinion for the affairs of activities carried out. Therefore, the reporting compliances under the IBRD loan has been completed satisfactorily.

Part IX - Monitoring and Evaluation

18. Results Monitoring and Evaluation

PMU has taken responsibility for the overall quality assurance, monitoring, evaluation and reporting with respect to Project Development Objectives (PDOs) and intermediate results indicators, in coordination with the relevant PIAs and PLAs. In this respect, the Monitoring and Evaluation (M&E) thematic area has been set up under MCUDP, under an M&E Specialist. The main objective of M&E is to gather information about inputs and outputs of the project and to assess the effects or impacts of the project. Further, it is expected to identify issues that could impact project scope, schedule and cost, and propose suitable measures to mitigate such issues.

Under the M&E thematic area of MCUDP, sub-projects were monitored individually to identify issues and find out remedial measures, in order to ensure completion of each sub-project as well as overall MCUDP within the agreed timeframe.

18.1. Assurance of Achievement of PDOs

Assurance of the achievement of PDOs has been incorporated into sub-project selection, design and implementation. Sub-projects were selected according to the relevant PDOs and intermediate results indicators stipulated in the Project Appraisal Document (PAD). All sub-projects were closely monitored, both in design as well as during implementation, to ensure the achievement of the PDOs and intermediate results indicators.

18.2. Progress Monitoring

18.2.1. Monitoring of the Progress of Overall Project and Achievement of PDOs against the Timeline through World Bank's Implementation Support Missions

The World Bank provided continuous support, monitoring and evaluation of the overall project, through regular Implementation Support Missions. Each mission would meet with the relevant high-level government officials for a kick-off meeting. They would then have a series of discussions and reviews with the operational level project staff at PMU, PIAs and PLAs. These missions would cover all thematic areas and would carry out a review of progress, issues and risk of each area. They would then look at the best possible course of action to mitigate the issues thus identified. Their findings, recommendations and agreed actions would be presented at the wrap-up meeting with the relevant senior officials.

18.2.2. Monitoring of the Progress of Individual Sub-projects

A monitoring system was developed for the project activities through site presence. For Component 1, PIAs (SLLDC, UDA and CMC) and for Component 2, CMC as the main PLA and PMU on behalf of other three (3) PLAs (SJKMC, DMMC and KUC) have been collecting data and compiling reports, and carrying out regular progress evaluations on project outcomes, mainly in terms of physical and financial progress. PMU provided technical assistance for progress monitoring and evaluation to the PIAs and PLAs as and when required.

The process of quality assurance, monitoring and evaluation has been primarily undertaken at site level by teams of Engineers and other technical staff consisting of those released from PIAs and PLAs, and hired consultants (for complex projects) through on-site supervision.

At the beginning, the PIAs were able to monitor most of the sub-projects under Component 1 by themselves. However, with the PIAs moving into implementation of more complex sub-projects, consultancy firms were

hired to undertake the role of Project Manager in "Design & Build" contracts and the role of Engineer for "Measure & Pay" contracts.

18.2.3. Project Monitoring and Management System (PMMS) by PMU

The PMMS (https://pmms.mcudp.lk/), a web based Management Information System (MIS) was developed maintained and used by the PMU to view details, for progress monitoring and record keeping purposes of all the subprojects by the relevant officers.

18.3. Project Implementation Plan

The project implementation plan had been prepared by PMU and agreed with World Bank, for overall MCUDP as well as for individual sub-projects. The sub-project wise implementation plan is based on the accepted work program of each contract, prepared by the respective contractor and approved by Project Manager or Engineer to the particular contract. This implementation plan is frequently updated to reflect the actual progress and shared with World Bank. Any changes would be discussed and agreed at World Bank's Implementation Support Missions.

18.4. Annual Activity Plan

PMU prepared an annual activity plan showing the anticipated physical and financial progress for each sub-project considering the approved annual budget provision and the implementation plan. The actual progress was measured against the activity plan. Periodic reviews were conducted with the relevant technical teams to find out reasons for not achieving anticipated progress at such times. Relevant parties were informed about the factors affecting and hindering the progress and decisions have been made to overcome such delays, after consulting relevant stakeholder agencies with the support from the line ministry. Actual cash flow was monitored against predictions throughout the implementation period.

18.5. Dealing with Uncertainties

While 10% of the cost had been allocated to allow for contingencies in "Measure and Pay" contracts within the fund allocation for each sub-project to cater for uncertainties, no such provision was available for "Design and Build" contracts. PMU identified the risk of not having any provision to manage the uncertainties of "Design and Build" contracts. Meanwhile, the originally planned micro-drainage sub-project "Improvements to Saunders Place Stormwater System" had to be cancelled due to social issues that arose from the surrounding community. After discussions, concurrence was obtained from World Bank to utilize the fund allocation for this sub-project as a provision to accommodate uncertainties in "Design and Build" contracts. Fund utilization was monitored and managed within the sub-projects in each sub-component to manage the total expenditure within the available funds.

18.6. Reporting

PMU coordinated with the on-site supervision teams and collected progress data on the implementation of each sub-project. Physical and financial progress updates have been received by the PMU periodically (monthly/quarterly) as appropriate. PMU prepared monthly/quarterly progress reports and presentations consolidating this information.

Progress of the project activities together with the issues encountered have been shared with the World Bank missions, line ministry, Department of Project Management and Monitoring (DPMM) of the Treasury and Steering Committee members through regular meetings and reports.

18.7. Coordination

A good coordination between stakeholder agencies was required for successful completion of the project activities. Utility shifting was one of the laborious activities that had a direct impact on progress, and was completed through considerable efforts of coordination. However, more time than anticipated has been taken for utility shifting.

MCUDP facilitated many portfolio meetings, World Bank missions and conducted Steering Committee meetings and progress review meetings as appropriate.

18.8. Identification and Addressing of Site-specific Issues

Site-specific issues affecting individual contract packages were identified from careful monitoring.

Case 1: Poorly Progressing Sub-projects

The progress of the two sub-projects "Improvements to Madiwela East Diversion Scheme – Stage I" and "Improvements to Kinsey Road Drainage" was observed to be very poor. After analyzing, it was observed that the contractor was facing a severe cash flow issue. Maintaining an escrow account was also not successful. Therefore, the scope of these sub-projects was reduced after mutually agreeing with the contractor, and the original sub-projects were successfully completed with reduced scope. A new sub-project named "Construction of Flood Gate with Culvert near Thalangama Tank and Culvert at Bauddhaloka Mawatha" was formed to complete the remaining scope of those sub-projects and was subsequently completed successfully through a different contractor selected after a new bidding process.

Case 2: Demolition of Existing Flood Gate Structures

Much care has been taken in sequencing construction activities for the demolition of existing flood gate structures under the purview of Irrigation Department that served flood protection purposes prior to the implementation of MCUDP. These old structures had to be demolished as they were proposed to be replaced with upgraded flood protection facilities under several sub projects of MCUDP. However, it was required to ensure that flood protection up to the safety level was provided under the new structures, before demolishing the existing structures. MCUDP worked in close coordination with Irrigation Department and obtained their approval before demolishing the old structures. Since then, construction activities have been successfully completed without any harm to the overall flood protection system.

Case 3: External Factors Affecting Progress

The progress of "Improvements to Madiwela East Diversion Scheme – Stage III" was observed to be very poor. One major reason for this was identified to be linked with the shifting of raw water mains supplying water to the drinking water treatment plant of National Water Supply and Drainage Board (NWSDB) at Ambathale. Shifting of these raw water mains had to be rescheduled many times due to reason such as; NWSDB not being able to grant interruptions to water supply to Colombo during festival seasons, major examinations and elections, prevalence of high water levels in canal and river, and some other unforeseen reasons. Fixing a suitable time period for demolition of existing flood gate structure (as described in Case 2) also caused delay in completion. Appropriate actions were taken in coordination with NWSDB and the sub-project was successfully completed before the project closure.

18.9. Budget for Training

The issue of not having a budget for training has been identified and this matter was discussed with the World Bank. Identifying the importance of training, World Bank approved a budget of USD 0.5 million for training, to be transferred to Component 3 from Component 1, during the 1st restructuring in 2017.

However, due to the Covid-19 pandemic and related travel restrictions, only a part of the planned training program could be achieved utilizing small portion from the allocation.

18.10. Extensions to the Project Closing Date

The project has been through unforeseen situations and considerable time period was required to complete the initial study phase, including feasibility studies. As such, the originally anticipated dates of project closure were not realistic. This was identified as part of the overall M&E exercise, and reasons for such delays were analyzed in detail. As a result, it was possible to submit requests to World Bank for extension of project period, together with detailed justifications and supporting information. Having explained the situation to World Bank, project closing date has been extended twice (first up to 30th June 2020 and then up to 31st December 2021). This has been explained in chapter 9.8: Project Implementation Timeline

The effect of Covid-19 pandemic on the project was identified to be severe, and accordingly, MCUDP requested for another time extension to compensate for the time lost due to Covid-19 pandemic, which had not been considered at all in previous extensions. However, this request was not accommodated and no time extension has been granted to compensate for the time lost due to Covid-19 pandemic.

19. Good Practices

19.1. Knowledge Sharing and Transfer

Under MCUDP, several knowledge sharing practices were followed. When certain work items were outsourced to external consultants, local counterpart Engineers were always assigned to them, so that they could get exposed to their knowledge, expertise and methods of working. This ensured effective transfer of knowledge to the local Engineers, which can be demonstrated using several case studies as follows:

Case1: Hydrological modeling

During the early stages of MCUDP, the hydrological modeling exercise was carried out by the consultancy firm COWI, in order to ascertain the impact of each intervention and identify the most effective interventions. Since then, the Engineers who got trained under them have been able to carry out model upgrades, modeling for various combinations of interventions to assess newer proposals, and prepare inundation maps for various scenarios. Even for routine works of SLLDC that are outside the scope of MCUDP, these trained Engineers have been able to provide accurate and timely model outputs that have been used for decision support.

Case 2: Preliminary design of pumping stations

The consultancy firm Kunhwa was assigned the premilitary design of stormwater pumping stations. At that time, only North Lock and Ambathale pumping stations were proposed under MCUDP, and the consultancy assignment was only for those two. However, for the later proposed South Lock pumping station, preliminary design and preparation or tender documents could be carried out successfully by the Engineers who got trained with the above consultant, without the need for recruiting another consultant.

Case 3: Management of "Design and Build" contracts with foreign contractors

For each of the "Design and Build" contracts, i.e., three (3) contracts for pumping stations and one (1) contract for stormwater tunnels, an international consultancy firm was appointed for design review, contract management and construction supervision. However, since those consultancy contracts were time-based with fixed ceiling amounts, and since all "Design and Build" contracts were severely affected by Covid-19 pandemic, all the consultancy contracts lapsed while the respective "Design and Build" contracts were still ongoing. By that time, service of the individual consultants handling those sub-projects had also

been discontinued, as per a decision taken by the line ministry. At that moment, it was possible to assign the role of "Project Manager" of the respective "Design and Build" contracts to SLLDC, since the Engineers who had been working very closely with the contractors and consultants at site level were very confident of taking over the responsibilities, with the hands-on experience they had obtained in areas such as contract administration, construction supervision, dispute resolution, evaluation of time extension claims, etc. All those contracts were successfully completed by the closure of MCUDP.

In addition to the above World Bank mission observed and recorded good practices applied by MCUDP. The quote below is the paragraphs 21-25, Aide-Memoire of the implementation support mission (August 22 – October 30, 2019).

"***21. Integrated Urban Wetland Management Strategy.*** Under MCUDP, Colombo became the first capital city in the world to have developed a comprehensive Integrated Urban Wetland Management Strategy, implementation of which has enabled municipal decision makers and urban planners to incorporate Colombo's remaining urban wetlands into its flood reduction system and the city development plan. The project pioneered the example of using urban wetlands as a nature-based solution for flood risk mitigation (complementing conventional engineering measures) and for building climate change resilience as well as improving urban livability through the formal recognition of the full range of ecosystem benefits that they offer. The Project supported a comprehensive risk-benefit assessment process involving hydraulic modelling and rainfall analysis which confirmed that 40% of the city's flood water is held by its intricate network of freshwater marshes. Further technical assessments using Robust Decision Making (RDM) technology evaluated the economic value of wetlands in the context of deep uncertainties about future urban development and climate change in the Colombo Metro Area. In this context, protecting and managing the urban wetlands were identified as the "no regret" option to building urban resilience and for ultimately avoiding high flood risk scenarios in which the CMA could lose 1% of GDP on average every year due to floods. Urban wetland management work supported by the MCUDP has led to remarkable achievements such as a cabinet approval for a moratorium on wetland reclamation within the metro Colombo area and international recognition as a Ramsar Wetland City (first capital in the world to be declared so).

22. The project has also demonstrated strategies for sustainable wetland use through the establishment of Colombo's first urban wetland park which has been in operation since 2016. The project has also technically supported the establishment of a second wetland park with a focus on urban wetland research and education, both of which together attracts more than 100,000 visitors a year. Implementation of the WMS has led to the establishment of 2 urban wetland parks in Colombo which have turned into centers for recreation and education, visited by over 100,000 a year. The GoSL is currently in the process incrementally implementing the WMS and plans are afoot to create a wetland circuit within the city that offers a variety of wetland experiences across the city. Since MCUDP initiated the dialogue on urban wetland conservation in 2013, many partners have joined hands with the government, namely the academia, environmental conservation organizations and private sector, to further the agenda on Metro Colombo Urban Wetland conservation.

23. Urban Resettlement. The rehabilitation of canals for flood reduction and drainage management under the Project caused displacement of both titleholders and non-titleholders living along the canal banks. 589 households have been affected by sub-projects implemented under MCUDP, including 193 squatter households and 23 titleholder households who were fully affected and displaced. MCUDP provided a condominium flat to each squatter household which was paid for by the Project (valued at SLRs 4 million). Moreover, additional resettlement and rehabilitation assistance such as transport allowances to shift household goods to the flats, awareness raising on condominium living, and support for livelihood restoration in the form of cash grants and guidance specifically for vulnerable squatter households who had cottage-based economic activities were also provided. Some of the 90 squatter households, who were resettled under the first resettlement program of MCUDP, expressed their continuous dissatisfaction with

the environment of their relocation site and were then given the option of moving into an alternative Project paid condominium flat of their choice in another location: 59 households opted to resettle into a new condominium. Arrangements have been made to provide 'conditional deeds' to the 193 resettled households by December 2019. Meanwhile, the 23 titleholder households who were fully affected by the project were compensated at replacement cost for their self-relocation. The resettlement program for both titled and non-titled households is closely monitored by MCUDP, and any issues arising from relocation are addressed through the Project grievance systems.

24. Impact and benefits of completed sub-projects. Activities under Component 2 which are all completed, were mostly discrete packages, such as parks, and roads. These were generally small contracts and the designs were less complex. The investments under Component 2 included:

- Rehabilitation of municipal roads and road drainage systems underlining road safety as paramount importance while aiming at improved walkability;
- Improvements to public spaces including provision of new waterfront recreational areas, improving both the aesthetic beauty and the bio-diversity through the protection of wetlands and landscaping flood retention areas; and
- Rehabilitation of maintenance facilities and provision of appropriate equipment and technical assistance to PLAs for proper O&M of their assets.

25. Twenty works packages were identified by the respective local authorities for implementation under MCUDP. In addition, the PLAs also prioritized equipment for road & drainage maintenance and solid waste collection for acquisition. Further support was provided in terms of design and construction through consultancies. With regards to three specific interventions – Vihara Maha Devi Park, Crow Island Beach Park and the Public Toilets within CMC – the numbers of users have been recorded by Colombo Municipal Council. Vihara Maha Devi Park users vary between 10,000 people on weekdays to 20,000 on the weekend; Crow Island Beach Park has between 4,150 (weekday)".

20. Problems Encountered and Lessons Learned

#	Lesson	Description
1.	Project duration should be defined considering the quantum of work & practical difficulties.	Allocated time is not enough for works like tunnel construction, with lots of utility diversions and traffic restrictions.
		A float should be included in the schedule for shifting utility lines and obtaining approvals, where external agencies are involved. Sometimes, utility shifting activities also interfere with social requirements (e.g., relocating pipelines along a road, which is kept open for public while project work is going on).
2.	More flexibility should be kept in the schedule for obtaining permanent electricity connections (e.g., for pumping stations).	Obtaining permanent electricity connections takes a considerable time, involving several steps, and the duration varies with the expected kVA rating of the supply.
3.	Stakeholder identification should be comprehensive and their requirements should be properly captured.	All stakeholders and their concerns were not properly included in the decision-making process e.g., Consultation with SLPA regarding land ownership and removal / rehabilitation of the existing lock gates.
4.	Threats to the project, such as social and environmental	All social and environmental concerns (e.g., foreseeable damages during construction to surrounding properties) should be

	concerns, should be properly identified during planning.	identified and provisions to implement mitigatory measures for them should be incorporated into the procurement documents.
		Community-related aspects such as involuntary resettlement, temporary relocation, extra compensation packages, etc., should be introduced at the planning stage of the project to overcome delays in the land acquisition process.
5.	Procurement document review and bid evaluation should be done very carefully.	Technical Evaluation Committees (TECs) should; - Comprise of relevant subject specialists - Be able to dedicate their time for proper evaluation - Examine the procurement documents very carefully, ensuring its completeness and clarity. Special emphasis is required on evaluation criteria.
		During bid evaluation, all aspects should be carefully considered and the most suitable bidder should be selected carefully.
6.	Procurement documents should be improved.	Appropriate procurement method should be selected, considering the risk distribution between Contractor and Employer (e.g., FIDIC Red Book, Yellow Book, Silver Book).
		Employer's Requirements should be well defined, without ambiguity and mismatches between different sections, such as specifications, drawings and Bills of Quantities (BOQs).
7.	When using "Design and Build" approach (lump-sum contracts), more price information should be obtained from the bidders.	Detailed price breakdown should be obtained from the bidders, in order to evaluate interim payments.
		Daywork rates should be obtained from the bidders, which will help in evaluating rates for unexpected additional works (e.g., boundary walls repairing).
8.	Obtaining consultancy services should be limited and when absolutely needed, their services should be well-defined.	Time-based consultancies are not effective as the consultants are not motivated to complete the project on time and sometimes even try to purposely extend the project period for their benefit. In case Consultants are absolutely required, assignment-based Consultants (focused on deliverables) should be hired instead of time-based Consultants.
		The performance of the Consultants and the actual expertise and knowledge transfer from so-called Consultants' experts were minimal and Employer has less authority to remove such persons as their paper qualifications fulfill the requirement of the Terms of Reference (TOR). Therefore, if any Consultants are employed in future, the TORs should be prepared giving more power to the Employer to remove experts if they are deemed to be incompetent during their actual work.
9.	Employer should have more control in "Design and Build" contracts.	When the Contractor's design team is stationed in their own country rather than in Sri Lanka, it leads to delays in communication and many miscommunications as well. Therefore, in future "Design and Build" contracts, it should be emphasized that the Contractor's full design team must be stationed in Sri Lanka during the design period.
		Starting of construction activities without fully coordinated construction drawings has yielded many alterations and delays in construction works. Therefore, construction works should not be allowed to be started without fully coordinated construction drawings.

Part X - Sustainability

21. Capacity Building Initiatives

With the view of capacity building, Metro Colombo Urban Development Project has undertaken/implemented following activities:

21.1. Capacity Enhancement of PIAs and PLAs

A total of USD 11.96 million under sub-components 1.3 and 2.1 was utilized to procure equipment, machinery and utility vehicles to PIAs and PLAs, in order to enhance their capacities in delivering their services, including Operation and Maintenance (O&M) of drainage network (SLLDC and CMC), and roads and other public facilities (PLAs). A summary of such procurements done for SLLDC is shown in Table 7.3 (section 7.3), whereas similar details on procurements done for CMC and other PLAs are given in section 7.5.

21.2. Enhancement of Technical Expertise

The technical expertise of SLLDC in areas such as hydrological modeling, flood risk assessment, etc., was significantly enhanced with the procurement of several state-of-the-art software and training of a number of individuals in these areas.

21.3. Exposure to New Technologies, Construction Methodologies and Best Practices

There are two (2) key areas in which extensive exposure was obtained by the technical staff of SLLDC, i.e., urban tunneling and stormwater pumping stations. The staff worked with three (3) international contractors and four (4) international consultancy firms, in implementing these sub-projects, i.e., three (3) pumping stations and two (2) tunnels.

The exposure thus gained includes geotechnical investigations, preliminary and detailed designs, procurement, construction methodologies, design, manufacturing, installation and testing of electro-mechanical equipment, quality assurance and quality control (QA/QC) aspects, health, safety and environment (HSE) aspects, project management, contract administration, dispute resolution, etc.

21.4. Capacity Enhancement of Staff (Including on-the-job Training)

- On-the-job training was provided to the staff nominated to take over the operation and maintenance of stormwater pumping stations, through the respective contracts
- Recurrent field and training sessions were organized for staff, with experts in related fields as resource persons, e.g., Architects, Environment Conservationists, Town Planners, Policy-makers, etc.
- Information and Communication Technology (ICT) knowledge and necessary facilities were provided to the professional and supporting staff for ease of communication, documentation and coordination
- Motivation and leadership training was provided to the staff to enhance work productivity

21.5. Foreign Training

During the years 2018 and 2019, the following project staff of MCUDP and SLLDC (PIA) were provided opportunities to enhance their skills and capabilities through foreign training, exposure visits and several factory visits including Factory Acceptance Tests (FATs) abroad:

- Fourteen (14) Key Management Personnel (KMPs) / Senior Engineers
- Eighteen (18) Engineers who were engaged in Civil and Mechanical work
- Eleven (11) Quantity Surveyors, Asst. Quantity Surveyors and Technical Officers
- Four (4) Social and Land Officers

These programs covered areas such as procurement, project development and management, contract management, communication and leadership strategy, FATs of electro-mechanical equipment, such as pumps, screens, gates, flap valves, etc., and tunnel pre-cast segments, etc., in a number of countries such as India, China, South Korea, Thailand, USA and Malaysia.

22. Project Exit Strategy

With the achievement of PDOs by implementing and successfully completing the identified 55 sub-projects (the developed facilities), a project exit strategy consisting of the following measures was adopted, to go hand in hand with the taking over of the final project outcomes by the respective ultimate clients (end-users):

1. ***Preparation of Operation and maintenance (O&M) plans to integrate the facility operation and maintenance to routine operations of the owner agency;***
    a. For each developed facility separately, and
    b. A master plan encompassing all facilities

    This includes assets registers for each developed facility

2. ***Providing on-the-job training for the staff of ultimate owner agencies***
    Operational staff was identified and on-the-job training was given by getting them involved in the development work from the installation stage of the facilities up to commissioning and handing over

3. ***Coordination with the owner agencies (SLLDC, CMC and UDA) and preparation of a plan with resource requirement for operation and maintenance***
    Capacity of owner agencies to attend to that was assessed and the agencies have requested for cadre expansion accordingly, around 2 years before MCUDP closure

4. Procurement of machinery, equipment and utility vehicles required to maintain the improved drainage system and road system in Colombo, which have already been handed over to SLLDC, CMC and other three (3) PLAs

5. Carrying out user satisfaction survey to get an awareness and to identify the pros and cons of the developed facilities by the project, to be used for future improvements

6. Estimation of the annual O&M cost for the developed facilities and taking necessary steps to request for budget allocation from the treasury by the owner agency (especially for SLLDC for flood and drainage management)

7. ***Disseminating flood alert data to the public***
    Proper coordination among relevant stakeholder agencies and setting up of a dynamic mechanism for the same

8. Proposing future improvements to flood and drainage management as an outcome of the comprehensive studies done; and proposals to owner agencies to get the maximum utilization of developed facilities for the intended main purpose as well as the probable use of the same for extended uses such as educational purposes, making the public aware about natural disasters and how to contribute to mitigate the same by each citizen

9. Giving support for flood damage assessments, proper identification of flood areas and depth, exposure assessment, providing inputs for development planning and insurance purposes from the already developed tools in flood risk assessment for CM area done by the project

10. Preparation of park management plans for owner agencies (UDA and CMC)

11. Mainstreaming of the outcomes of two complementary studies done in parallel with MCUDP namely; Flood Risk Assessment and Wetland Management Strategy for CM Area

12. Documenting the lessons learned to facilitate planning and execution of future projects

13. Proper archiving of all project documents for future reference

23. Sustainability

Several actions have been taken to ensure sustainability of project interventions, such as the following:

1. ***Preparation of Operation and Management (O&M) plans by relevant PIAs for the respective facilities constructed under the project***
   O&M manuals have been prepared for each facility, and arrangements have been made to integrate those into the routine operations of PIAs, so that continuous maintenance is ensured. For example, for the stormwater pumping stations that are to be operated and maintained by SLLDC;
   - A separate O&M team has been identified.
   - New recruitments have been done.
   - Training has been provided by respective contractors.
   - Development of Standard Operating Procedures (SOPs) is in progress.

2. ***Annual fund requirement for O&M of pumping stations***
   Annual fund requirement has been calculated and a request has been made to the Treasury for obtaining funds. Considering the reduction in flood damages, impacts and relief requirement, the possibility of obtaining funds for O&M through funds normally allocated for flood relief through Disaster Management Center (DMC) is being investigated.

3. ***Development of the Wetland Management Strategy (WMS)***
   The WMS is the first comprehensive study conducted within Colombo Catchment on all relevant disciplines in wetland management. According to the WMS, urban wetlands in Colombo are a mosaic of interconnected freshwater wetlands which cannot be prioritized as every wetland patch is equally and significantly important. After completing the WMS in 2016, there were several important initiatives were taken for the betterment of Colombo urban wetlands and they can be summarized as follows.
   1. Declaring the Kolonnawa marsh, Kotte marsh and Heen Ela marsh as Wildlife Sanctuaries by Department of Wildlife Conservation in 2021.
   2. Accreditation of Colombo as the first Wetland Capital City in the world by Ramsar International in 2018.

3. Recognizing Diyasaru Park as the main wetland center in Colombo by City Development Plan of Urban Development Authority in 2018 and membership for two wetland parks in Colombo, Diyasaru Park and Beddagana Park by Wetland Link International (WLI)
4. Focusing wetland landscapes in Colombo for promoting community engagements for wetlands by GEF Small Grants Program Cycle 6 and 7
5. Commencing Darwin Project for wetland livelihood development of selected wetland communities

4. ***System for disseminating flood alerts***
   As part of the IFMS, preliminary work has been done for the implementation of a system for public dissemination of flood alerts using methods such as electronic media networks, mobile phone alerts, social media, etc. This will supplement the already implemented system for data collection and analysis, and will be highly useful for the general public.

5. ***Sustainability of urban parks***
   The following steps have been taken to ensure sustainability of urban parks:
   - Identifying potential public gathering places.
   - Releasing underutilized lands for urban development and enhancing city economy.
   - Identifying the potential for research, education and awareness-raising.
   - Inclusion of linear park maintenance under Lotus Tower maintenance program

24. Further Improvements

The master plan for stormwater drainage in the Colombo Metropolitan area includes a large number of proposed interventions. Individual components of this master plan have been implemented from time to time, prioritized based on the impact for flood mitigation, and considering factors such as technical complexity, fund availability, land acquisition and resettlement, etc.

As discussed in the preceding chapters, a number of major urban flood mitigation interventions thus identified have been successfully completed under MCUDP. As the next step of the master plan, it is proposed to implement the following interventions:

1. ***Madiwela South Diversion Scheme***
   As described in section 6.4.5, this is the most effective intervention for mitigation of floods in CM area. This was not implemented under MCUDP, as it was earmarked for implementation as part of a separate project under SLLDC. However, since it has not materialized up to now, this will be the first priority project to be considered when implementing any future improvements.

2. ***Installation of gate-mounted pumps at Kalu Palama (Kolonnawa)***
   Several major improvements have been proposed by Irrigation Department to address the riverine flooding issue in lower reaches of Kelani River. These were originally proposed under Climate Resilience Improvement Project (CRIP) and have since been included under Climate Resilience Multi Phased Programmatic Approach (CRes MPA) funded by the World Bank. While broader flood protection from Kelani River will be ensured with the implementation of CRes MPA proposals in the long term, it needs to be supplemented with installation of gate-mounted pumps at Kalu Palama, which is the next critical step towards achieving comprehensive flood protection.

3. Improvements to drainage in Kolonnawa catchment (improvement of secondary canals, crossing structures, etc.)

4. Improvement of water quality in inland water bodies
5. Implementation of prioritized actions proposed under Wetland Management Strategy (WMS)
6. Improvement of secondary drainage related to remaining localized flooding pockets
7. Expansion of IFMS to a full-fledged system, in order to get its maximum utilization in achieving flood resilience, considering climate change as well.

References

1. The World Bank (2012), Project Appraisal Document on a Proposed Loan in the Amount of US$213 Million to the Democratic Socialist Republic of Sri Lanka for the Metro Colombo Urban Development Project

2. Nippon Koei Co., Ltd. (2003), The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka, Final Report

3. Mohamed Ali, Sithy Kadija (1991), Industrial water pollution in a surface water system in Colombo, Sri Lanka., Durham theses, Durham University. Available at Durham E-Theses Online: http://etheses.dur.ac.uk/1180/

4. Rozenberg, J., Simpson, M., Bonzanigo, L., Bangalore, M., & Prasanga, L. (2015). Wetlands Conservation and Management: A New Model for Urban Resilience in Colombo (p. 38). World Bank.

Annexes

Annex 1: Detailed Analysis of Implementation of Sub-projects under Sub-component 1.1:

According to Annex 2: Part B: Clause 6 of the Project Appraisal Document (PAD), the following list of the sub-projects had been proposed to be implemented under sub-component 1.1 of MCUDP:

1. Main Drain and Mutwal Tunnel:
    (i) Rehabilitation of Main Drain bank protection (gabions)
    (ii) Reconstruction of Aluth Mawatha Culvert (reinforced concrete box culvert), and
    (iii) Rehabilitation of Mutwal Box Drain, and tunnel inlet and outlet
2. Dehiwala Canal:
    (i) Rehabilitation of Dehiwala Canal bank protection from Galle Road Bridge to outfall (gabions), and
    (ii) Removal of rock outcrops in canal bed
3. St. Sebastian South and Dematagoda Canals: Rehabilitation of bank protection along St. Sebastian and Dematagoda Canals (gabions and sheet piles)
4. Secondary Canals—Sethsiripaya and Sarana Mawatha Canals:
    (i) Rehabilitation of canal banks and improvement of culverts of Sethsiripaya Canal, and
    (ii) Rehabilitation of canal banks and improvement of culverts of Sarana Mawatha Canal
5. Madiwela East Diversion Scheme:
    (i) Design of flood-control gate and spillway of Thalangama Tank, and
    (ii) Rehabilitation of bank protection of Madiwela East Diversion Canal between Averihena Tank and Athurugiriya Road (gabions and turfing of earthen sections)
6. Wellawatte and Poorwarama Canals:
    (i) Rehabilitation of Wellawatte Canal bank protection from Galle Road Bridge to outfall (sheet piles), and
    (ii) Rehabilitation of Poorwarama Canal bank protection
7. Formation of Lakes – Part I:
    (i) Creation of Lake 06 with outflow control structure, and
    (ii) Creation of Lake 07 with outflow control structure
8. St. Sebastian North and Sri Wickrama Canals:
    (i) Rehabilitation of bank protection in St. Sebastian North Canal (gabions and sheet piles), and
    (ii) Rehabilitation of Sri Wickrama Canal bank protection
9. North Lock Pumping Station and North Lock Gates:
    (i) Upgrade of set of North Lock Gates and downstream improvement with embankment protection; and
    (ii) Construction of pumping station at North Lock
10. St. Sebastian South Diversion Canal: Construction of St. Sebastian South Diversion Canal bypassing Beira Lake, including treatment at outlet
11. Construction of New Mutwal Tunnel
12. Galle Road Bridge across Wellawatte Canal: Removal of bottleneck in Wellawatte Canal at Galle Road Bridge by providing guide walls or additional openings on either side
13. Amaragoda Culvert at Madiwela East Diversion Scheme: Provision of additional openings to Amaragoda Culvert to enhance the conveyance capacity
14. Restoration of Kolonnawa Retention Area: Construction of gate and pumping station and connecting outlet canal
15. Formation of Lakes – Part II: Formation of Lakes 01, 08, and 10
16. Beira Lake water quality improvement: Interception of sewerage draining to stormwater drains

In order to ascertain the impact of each intervention and identify the most effective interventions, a comprehensive study was undertaken as described in Chapter 3. The assignment carried out by COWI Consultants formed the core of this study.

Subsequently, a preliminary cost estimate was also carried out for all identified interventions, in order to rank them based on the feasibility and prioritize them for implementation as sub-projects of MCUDP. The priority list was reviewed during the mid term review (from Nov 24th to 5th Dec 2014) and is included in the subsequent Aide Memoire.

A comparison of the PAD with the final list of implemented sub-projects is given in Table A. 1.1.

Table A. 1.1 Status of Sub-projects Given in the PAD

No. in PAD	Implemented	Implemented with Modifications	Dropped	Remarks
1	√	-	-	-
2	√	-	-	-
3	-	√	-	Implemented without Dematagoda Canal*
4	-	-	√	Implemented under other GOSL provisions
5	-	√	-	*(See Note below)*
6	-	√		Implemented without Poorwarama Canal (secondary canal)*
7	-	-	√	Categorized as low priority projects
8	-	√	-	Implemented without Sri Wickrama Canal (secondary canal)*
9	√	-	-	-
10	-	√	-	Proposal revised to a pumping station
11	√	-	-	-
12	√	-	-	-
13	-	√	-	Proposal revised to removal of drop structure and construction of new drop structure upstream
14	-	√	-	Proposal revised to rehabilitation of canal and construction of inlet and outlet gates
15	-	-	√	Categorized as low priority projects
16	-	√	-	In a selected area by CMC

* *Selected parts of bank protection works of canals were carried out as front-runner projects. But early implementation of the balance part of the proposed bank protection works in the PAD had been put on hold in the view of uncertainty about the availability of sufficient funds for implementation of highest priority interventions, and some of those were not implemented.*

Note:

In addition to the work items specified in item No. 5 of the PAD list, the following two (2) items were also implemented under this, but as separate sub-projects:

1. Madiwela East Diversion Scheme – Stage III
   Implemented as required downstream improvements, to supplement proposal under item No. 5 of the PAD list
2. Ambathale Stormwater Pumping Station
   Implemented in order to avoid aggravating of flooding in Malabe/Ambatale area (upstream of the flood bund) with the diversion of more flow from Talangama tank (References: Herath, S. (2016). *Ambatale Pumping Station Proposal* and Deltares/ADPC/CECB. (2017). *Detailed flood risk analysis and impact of mitigation interventions for the Colombo Metropolitan Region*) and to fulfill the strong request from Irrigation Department

Details of sub-projects that were not included in the PAD but introduced later and implemented under the final arrangement of MCUDP are given in Table A. 1.2.

Table A. 1.2 Sub-projects not in PAD but Implemented under Final Arrangement

No.	Sub-project	Reason for Introduction
1	Torrington Tunnel	Initially 'improvements to storm water drains in upper catchment of Torrington North, including Thummulla Junction' was under micro-drainage; Extension of the Torrington Canal under the macro drainage system, up to the sea was proposed as an intervention to increase outfall capacity at the mid-term review. The proposal of Torrington tunnel which leads to the sea outfall contributes to the outfall capacity improvement of the macro drainage system as a new diversion path while mitigating the floods in the above localized areas. Therefore, funds from both subcomponents 1.1 and 1.2 were utilized for this construction.

Annex 2: Integrated Flood Management System (IFMS)

A.2.1 Introduction

MCUDP consists of a series of flood mitigation interventions, implemented as sub-projects, including storm water pumping stations, underground tunnels, diversion canals, canal conveyance improvement, removal of bottlenecks, canal bank protection works with maintenance road, and construction of hydraulic structures such as bridges, culverts, flood control gates & flushing gates. Under the MCUDP, establishment of an Integrated Flood Management System (IFMS) has been proposed to operate the flood control facilities considering the rainfall conditions and the flooding potential. The physical infrastructure and the unit to carry out this activity came to be referred to as Real Time Control (RTC) center within the project management unit. A state-of-the-art central operation center is expected to provide decision making support, and centrally control and monitor the activities of the interventions.

For this purpose, real time data monitoring and integration, forecasting of canal water levels and canal discharges with numerical models and control of facilities through SCADA (Supervisory Control and Data Acquisition) will be carried out at the center. The center will also help for supporting sustainable water management practices.

1. Component A: Physical infrastructure of the Flood Control Centre
2. Component B: Computing and analysis infrastructure
3. Component C: Forecasting, risk assessment and operational guidance system
4. Component D: Monitoring (rainfall, water levels) and control (gates and pumps)
5. Component E: Stakeholder collaboration, information sharing and real-time information assimilation

The main components of the center are shown in Figure A. 2.1.

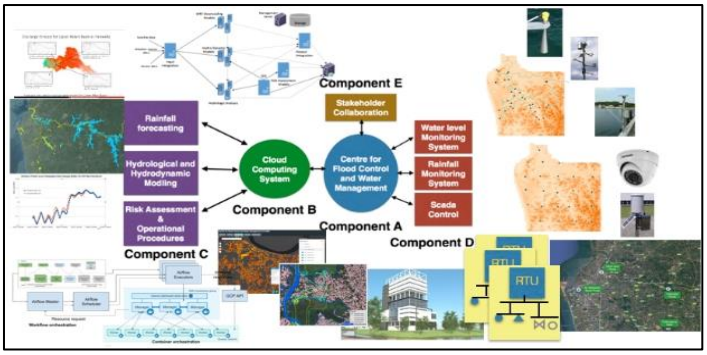


Figure A. 2.1 Components of IFMS

A.2.2 Objectives

Controlling of flood control facilities (structural measures) developed under MCUDP through SCADA

Under this objective, centrally controlling the flood controlling facilities (pumping stations, gates, and water storage) by SCADA system is considered. Also, development of the controlling rules (logics, e.g., pump rules) will be done. RTC will be directly responsible for providing decision making support for operating the following facilities with the optimal utilization, to reduce the flood risk in the Metro Colombo Urban Area.

- Pumping stations (North Lock, Ambathale and South Lock)
- Gates structures in canals (Kolonnawa Canal Diversion gate structures and Thalangama gates)
- Other smaller storage systems (wetlands, etc.)

Establishment of a Flood Early Warning System (FEWS)

Under this objective, information will be shared with stakeholders for disaster mitigation and evacuation purposes and flood early warnings/flood alerts will be provided to the public. For this task, integration of automated telemetry data (rainfall and water level observations), rainfall forecasting with Numerical Weather Prediction (NWP), verification and validation of rainfall observations from satellite data obtained from Japan Aerospace Exploration Agency (JAXA), hydrological and hydrodynamic modelling to forecast water levels of the Colombo canals and the river in the Kelani Basin which are to be streamlined using an automated workflow system should be in place for the resulting FEWS. This system should be able to provide the Colombo canal water levels with 2 days of lead time.

Implementation of the hydro-meteorological monitoring system

Under this objective, RTC is expected to collect real-time weather data (rainfall, temperature, humidity, wind speed-direction, atmospheric pressure) and real-time water level data, through automated telemetry stations. This data is expected to be received and stored in RTC owned databases. Data will be post-processed and should be used for mathematical modelling as well as for dissemination to stakeholders.

Information dissemination to public and stakeholders

Under this objective, the information dissemination to the stakeholders and public is considered, and this is expected to achieve through a website, a display system and a 3D model placed in the RTC building.

A.2.3 Scope of Work

Real Time Data Collection

The center currently owns and operates 52 automated weather stations and 6 (study phase) water level gauges. Further, 33 water level stations to be implemented in near future. In addition, 10 “long range”

(LoRa) base stations will be implemented for telemetry stations data transfer as redundant system for ensuring continuous data reporting. All of the telemetry stations are automated to send their observed data to cloud operated servers, which are post processed by the processing applications. All of the telemetry stations are operated from solar power, with the minimum attendance to maintenance and free from main electricity power requirement.

The weather stations are shown in Figure A. 2.2 and the water level stations and LoRa base stations are shown in Figure A. 2.3.

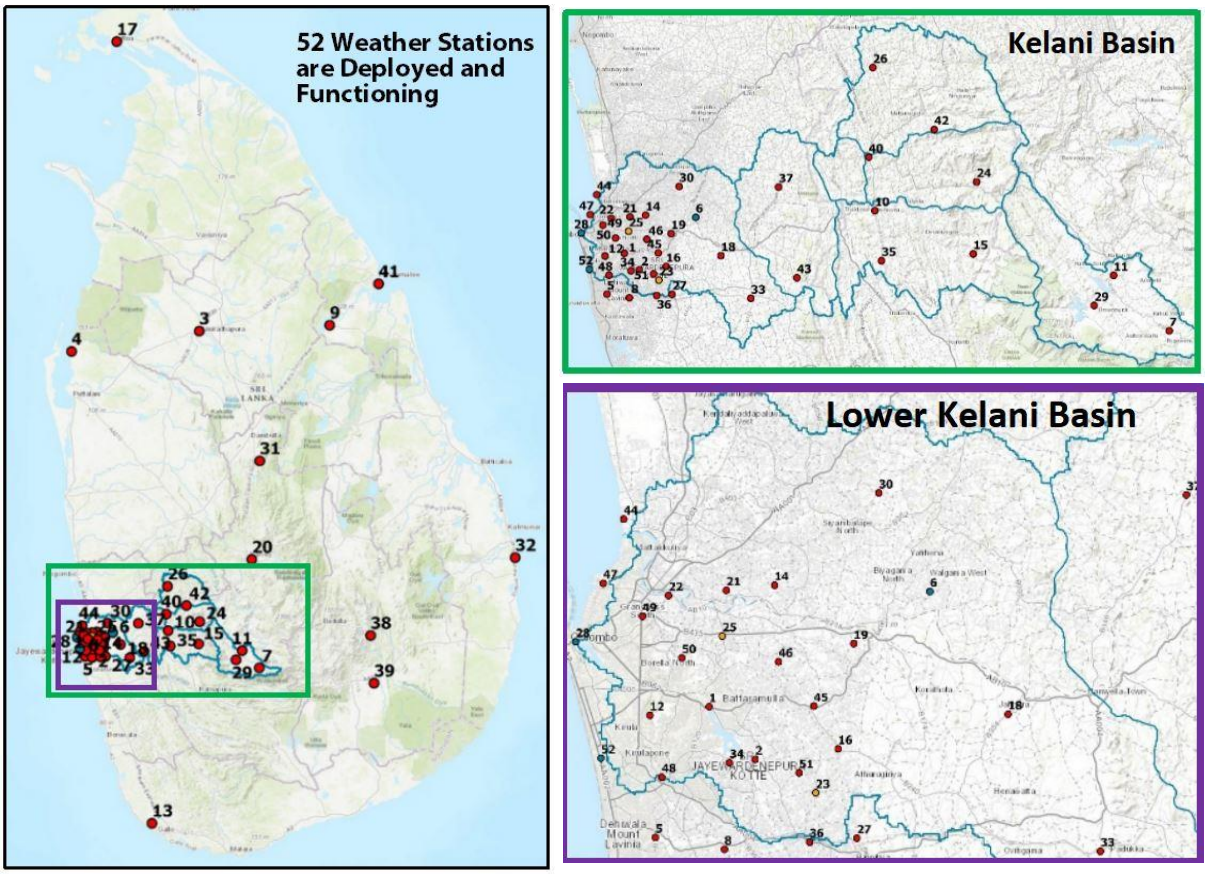


Figure A. 2.2 Weather stations

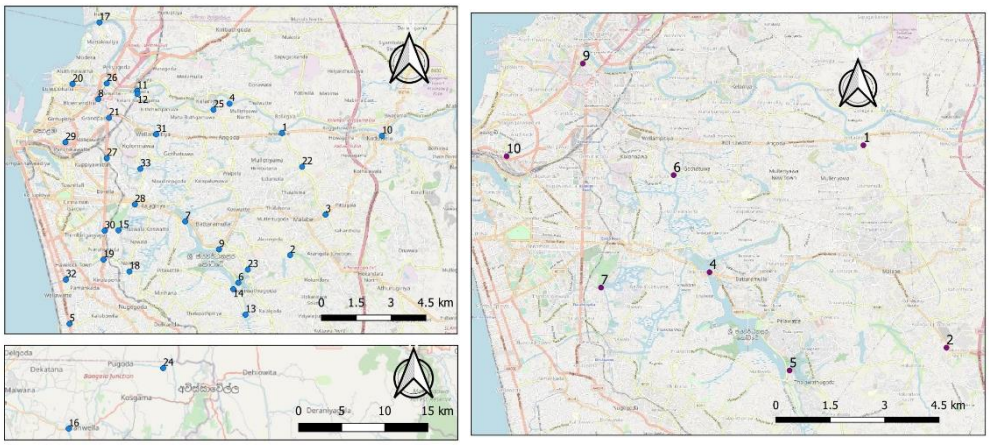


Figure A. 2.3 Water level stations and LoRa base stations

Computing System

The RTC computing system comprising of weather forecasting modelling system, Satellite Rainfall data integration system and Hydrological-Hydrodynamic modelling system which resulting flood forecasting. These systems are integrated by an automated workflow system and running in Google Cloud environment and Local cloud environment as well.

Weather forecasting and satellite data

Development of rainfall data integration system, using existing sources such as satellite rainfall observations, numerical weather forecasts and observations from rain gauges. RTC uses numerical weather forecast to anticipate rainfall in the Kelani basin 1-2 days in advance. Models and forecasts are verified using satellite-based rainfall estimates. RTC run four models with different parameterizations that run-in cloud servers 2 times a day. Rainfall from satellite observations (JAXA) - dynamic maps for the regional rains and rainfall in Sri Lanka for the current date and yesterday. Satellite rainfall data feeds at hourly intervals are received and integrated.

Hydrological Modelling

Hydrological modelling system generates discharges at Glencourse and Hanwella as outputs by using Kelani upper basin Rainfall as input. These discharge data are used for hydrodynamic models that are setup for Kelani lower basin. Four (4) HEC-HMS Hydrological models were setup with different physics parameters and catchment definition:

- HDC – HEC-HMS distributed continuous model
- HDE – HEC-HMS distributed event model
- HLC – HEC-HMS lump continuous model
- HLE – HEC-HMS lump event model

Catchment area of the distributed models is divided into few sub-catchments using geographical conditions in the catchment area. On the other hand, for lump models the whole catchment area is a single unit. Therefore, the distributed models' input is a collection of mean rain in each sub-catchments and lump models' input is single mean rain for the whole catchment area. Because of that, there can be discrepancies between each model's accuracy with the input rainfall distribution in the catchment area. Therefore, in RTC we are running all the four models and picking the highest accurate model for input preparation for the descendent models.

Hydrodynamic Modelling

As for the hydrodynamic modelling component of the IFMS, both FLO-2D and MIKE software are currently being used. The system consists of four hydrodynamic models that differ from each other with respect to resolution, boundaries and computation time as follows:

- FLO-2D 10 m resolution models - 15 flood models
- FLO-2D 30 m resolution model - Ambathale to sea outfalls
- FLO-2D 150 m resolution model - Glencourse to sea outfalls
- FLO-2D 250 m resolution model - Hanwella to sea outfalls
- MIKE11 30 m resolution model - Ambathale to sea outfalls

Simulations of FLO-2D 150 and 250 resolution models are fully automated. Outputs of these model simulations can be applied for decision making and dissemination purposes, which provides forecast water levels, discharge and flood extent.

Cloud Computing

The cloud computing system of the RTC is set to perform the computation activities fully automatically. These activities include:

- Integrating data from multiple sources using Data Integration and Analysis System (DIAS) by:
    - Maintaining the receiving servers
    - Data processing, validating services and pushing services, to the databases
    - Maintaining databases
- Running downscaling models on Weather Research and Forecasting (WRF) Model
- Running hydro dynamic models
- Running hydrologic analysis models
- Running GIS data sources
- Running risk assessment modules
- Integrating outputs from the model results from multiple modules
- Running the web server to visualize the generated data from multiple modules.
- Managing the cloud environment, deployments, software, versioning, and server availability
- Storing production and archive data
- Maintaining the website

The cloud system is currently hosted in the Google cloud platform. It is comprised of mostly Linux operating systems and some Windows server operating systems. Receiver servers are initially programmed by Nginx and NodeJS server applications, followed by the scheduled tasks (mostly Python programs) which are programmed to run by the Linux operating system. In addition, there are software such as WRF, HEC-HMS, FLO-2D, Wolfram Mathematica, ArcMap to support the functions of the system. Some of the tasks are streamlined by Apache Airflow programme, combined with Docker programme to improve the mobility. All the web services are hosted on Apache2 web hosting services.

Web based Information Dissemination

A website open for the stakeholders to view and download data from the Center for Urban Water (CUrW) is now available at http://pub.curwsl.org/. The website basically contains the following real-time information:

- Observed weather (precipitation, temperature, humidity, wind directions and velocities) at 5 minutes interval at island-wide weather stations. Most of these weather stations are installed in schools, where a web link will be given to the schools to view data from the station on their schools.
- Observed water levels at canals and river - selected water level gauges based in Colombo (most of them covering the Kelani basin)
- Hourly Rainfall distribution and cumulative rainfall distribution static maps for the recent 1, 3 and 6 and 24 hours
- Hourly Rainfall distribution and cumulative rainfall distribution dynamic maps (animated) for the recent 1, 3 and 6 and 24 hours
- Rainfall from Satellite Observations (JAXA) - dynamic maps for the regional rains and rainfall in Sri Lanka for the current date and the day before
- Water level forecast for 2 days at selected water level stations
- Rainfall forecast for the next day. It should be noted that some of these data is accessible for the registered users (which will be made available through a data dissemination agreement) while some other data is publicly available.

In addition, the website contains information about the interventions carried out by MCUDP, for flood management and flood controlling purposes.

Supervisory Control and Data Acquisition (SCADA) Control of Facilities

All SCADA facilities will be able to operate in three modes; Local Manual, Local Automatic and Remote-Controlled modes. The Remote-Controlled mode will be operated by the Central SCADA control located in RTC building, in Kirimandala Mawatha. Central SCADA system will control North Lock Pumping Station, Ambathale Pumping Station, South-lock Pumping Station, Gate Structure at Gothatuwa Bund, Gate Structure at Kalu Palama and Gate Structure at Thalangama tank.

Apart from the main Central SCADA system (flood controlling), a separate Central SCADA system (for water quality management) was implemented under IFMS for remote operation of flushing gates. This system operates Flushing Gate system neat Sri Jayewardenepura Road bridge (near SLLDC Head Office), Flushing Gate system at Yakbedda Bridge and Flushing Gate system at Port Access Road.

The Central SCADA systems will facilitate the following:

- Monitoring
  - Water level
  - Weather monitoring station data
  - Pump house equipment status/alarms
  - Historical data storing/trending
- Controlling
  - Open, close gates at stormwater ponds/channels
  - Start, stop pumps at stormwater pump houses

The pumping operation rules based only on local water levels would not be adequate to ensure the best strategy to reduce flood risk. Optimized pumping strategies will be used in Central SCADA System, considering entire system and flood controlling mechanism. Hence, most effective pumping strategies are determined for least number of persons affected and the highest economic damage reduction.

Pre-defined pump rules are setup based on the water level of the canals and outfall discharge conditions. For each pumping stations, a number of pumping on/off conditions need to be setup considering priority of pumping station, duration of pumping, pumping sequence, etc. Each pumping rule (based on models) need to be verified by actual pumping operation prior to use for central SCADA operations.

A.2.4 Future Expansion

In addition to operation and management of flood control facilities during extreme events, RTC can contribute to improve the quality of life in the city by providing appropriate information for relevant sectors. The future directions of this center are described below in detail with respect to each aspect.

Improving water quality in canals and inland water bodies

This process consists of three components such as monitoring, modelling and cleaning programme. Monitoring of real time water quality parameters can be done by devices using LoRa. The selection of the monitoring stations can be decided based on the importance of locations, their inflow coverage by existing monitoring and modeling tools and the ease of automated water quality monitoring using communication network. A volume and concentration-based analysis and design program can be set up to carry out water quality modeling which carrying out continuous simulations parallel to hydrodynamic modeling.

These simulations will also help to detect polluters when observations deviate from expected concentrations. For the cleaning purposes of canal network, it can be derived flushing gate operations and scheme and program the central SCADA system to operate and monitor flushing operations. Further, reverse pumping facility also available at North Lock for pump water from Kelani river in to the canal

system. This information is important in pollution control and policy-making with related authorities and also to develop support service programs.

Taking precautionary measures and planning in advance evacuation due to climate change

The RTC computing system comprising of weather forecasting system with 2 days forecast and this system outputs can be applied to identify any adverse climate changes in advance and take necessary precautionary measures and improvements in advance evacuation planning.

Transportation and evacuation

RTC has initiated a transportation modeling study with the objective of finding roads under inundation during a flood event using past flood events and finding safe routes to use in a future flood event. Through the system flood maps can be created and that outputs can be intersected with the road network and further can be identified roads under inundation. During flood events, these results can be used for re-arranging transport facilities and identify feasible routes to evacuation centers. Furthermore, this process can be automated and can also be used to provide information to the relevant authorities.

Sharing information with insurance sector as a proper guidance for risk management

The methods adopted by the RTC for the loss estimations for the simulated past and future flood scenarios are in two types. Structural (damages to the structural elements of a building) and content (damages to the contents of a building) damages are the two types of direct damages to the buildings which are calculated. Damage functions are used to calculate the damages occurred for each building. Exposure mapping can be also carried out to assess economic vulnerability. Possible evacuation locations and people at risk for different flood frequencies have been established.

Field surveys to assess economic and financial damage to the structural and content damages to the buildings, which were exposed to the recent floods have been carried out. Data from two sets of such surveys, one for structural damage and the other for flood affected commercial and industrial entities, in the Metro-Colombo urban region were used to develop loss functions to be used with inundation maps to estimate economic losses. RTC have the ability to estimate total potential damage from a future flood from damage function and inundation simulation of hydrodynamic models. Sharing this information with insurance sector would be beneficial as a proper guide to risk management.

Giving recommendations for development activities on flood safety

For any development activities, it is necessary to pay attention on flood safety levels within the area and possible impacts of those developments. In order to grant clearance for developments, comprehensive hydrology and hydrodynamic modelling studies need to be conducted and also to be analyzed for any consequences which can be occurred due to the proposed developments

Annex 3: Details on machinery and equipment procured

Details of the machinery and equipment procured are as follows.

Table A. 3.1Details of the machinery and equipment procured

		Total/LKR		**Total/USD**
CMC-Machinary/vehicle				
G/01	268,873,787.36		2,057,343.40	
G/02	70,771,530.03		540,753.24	
G/04	7,264,326.54	346,909,643.93	51,397.85	2,649,494.49
LA's-Machinary				
LA/G/01	233,949,608.22	233,949,608.22	1,543,858.33	1,543,858.33
SLLDC				
Machinary & Equipment				
G/01	459,101,182.79		3,616,945.45	
G/02	135,805,068.39		1,040,484.86	
G/02-A	12,275,511.25		94,197.72	
G/04	182,441,075.77		1,369,803.11	
G/04-A	93,846,247.23		637,162.45	
G/03	13,980,798.77		91,260.92	
G/03-A	73,185,860.94		392,806.39	
G/15	9,539,999.89	980,175,745.03	62,291.87	7,304,952.77
Workshop tools				
G/06	11,905,998.16	11,905,998.16	78,246.98	78,246.98
Office equipment				
G/08	11,567,171.39	11,567,171.39	75,645.98	75,645.98
Software				
G09 to G17	44,418,082.90	44,418,082.90	306,469.17	306,469.17
RTC (18-A to Q)	77,650,417.45	77,650,417.45	414,065.58	414,065.58
Total Amount		**1,706,576,667.09**		**12,372,733.30**

Annex 4: Economic benefit assessment related calculations

A.4.1 Model Results of the simulations

A.4.1.1 Reduction of area

The following table shows the reduction of area compared to the existing condition (before the project start). As discussed, there are several scenarios we have simulated, which are explained below.

Table A. 4.1 Reduction of area

Reduction in the area under risk of flooding (km²)		
50-year return period worst scenario with final pump operational rule, for macro drainage system	Study (Including MSD)	Implemented (excluding MSD)
	4.33	3.03
Improvements to micro drainage systems (10-year return period)		
Improvements to Torrington secondary drainage system		0.54

Notes:

- Worst conditions - Kelani River high water level (precipitation in upstream), saturated soil conditions in the lower Kelani Basin
- Including MSD - Including the intervention 'Madiwela South Diversion', which was simulated, but not implemented under MCUDP
- 50 year - probability of exceedance of occurring once in every 50 years (rainfall 477 mm/day)
- 10 year - probability of exceedance of occurring once in every 10 years (rainfall 103 mm/hour)
- *Maps will be provided separately*

A.4.1.2 Reduction in the damages to the structures per event

Table A. 4.2 Reduction in the damages to the structures

Reduction in the structural damage (LKR Millions)	**Study (Including MSD)**	**Implemented (excluding MSD)**
50-year return period worst scenario with final pump operational rule, for macro drainage system	5,074.57	3,807.94

Notes:

- All aforementioned conditions in Section A.4.1.1 apply
- Structural damage only includes the damages to the structure to the buildings (such as walls, paint, etc., similar to the fabric damage in PHRD study), based on 4 categories (A - Unreinforced masonry walls (URM), B - Concrete frame with unreinforced masonry fill walls, C - Wooden structures, D - Commercial buildings and Watta (underdeveloped houses, more temporary based))
- This does not cover the damages to the infrastructure or critical infrastructures
- Detailed damage assessment methodology including the used damage functions is available in the short report "Damage assessment methodology for floods"

A.4.1.3 Reduction in the damages to the content of the buildings per event

Table A. 4.3 Reduction in the damages to the content of the buildings

Reduction in the content damage (LKR Millions)	**Study (Including MSD)**	**Implemented (excluding MSD)**
50-year return period worst scenario with final pump operational rule, for macro drainage system	2,099.55	1,721.27

Notes:

- All aforementioned conditions in Section A.4.1.1 apply
- Content damage includes the damages done to the building content (such as furniture, televisions and radios, sofas, refrigerators etc.) under eight categories (Health sector buildings, Industrial buildings, Warehouses, Educational, Residential, Shops, Vacant buildings and Office buildings)
- Detailed damage assessment methodology including the used damage functions is available in the short report "Damage assessment methodology for floods"

A.4.1.4 Reduction in the total damage per event

Table A. 4.4 Reduction in the total damage

Reduction in the content damage (LKR Millions)	Study (Including MSD)	Implemented (excluding MSD)
50-year return period worst scenario with final pump operational rule, for macro drainage system	7,174.12	5,529.21

- This table is obtained by the addition of the tables in section A.4.1.3 and A.4.1.4

A.4.1.5 Reduction of the people at risk per event

Table A. 4.5 Reduction of the people at risk

Reduction in the people at risks	Study (Including MSD)	Implemented (excluding MSD)
50-year return period worst scenario with final pump operational rule, for macro drainage system	37,782	29,700

Notes:

- Assumptions made in to derive the numbers in the table above:
  - Population distribution was taken GND (Grama Niladhari Division)-wise, according to the 2012 census and the number of people in a particular GND was divided from the residential floor area that falls in to that particular GND; the resulting ratio was multiplied by the floor area of each of the residential building to obtain the population at each building.
  - If a building was affected, only the people in the affected floor was considered as people at risk, as the people in higher floors may not be exposed to a bigger risk
  - The average floor height is considered as 3 m
- All aforementioned conditions in Section A.4.1.1 apply

A.4.1.6 Reduction in area, according to the landuse category per event

Table A. 4.6 Reduction in area, according to the landuse category

Reduction in area, in landuse categories (km^2)		1_AGRIA	2_BLTPA	3_CANALS	4_HOMSA	5_MARSH	6_SANDA	Total
50-year return period worst scenario with final pump operational rule, for macro drainage system	Incl MSD	0.87	0.12	0.13	2.49	0.68	0.04	4.33
	Excl MSD	0.55	0.09	0.08	1.88	0.41	0.03	3.03

- Landuses published by the Survey department has several landuse categories, which were re-categorized as below, for the convenience of comparison. The same landuse categories were used to get the reduction of area under each landuse category, for the simulated scenarios

Table A. 4.7 Recategorization of landuse

Landuse categories published from Survey Department	**Acronym**	**Recategorized Landuses**	**Acronym**
Bay area	BAYA	Built-up area	1_AGRIA
Built up area	BLTPA		
Coconut	CCNTA	Agricultural area	2_BLTPA
Chena	CHENA		
Paddy	PDDYA		
Rubber	RBBRA		
Other cultivations	OTHRA		
Canal area	CNNLA	Canals	3_CANALS
Areas of all Minor Streams	STRMA		
Areas of all tanks	TANKA		
Areas of all Water holes	WTRHA		
Homesteads/Garden	HOMSA	Homesteads/Garden	4_HOMSA
Marsh	MRSHA	Marshes	5_MARSH
Sand areas	SANDA	Sand areas	6_SANDA
Scrub land	SCRBA		

A.4.1.7 Reduction in damage, according to the landuse category per event

Table A. 4.8 Reduction in damage, according to the recategorized landuse

Reduction in damage, in landuse categories (**LKR** Millions)		1_AGRIA	2_BLTPA	3_CANALS	4_HOMSA	5_MARSH	6_SANDA	Total
50-year return period worst scenario with final pump operational rule, for macro drainage system	Incl MSD	820.60	178.36	129.87	4,254.20	1,785.90	5.41	7,174.34
	Excl MSD	656.77	139.23	97.04	3,444.40	1,187.91	4.00	5,529.36

- In this table, total damage is re-categorized according to the landuse by survey department

A.4.1.8 Reduction in area and total damage, according to the building use category per event

Since the landuse from Survey department is not very representative of the landuses which were identified in the section A.4.1.3, tables in the next page shows the reduction in area and total damage, according to the landuse determined by the building uses. The building uses and the acronyms are as follows.

Table A. 4.9 Building uses and the acronyms

07_edu	Educational buildings
08_hlt	Health sector buildings
09_ind	Industrial buildings
10_ofc	Office buildings
11_res	Residential buildings
12_shp	Shops
13_vac	Vacant buildings
14_wrh	Warehouses
15_nlsp	Empty spaces/unidentified buildings

Table A. 4.10 Reduction in area, in landuse determined by building use categories

Reduction in area, in landuse determined by building use categories (km²)		**07_ edu**	**08_ hlt**	**09_ ind**	**10_ ofc**	**11_ res**	**12_ shp**	**13_ vac**	**14_ wrh**	**15_ nlsp**	**Total**
50-year return period worst scenario with final pump operational rule, for macro drainage system	Incl MSD	0.07	0.01	0.08	0.03	0.81	0.09	0.04	0.11	3.09	4.33
	Excl MSD	0.05	0.00	0.08	0.02	0.58	0.07	0.03	0.10	2.10	3.03

Table A. 4.11 Reduction in total damage, in landuse determined by building use categories (LKR Millions)

Reduction in total damage, in landuse determined by building use categories (LKR Millions)		**07_ edu**	**08_ hlt**	**09_ ind**	**10_ ofc**	**11_ res**	**12_ shp**	**13_ vac**	**14_wrh**	**15_nlsp**	**Total**
50-year return period worst scenario with final pump operational rule, for macro drainage system	Incl MSD	177.41	19.14	491.27	123.57	2,235.32	275.08	75.14	579.39	3,212.43	7,188.75
	Excl MSD	139.56	14.45	442.59	87.34	1,639.76	208.06	59.27	531.05	2,419.82	5,541.89

A.4.2 Calculation of benefits for the macro drainage component

A.4.2.1 Model results

The RTC models yielded the following benefits gained in each of the interventions, as mentioned below.

- 50-year return period worst scenario with final pump operational rule, for macro drainage system Implemented (excluding MSD), building structural damage + content damage (refer document 'Model results of the simulations')

Table A. 4.12 Calculated benefits for returns periods

Return Period (years)	Frequency	Benefit LKR millions
2	0.5	206.85
5	0.2	404.43
10	0.1	1,387.47
25	0.04	3,274.63
50	0.02	5,529.00

- The data (flood probabilities) could be plotted and fitted in to a power series as follows.

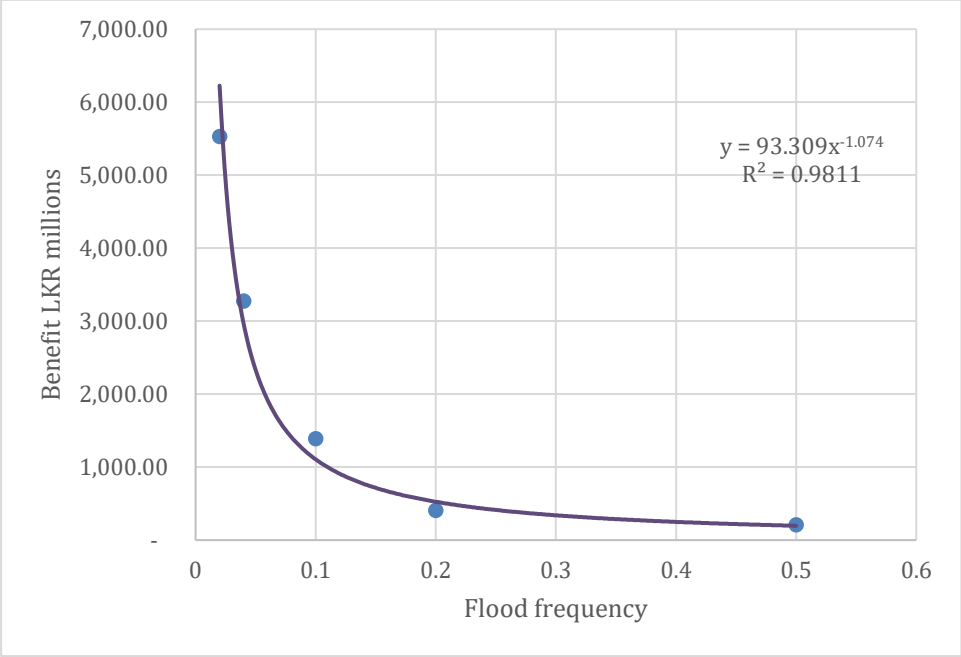


Figure A. 4.1 Probability distribution function for benefits

Notes:

- Integration of the obtained function ($y = 93.309 \times x^{-1.074}$) from 0.005 (200-year event) to 1 gives the average annual benefit, which is equivalent to 605.31 LKR Millions.
- The additional benefits will be calculated based on the Post Disaster Needs Assessment report for floods and landslides for 2016.

A.4.2.2 Calculation of the secondary and sectorial damages based on the obtained total damage

The sector-wise damage and losses, and recovery needs percentages as a percentage of the structural + content damage is shown below. These values are based on the PDNA 2016, and the methodology to obtain the ratios and the assumptions made are annexed.

Table A. 4.13 Sector wise damages and losses, and recovery needs

Sector	Damages and Losses	Recovery Needs
Social		
Housing, Land, and settlements	100.46%	264.57%
Health and Nutrition	1.84%	2.78%
Education	1.92%	1.11%
Productive sectors		
Food Security, Agri and Livestock, Fisheries	0.05%	0.03%
Industry and Commerce	40.65%	0.04%
Infrastructure		
Irrigation	0.25%	0.02%
Water and Sanitation	0.79%	0.40%
Transport	2.90%	2.85%
Power Supply	1.18%	0.22%
Cross cutting issues		
Environment	1.02%	0.14%
Disaster Risk Reduction	0.70%	0.19%
Employment and Livelihoods	9.05%	11.05%
Gender and Social inclusion	0.00%	0.07%
Total	**160.82%**	**283.46%**

For an annual average benefit of 605.31 LKR Millions, the total saving will be as follows (all values are in LKR millions).

Table A. 4.14 Sector wise total savings

Sector	Damages and Losses	Recovery Needs
Social		
Housing, Land, and settlements	608.08	1,601.45
Health and Nutrition	11.15	16.84
Education	11.65	6.74
Productive sectors		
Food Security, Agri and Livestock, Fisheries	0.31	0.21
Industry and Commerce	246.06	0.21
Infrastructure		
Irrigation	1.49	0.15
Water and Sanitation	4.78	2.39
Transport	17.55	17.23
Power Supply	7.14	1.30
Cross cutting issues		
Environment	6.16	0.82
Disaster Risk Reduction	4.26	1.14
Employment and Livelihoods	54.80	66.90
Gender and Social inclusion	-	0.42
Total	973.44	1,715.82

A.4.2.3 Mapping of the pre-identified damage categories to the sectors

The pre-identified damages (direct tangibles, and indirect tangibles) can be mapped into the sectorial damages in the following manner, enabling it to assign a monetary value for the benefits.

Table A. 4.15 Pre-identified impacts and damages to the sectors

Sector	Pre-identified impact	Type of damage
Social		
Housing, Land, and settlements	Structural and content damages	Direct and tangible
	Compensation payment for flood victims	Direct and tangible (identified under losses of the sub-sector)
	Relief camp costs (Cooked food, dry rations after 3 days, mobilization of medical units, security costs, maintenance costs, sanitary costs, transport of goods such as tents, waste generation and disposal costs, electricity - generator costs, collection of aids)	Direct and tangible (identified under losses of the sub-sector)
	Cleaning costs (cleaning of wells), Septic tank clearing	Direct and tangible (identified under losses of the sub-sector)
	Damages to vehicles (costs for towing, insurance compensation payments, repair costs)	Direct and tangible (identified under losses of the sub-sector)
	Mobilization of police units for traffic control (time, mobilization cost)	Indirect tangible
Health and Nutrition	Medication costs (direct treatment of patients, medication and mobilization of patient costs)	Direct and tangible
	Medication costs (time of the response personnel)	Indirect tangible
Education		
Productive sectors		
Food Security, Agri and Livestock, Fisheries	Losses due to the inundation of the crops, productive lands and livestock	Direct and tangible
Industry and Commerce	Loss of inventory	Direct and tangible
	Cascaded loss/delay of business due to dependent businesses	Indirect tangible
	Loss of business through due to blockage of roads	Indirect tangible
Infrastructure		
Irrigation		
Water and Sanitation		
Transport	Use of alternative transport routes (fuel and time)	Indirect tangible
Power Supply		
Cross cutting issues		
Environment	Loss of water quality, Biological and ecological growth hindrance	Indirect intangible
Disaster Risk Reduction	Rescue operation costs (mobilization of rescue teams, hire of boats, fuel and time for rescue equipment, teams and vehicles)	Direct and tangible
Employment and Livelihoods	Loss of business through due to blockage of roads	Indirect tangible
	Cascaded loss/delay of business due to dependent businesses	Indirect tangible
Gender and Social inclusion		

A.4.2.4 Computation of the sectorial damages for Colombo

PDNA 2016 has mainly considered damage occurred, as well as the recovery costs associated to bounce back to the normal condition. Since the PDNA 2016 report essentially contained the all-island disaster cost and recovery costs categorized by sectors, followed by the district breakdown of the damages (Appendix 3: PDNA 2016) and recovery costs (Appendix 4: PDNA report), some calculations were done with some assumptions to obtain the ratios for Colombo floods. Workings are shown below.

A.4.2.5 Sector wise damages, losses and recovery needs for the whole island, for the disaster event in 2016

- All values are in LKR
- Extracted from Table 9 and 12: PDNA 2016

Table A. 4.16 Sector wise damages, losses and recovery needs for the whole island, for the disaster event in 2016

Sector		Damages	Losses	Total LKR	Recovery need
Social					
	Housing, land and settlements	55,821,850,000	256,000,000	56,077,850,000	122,492,974,760
	Health and Nutrition	478,500,000	118,682,285	597,182,285	1,032,600,000
	Education	525,500,000	98,190,000	623,690,000	413,130,000
Productive Sectors					
	Food Security, Agri and Livestock, Fisheries	1,698,050,000	1,901,750,000	3,599,800,000	2,411,500,000
	Industry and Commerce	21,895,480,000	9,070,110,000	30,965,590,000	27,000,000
Infrastructure					
	Irrigation	1,723,420,000	-	1,723,420,000	1,968,000,000
	Water and Sanitation	366,620,000	76,520,000	443,140,000	670,100,000
	Transport	4,143,400,000	43,500,000	4,186,900,000	3,987,340,000
	Power Supply	207,660,000	454,200,000	661,860,000	364,540,000
Cross cutting issues					
	Environment	27,400,000	542,842,332	570,242,332	230,500,000
	DRR	140,000,000	254,361,123	394,361,123	320,000,000
	Employment and Livelihoods	-	5,054,000,000	5,054,000,000	5,117,000,000
	Gender and Social inclusion	-	-	-	32,000,000
Total		87,027,880,000	17,870,155,740	104,898,035,740	139,066,684,760

A.4.2.6 Sector wise damages, losses and recovery needs for Colombo District, for the disaster event in 2016

- All values are in LKR
- Extracted from Table 109 and 123: PDNA 2016
- Some data is not available district-wise, hence NA

Table A. 4.17 Sector wise damages, losses and recovery needs for Colombo District, for the disaster event in 2016

Sector	Damages	Losses	Total LKR	Recovery need
Social				
Housing, land and settlements	29,223,183,725	141,645,377	29,364,829,102	77,412,193,800
Health and Nutrition	468,500,000	70,974,030	539,474,030	814,600,000
Education	NA	NA	NA	NA
Productive Sectors				
Food Security, Agri and Livestock, Fisheries	124,439	13,063,465	13,187,904	9,689,112
Industry and Commerce	7,311,320,000	1,801,640,000	9,112,960,000	NA
Infrastructure				
Irrigation	70,000,000	0	70,000,000	7,000,000
Water and Sanitation	192,000,000	39,390,000	231,390,000	115,840,000
Transport	791,790,000	16,400,000	808,190,000	791,800,000
Power Supply	NA	NA	NA	NA
Cross cutting issues				
Environment	NA	NA	NA	NA
DRR	NA	NA	NA	NA
Employment and Livelihoods	NA	NA	NA	NA
Gender and Social inclusion	NA	NA	NA	NA
Total	38,056,918,164	2,083,112,872	40,140,031,036	79,151,122,912

A.4.2.7 Sector wise total damages, losses and recovery needs for the whole island, for the disaster event in 2016

This data table is taken into consideration, in order to calculate the proportion of damages and recovery need borne by Colombo, compared to the whole island damages and recovery needs.

Table A. 4.18 Sector wise total damages, losses and recovery needs for the whole island, for the disaster event in 2016

Sector	Damages	Losses	Total LKR	Recovery need
Social				
Housing, land and settlements	55,729,239,975	255,945,700	55,985,185,675	122,412,328,310
Health and Nutrition	478,500,000	118,682,288	597,182,288	1,032,600,000
Education	NA	NA	NA	NA
Productive Sectors				
Food Security, Agri and Livestock, Fisheries	1,604,193,926	1,543,527,826	3,147,721,752	2,312,621,412
Industry and Commerce	14,667,839,960	9,041,299,960	23,709,139,920	NA
Infrastructure				
Irrigation	1,675,420,000	-	1,675,420,000	1,956,000,000
Water and Sanitation	366,620,000	76,520,000	443,140,000	670,100,000
Transport	3,943,380,000	43,500,000	3,986,880,000	3,787,340,000
Power Supply	NA	NA	NA	NA
Cross cutting issues				
Environment	NA	NA	NA	NA
DRR	NA	NA	NA	NA
Employment and Livelihoods	NA	NA	NA	NA
Gender and Social inclusion	NA	NA	NA	NA
Total	38,056,918,164	2,083,112,872	40,140,031,036	79,151,122,912

A.4.2.8 Proportions of sectorial damages in Colombo

- Following data table is obtained by dividing the values in section 0 by section A.4.2.7.
- Since some ratios cannot be calculated according to the sector in a district basis (highlighted) (due to unavailability of data), ratios were assumed based on several assumptions which are stated alongside.

Table A. 4.19 Proportions of sectorial damages in Colombo

Sector	Damages and losses	Recovery need	Assumptions if any
Social			
Housing, land and settlements	52.45%	63.24%	
Health and Nutrition	90.34%	78.89%	
Education	90.34%	78.89%	Similarity of the total cost for sector (considered similar to the health sector)
Productive Sectors			
Food Security, Agri and Livestock, Fisheries	0.42%	0.42%	
Industry and Commerce	38.44%	38.44%	Similar to the ratio damage curve
Infrastructure			
Irrigation	4.18%	0.36%	
Water and Sanitation	52.22%	17.29%	
Transport	20.27%	20.91%	
Power Supply	52.22%	17.29%	Water and Sanitation proportion
Cross cutting issues			
Environment	52.22%	17.29%	Water and Sanitation proportion
Disaster Risk Reduction	52.22%	17.29%	Water and Sanitation proportion
Employment and Livelihoods	52.45%	63.24%	Based on the rationale that at least the housing proportionate should be given to employment, provided that around 700,000 employment is around
Gender and Social inclusion	52.45%	63.24%	Housing proportion

Next, using the obtained ratios above, total costs and recovery needs incurred to Colombo was computed. Done through multiplying the ratios in section A.4.2.8 by the total disaster costs and recovery needs in section A.4.2.5, which are shown in section A.4.2.9 below.

A.4.2.9 Costs and recovery needs for Colombo, from the entire disaster cost for 2016 floods

Table A. 4.20 Costs and recovery needs for Colombo, from the entire disaster cost for 2016 floods

Sector	Damages and losses	Recovery need
Social		
Housing, land and settlements	29,413,432,532.26	77,463,193,717.27
Health and Nutrition	539,474,027.29	814,600,000.00
Education	563,420,189.33	325,910,999.42
Productive Sectors		
Food Security, Agri and Livestock, Fisheries	15,081,961.04	10,103,380.29
Industry and Commerce	11,902,084,343.78	10,377,850.94
Infrastructure		
Irrigation	72,005,467.29	7,042,944.79
Water and Sanitation	231,390,000.00	115,840,000.00
Transport	848,736,533.58	833,612,987.48
Power Supply	345,596,843.89	63,017,928.07
Cross cutting issues		
Environment	297,757,758.73	39,846,470.68
Disaster Risk Reduction	205,919,619.65	55,318,310.70
Employment and Livelihoods	2,650,823,000.00	3,235,990,800.00
Gender and Social inclusion	-	20,236,800.00
Total	47,085,722,276.83	82,995,092,189.63

Breakdown of the **Housing, Land and Settlement** sector is given below (extracted from table 17: PDNA 2016).

Table A. 4.21 Breakdown of costs of the Housing, Land and Settlement damages

Damages		
	Structural Damage	23,122,529,836
	Content Damage	6,156,706,633
	Total Damage	29,279,236,469
Loss		
	Cleaning cost	88,117,798
	Provision of temporary shelter	9,965,703
	Cost of Safe Location Management	23,602,982
	Cash grant for evacuated people	12,588,257
Total		29,413,511,209

This is used to identify the cost occurred due to the building structural damage and the content damage, which is comparable with the model results explained in section A.4.2.1. Therefore, to obtain the total cost and the recovery need from a modelled disaster, an extrapolation could be done, using the structural and the content damage as a base value (29,279,236,469 LKR). The relevant ratios for the cost categories/sectors are calculated as shown in the tables in section A.4.2.2, taking the structural and content damage as a base value.

Example: Cost ratio for the Housing, land and settlements sector, as a proportion of the structural and content damage = $\frac{29,413,432,532.26}{29,279,236,469} = 100.46\%$

A.4.3 Comparison of the benefits with Project Appraisal Document (PAD) Figures

A.4.3.1 Benefits of return periods for base year figures

- PAD figures are extracted from Table A.3
- MCUDP figures are extracted from report "Calculation of benefits for the macro drainage component". Please refer the same document for the basis of following calculations
    - Section 1 benefit values are multiplied by a factor of 160.82% to obtain the *damage* figures of MCUDP
    - Section 1 benefit values are multiplied by a factor of 283.46% to obtain the *recovery need* figures of MCUDP
- All figures are in LKR millions, unless specified otherwise

Table A. 4.22 Benefits of return periods for base years

Flood Return Period in Years	**PAD figures (base year: 2011)**	**MCUDP Damage figures (base year: 2016)**	**MCUDP Recovery need figures (base year: 2016)**
2	931	332.6	586.3
5	1 ,520	650.4	1,146.4
10	2,014	2,231.3	3,932.9
25	3,884	5,266.1	9,282.3
50	6,740	8,891.5	15,672.5
Expected damage (Annual average damage)	**1,062**	**973.44**	**1,715.82**

A.4.3.2 Moderation of base years

For comparison purposes, all the values in the section 1 are taken into 2021 with a common escalation rate of 5%, as assumed in the PAD.

- $cost\ at\ year\ n = cost\ at\ base\ year \times 1.05^n$
  - Escalation $when\ n = 10$ (2011 to 2021), $1.05^n = 1.6289$
  - Escalation $when\ n = 5$ (2016 to 2021), $1.05^n = 1.2763$

Table A. 4.23 Moderation of base years

Flood Return Period in Years	PAD figures (base year: 2021)	MCUDP Damage figures (base year: 2021)	MCUDP Recovery need figures (base year: 2021)
2	1,516.50	424.55	748.33
5	2,475.92	830.08	1,463.13
10	3,280.59	2,847.74	5,019.53
25	6,326.63	6,721.07	11,846.81
50	10,978.75	11,348.08	20,002.57
Expected damage (Annual average damage)	**1,729.89**	**1,242.38**	**2,189.86**

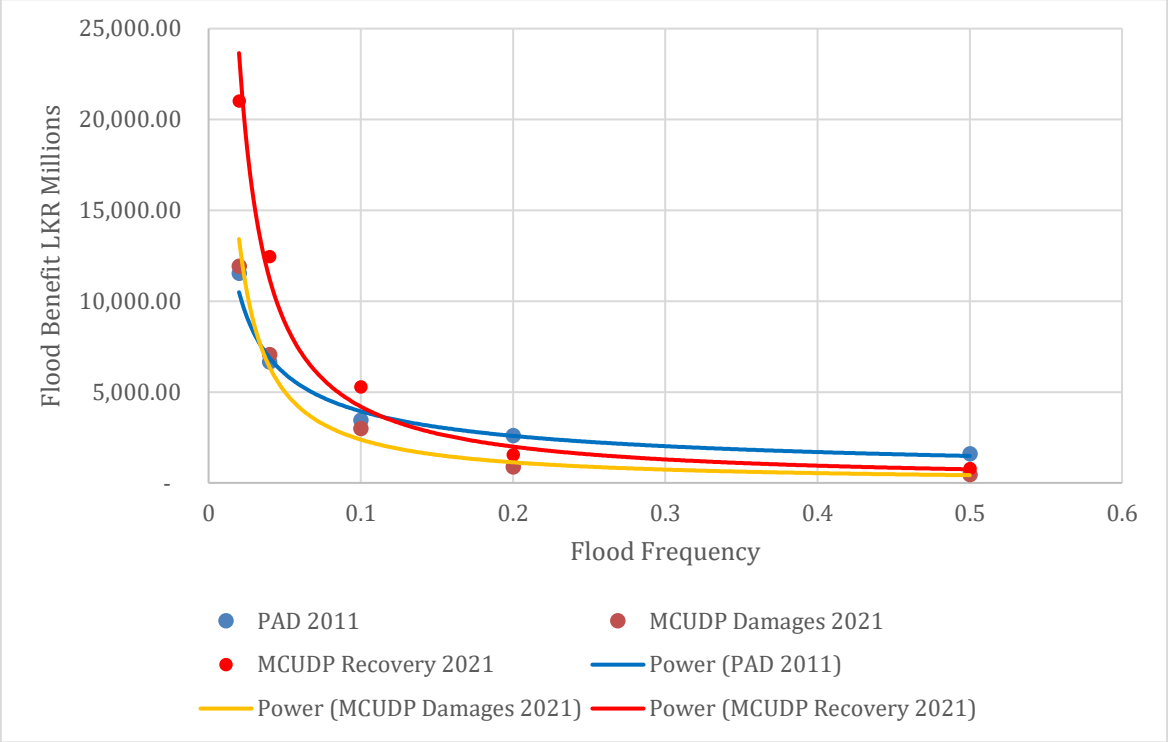


Figure A. 4.2 Comparison of Benefit Curves

A.4.3.3 Calculation of the benefit by 2051

Assumptions taken in the PAD (which are replicated for MCUDP figures as well):

- The cost of disaster will be increased by 5% each year
  - $cost\ at\ year\ n = cost\ at\ base\ year \times 1.05^n$
  - $when\ n = 40, 1.05^n = 7.0399$
- Climatic effect is taken as 37% of the cost of the disaster, without the climate change effect
  - $Cost\ with\ climate\ change = cost\ without\ cc \times 1.37$

Table A. 4.24 Expected mean annual damage calculation

Flood Return Period in Years	PAD figures by 40 years WITHOUT Climate Change Effect	MCUDP Damage by 40 years WITHOUT Climate Change Effect	MCUDP Recovery need by 40 years WITHOUT Climate Change Effect	PAD figures by 40 years WITH Climate Change Effect	MCUDP Damage by 40 years WITH Climate Change Effect	MCUDP Recovery need by 40 years WITH Climate Change Effect
2	6,558	1,834.89	3,234.25	9,019	2,520.92	4,443.47
5	10,770	3,587.55	6,323.56	14,176	4,928.87	8,687.81
10	14,811	12,307.75	21,694.10	20,371	16,909.36	29,805.08
25	26,656	29,048.06	51,201.23	36,663	39,908.54	70,344.31
50	46,031	49,045.77	86,449.95	63,310	67,382.97	118,771.80
Expected damage	7,474	5,369.49	9,464.46	10,280	7,377.03	13,003.03

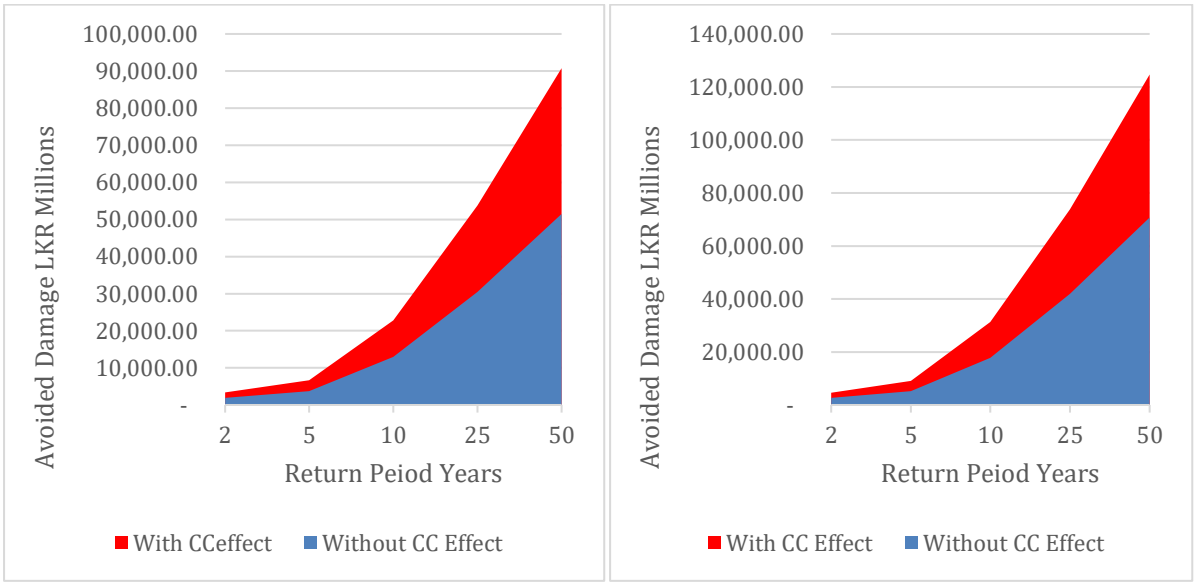


Figure A. 4.3 With and Without Climate Change for MCUDP Damages (left) and Recovery needs (right) by 2051

It can be seen that the value obtained for MCUDP Recovery need by 40 years WITHOUT Climate Change Effect is close to the value obtained for PAD figures by 40 years with Climate Change Effect.

A.4.4 Land Appreciation

A.4.4.1 Observed Land Appreciation Patterns

According to the Central Bank of Sri Lanka (CBSL), the following patterns are observed for the land value prices in Colombo District, by means of the Land Value Index (LVI). LVI explains the current price of the land, considering the land price of a selected base year as 100[1]. This is issued twice every year, and data is available until 2021 first half.

Table A. 4.25 LVI for Colombo[2]

	Item Name	2016-H1	2016-H2	2017-H1	2017-H2	2018-H1	2018-H2	2019-H1	2019-H2	2020-H1	2020-H2	2021-H1
1	Land Valuations Indicator (LVI) for Colombo (1998=100) - Overall	558.1	599.1	628.6	661.3							
2	Land Valuations Indicator (LVI) for Colombo (1998=100) - Residential	574.4	614.7	642.7	674.5							
3	Land Valuations Indicator (LVI) for Colombo (1998=100) - Commercial	585	623.9	653	694.1							
4	Land Valuations Indicator (LVI) for Colombo (1998=100) - Industrial	514.9	558.5	590.1	615.2							
5	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Overall			100	106.7	116.3	125.8	132.2	138.8	141.6	145.2	155.1
6	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Residential			100	107	116.5	125	131.4	137.9	140.7	144.4	154.2
7	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Commercial			100	107.3	116.8	125.9	132.2	138.8	141.6	145.1	154
8	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Industrial			100	106	115.8	126.6	133	139.6	142.5	146.1	157

*Note: CBSL has revised the base year to 2017 after considering the change of landuse and other factors during the prevailing years.

Land values can be revised to have the base year as 2017, and the LVI will be similar to the following.

Table A. 4.26 LVI for Colombo moderated for 2017 base year

	Item Name	2016-H1	2016-H2	2017-H1	2017-H2	2018-H1	2018-H2	2019-H1	2019-H2	2020-H1	2020-H2	2021-H1
1	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Overall	88.78	95.31	100	106.7	116.3	125.8	132.2	138.8	141.6	145.2	155.1
2	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Residential	89.37	95.64	100	107	116.5	125	131.4	137.9	140.7	144.4	154.2
3	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Commercial	89.59	95.54	100	107.3	116.8	125.9	132.2	138.8	141.6	145.1	154
4	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Industrial	87.26	94.64	100	106	115.8	126.6	133	139.6	142.5	146.1	157

[1] Central Bank of Sri Lanka, "Land Valuation Indicator H1 2021," Aug. 2021. Accessed: Jun. 03, 2022. [Online]. Available: https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/press/pr/press_20210806_land_valuation_indicator_first_half_2021_e.pdf
[2] Central Bank of Sri Lanka, "Statistics Database of Central Bank of Sri Lanka." https://www.cbsl.lk/eresearch/ (accessed Jun. 03, 2022).

At the same time, the semiannual percentage increment of Land Value can be calculated as follows.

Table A. 4.27 Semiannual percentage increment of LVI

	Item Name	2016-H1	2016-H2	2017-H1	2017-H2	2018-H1	2018-H2	2019-H1	2019-H2	2020-H1	2020-H2	2021-H1
1	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Overall		6.5	4.7	6.7	9.6	9.5	6.4	6.6	2.8	3.6	9.9
2	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Residential		6.3	4.4	7.0	9.5	8.5	6.4	6.5	2.8	3.7	9.8
3	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Commercial		6.0	4.5	7.3	9.5	9.1	6.3	6.6	2.8	3.5	8.9
4	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Industrial		7.4	5.4	6.0	9.8	10.8	6.4	6.6	2.9	3.6	10.9

A.4.4.2 Obtaining Land Appreciation for 2021 H2 and 2022 H1

LankaPropertyWeb maintains its own record of Colombo Land Values[3], and it contains land values of Colombo residential areas from 2016 to 2022, and the variation in the land values can be used to estimate the CBSL values for 2021 H2 and 2022 H1. The relevant data is shown below.

Table A. 4.28 Statistics from Lanka Property Web

	Item Name	2016-H1	2016-H2	2017-H1	2017-H2	2018-H1	2018-H2	2019-H1	2019-H2	2020-H1	2020-H2	2021-H1	2021-H2	2022-H1
1	Colombo City Observed Land Values in LKR millions	7.9	9.0	10.9	11.0	11.4	11.6	10.7	11.2	11.4	11.3	11.9	11.7	11.7
2	Colombo Residential Observed Land Values in LKR millions	0.78	0.78	0.94	0.96	1.02	1.23	1.36	1.34	1.45	1.49	1.91	1.27	0.97
3	Colombo City Moderated to 2017 base value	72.4	82.7	100.0	100.3	104.3	105.8	98.2	102.7	104.1	103.4	108.9	107.0	107.0
4	Colombo Residential Moderated to 2017 base value	83.1	83.0	100.0	102.2	108.9	131.3	145.1	143.0	154.7	159.0	203.8	135.5	103.5
5	Percentage increment in Colombo City		10.3	17.3	0.3	4.0	1.5	-7.6	4.6	1.4	-0.7	5.5	-1.8	0.0
6	Percentage increment in Colombo Residential		-0.1	17.0	2.2	6.6	22.4	13.9	-2.1	11.7	4.3	44.8	-68.3	-32.0

When plotted the percentage increment, the variation in the percentage increment is highly comparable with the CBSL variation, hence it could be estimated that in 2021 H2, a similar figure for 2020 H2, and the increment from 2020 H1 to 2020 H2 can be expected from 2021 H2 to 2022 H1. Using those, the LVI increments and the LVI values can be worked out as follows.

[3] LankaPropertyWeb, "Lanka Property Web - Average Sri Lanka House & Land Prices | Sri Lanka House price index." https://www.lankapropertyweb.com/house_prices.php (accessed Jun. 03, 2022)

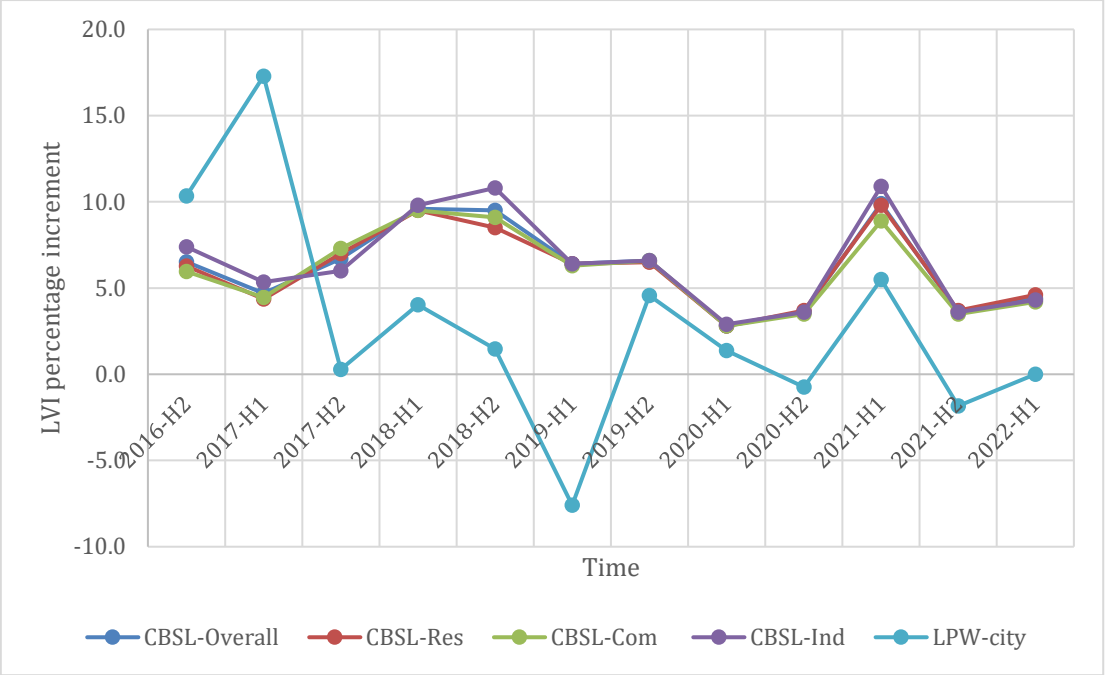


Figure A. 4.4 Percentage variation of LVI

Table A. 4.29 Final LVIs

	Item Name	2016-H1	2016-H2	2017-H1	2017-H2	2018-H1	2018-H2	2019-H1	2019-H2	2020-H1	2020-H2	2021-H1	2021-H2	2022-H1
1	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Overall	88.78	95.31	100	106.7	116.3	125.8	132.2	138.8	141.6	145.2	155.1	145.2	158.7
2	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Residential	89.37	95.64	100	107	116.5	125	131.4	137.9	140.7	144.4	154.2	144.4	157.9
3	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Commercial	89.59	95.54	100	107.3	116.8	125.9	132.2	138.8	141.6	145.1	154	145.1	157.5
4	Land Valuations Indicator (LVI) for Colombo (2017 1st Half = 100) - Industrial	87.26	94.64	100	106	115.8	126.6	133	139.6	142.5	146.1	157	146.1	160.6

A.4.4.3 Comparison of field measured values and the projected land values

The field measured observed values are compared with the projected land prices, based on the 2016 H1 land value taken as a base price.

Table A. 4.1 Comparison of field measured land values and the projected land values

Project	Location	Observed Land Value in 2016	Projected Value 2022 H1	Observed Land Value at 2022 April	Difference
New Mutwal Tunnel	Wales Lane	1,500,000	2,439,612.26	2,500,000	60,387.74
	Aluth Mawatha	1,600,000	2,602,253.07	2,700,000	97,746.93
	De La Saale Street / Eli house Road	2,200,000	3,578,097.98	3,500,000	(78,097.98)
	Mutwal Road	1,750,000	2,846,214.30	2,700,000	(146,214.30)
Kolonnawa Canal Diversion		750,000	1,219,806.13	1,500,000	280,193.87
Rehabilitation of St. Sebastian North Canal	Nagalagam Street	1,200,000	1,974,666.76	3,000,000	1,025,333.24
	Ingurukade Junction	1,800,000	2,962,000.14	4,500,000	1,537,999.86
St. Sebastian North Lock Gate & Pumping Station	Sedawatta Road	1,200,000	1,951,689.80	1,500,000	(451,689.80)
	Nagalagam Street	1,200,000	1,961,150.90	2,500,000	538,849.10
Madiwela East Diversion Scheme – Stage III	Ambatale	400,000	650,563.27	1,500,000	849,436.73

Therefore, the least incremented land values for the flood freed areas were used to estimate the land value increment. The flood freed areas were initially categorized according to the GND divisions, and initially categorized according to the observed value availability and vicinity. For all other locations, the lowest values are used, again based on the land values. At the same time, a factor of 0.6 for the increment value is applied, due to the uncertainties involved in recording the land price values in the survey. The resultant table is shown below. (Note that only approach 1 freed land is used)

Table A. 4.2 Calculation of land value increment

DSD_N	GND_N	Directly Saved area in purchase	Closest observed value	Increment in Land Values per Perch LKR	LV increment approximately Mn LKR
Colombo	Lunupokuna	45	New Mutwal Tunnel	36,000	2
	Kotahena East	1188	New Mutwal Tunnel	36,000	43
	Aluthkade East	285	-	36,000	10
	New Bazaar	1425	Ingurukade Junction	600,000	855
	Khettarama	3790	Ingurukade Junction	600,000	2,274
	Nawagampura	1776	Ingurukade Junction	600,000	1,066
	Maligakanda	339	-	36,000	12
	Panchikawatta	975	-	36,000	35

	Maligawatta West	6297	-	36,000	227
	Maligawatta East	1029	-	36,000	37
	Grandpass South	2624	Ingurukade Junction	600,000	1,574
	Grandpass North	2317	Ingurukade Junction	600,000	1,390
	Bloemendhal	10029	New Mutwal Tunnel	36,000	361
	Mahawatta	294	Nagalagam Street	600,000	176
Kaduwela	Mahadeniya	282	Ambatale	510,000	144
	Subhoothipura	1459	-	510,000	744
	Walpola	147	-	510,000	75
	Udumulla	379	-	510,000	193
	Kotuwegoda	521	-	510,000	266
	Kalapaluwawa	818	-	510,000	417
	Batapotha	984	-	510,000	502
	Battaramulla North	445	-	510,000	227
	Rajamalwatta	2600	-	510,000	1,326
	Asiri Uyana	191	-	510,000	97
	Aruppitiya	27	-	510,000	14
	Evarihena	107	-	510,000	55
	Kumaragewatta	178	-	510,000	91
	Malabe East	71	-	510,000	36
	Malabe North	71	-	510,000	36
	Thalangama North A	732	-	510,000	373
	Muttettugoda	112	-	510,000	57
	Pothuarawa	2	-	510,000	1
	Malabe West	36	-	510,000	18
	Thalahena North	71	-	510,000	36
	Thalangama North B	36	-	510,000	18
	Thalahena South	233	-	510,000	119
	Battaramulla South	557	-	510,000	284
	Pahalawela	2446	-	510,000	1,247
	Hokandara North	0	-	510,000	-
Kolonnawa	Orugodawatta	5834	Rehabilitation of St. Sebastian North Canal	900,000	5,251
	Gajabapura	203	-	36,000	7
	Wijayapura	128	Nagalagam Street	318,000	41
	Meethotamulla	1071	Nagalagam Street	318,000	341
	Salamulla	904	Nagalagam Street	318,000	287
	Elhena	209	-	36,000	8
	Welewatta	36	-	36,000	1
	Udumulla North	156	-	36,000	6
	Maligagodella	129	Ambatale	510,000	66
	Dodamgahahena	473	-	36,000	17
	Wadulla	6446	Nagalagam Street	318,000	2,050
	Gothatuwa	911	-	36,000	33

	Madinnagoda	609	-	36,000	22
	Rajasinghagama	264	Ambatale	510,000	135
	Sedawatta	78	Rehabilitation of St. Sebastian North Canal	600,000	47
	Kolonnawa	0	-	36,000	-
	Udumulla South	0	-	36,000	-
Maharagama	Thalawathugoda West	1469	-	36,000	53
	Madiwela	1866	-	36,000	67
Sri Jayawardanapura Kotte	Obesekarapura	2013	-	36,000	72
	Welikada West	1371	-	36,000	49
	Rajagiriya	888	-	36,000	32
	Nawala East	1199	-	36,000	43
	Koswatta	2143	-	36,000	77
	Nugegoda	631	-	36,000	23
	Welikada North	1808	-	36,000	65
	Nawala West	2033	-	36,000	73
	Nugegoda West	2169	-	36,000	78
	Welikada East	1418	-	36,000	51
	Ethulkotte	788	-	36,000	28
	Pitakotte	210	-	36,000	8
	Pitakotte West	607	-	36,000	22
	Ethulkotte West	1653	-	36,000	60
	Pagoda	476	-	36,000	17
	Pitakotte East	1141	-	36,000	41
Thimbirigasyaya	Dematagoda	3178	-	36,000	114
	Wanathamulla	497	-	36,000	18
	Wellawatta North	411	-	510,000	210
	Pamankada East	321	-	510,000	164
	Thimbirigasyaya	1009	-	510,000	515
	Borella South	1702	-	510,000	868
	Borella North	3048	-	510,000	1,554
	Narahenpita	1905	-	510,000	972
	Gothamipura	3199	-	510,000	1,631
	Kirulapone	2141	-	510,000	1,092
	Kirula	4075	-	510,000	2,078
Total		**107,738**			**32,825**

A.4.4.4 Correction factors on actual land use

The above derived 54,709 million LKR value should be further corrected, according to the landuse of the flood freed area. The mentioned flood freed area of 107,738 purchases already does not include the canals, and marshes, however since the CBSL predictions are valid only for residential, commercial and industrial landuses, only that land appreciation can be used here. The relevant proportions of the total flood freed area are shown below.

Table A. 4.3 Correction factors on actual land use

Reduction in area, in landuse categories (km^2)		1_AGRIA	2_BLTPA	3_CANALS	4_HOMSA	5_MARSH	6_SANDA	Total
50-year return period worst scenario with final pump operational rule, for macro drainage system	Incl MSD	0.87	0.12	0.13	2.49	0.68	0.04	4.33
	Excl MSD	0.55	0.09	0.08	1.88	0.41	0.03	3.03

Notes:

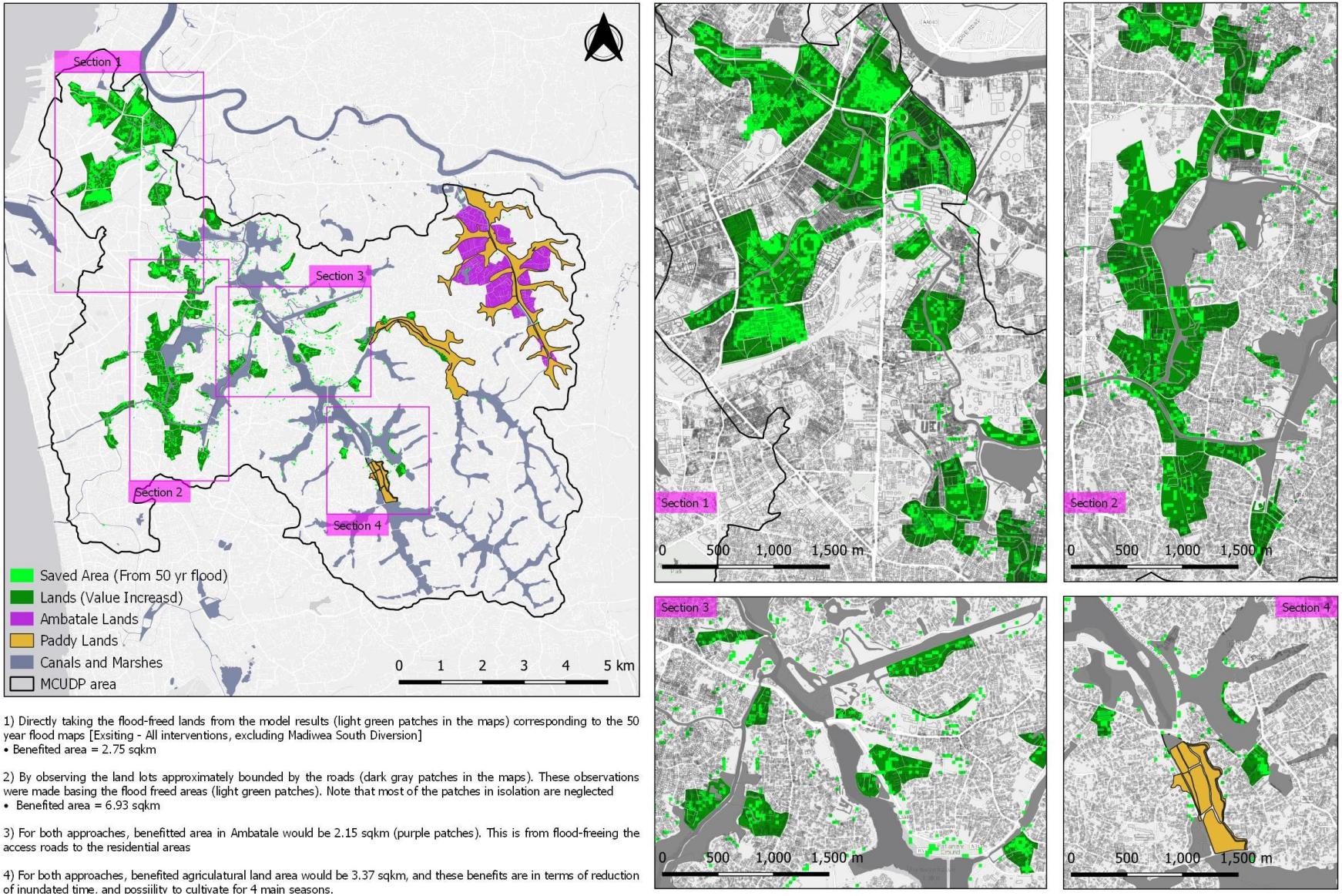
- Landuses published by the Survey department has several landuse categories, which were re-categorized as below, for the convenience of comparison. The same landuse categories were used to get the reduction of area under each landuse category, for the simulated scenarios

Table A. 4.4 Recategorization of land uses

Landuse categories published from Survey Department	**Acronym**	**Recategorized Landuses**	**Acronym**
Bay area	BAYA	Built-up area	1_AGRIA
Built up area	BLTPA		
Coconut	CCNTA	Agricultural area	2_BLTPA
Chena	CHENA		
Paddy	PDDYA		
Rubber	RBBRA		
Other cultivations	OTHRA		
Canal area	CNNLA	Canals	3_CANALS
Areas of all Minor Streams	STRMA		
Areas of all tanks	TANKA		
Areas of all Water holes	WTRHA		
Homesteads/Garden	HOMSA	Homesteads/Garden	4_HOMSA
Marsh	MRSHA	Marshes	5_MARSH
Sand areas	SANDA	Sand areas	6_SANDA

It can be seen that the categories 2_BLTPA and 4_HOMSA should only be considered from the area derived above. Furthermore, a factor of 0.8 is applied to account for the uncertainties included in calculation of the flood freed area. Therefore the total land value increment would be:

$$\frac{0.09 + 1.88}{0.55 + 0.09 + 1.88 + 0.03} \times 32{,}825 \times 0.8 = \mathbf{20{,}287\ \boldsymbol{Million\ LKRs}}$$



1) Directly taking the flood-freed lands from the model results (light green patches in the maps) corresponding to the 50 year flood maps [Exsiting - All interventions, excluding Madiwea South Diversion]
• Benefited area = 2.75 sqkm

2) By observing the land lots approximately bounded by the roads (dark gray patches in the maps). These observations were made basing the flood freed areas (light green patches). Note that most of the patches in isolation are neglected
• Benefited area = 6.93 sqkm

3) For both approaches, benefitted area in Ambatale would be 2.15 sqkm (purple patches). This is from flood-freeing the access roads to the residential areas

4) For both approaches, benefited agriculatural land area would be 3.37 sqkm, and these benefits are in terms of reduction of inundated time, and possiility to cultivate for 4 main seasons.

Figure A. 4.1 Lands considered for calculation of land value increment

A.4.5 Estimation of the operation and maintenance costs for components 1.1 to 1.3

Estimated annual costs for the operation and maintenance of the facilities developed by the components 1.1 to 1.3 are shown below. Al figures are in LKR.

Table A. 4.5 Estimation of the operation and maintenance costs for components 1.1 to 1.3

	Monthly cost	Amount (no's)	Annual cost
Pumping Stations			
South lock pumping station			
Pump maintenance	41,667	1	500,000
Gate maintenance	208,333	1	2,500,000
Trash screen maintenance	41,667	1	500,000
Office operation and maintenance	7,500	1	90,000
Engineering Assistant staff cost	136,272	2	3,270,528
Operator staff cost	130,958	0.1	157,150
Helper cost	111,271	2	2,670,509
Annual material and staff			9,688,187
Annual power cost assuming 5 pumping months with 24 hours of pumping per month	2,113,920	5	10,569,600
Total			**20,257,787**
Ambatale pumping station			
Pump maintenance	41,667	1	500,000
Gate maintenance	208,333	1	2,500,000
Trash screen maintenance	41,667	1	500,000
Office operation and maintenance	7,500	1	90,000
Engineering Assistant staff cost	136,272	2	3,270,528
Operator staff cost	130,958	0.1	157,150
Helper cost	111,271	2	2,670,509
Annual material and staff			9,688,187
Annual power cost assuming 5 pumping months with 24 hours of pumping per month	3,420,000	5	17,100,000
Total			**26,788,187**
North lock pumping station			
Pump maintenance	41,667	1	500,000
Gate maintenance	208,333	1	2,500,000
Trash screen maintenance	41,667	1	500,000
Office operation and maintenance	7,500	1	90,000
Engineering Assistant staff cost	136,272	2	3,270,528
Operator staff cost	130,958	0.1	157,150
Helper cost	111,271	2	2,670,509
Annual material and staff			9,688,187
Annual power cost assuming 5 pumping months with 24 hours of pumping per month	4,104,000	5	20,520,000
Total			**30,208,187**
Gate Stations			
Cost for operating Flushing gates	83,333	3	3,000,000
KCD 1 gate operations	83,333	1	1,000,000
KCD 4 gate operations	83,333	1	1,000,000
Thalangama gate operations	83,333	1	1,000,000
Total			**6,000,000**
RTC cost			
Staff cost (8 persons)	1,012,153	1	12,145,839
Internet, Cloud and other maintenance	800,000	1	9,600,000
Total			**105,000,000**

Annex 5: Details of the sub-projects and the procurement processes

Table A. 5.1 Details of the sub-projects and the procurement processes

Details of Works Contract

#	Description of Sub - Project	Procurement Method & Process	Contract Amount as at 30.06.2022 (Excl. duties & taxes)	Social Safeguard Measures			Environmental Assessment Category	Amount Paid as Taxes & Duties/LKR	Total Expenditure on Social Safeguards/LKR (Mn)
				Assessment Category	Land Acquisition *(Extent in ha and # of lots)*	Resettlement *(# of families)*			
Component 1: Flood and Drainage Management									
Component 1.1 Enhancement of drainage capacity in the Colombo Water Basin									
1	Construction of canal bank protection works of Dehiwala Canal SLLRDC/W/01	NCB Single Stage One Envelope	LKR 151,543,189	C	-	-	Environmental Management Plan	17,879,053	-
2	Rehabilitation of Main Drain, Aluth Mawatha Culvert, Mutuwala Box Drain, Tunnel inlet and Outlet SLLRDC /W/02	NCB Single Stage One Envelope	LKR 342,438,294	C	-	-	Environmental Management Plan	40,806,195	-
3	Construction of canal bank protection works of St. Sebastian South Canal SLLRDC/W/03-A	NCB Single Stage One Envelope	LKR 226,750,576	A	-	90	Environmental Screening	26,560,547	329.0
4	Improvements to Madiwela East Diversion Scheme – Stage I SLLRDC/W/05	NCB Single Stage One Envelope	LKR 161,508,834	C	-	-	Environmental Assessment	22,232,808	

5	Conveyance Improvements to Wellawatta Canal at Galle Road Bridge SLLRDC/W/07-A	NCB Single Stage One Envelope	LKR 111,570,072	C	-	-	Environmental Management Plan	16,240,377	
6	Improvements to Madiwala East Diversion Scheme – Stage III SLLRDC/W/19	NCB Single Stage One Envelope	LKR 326,469,651	B	0.5950 Ha 07 Lots	1	Environmental Management Plan	44,366,130	71.94
7	Construction of bank protection works of St. Sebastian North Canal SLLRDC/W/09	NCB Single Stage One Envelope	LKR 280,508,052	A	0.6172 Ha 191 Lots	10	Environmental Management Plan	39,752,539	276.68
8	Improvements to Madiwala East Diversion Scheme – Stage II SLLRDC/W/11	NCB Single Stage One Envelope	LKR 115,098,993	C	-	-	Environmental Management Plan	17,097,521	
9	Design and Building of St. Sebastian North Lock Gates & Pumping Station SLLRDC/W/12	ICB Single Stage Two Envelope	LKR 690,517,889 + USD 10,083,287	A	0.9767 Ha 99 Lots	7	Environmental Management Action Plan	419,867,460	194.43
10	Plant design, supply, & installation of pumping station at St. Sebastian South SLLRDC/W/13	ICB Single Stage Two Envelope	LKR 161,882,707 + USD 5,923,639	C	-	-	Environmental Screening	141,110,589	-
11	Design and Building of New Mutuwal Tunnel & Torrington Tunnel SLLRDC/W/14	ICB Single Stage Two Envelope	LKR 413,903,088 + USD 32,141,573	A	1.458 Ha 195 Lots	63	Initial Environmental Assessment	1,118,162,898	698.36
12	Kolonnawa Canal Diversion Scheme Stage – I SLLRDC/W/16-A	NCB Single Stage One Envelope	LKR 836,931,072	A	0.3716 Ha 63 Lots	3	Environmental Screening	93,673,338	32.74

13	Kolonnawa Canal Diversion Scheme Stage – II SLLRDC/W/16-B	NCB Single Stage One Envelope	LKR 269,072,884		1.8433 Ha 119 Lots	-	Environmental Screening	36,090,081	37.45
14	Kolonnawa Canal Diversion Scheme Stage – III SLLRDC/W/16-C	NCB Single Stage One Envelope	LKR 1,001,872,958		2.3911 Ha 250 Lots	4	Environmental Screening	126,793,661	94.65
15	Kolonnawa Canal Diversion Scheme Stage – IV SLLRDC/W/16-D	NCB Single Stage One Envelope	LKR 1,351,431,364		0.5608 Ha 71 Lots	4	Environmental Screening	139,844,378	29.79
16	Dredging of Thalangama Tank SLLRDC/W/23	Force Account	LKR 107,283,698	C	-	-	Environmental Screening	16,092,555	-
17	Design, building of pumping station at Ambathale SLLRDC/W/24	ICB Single Stage Two Envelope	LKR 1,302,674,953 + USD 5,847,219	B	0.8490 Ha	-	Environmental Screening	396,315,631	41.76
18	Construction of flood gate with culvert near Thalangama Tank and Construction of culvert at Bauddhaloka Mawatha SLLRDC/PMU/W/01	NCB Single Stage One Envelope	LKR 247,839,320	C	-	-	Environmental Management Action Plan	26,087,591	-
Component 1.2 Micro-drainage Systems with CMC									
19	Improvements to storm water drains in catchment 2 & 3 (revised package) of Marine Drive CMC/W/MD/02	NCB Single Stage One Envelope	LKR 233,291,940	C	-	-	Environmental Management Plan	26,891,660	-

20	Improvements to distributed sewerage network around Beira Lake - 08 sub project CMC/W/SD/01	NCB Single Stage One Envelope	LKR 36,475,565	B	-	1	Environmental Screening	4,294,741	-
21	Rehabilitation of Gregory's canal CMC/W/MD/03	NCB Single Stage One Envelope	LKR 267,711,760	C	-	-	Environmental Screening	31,646,770	-
22	Improvements to Norris Canal CMC/W/MD/04-B	NCB Single Stage One Envelope	LKR 269,445,608	A	0.013 Ha 2 lots		Environmental Screening	31,185,283	-
23	Improvement to Kinsey Road Drain CMC/W/MD/12	NCB Single Stage One Envelope	LKR 116,649,159	C	-	-	Environmental Management Plan	16,027,241	-
24	Improvement to drain at Devi Balika Junction CMC/W/MD/13	NCB Single Stage One Envelope	LKR 345,790,786	B	-	12	Environmental Screening	44,220,202	44.0
Component 1.3 Capacity enhancement for flood and drainage management									
25	Installation of Flushing Gates for water quality improvement SLLRDC/W/20	NCB Single Stage One Envelope	LKR 600,181,956	C	-	-	Environmental Screening	59,214,979	-

Component 1.4 Beira Lake Linear Park and Beddagana Park									
26	Development of Beddagana Bio - Diversity Park UDA/W/01-A	NCB Single Stage One Envelope	LKR 166,178,562	C	-	-	Environmental Screening	19,050,450	-
27	Development of Bio - Diversity Park at Kotte Rampart UDA/W/01-B	NCB Single Stage One Envelope	LKR 407,728,958	C	-	-	Environmental Screening	43,001,193	-
28	Development of McCallum Entrance Park at D.R. Wijewardhana Mw UDA/W/02	NCB Single Stage One Envelope	LKR 76,282,804	C	-	-	Environmental Screening	8,816,482	-
29	Construction of bank protection works of Eastern bank of East Beira Lake - 1.2km UDA/W/03-A	NCB Single Stage One Envelope	LKR 263,006,856	C	-	-	Environmental Screening	31,501,710	-
30	Construction of bank protection works of Western bank of West Beira Lake – 1.05km UDA/W/03-B	NCB Single Stage One Envelope	LKR 198,893,702	C	-	-	Environmental Screening	23,906,786	-
31	Construction of bank protection works of Eastern bank of West Beira Lake – 1.2km UDA/W/03-C	NCB Single Stage One Envelope	LKR 187,705,685	C	-	-	Environmental Screening	21,908,480	-

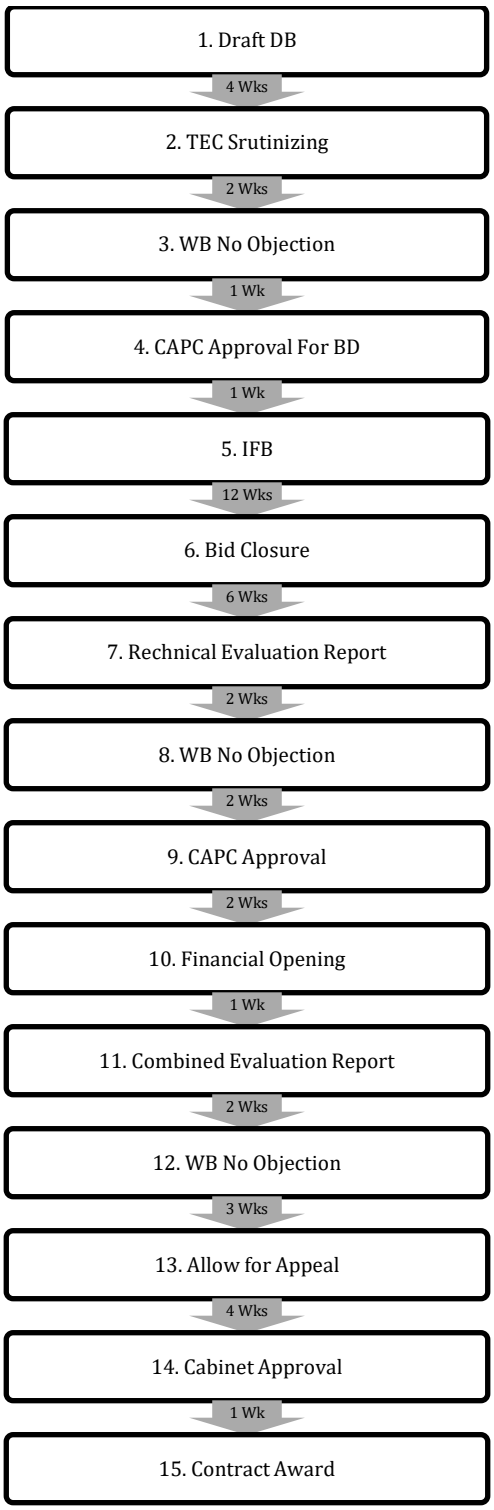
32	Construction of Linear Park along Eastern bank of East Beria Lake Phase – I UDA /W/04-A	NCB Single Stage One Envelope	LKR 139,573,010	C	-	-	Environmental Screening	17,840,990	-
33	Construction of Linear Park along Eastern bank of East Beria Lake Phase – II UDA /W/04-D	NCB Single Stage One Envelope	LKR 216,784,489	C	-	-	Environmental Screening	26,928,017	-
34	Construction of Linear Park along Western bank of West Beria Lake – Phase – III UDA /W/04-C	NCB Single Stage One Envelope	LKR 120,387,392	C	-	-	Environmental Screening	15,145,962	-
35	Construction of Cycle Track and Jogging Trail at Nippon Mawatha – Kotte UDA/W/01-C	NCB Single Stage One Envelope	LKR 90,272,862	C	-	-	Environmental Management Plan	10,23,70	-

Component 2: Investment support to local authorities									
Component 2.1 Investment support to local authorities									
36	Improvement to public convenience (Package - I) CMC/W/01	NCB Single Stage One Envelope	LKR 49,269,371	C	-	-	Environmental Management Plan	5,912,324	-
37	Walkability improvement and Asphalt Overlaying (Package - I) CMC/W/02	NCB Single Stage One Envelope	LKR 178,139,137	C	-	-	Environmental Management Plan	21,112,164	-
38	Improvement to public convenience (Package - II) CMC/W/03	NCB Single Stage One Envelope	LKR 40,756,625	C	-	-	Environmental Management Plan	4,868,474	-
39	Walkability improvement and Asphalt Overlaying (Package - II) CMC/W/04	NCB Single Stage One Envelope	LKR 178,399,713	C	-	-	Environmental Management Plan	21,287,350	-
40	Model zone development in town hall square - package – II CMC/W/06	NCB Single Stage One Envelope	LKR 282,420,917	C	-	-	Environmental Management Plan	33,519,505	-
41	Model zone development in town hall square – package – III CMC/W/07	NCB Single Stage One Envelope	LKR 254,815,391	C	-	-	Environmental Management Plan	30,556,719	-
42	Walkability improvement and Asphalt overlaying package – III CMC/W/08	NCB Single Stage One Envelope	LKR 224,323,678	C	-	-	Environmental Management Plan	26,634,127	-

43	Model zone development in town hall square- Package -I CMC/W/09	NCB Single Stage One Envelope	LKR 77,233,718	C	-	-	Environmental Management Plan	9,183,278	-
44	Rehabilitation of Galle Road and R.A. De Mel Mawatha Package – A CMC/W/12-A	NCB Single Stage One Envelope	LKR 960,425,403	C	-	-	Environmental Screening	118,148,131	-
45	Rehabilitation of Galle Road and R.A. De Mel Mawatha Package – B CMC/W/12-B	NCB Single Stage One Envelope	LKR 1,119,189,130	C	-	-	Environmental Management Plan	132,833,599	-
46	Rehabilitation of Galle Road and R.A. 4De Mel Mawatha (Package – C) CMC/W/12-C	NCB Single Stage One Envelope	LKR 1,401,609,086	C	-	-	Environmental Screening	163,440,109	-
47	Construction of Beach parks at Crow Island CMC/W/ 13-A	NCB Single Stage One Envelope	LKR 266,667,990	C	-	-	Environmental Screening	33,146,220	-
48	Improvement to public convenience (Package – III) CMC/W/03-A	NCB Single Stage One Envelope	LKR 52,265,118	C	-	-	Environmental Management Plan	6,072,057	-
49	Infrastructure development in SJKMC (Package - I) SJKMC/W/01	NCB Single Stage One Envelope	LKR 304,162,027	C	-	-	Environmental Screening	36,401,520	-
50	Infrastructure development in SJKMC (Package - II) SJKMC/W/02	NCB Single Stage One Envelope	LKR 283,533,568	C	-	-	Environmental Screening	31,488,157	-
51	Infrastructure development in SJKMC (Package - III) SJKMC/W/03	NCB Single Stage One Envelope	LKR 65,765,032	C	-	-	Environmental Management Plan	7,726,595	-

52	Infrastructure development in DMMC (Package - I) DMMC/W/01	NCB Single Stage One Envelope	LKR 209,094,444	C	-	-	Environmental Screening	25,029,759	-
53	Infrastructure development in DMMC (Package - II) DMMC/W/02	NCB Single Stage One Envelope	LKR 115,495,788	C	-	-	Environmental Screening	13,825,051	-
54	Infrastructure development in DMMC (Package - III) DMMC/W/03	NCB Single Stage One Envelope	LKR 63,749,712	C	-	-	Environmental Screening	7,632,815	-
55	Infrastructure development in KUC (Package – I) KUC/W/1	NCB Single Stage One Envelope	LKR 178,054,163	C	-	-	Environmental Screening	26,034,773	-

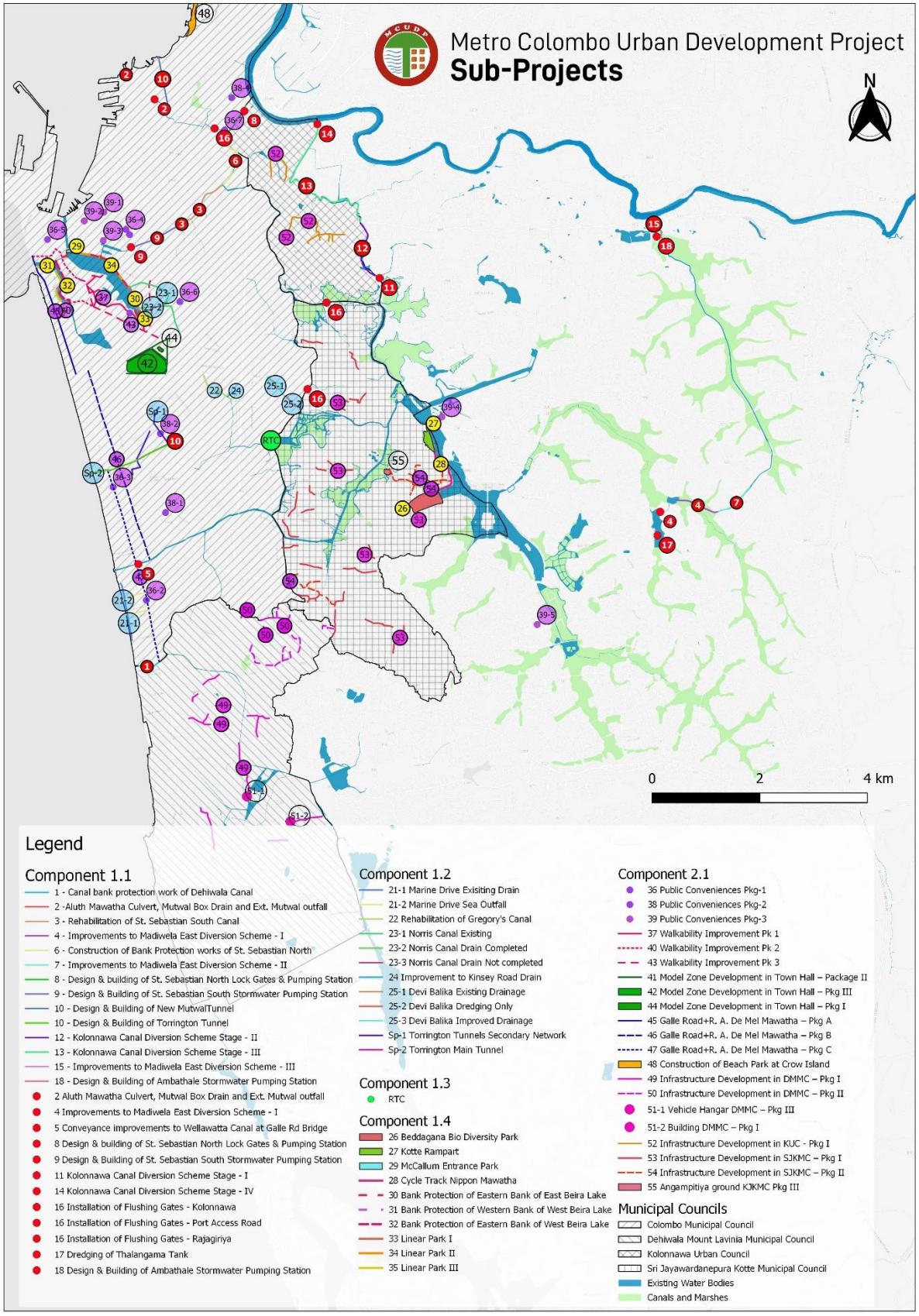
Annex 6: Procurement Process of Cabinet Level Procurements



Approximate Total Time Required = 43 Wks

Figure A. 6.1 CAPC Level Procurement (Single Stage 2 Envelope)

Annex 7: Overview of MCUDP Sub Projects



Annex 8: Photos

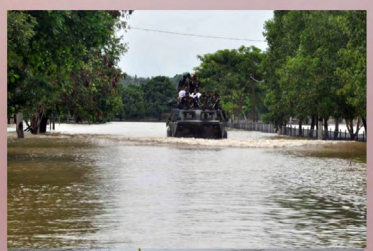
Metro Colombo Urban Development Project

Component 1: Flood and Drainage Management

2010 FLOODING EVENT

Thalangama Tank Spilling

Roads were Flooded



Parlimentarians used Armed cars to go to Parliment

NORTH LOCK PUMPING STATION

Before the Project

NORTH LOCK PUMPING STATION

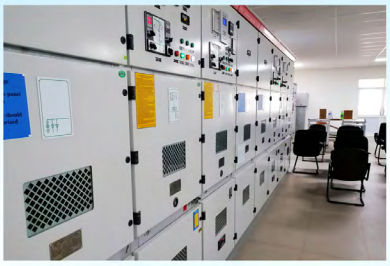
After the Project

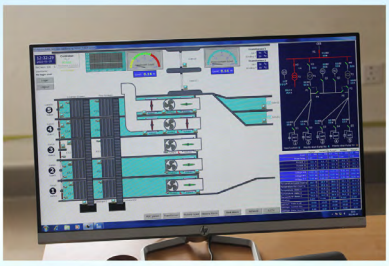
Pumping Capacity = $30m^3/s$

Reverse Pumping Capacity = $12m^3/s$

Pumping out stormwater to Kelani river.

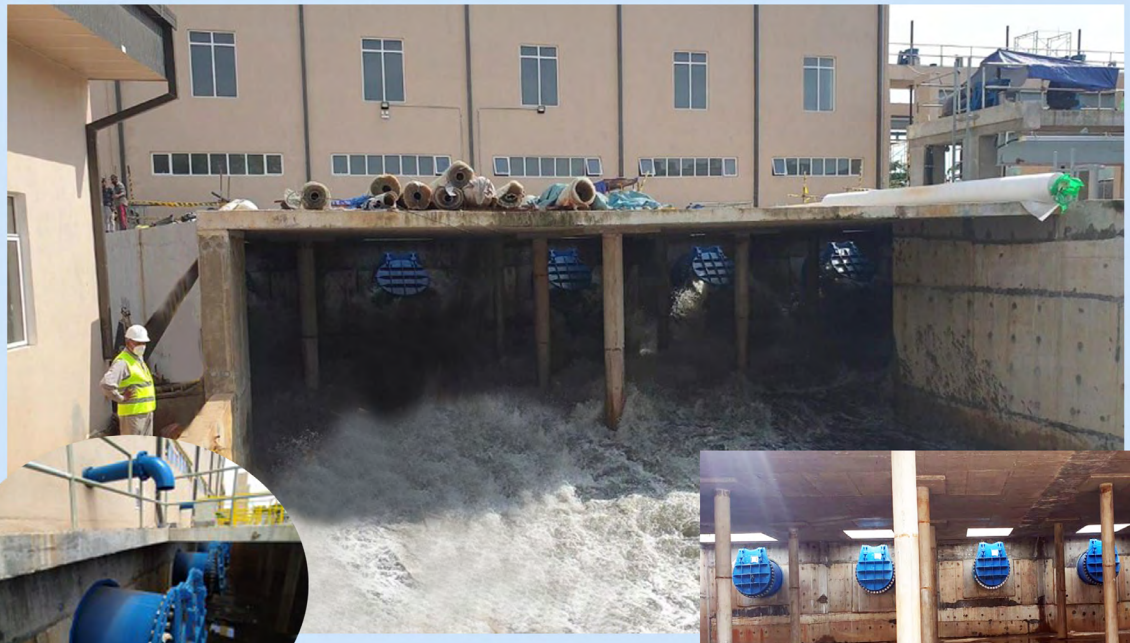
NORTH LOCK PUMPING STATION





NORTH LOCK PUMPING STATION

View from Downstream



NORTH LOCK PUMPING STATION

NORTH LOCK PUMPING STATION

Old Gate Structure (Before the Project)

New Gate Structure (After the Project)

AMBATHALE PUMPING STATION

Before the Project

AMBATHALE PUMPING STATION

Pumping Capacity = 20m^3/s

Pumping out stormwater to Kelani river.

AMBATHALE PUMPING STATION

AMBATHALE PUMPING STATION

Downstream at Ambathale Pumping Station

AMBATHALE PUMPING STATION

DEAD END OF ST. SEBASTIAN SOUTH CANAL BEFORE CONSTRUCTION OF THE PUMPING STATION

STORMWATER PUMPING STATIONS

South Pumping Station at Maradana

Pumping Capacity = 10m³/s

Pumping out stormwater to Beria lake.

CANAL BANK PROTECTION WORKS OF ST.SEBASTIAN SOUTH CANAL

After the Project

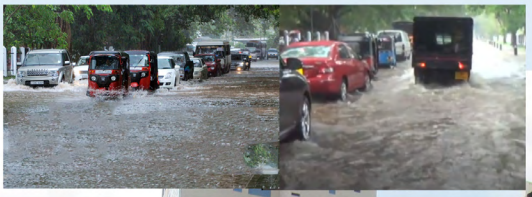
- Canal widening, streamlining and protecting banks
- Cleaning the reservation and construction of operations and maintenance road


NEW MUTWAL TUNNEL
DL432
ZTE3730


NEW MUTWAL TUNNEL

TORRINGTON TUNNEL

Previous condition



Torrington main Tunnel

TORRINGTON TUNNEL

INSTALLATION OF FLUSHING GATES

After the Project

o Yakbedda bridge

o Infront of SLLDC

o New Ingurukade junction

3 Nos. of regulatory gates within the Northern section of canal system to complement water quality improvement.

IMPROVEMENTS TO MADIWELA EAST DIVERSION

Before the Project

Near The Bridge

Old Irrigation Structure

NWS&DB Water Mains

IMPROVEMENTS TO MADIWELA EAST DIVERSION

After the Project

Canal streamlining and bank protection in deep sections with construction of operations and maintenance road from Thalangama tank and Ambatale pumping station.

IMPROVEMENTS TO EXISTING DRAINAGE STRUCTURES

Before

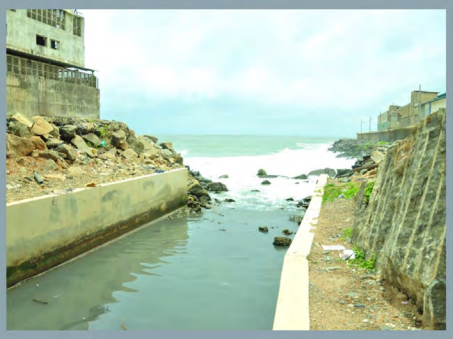
After

Aluth Mawatha Culvert

Before

Existing Mutwal Outfall

After



KOLONNAWA CANAL DIVERSION SCHEME

Before the Project

Old structure near CPC

KOLONNAWA CANAL DIVERSION SCHEME

After the Project

New CPC structure

Flood gate structure at Kittampahuwa canal connection to Kelani River

KOLONNAWA CANAL DIVERSION SCHEME

After the Project

Flood gate structure at Kittampahuwa canal connection to Kelani River

KOLONNAWA CANAL DIVERSION SCHEME

DREDGING OF THALANGAMA TANK

Capacity enhancement of Thalangama tank which is mainly a triple purpose tank.

Functions: Supply water for irrigation, act as a stormwater retention tank and declared as environmentally sensitive area.

After the Project

FLOOD GATE NEAR THALANGAMA TANK

After the Project

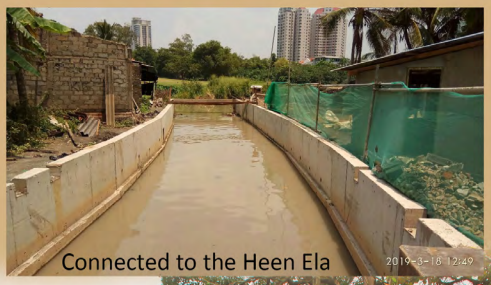
IMPROVEMENTS TO DRAIN AT DEVI BALIKA JUNCTION

Before the Project

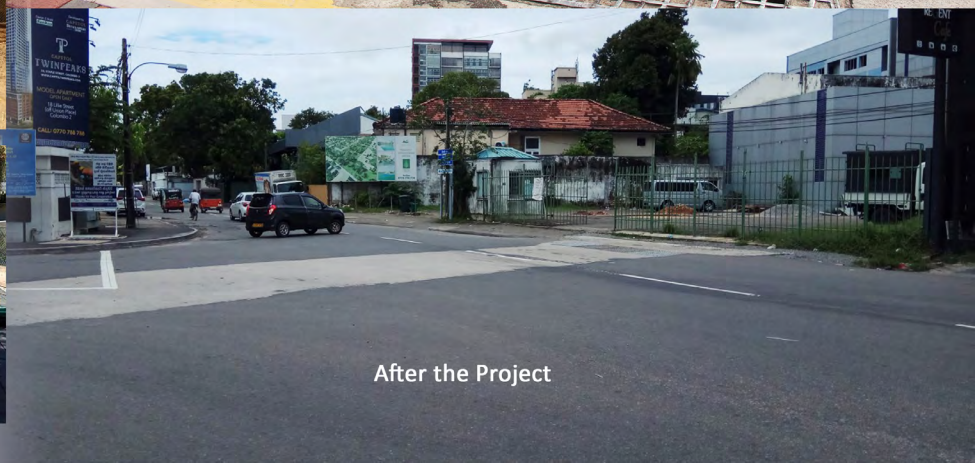
During Construction

IMPROVEMENTS TO DRAIN AT DEVI BALIKA JUNCTION

After the Project



IMPROVEMENTS TO KINSEY ROAD DRAINAGE

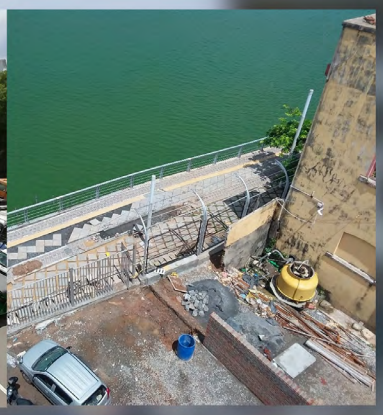


After the Project

IMPROVEMENTS TO NORRIS CANAL

Before the Project

After the Project



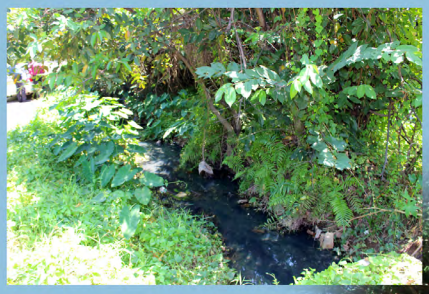
COLOMBO CATCHMENT IS BLESSED WITH BEAUTIFUL MARSHES

Wetland Management Strategy was developed under the project through a special grant and Colombo city was awarded the first **RAMSAR** wetland city in world

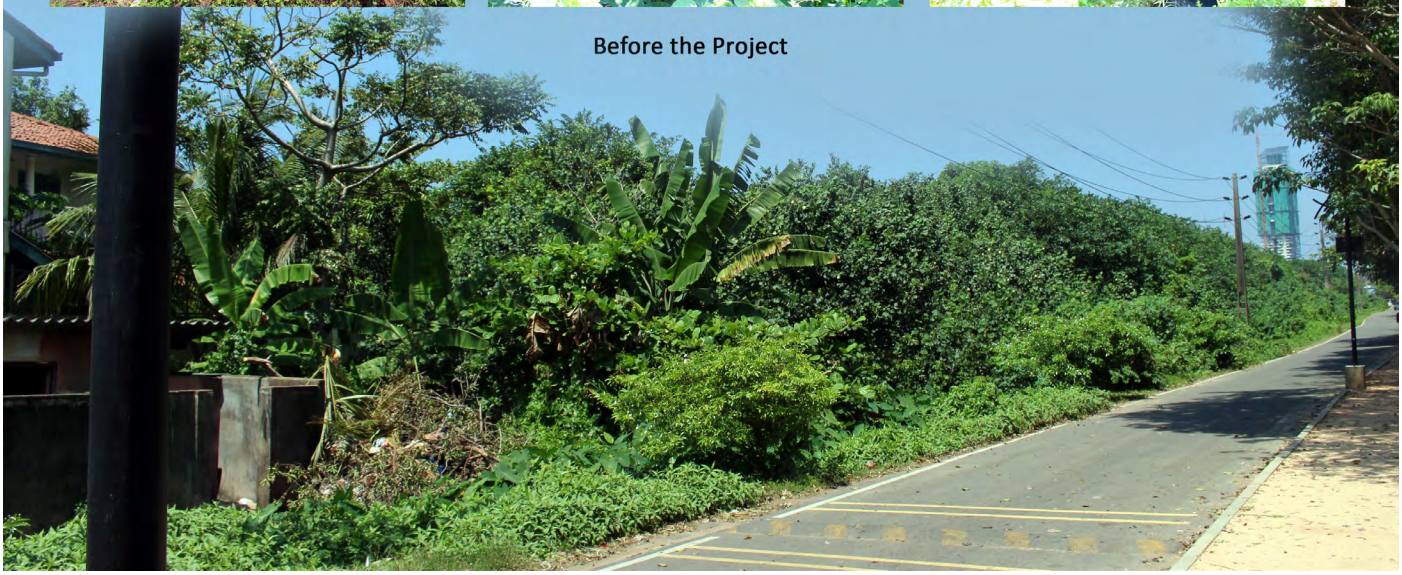
BEDDAGANA BIO-DIVERSITY PARK

After the Project

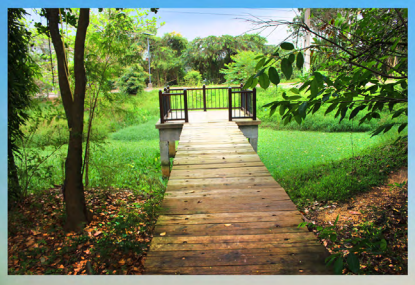
BIO-DIVERSITY PARK AT KOTTE RAMPART



Before the Project



WETLAND PARK AT KOTTE RAMPART



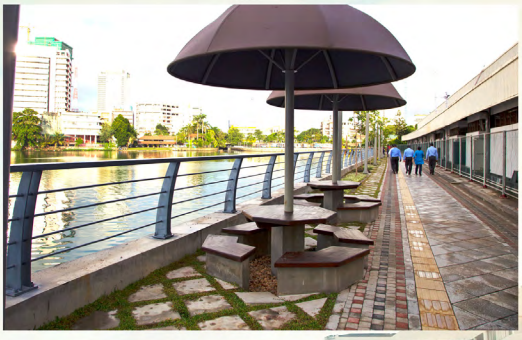
After the Project

BEIRA LAKE BEFORE THE IMPROVEMENTS

Before the Project

WATER FRONT DEVELOPMENT - BEIRA LINEAR PARKS

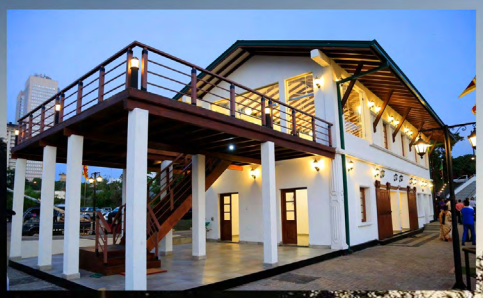
After the Project



Clearing reservations, protection banks and constructing linear parks – 3.4 km in Beira Lake.

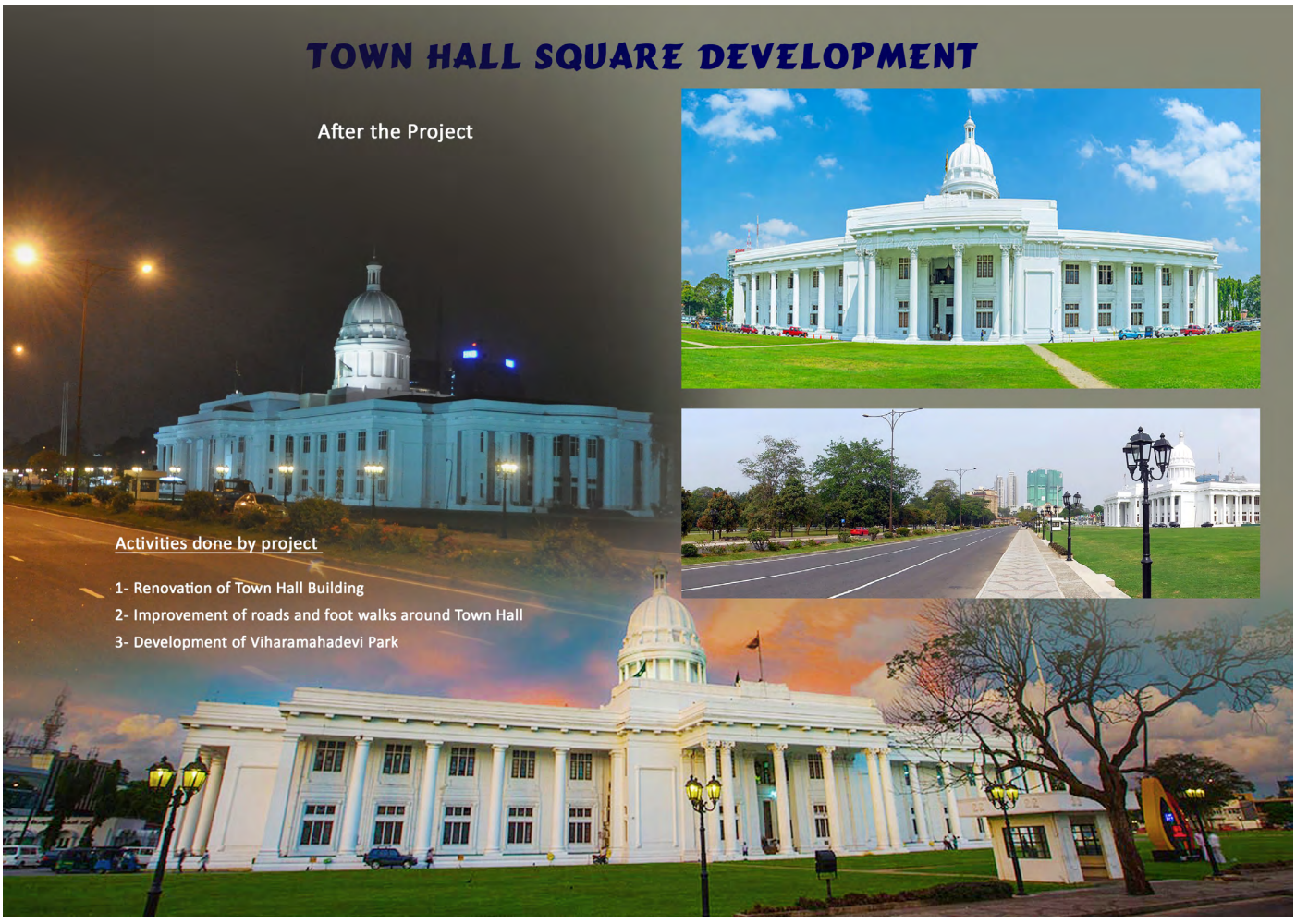
MCCALLUM ENTRANCE PARK

After the Project



Metro Colombo Urban Development Project

Component 2: Infrastructure Development



VIHARAMAHADEVI PARK DEVELOPMENT

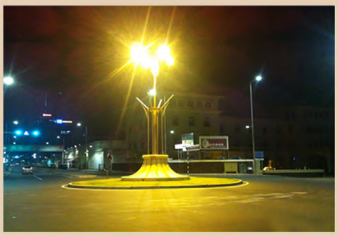
Before the Project

After the Project

VIHARAMAHADEVI PARK

REHABILITATION OF GALLE ROAD

After the Project



REHABILITATION OF GALLE ROAD

Contract A:
Galle Road from Galle Face (Galadari) roundabout to Kollupitiya Jct.
Approx. 2.3 km

JUNCTIONS

Before the Project

After the Project

Slave Island Junction

Works Included

Laying of water pipes
Laying of storm water pipes
Laying of power cables
Common utility ducts
Landscaping
Street lamps
Asphalting

JUNCTIONS

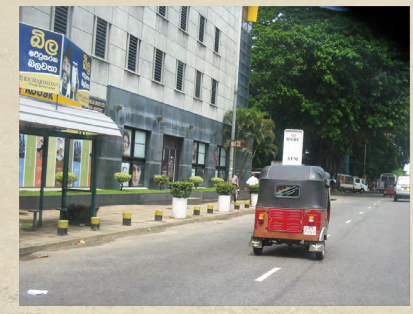
After the Project

Lake House Roundabout

Ceramic Junction

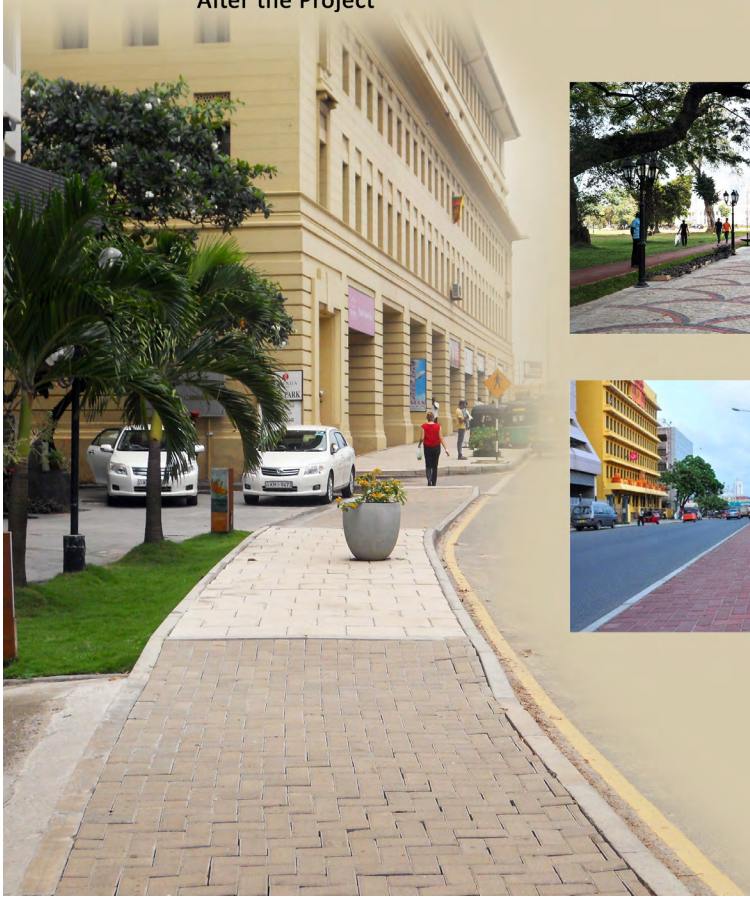
WALKABILITY IMPROVEMENTS

Before the Project



WALKABILITY IMPROVEMENTS

After the Project



Activities done by project

Laying of water pipes	Landscaping
Laying of power cables	Street lamps
New walkways	Asphalting
Common ducts for future utility expansions	

PUBLIC CONVENIENCES

Before the Project

Bambalapitiya

Bastiyan Mw

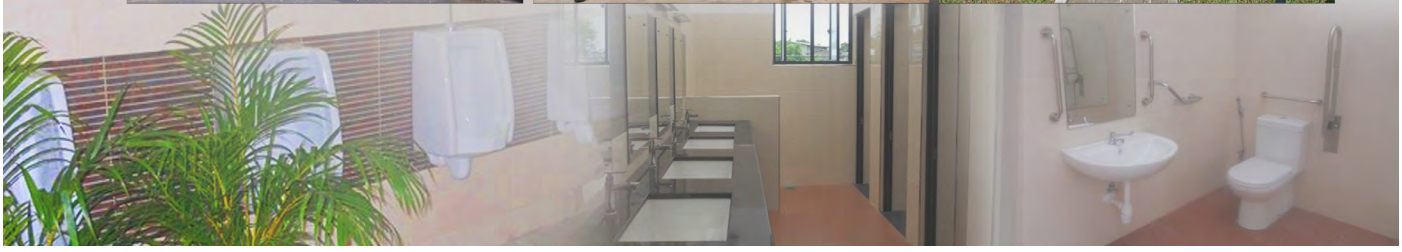
Wellawaththa

After the Project

Bambalapitiya

Bastiyan Mw

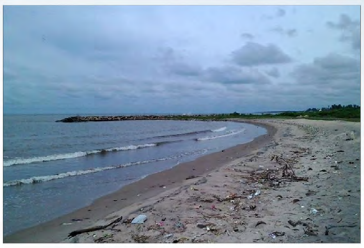
Wellawaththa



CROW ISLAND BEACH PARK








Before the Project

CROW ISLAND BEACH PARK


After the Project


ANGAMPITIYA PLAYGROUND

Before the Project

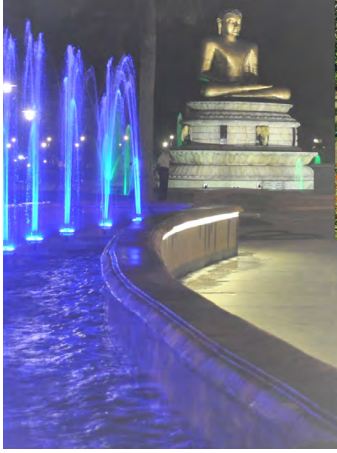
ANGAMPITIYA PLAYGROUND - SRI JAYAWARDENEPURA KOTTE

After the Project

VIHARAMAHADEVI PARK DEVELOPMENT

Before the Project

After the Project



VIHARAMAHADEVI PARK

PROJECT COMPLETION REPORT

Metro Colombo Urban Development Project

Democratic Socialist Republic of Sri Lanka
Ministry of Urban Development and Housing

Funded by:

THE WORLD BANK
IBRD - 8145 LK