6.6.2 The Study of Storm Water Drainage Plan

6.6.2.1 Comparison of priority issues (KaluOya and Mudun Ela sub-basin)

(1) Kalu Oya Improvement

Kalu Oya is one of the tributaries of Kelani Ganga and is greatly affected by the backwater. Therefore, the backwater is one of the factors for the inundation near the confluence. The type of confluence is examined by comparing the backwater dike and the normal dike with a pumping station.

According to CRIP, the design scale of the entire Kelani Ganga basin is a 100-year return period. And, the design scale of the downstream section (about 35 km from the river mouth) is set to a 50-year return period based on the precondition which is upstream flood control dams. The overall project schedule is unknown, but at this point (as of 2020), F/S and D/D phase for river improvement has started. Considering this progress, it is appropriate that the boundary condition of the water level for Kalu Oya is based on the Kelani Ganga 50-year return period water level.

However, considering the current situation where the overall project implementation schedule of CRIP has not been decided, it is rational to improve the Kalu Oya confluence in line with the progress of the Kelani Ganga embankment project without any rework. In this section, it will be examined whether it is appropriate to construct a backwater dike based on the Kelani Ganga water level of the 50-year return period.

1) Backwater dike

When the Kelani Ganga embankment is completed, the calculated water level of Kalu Oya will be as shown in Case 1 in Figure 6.6.16. In this case, the backwater affects more than 10 km upstream. Not only the section about 5 km downstream of the expressway where river improvement is expected, but also the area upstream of the expressway where the natural water flow effect is expected will be greatly affected, and the risk of inundation of surrounding houses will increase.

2) Gate structure and Pumping station

If the gate structure and pumping station are installed at the mouth of Kalu Oya, it is possible to set the embankment height low because it is not affected by the backwater of Kelani Ganga, but there is no suitable site for the regulating reservoir, so the pumping capacity is about the same as the discharge. The efficiency of the facility is extremely low. For that reason, it was rejected in the examination of both JICA 2003 M/P and 2018 F/S.

The pumping station and gate structure are effectively operated by the combination of the effects of "(1) Discharge reduction effect by the Old Dutch Canal floodway" and "(2) Effect of the regulating pond by the river channel storage of Kalu Oya and Old Dutch Canal". Therefore, the Gate structure and Pumping station were proposed in this study. The calculated water level in this case is as shown in Case 2 in Figure 6.6.16.

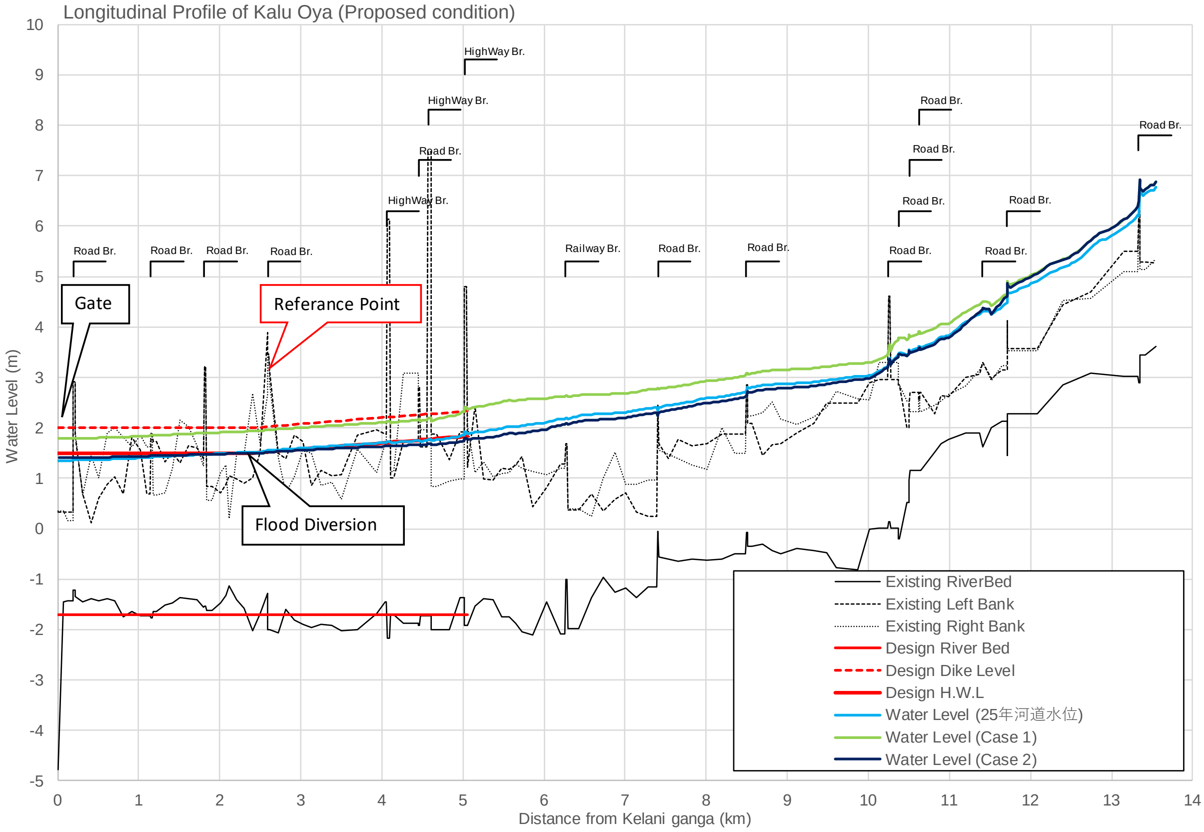
3) Comparison between Backwater dike and Pumping station

A comparison table of the backwater dike and the pumping station and gate structure plan is shown below. In the case of the backwater dike, the risk of flooding due to embankment increases, and the risk of inundation of houses around the upstream natural retarding area increases, so additional inundation measures are required. As a result, the pumping station and gate structure plan were selected. At a slight cost disadvantage, this pump gate project will take place within the Kelani Ganga river improvement project, as stated in the CRIP report. In that case, it is extremely cost-effective.

Table 6.6.11 Comparison of alternative

Comparison Item	Backwater dike	Pump and gate
Construction cost	10,390 million LKR	11,564 million LKR
Land cost	4,321 million LKR	3,313 million LKR
Dike break risk due to embankment	Large	Small
Impact on inundation level in natural retarding area	Large	Small
Impact on other tributary measures	Large	Small

Source: JICA Study team



Source: JICA Study team

Figure 6.6.16 Longitudinal Profile of Kalu Oya

(2) Flood diversion channel to Old Dutch Canal

A method of widening the existing waterway in the downstream part was proposed in comparison with the route crossing the main road in the underground tunnel proposed by JICA 2003 M/P and 2018 F/S. The route of the flood bypass plan is shown in the following figure.

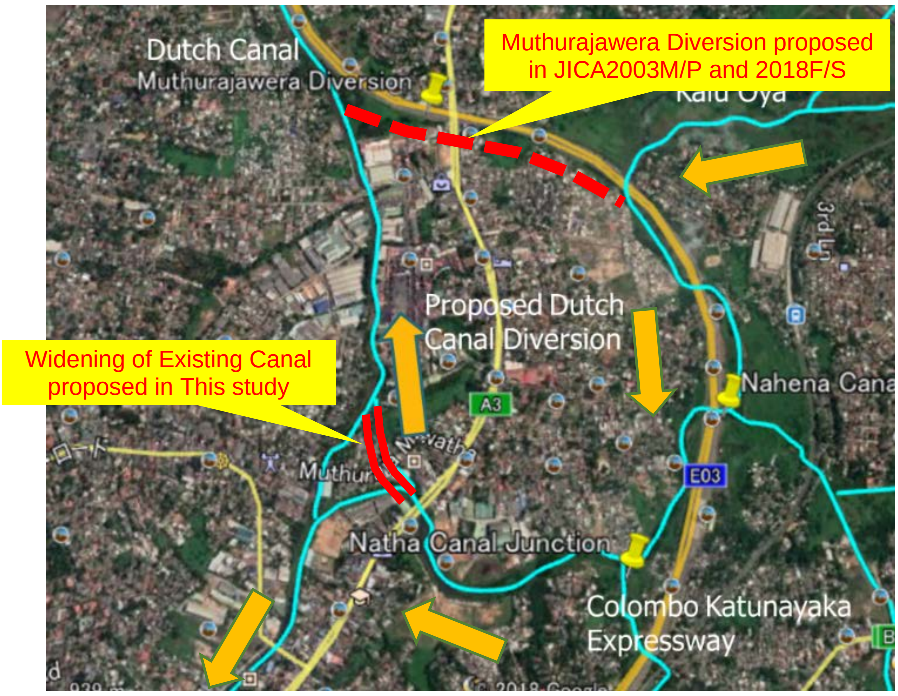


Figure 6.6.17 Route of Old Dutch Canal Diversion

For the diversion channel to the Old Dutch Canal, it is proposed to improve the existing open channel with a natural diversion method. It is more effective than the Muthurajawera diversion plan and has an advantage in terms of cost-benefit. Since the hydraulic function of the Muthurajawera diversion plan in 2018 F/S in the 10-year return period flood is unclear, the hydraulic control effect by diversion was examined using the simulation results of the 25-year return period flood. The results are shown in the following table. As shown in the table, the hydraulic effect is almost the same as that of the diversion plan in which a tunnel is excavated under the existing trunk road proposed in the previous study.
The method of diversion to the Old Dutch Canal by excavation and widening an existing waterway with an extension of about 400 m is superior in terms of construction cost, construction method, construction period, and environmental and social impact.

Table 6.6.12 Comparison of Discharge to Old Dutch Canal

Diversion Route	Peak Discharge (m^3/s)			Remarks
	Before Diverting	Diverting Q	Rivermouth	
Muthurajawera Diversion	103	52	107	25-year Flood
Widening of Existing Canal	116	45	75	25-year Flood

Table 6.6.13 Comparison of each Parameter

Alternative Diversion Route / Comparative Parameters	Muthurajawela Diversion	Old Dutch Canal Diversion
Approx. Construction Cost	943 million LKR	240 million LKR
Major Construction Works	Tunnel excavation & Channel widening	Channel widening
Approx. Construction Period	8 months	3 months
Socio-environmental Issues	Many houses are to be relocated.	Several houses are to be relocated.

(3) Improvement of Peliyagoda Pumping station

In the Mudun Ela sub-basin, an Oliyamulla pumping station with a drainage capacity of 35 m3 / s on the north side is under construction, and the primary canal will be renovated to fully exert this effect, and the rainwater drainage capacity of the basin will be improved. However, the Peliyagoda pumping station, which is responsible for draining the secondary canal on the south side, is aging and has a drainage capacity of 0.5 m3/s, so it is necessary to improve this drainage capacity. However, the area is densely populated, and it is difficult to expand the existing pumping station. Furthermore, since there is no site for a regulating pond at the pumping station, it is conceivable to adjust the flow rate in anticipation of the storage effect of the waterways surrounding the area. On the other hand, since there is room for pump installation in the Peliyagoda pumping station, it is possible to upgrade the current pump with its discharge of 0.5 m^3/s and install a new pump with one of 1.0 m^3/s. The following figure shows the effect when the drainage capacity is changed from 0.5 m^3/s to 1.0 m^3/s.

As shown in the figure, as a result of the renovation, the inundation area is reduced for a flood with a 25-year return period, and the inundation area remains only in the wetlands along the canal, and the inundation depth is shallow.

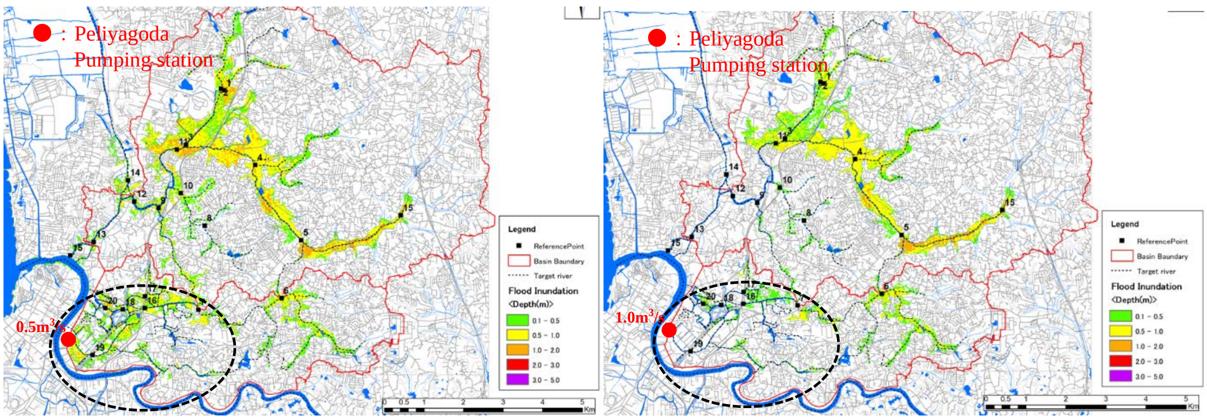


Figure 6.6.18 Comparison Before and After Improvement of Peliyagoda **Pumping Station (10-Year Return Period Left: Without Improvement, Right: With Improvement)**

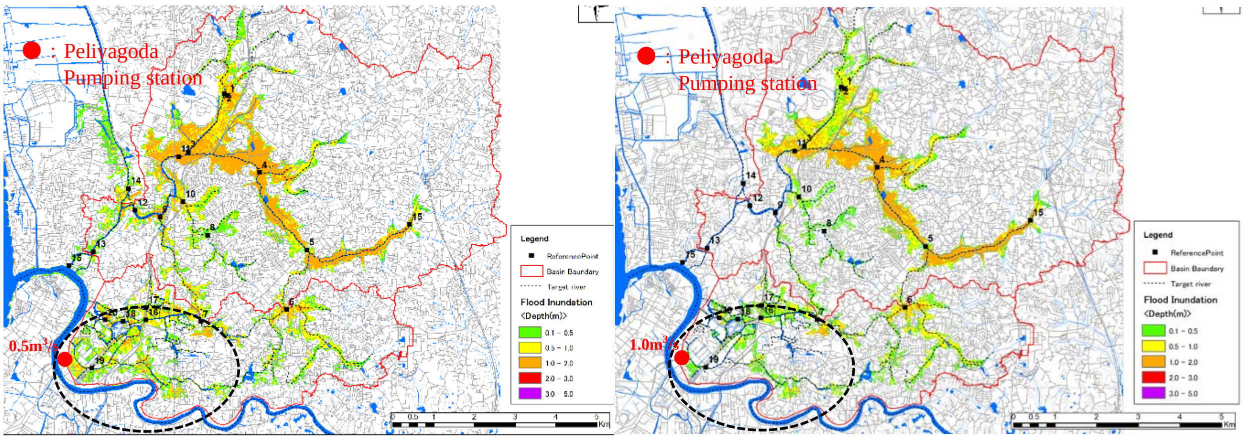


Figure 6.6.19 Comparison Before and after Improvement of Peliyagoda **Pumping Station (25-Year Return Period Left: Without Improvement, Right: With Improvement)**

6.6.2.2 Study on Storm Water Drainage Plan (Bolgoda Basin)

(1) Weras Ganga Improvement (Priority Area (1))

Banking on the right bank of Weras Ganga is proposed as a measure to prevent inundation due to flooding from Weras Ganga in the Moratuwa-Rathmalana area. Since the Weras Ganga basin has already been rehabilitated based on the JICA 2003 M/P and is included in the nature reserve. Therefore, the drastic river rehabilitation by widening the Weras Ganga main river is extremely difficult due to a large social impact. Hence, it is appropriate to protect against flooding by dike construction. Because river structures have already been constructed with the HWL set to 1.5 m at other points on the left bank, the right dike construction plan will be arranged to comply with this.

The long-term plan for the Bolgoda basin is a 50-year return period, but it is extremely difficult to take additional flood countermeasures in the upper stream of Weras Ganga, which has already been improved with a 2 to 10-year return period. Therefore, the future impact of the water level rise due to the impact of the embankment was studied in this study. The combinations of bridge repair and riverbed dredging as additional alternatives were compared and examined according to the following policy.

- Dredging of drift sand accumulated near the estuary is considered. The effect of reducing the water level by dredging is regarded as a prerequisite.
- The possibility of riverbed excavation to enhance the flood communication capacity of the narrowed river channel in the planned embankment section will be examined.
- The effect of reducing the water level by widening the river channel in the narrowed area upstream and downstream of the bridge will be examined.

Table 6.6.14 Comparison of Alternatives in the Weras Ganga Improvement Plan

Case	Embankment of Right side	Improvement of the Bridge (Improvement of narrowed channels)	Dredging	Water level at the target point on 50-yr (25-yr)	Comparison to HWL (1.5m MSL)
1	No	No	No	1.483m (1.344m)	Below HWL
2	Yes	No	No	1.512m (1.364m)	Above HWL
3	Yes	At both upstream and downstream	No	1.476m (1.335m)	Below HWL
4	Yes	No	-2m MSL(Length ofembankment:1.4km)	1.478m (1.331m)	Below HWL

As shown in this result, in order to keep the water level below HWL, two plans, Case 4 upstream and downstream bridge repair and widening, and Case 4 dredging, are appropriate. Although the hypothetical factor is strong, it is impossible to improve the stenosis because the bridge on the upstream side in Case 3 is located in the wildlife sanctuary. Furthermore, since the bridge on the downstream side is not aged, the economic loss associated with the replacement is not small. Therefore, it is judged that the improvement of the narrowed part accompanied by the replacement of the bridge is not realistic. Therefore, only Case 4 dredging can keep the HWL below 1.5 m.

In the 25-year return period, the effect of the water level rise due to embankment (comparison between Case 1 and Case 2) is minor, which is less than HWL (MSL + 1.5 m). Therefore, in this study, the embankment only is proposed in the mid-term plan of the 25-year return period, and the dredging is proposed as a countermeasure for the 50-year return period in the long-term plan.

Figure 6.6.20 Longitudinal Profile of Weras Ganga

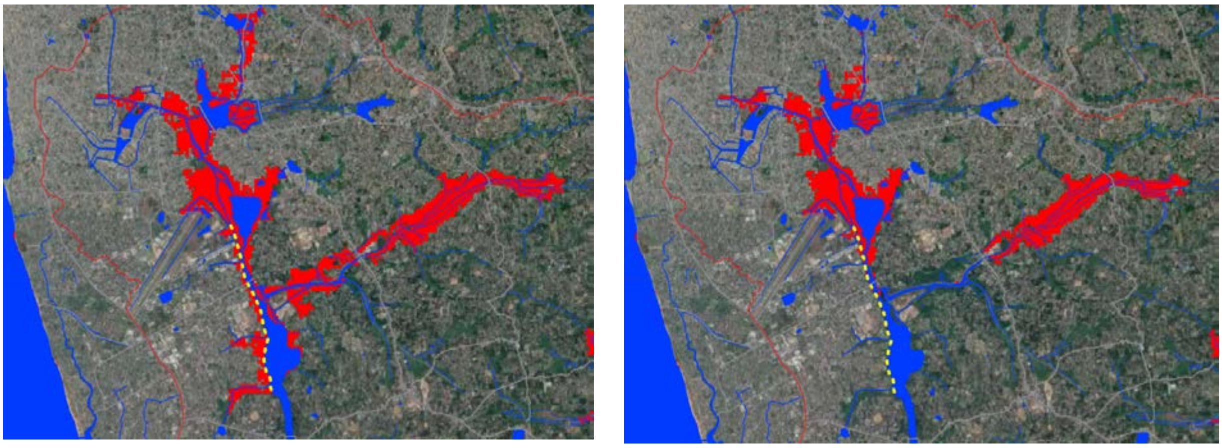


Figure 6.6.21 Comparison between With and Without Countermeasure (Left: Without, Right: With)

(2) Maha Oya Basin (Priority Area (2))

The middle reaches of Maha Oya is a transportation hub where highways intersect with highways and interchanges and will be connected to new highways in the future. Maha Oya's revetment and bridge replacement have been partially carried out along with the construction of the highway that runs north-south, but it does not have a 25-year return on hydraulic safety. It is a low-lying area with farmland and wetlands up to the confluence of Bolgoda Ganga in the lower reaches. It is a natural retarding basin area that is extremely effective for hydraulic control.

Therefore, partial river improvement is proposed to conserve the downstream natural retarding basin area and improve the upstream flow capacity. However, it is not economically effective to install surrounding embankments in the entire area for the conservation of the natural retarding basin area. Therefore, it is proposed to install a continuous embankment on a part of the boundary between the natural retarding basin area and the neighboring urban area.

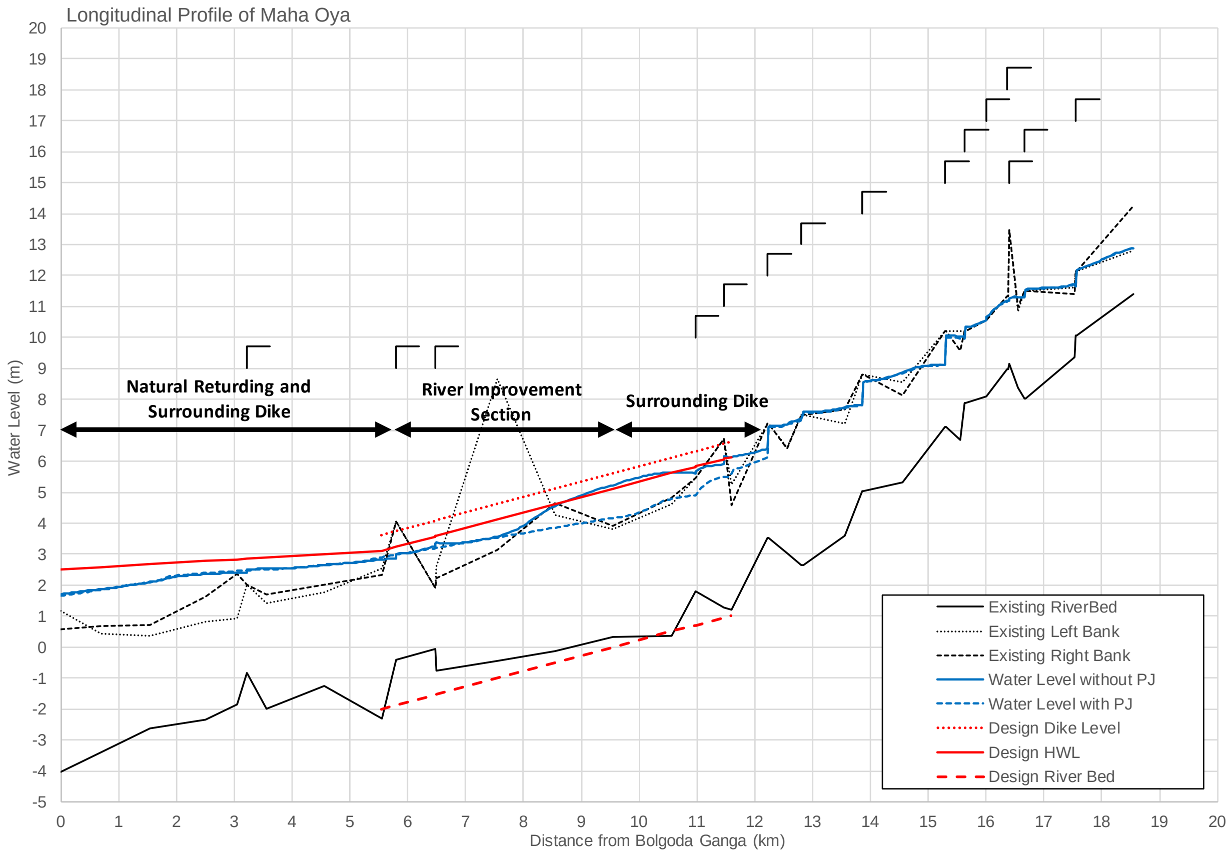


Figure 6.6.22 Longitudinal Profile of Maha Oya

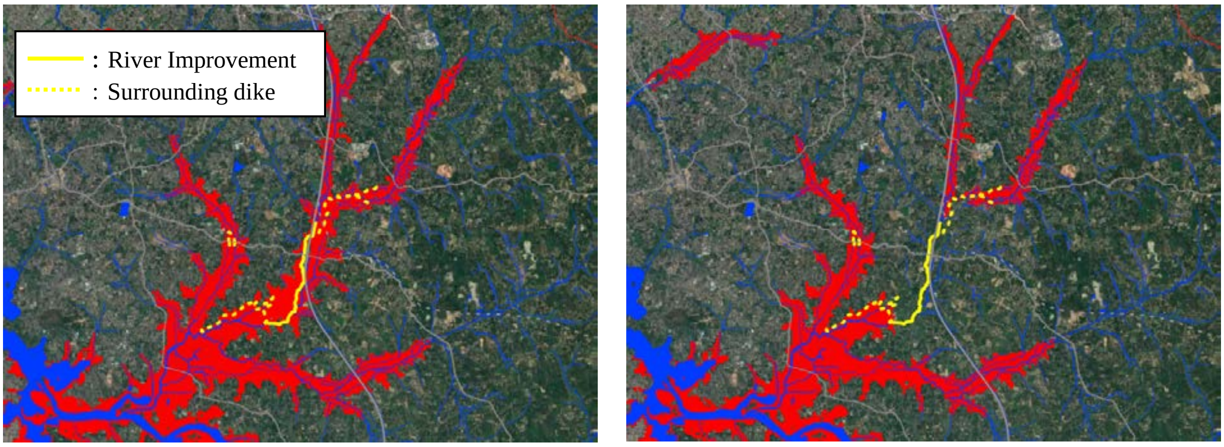


Figure 6.6.23 Comparison between With and Without Countermeasure (Left: Without, Right: With)

(3) Alut Ela Basin (Priority Area (3))

The Alut Ela basin is located at the southernmost tip of the Bolgoda basin, and the number of households in the vicinity is relatively small, so it is not an area where general assets are concentrated. The riverbed gradient is extremely small, and the middle and upper reaches are flooded areas due to the influence of the backwater of South Bolgoda Lake downstream. Since the riverbed gradient is small, widening and embankment are effective for improving the flow capacity.

Therefore, river improvement with discontinuous revetment height and riverbed height between bridges is proposed. Similar to Maha Oya mentioned above, the downstream area is set as a natural retarding basin area because it is an area where farmland and wetlands spread.

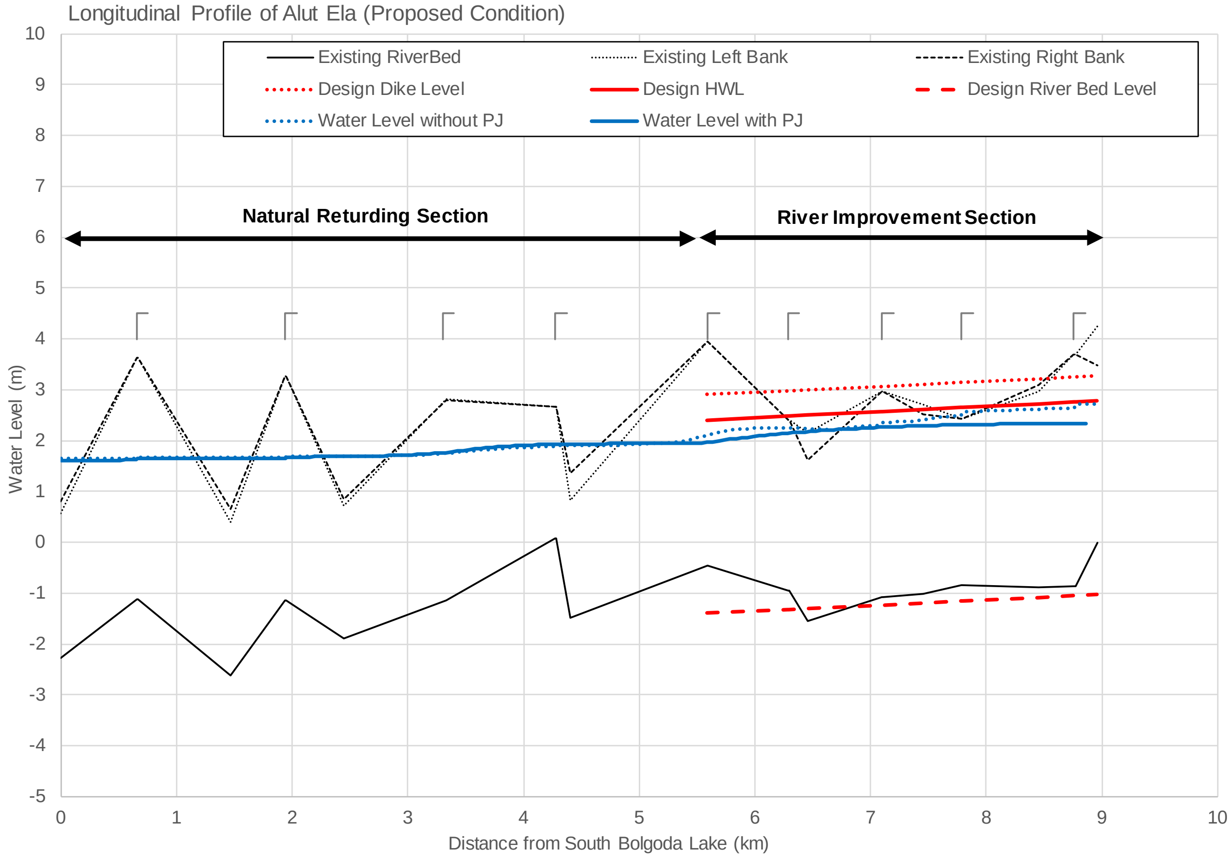


Figure 6.6.24　Longitudinal Profile of Alut Ela

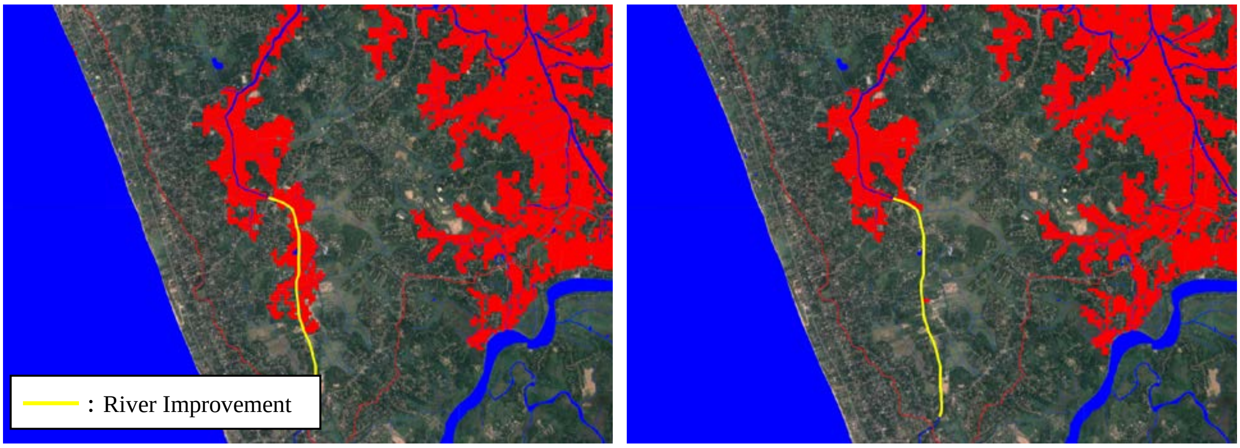


Figure 6.6.25　Comparison between With and Without countermeasure (Left: Without, Right: With)

(4) Panape Ela (Priority Area (3))

The Panape Ela basin is located on the southeastern side of the Bolgoda basin, and the distribution of the number of households in the vicinity is relatively small. The catchment area is divided by the north-south highway, and the flood flow extends to the downstream area through the opening of the embankment. Most of the flooded areas are farmland and wetlands, but partial flooding is expected at the edges of farmland and wetlands and residential areas. Therefore, it is proposed to install a continuous embankment to ensure the natural retarding basin effect in farmland and wetlands and prevent inundation in residential areas.

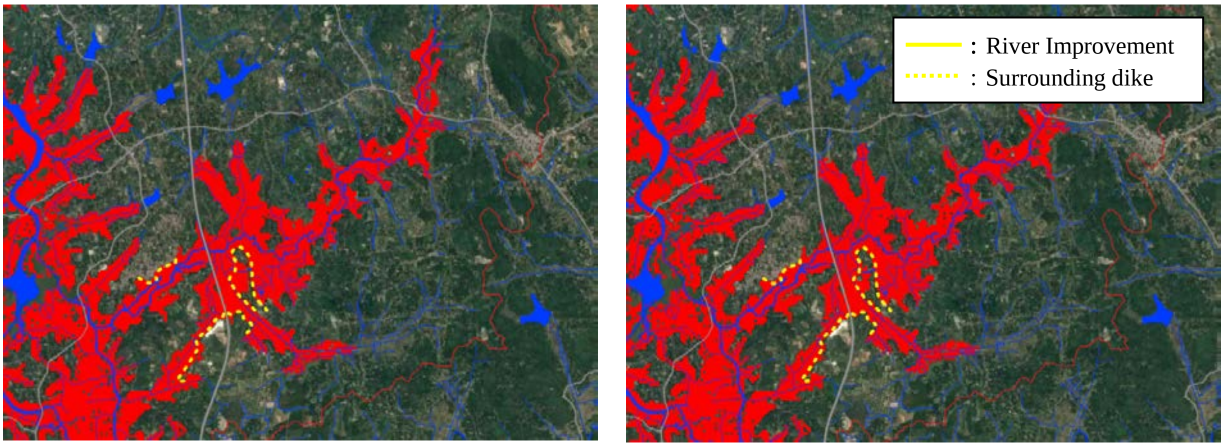


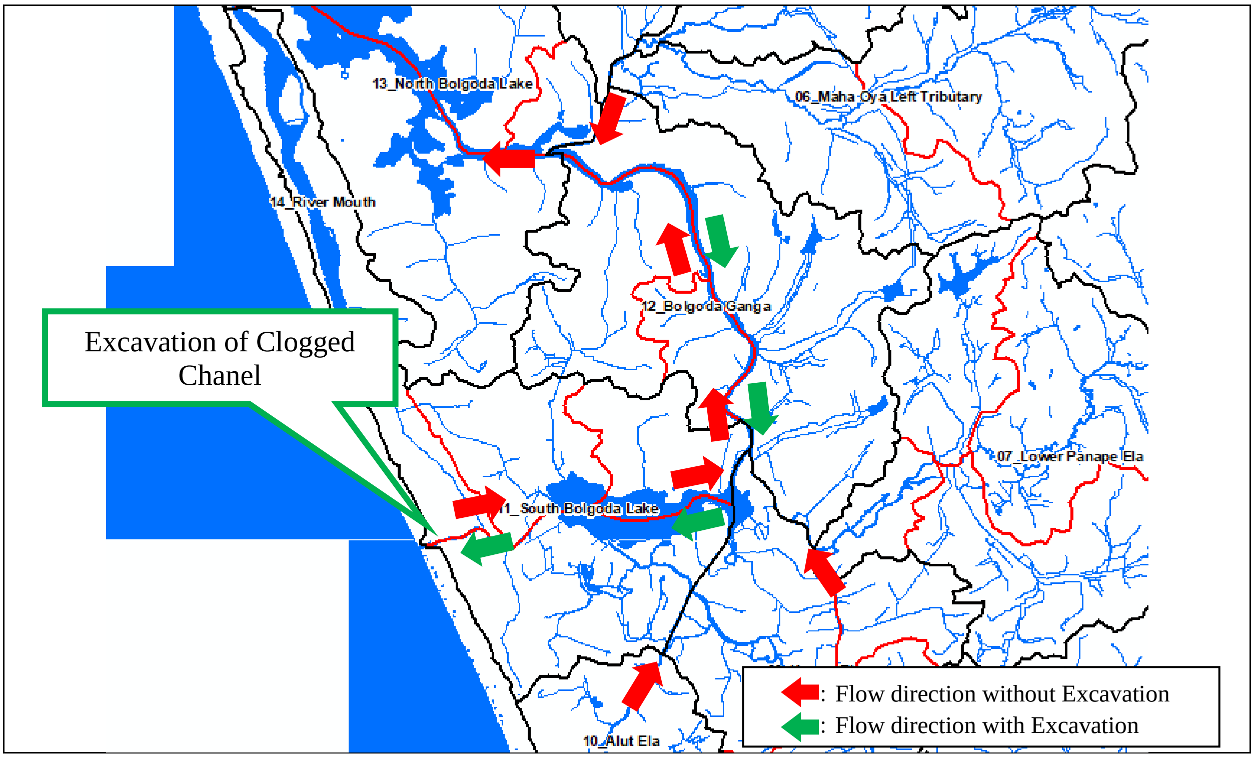
Figure 6.6.26 Comparison between With and Without Countermeasure (Left: Without, Right: With)

(5) South Bolgoda Lake and North Bolgoda Lake (Priority Area (4))

1) Temporary Excavation of the Clogged Channel

The area around South Bolgoda Lake, Bolgoda Ganga and North Bolgoda Lake has been designated as a nature conservation area by the Ministry of the Environment of Sri Lanka. Therefore, it is difficult to implement drastic structural measures that involve environmental changes such as river improvement. Therefore, it is necessary to take measures such as promoting evacuation measures for residents in areas where inundation is expected (maintenance of hazard maps, etc.) and promotion of inundation-resistant building structures related to urban development management. However, as one of the emergency measures, if an extreme rise in lake surface water level and the river water level is expected, some effective measures are required.

As shown in Figure 6.6.27, the current runoff from the southern Bolgoda basin flows into Bolgoda Ganga and outflows into the sea through North Bolgoda Lake. However, in the past, Thalpitiya Ela, located on the west side of South Bolgoda Lake, was directly connected to the sea and had a certain outflow to the sea. However, as of 2020, the channel is completely clogged due to the progress of aging sedimentation from the sea. Temporary excavation of the clogged channel by this sediment will change the flow direction around South Bolgoda Lake and reduce the water level of lakes and rivers.



Source: JICA study team

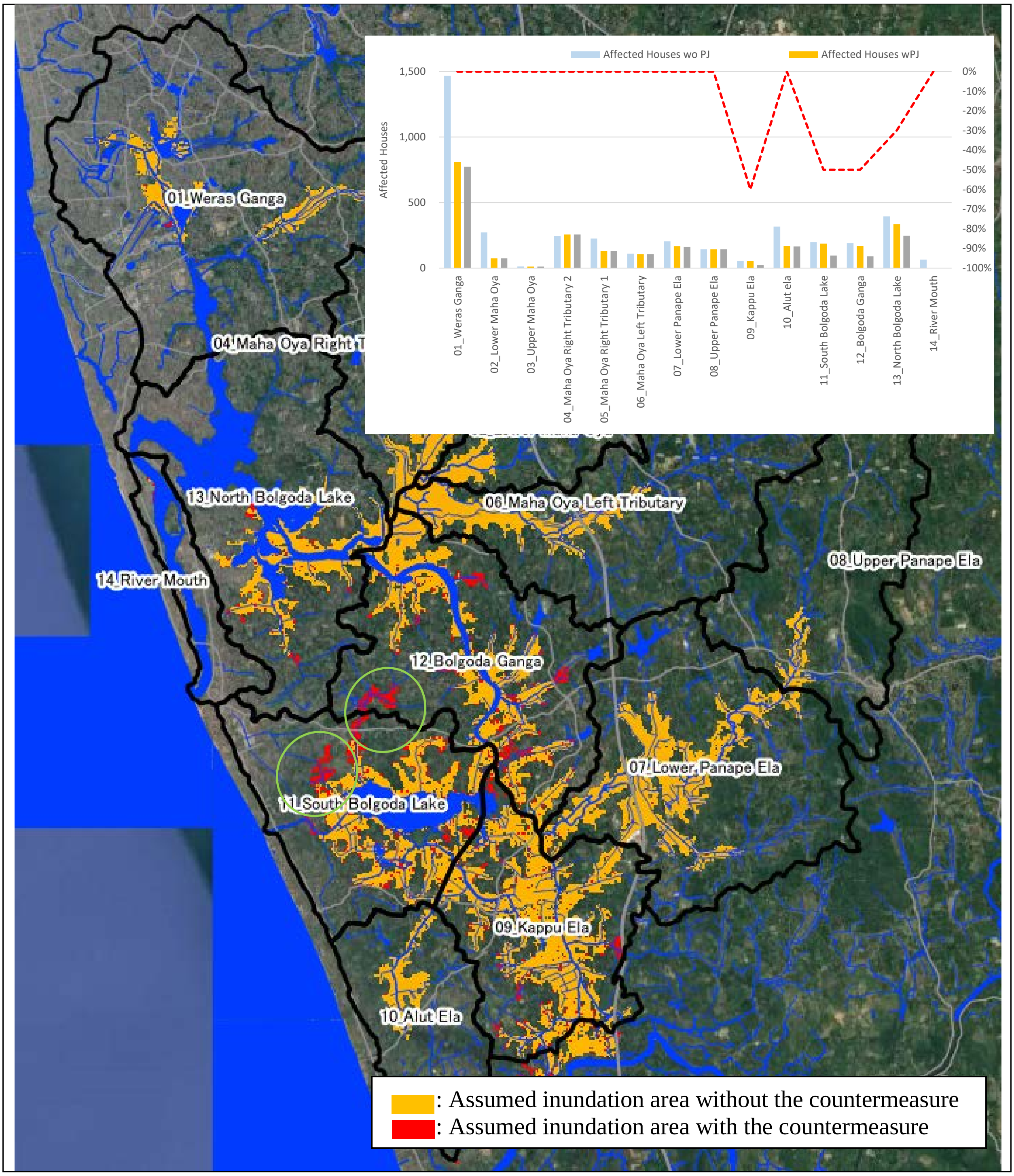
Figure 6.6.27 Flow Direction around South Bolgoda Lake and Location of the Clogged Channel

2) The Effect of Temporary Excavation of the Clogged Channel

However, as mentioned above, it is clear that the progress of sedimentation from the sea area will continue in the future, and it is not realistic to install the tide embankment and conduct river channel maintenance dredging to prevent the river channel from clogging in the medium term. Therefore, this measure is proposed as a temporary emergency measure or a long-term measure.

For reference, Figure 6.6.28 shows the results of a 25-year return period inundation simulation in the case of the Thalpitiya Ela was excavated.

As a result, although the effect of excavation of the clogged channel is limited, there is a certain effect not only in the South Bolgoda Lake, Bolgoda Ganga, and North Bolgoda Lake areas set as priority area (4) but also in other surrounding areas. In particular, the number of affected houses has been reduced by up to 50%.



Source: JICA study team

Figure 6.6.28 The Countermeasure Effect by the Excavation of the Clogged Channel

3) Appropriate Timing of The Excavation

The proposed "excavation of clogged channel" in this study is positioned as an "emergency measure" in the event of flooding. The timing of excavation should be determined by monitoring the water level of the river and South Lake Borgoda, etc., and by understanding the trend of the water level rise. Here, basic indicators (guidelines) for the timing are considered.

Figure 6.6.29 shows the cross-sectional survey line and Figure 6.6.30 shows the elevation distribution in the same area. The water level reference point was set at St.0+000, and the hydraulic simulation was used to verify the Talpitiya Ela water level fluctuation if the excavation was conducted when the water level at this point reached a certain value.

Figure 6.6.29　Location Map of Cross-sectional Survey Line

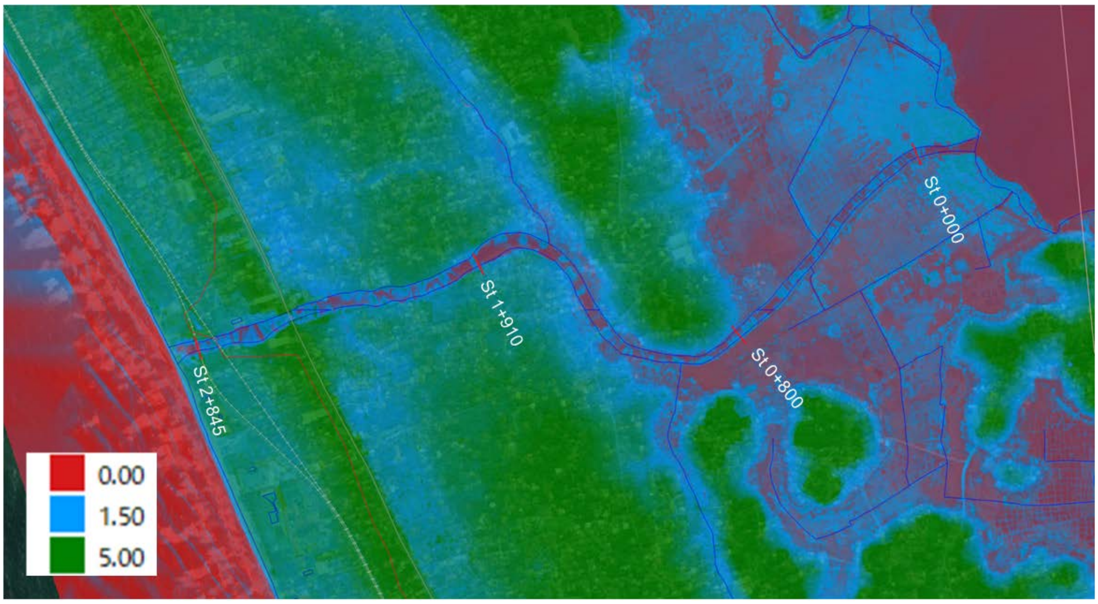


Figure 6.6.30　Distribution Map of Elevation using LiDAR data

Figure 6.6.31 shows the results of the calculations. These water levels represent the maximum water level in Talpitiya Ela when the clogged channel is excavated (released) when the water level at the reference point reaches the "specified value". As shown in the elevation distribution (see Figure 6.6.30), the elevation around Talpitiya Ela and its north-south connecting tributaries (Kerapan Ela and Bindunu Ela) is approximately 1.5 m, and flooding of houses and other structures is expected when the water level is above this level. Incidentally, if the clogged point is not excavated, the water level at Talpitiya Ela is expected to rise to about 1.9 m, and flooding of nearby residences is inevitable. If the clogged point is excavated, the water level at the reference point can be reduced to 1.5 m or less. Confirming the calculation results, it can be seen that if the channel is excavated after the water level at the reference point becomes greater than 1.3 m, the channel water level will be higher than 1.5 m and the possibility of flooding to the surrounding area will increase.

Based on the above, under the premise that the water level observed at the reference point is continuously carried out, it is conceivable to open the clogged part of the river mouth when the following indicator (draft) are applicable. However, for more reliable operation, it is essential not only to observe the water level at the reference point but also to understand the rainfall trend in the surrounding catchment area.

Indicator (draft) In case the water level at the reference point is expected to reach 1.3 m and it is clear that the water level will exceed 1.3 m

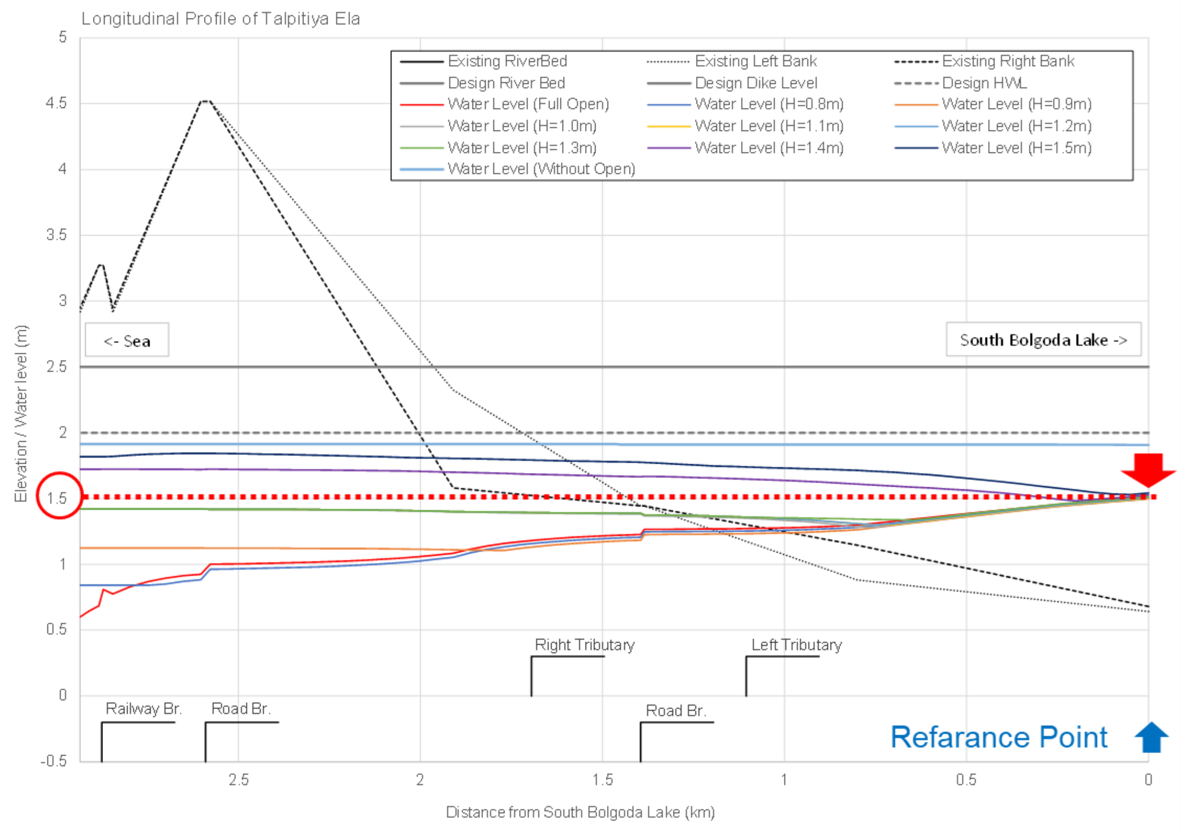


Figure 6.6.31 Longitudinal Water Level of Talpitiya Ela

4) The necessity of Improvement for the Tributary of Talpitiya Ela

According to the SLLDC survey results, the South Bolgoda Lake area is frequently flooded due to insufficient flow capacity of the tributary (Kerapan Ela and Bindunu Ela) that connect the Talpitiya Ela from the north and south.

It would be extremely useful to improve the flood control safety level of the entire basin in a stepwise manner by not only taking measures to excavate the clogged river mouth of Talpitiya Ela, but also by proactively implementing drastic drainage channel rehabilitation of these two tributaries.

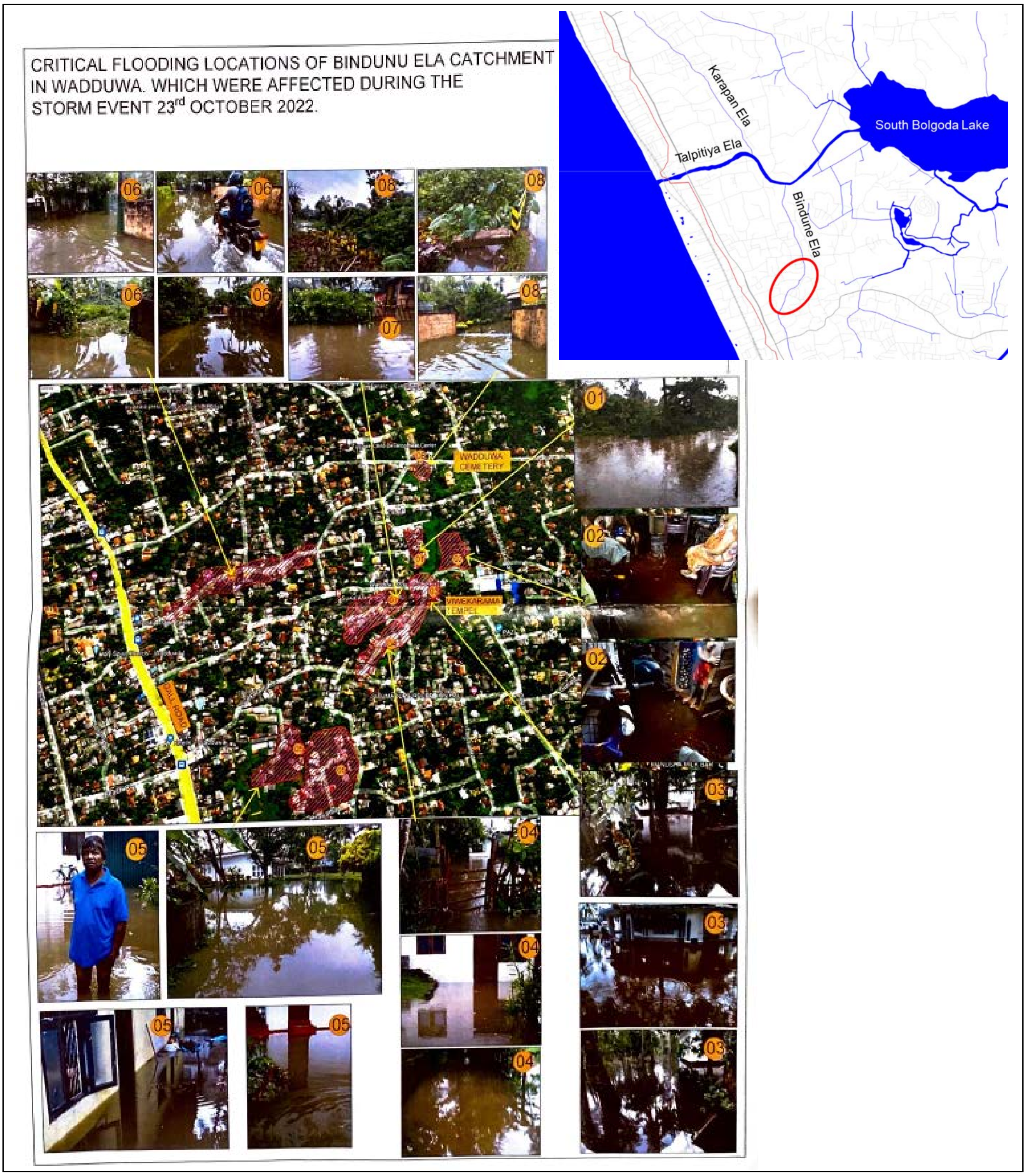


Figure 6.6.32 Flood Inundation Situation Around the Bindunu Ela in 2022

6.6.2.3 Conservation of Natural Retention Water Function

(1) Conservation of natural retention water functions for stormwater drainage plan

The conservation of the natural retention function of agricultural lands and wetlands is essential for stormwater drainage measures in the target area. It is proposed that the maintenance of the water retention function of wetlands and the preservation of the natural environment be defined as non-structural measures and that areas with water retention function be designated as "natural retention areas".

Especially, the proposed “Natural Wetland Park” development as a non-structural measure by conservation and enhancement of wetlands in the Kalu Oya basin and the Mudun Ela sub-basin, in which retarding areas by the wetlands play an indispensable role in storm water drainage management.

In the Bolgoda watershed, it is proposed to establish a "Natural Retention Area" that includes the nature conservation areas around Bolgoda Lake and the Bolgoda Ganga, as well as areas downstream of the tributaries where natural retention effects can be expected.

(2) Natural Wetland Park Development in the Kalu Oya Basin and the Mudun Ela Sub-basin

1) Development Framework of the Retention area

The storm water drainage plan for the target basins sets a goal of securing flood safety levels by the probability of a 25-year (return period 1/25) by the year 2030, of which the water storage capacity of retarding areas by natural wetlands will enable to provide 31% storage capacity out of the total rainwater discharge of the Kalu Oya basin and the Mudun Ela sub-basin. Table 6.6.15 indicates the planned water storage capacities by each return period and Table 6.6.16 shows the required areas of the retarding areas and their current land use conditions.

Table 6.6.15 Development Framework for Retarding Areas in the Kalu Oya Basin and Mudun Ela Sub-basin

Storm Water Drainage Function	Water Storage Capacity in Four Cases of Flood Probabilities (m3/sec)							
	2- Yr	(Share)	10- Yr	(Share)	25- Yr	(Share)	50- Yr	(Share)
River / Water Channel	28.2	24%	84.3	40%	131.5	42%	143.8	36%
Retarding Basin	0	0%	0	0%	0	0%	24	6%
Natural Wetland Park	**54.3**	**45%**	**76.3**	**36%**	**96.3**	**31%**	**111.8**	**28%**
Other Inundation	37.5	31%	51.2	24%	84.8	27%	119.9	30%
Total	120	100%	212	100%	313	100%	400	100%

Source: JICA Study Team

Table 6.6.16 Area Requirement and Existing Land Use of the Retarding Areas in the Kalu Oya Basin and Mudun Ela Sub-basin

Target Basin	Area Requirement and Existing Land Composition for Proposed Natural Wetland Park (ha)				
	Agriculture Land	Natural Grass Land	Wetland*	Water Bodies	Total
Kalu Oya Basin	71.7	0.3	161.8	11.3	245.1
Mudun Ela Sub-basin	4.5	0.2	82.5	0.5	87.8
Total	76.2	0.5	244.4	11.8	332.9

Source: JICA Study Team

2) Urban development management issues for urban storm water drainage management

As large investment programs such as public infrastructure (public transportation by LRT and suburban railway, logistic center, etc) in the well-developed urban area comparatively of the Mudun Ela Sub-basin and the Kalu Oya Basin are underway currently, it is presumed that further urban developments in the basins would be accelerated by increasing convenience. The followings are urban development management issues of the basins to be promoted for effective storm water drainage management in the basin.

- The prevention of the lowlands and wetlands from unsuitable encroachment and conservation has become a critical issue on urban development management to secure retarding function as a part of the storm water drainage management in the basins, where a lot of lands in the peripheral areas of the lowlands and wetlands as high flood risk areas were decreased by landfilling including illegal house building and agriculture cultivation (27% decrease from 2004 to 2018).
- As invisible or unclear physical boundaries of lowlands/wetlands have allowed easy encroachment into their domains, illegal or unsuitable land fillings have happened as a result, despite a legal process of declaration of lowlands/wetlands by the designation of a boundary. The majority of lowlands/wetlands have not been designated by boundaries because of their large extent. It is expected that visible physical barriers (boundaries) of lowlands/wetlands could strengthen and promote their effective management for protection and utilization.
- Cooperative or collaborative activities for the conservation and utilization of lowlands/wetlands are required under a common goal or mission among relevant stakeholders (SLLDC, UDA, ADD, CEA, LGAs) because there are ineffective coordination and cooperation and weak capacity of local governments for appropriate development permit under decentralization circumstances to local governments.

3) Natural Wetland Park Development in Kalu Oya basin and Mudun Ela sub-basin

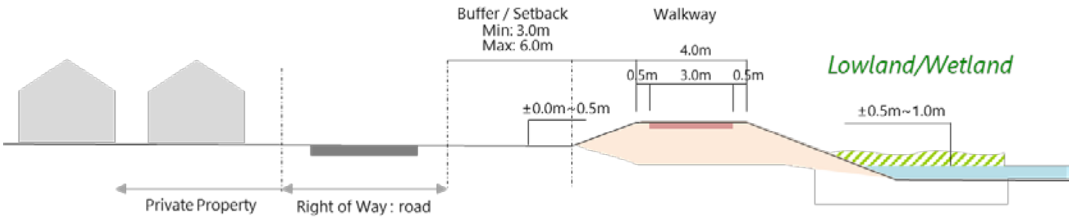
The natural wetland park aims to prevent settlements from flood or inundation and retain the retarding areas in the Kalu Oya basin and the Mudun Ela sub-basin through the development of footpath with a berm as basic facilities functioning physical boundaries of the park in peripheral areas of lowlands/wetlands. The key elements of the park are described as follows and Table 6.6.17.

- Development theme: The eight park developments with footpaths and other facilities in the basins are given by specific development themes considering local character (A: Natural wetland learning, B: Flood risk awareness, C. Citizen’s health and recreation, D. Urban agriculture understanding)
- Development components: The development component of the park is composed of 1) Analyses and Planning of the park, 2) Footpath development (berm, walkway, milestone, lightings rest benches), 3) Visitor center (thematic exhibition hall, parking, toilet, etc), 4) soft-components (operation-management plan, learning program, field activities in cooperation with local communities, NGO/NPO, institutions, etc)

Table 6.6.17 Proposed Natural Wetland Parks in the Kalu Oya Basin and Mudun Ela Sub-basin

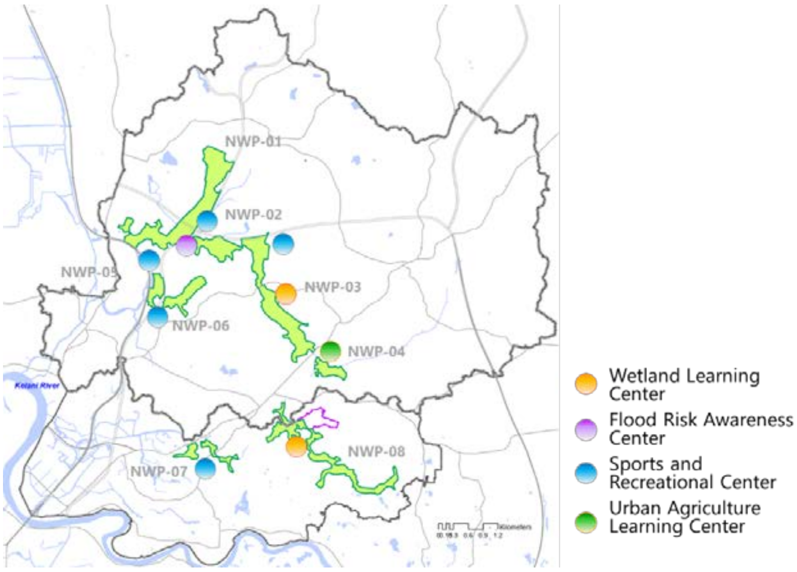
Basin	Code	Area (ha)	Amount by Development Component							Development Theme
			Walkway (km)	Visitor Center (ha)	Ancillary Facilities				No. of Location	
					TO	PF	EX	TF		
Kalu Oya Basin	NWP-01	98.8	9.6	2.2	✓	✓	✓	✓	1	• C: Outdoor Recreation • B: Flood Risk Mitigation
	NWP-02	24.6	3.2	1.9	✓	✓	--	--	1	• C: Outdoor Recreation
	NWP-03	75.1	8.4	4.1(1.7+2.4)	✓	✓	✓	✓	2	• A: Wetland Learning
	NWP-04	13.5	2.3	1.8	✓	✓	✓	✓	1	• D: Urban Agriculture
	NWP-05	12.2	2.2	0.5	✓	✓	--	--	1	• C: Outdoor Recreation
	NWP-06	21.0	3.1	0.8	✓	✓	--	--	1	• C: Outdoor Recreation
	Sub-total	**245.1**	**28.8**	**11.3**	--	--	--	--	**7**	--
Mudun Ela Sub-basin	NWP-07	13.8	4.4	0.6	✓	✓	--	-✓-	1	• C: Outdoor Recreation
	NWP-08*	57.4	12.5	2.1(1.3+0.8)	✓	✓	✓	✓	2	• A: Wetland Learning
	Sub-total	**71.3***	**16.9**	**2.7**	--	--	--	--	**3**	--
Ground Total		**316.4**	**45.7**	**14.0**	--	--	--	--	**10**	--

Source: JICA Study Team



Source: JICA Study Team

Figure 6.6.33 Conceptual Sketch of the Proposed Footpath of the Natural Wetland Park



Source: JICA Study Team

Figure 6.6.34 Proposed Natural Wetland Park in the Kalu Oya Basin and the Mudun Ela Sub-basin

4) Action Plan for Natural Wetland Park Development

(a) Implementation bodies

There are several issues toward implementation of the park development such as how to handle private properties in the lowlands/wetlands, how to conserve the ecosystem with relevant authorities (e.g. CEA), how to treat abandoned paddy fields, and how to involve local communities' cooperation, taking account of the appropriate organization for effective development, sustainable operation and management, and financing.

Although existing wetland improvement projects in the Colombo District with the capital city were implemented by full-government funding, the proposed park development in the Kalu Oya and Mudun Ela sub-basins may require another way by a wider range of possible implementation bodies and mechanisms, taking account of effective and appropriate stakeholders to fit with each project environment character of the project component apart from the Capital District of Colombo.

Table 6.6.18 Proposed Natural Wetland Parks in the Kalu Oya Basin and the Mudun Ela Sub-basin

Project Components for Implementation of Natural Wetland Park Project		Suitability as Implementation Body for Natural Wetland Park					
		Central Government	SLLDC	Other Semi-Gov. Authorities	Local Government Authorities	NGO / CBO / NPO	University / Academic Institutions
1. Land Expropria-tion	Wetland	●	△	◎	△	--	--
	Footpath	●	◎	◎	◎	--	--
	Visitor Center	●	◎	◎	◎	--	--
2. Facilities Development		◎	●	●	◎	--	--
3. Operation and Management		◎	●	●	△	△	--
4. Education / Public Awareness Program		◎	◎	◎	◎	●	●

Legend: ●= the fittest, ◎= applicable, △= not suitable, -- = difficult
Source: JICA Study Team

(b) Implementation schedule

Key physical development component including footpath development with a berm (45 km length requiring 5~5.5 km development per year) and visitor centers (12 ha in total) of the park developments is expected to complete within the target year 2030 as the target year for the structural measure projects of the storm water drainage plan in the Kalu Oya basin and the Mudun Ela sub-basin.

The seven visitor centers' development and land expropriation of the lowlands/wetland will be implemented gradually until 2030 and beyond 2030 in association with proper development methods through discussions and negotiations with landowners. Total development costs excluding survey and design and land costs are estimated at roughly Rs.1,595 million composing of the footpath development (around Rs. 700 million) and the visitor centers with ancillary facilities (Rs. 895 million)

Table 6.6.19 Proposed Natural Wetland Parks in the Kalu Oya Basin and Mudun Ela Sub-basin

Project Components for Implementation of Natural Wetland Park Project		Implementation Phase			Beyond 2030
		Short-term (0-3 Y)	Mid-term (3-5 Y)	Long-term (5-10 Y)	
1. Land Expropriation	Wetland				
	Footpath				
	Visitor Center				
2. Facilities Development	Footpath				
	Visitor Center				
3. Operation and Management					
4. Education / Public Awareness Program					

Source: JICA Study Team

5) Designation of natural retention areas and natural wetland parks in the KaluOya and Mudun Ela Sub-basin

The Natural retention areas and Natural Wetland Parks in the Kalu Oya and Mudun Ela Sub-basin are shown in d below.

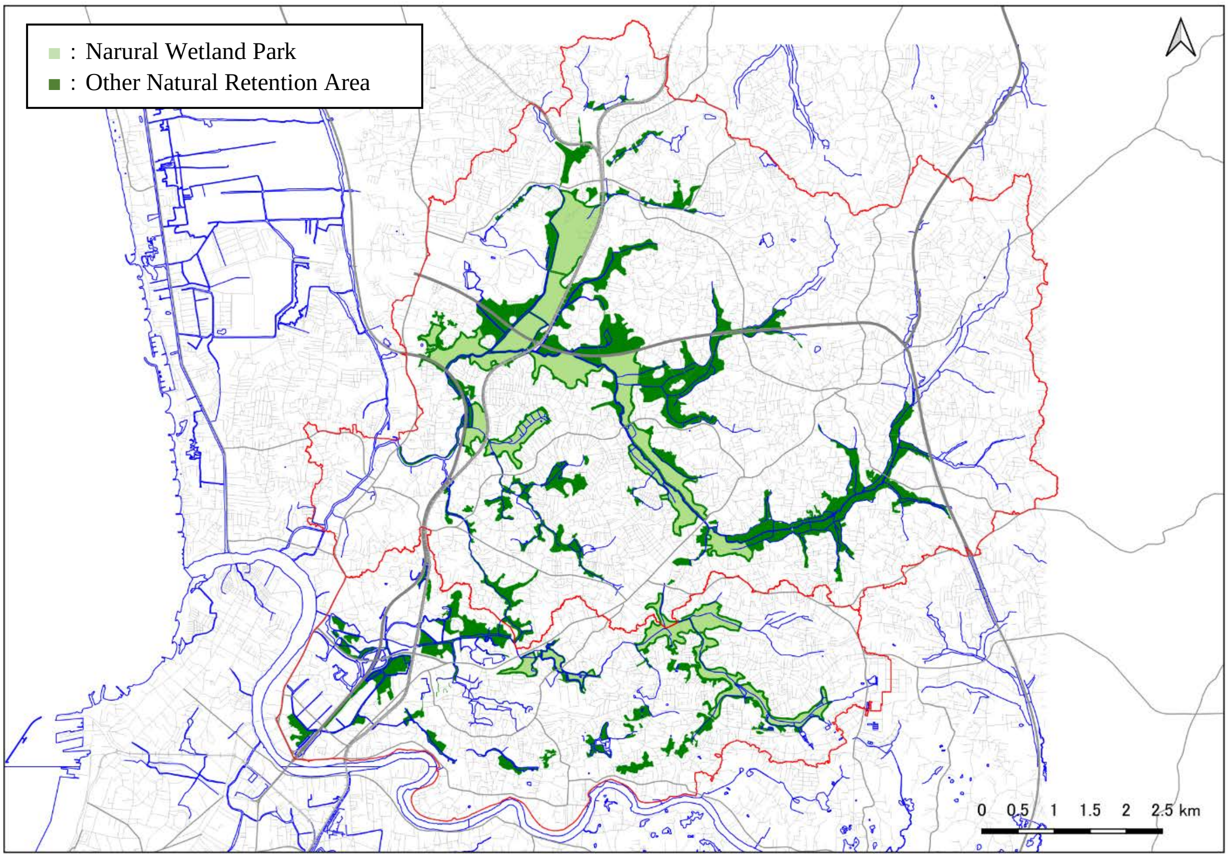


Figure 6.6.35 Natural Wetland Park and Natural Retention Area in Kalu Oya Basin and Mudun Ela Sub-basin (Draft)

(3) Conservation of Natural retention function in Bolgoda Basin

1) Basic Policy of Conservation of Natural retention Function in Bolgoda Basin

According to the urban storm water drainage plan for the Bolgoda basin, the basin will be limited its investment to a minimum of structural measures in a few priority areas, taking into account the effectiveness of investment due to low dense settlements and limited future urban developments, where a lot of green areas such as the Bolgoda Environment Protection Area and agricultural lands has remained. Looking at the importance of natural water retarding function by the green area including paddy fields, wetlands, and natural grasslands in the Bolgoda basin, the land use formulating natural retarding basin needs to be retained as a non-structure measure toward a medium-long term time frame. Therefore, the "Natural Retarding Area" that overlaps with the flood risk area assumed with a probability of a 50-year return period will be the pillar of non-structural measures in the Bolgoda basin.

2) Framework of non-structural measures in the basin

The storm water drainage plan for the target basins sets a goal of securing flood safety level by the probability of a 25-year (return period 1/25) by 2030, of which the water storage capacity of natural retarding areas will enable to provide 30% storage capacity out of the total rainwater discharge of the Bolgoda basin. Table 6.6.20 indicates the expected water storage capacities for each return period.

- Proposed natural retarding areas based on the identified flood risk areas compose of paddy fields, other agricultural lands, wetlands, natural grasslands, and some built-up areas.
- The Bolgoda Environment Protection Area (3.8% out of the total natural retarding areas) as the inland buffer area (60 m buffer) excluding its water body (rivers, lake) is composed of paddy fields (0.2% share), other agricultural lands (1.9%), abandoned agricultural lands (1.9%) natural grasslands (16.7%), wetlands (15.4%) and others. (refer to Table 6.6.20)
- The major land uses of the natural retarding area are composed of abandoned agricultural lands (39.6%), paddy fields (28.8%), other agricultural lands (14.1%), and followed by wetlands (10.2%). (refer to Table 6.6.20)

Table 6.6.20 Development Framework for Natural Retention Areas in the Bolgoda Basin

Storm Water Drainage Function	Flood Carrying and Retarding Capacity in Flood Safety Level					
	2- Yr	(Share)	25- Yr	(Share)	50- Yr	(Share)
River / Water Channel	236.9	54%	535.1	53%	605.7	52%
Natural Wetland	119.4	27%	**282.9**	**28%**	329.1	28%
Other Inundation	83.0	19%	198.2	20%	241.0	20%
Total	439.3	100%	1016.2	100%	1175.8	100%

Source: JICA Study Team

Table 6.6.21 Composition of Existing Land Use of the Natural Retarding Areas for the Bolgoda Basin

District	Area Requirement and Existing Land Composition for Retarding Basin (ha)							Total
	Paddy	Other Agriculture Lands	Abandoned Agriculture Lands	Natural Grass Lands	Wetland*	Built-up Area	Aquaculture Area	
Colombo	830.9	198.4	241.4	56.6	262.3	1.7	0.0	1,591.4
Kalu Oya	1,216.6	804.4	2,569.3	443.3	465.8	13.2	0.0	5,512.6
Total	2,047.5	1,002.8	2,810.7	499.9	728.1	14.9	0.0	7,104.0
(share)	28.8%	14.1%	39.6%	7.0%	10.2%	0.2%	0.0%	100.0%
Protected Area*	0.2%	1.7%	1.9%	16.7%	15.4%	0.0%	0.0%	3.8%

Note: Other agricultural lands include orchard trees, and vegetables, Build-up area includes houses, other buildings, or open spaces as urban areas, The land use composition of Protected Aera by the Bolgoda Environment Protection Area excluding the area of water bodies indicates the land shares out of the total area of the natural retarding area.
Source: JICA Study Team

3) Natural Retention Area in Bolgoda Basin

The "Natural Retention Areas" in the Bolgoda basin are shown in Figure 6.6.36. However, since institutional measures are required to maintain existing land use and regulate development within the designated areas, these issues are discussed in detail in a separate section, "6.8 Urban Development Management for Stormwater Drainage Management".

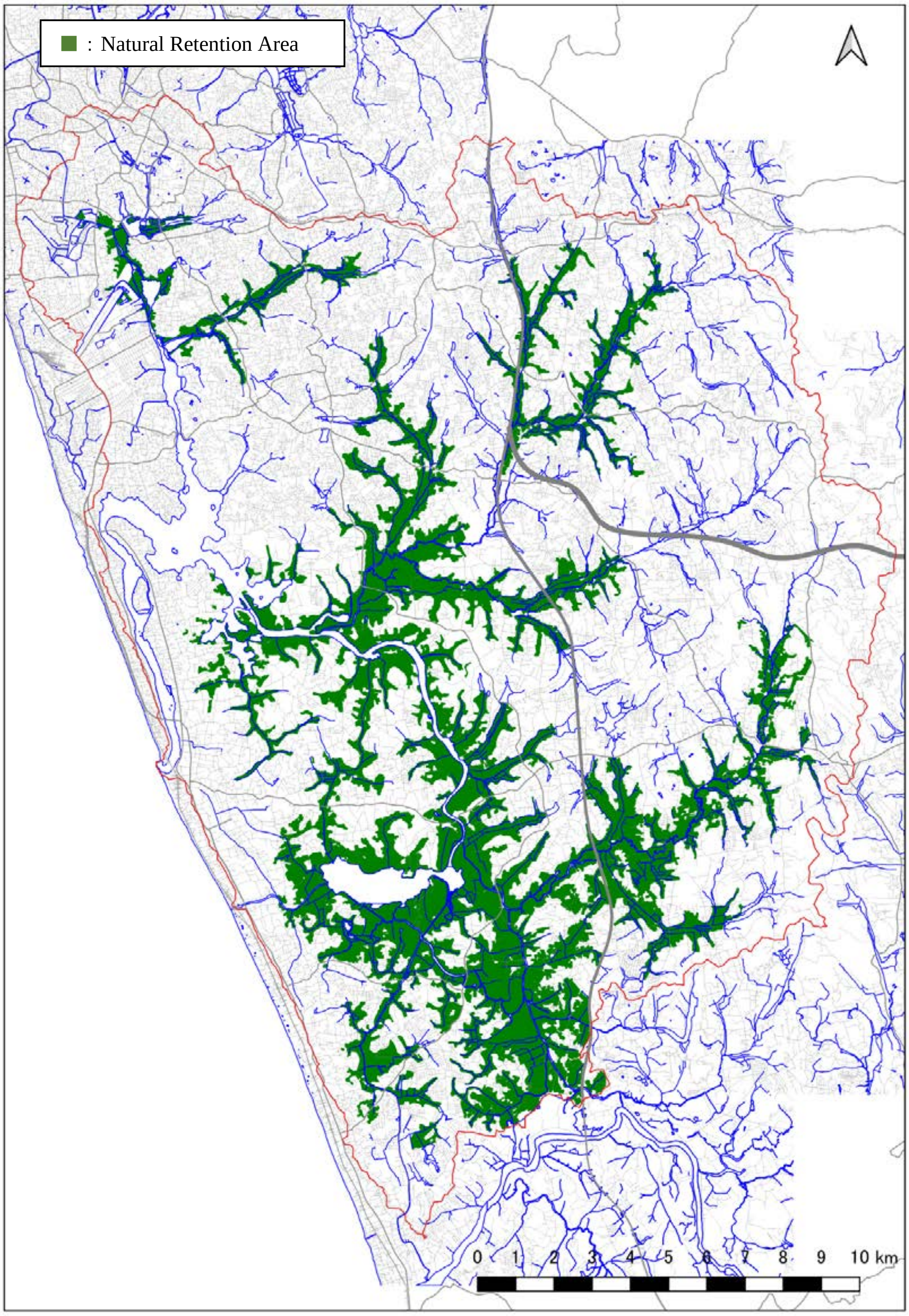


Figure 6.6.36 Natural Retention Area in Bolgoda Basin (Draft)

6.6.2.4 Storm water drainage plan

As shown in Clause 6.3, Planning Frame, the storm water drainage plan in this study is proposed as a long-term plan (overall plan) on the precondition that the flood control safety level of the entire basin is gradually improved to a 50-year return period. Based on the menu of countermeasures for each basin planned up to the previous section, the combination of appropriate countermeasures to gradually improve the flood control safety level will be proposed considering the feasibility (construction cost and workable amount).

The countermeasure menu to be implemented during the project period until 2030 will be selected as the mid-term plan for the storm water drainage plan. During the maintenance period until 2030, the flood control safety level of the Kalu Oya basin and the Bolgoda basin will improve to a 25-year return period.

In this study, conceptual design and preliminary cost-benefit analysis will be conducted for the countermeasure menus listed in the mid-term plan. These layouts are shown in Figure 6.6.6 for Kalu Oya and Mudun Ela and in Figure 6.6.15 for Bolgoda.

(1) Storm Water Drainage Plan in Kalu Oya Basin

The summary of the storm water drainage plan in Kalu Oya Basin is shown in Table 6.6.22. In the mid-term plan (2030), the countermeasure of priority numbers 1 to 5 as indicated in the following table should be implemented until 2030 to mitigate flood inundation risk.

Table 6.6.22 Storm Water Drainage Plan in Kalu Oya Basin

Safety Level	Priority	Summary of Countermeasure
10-year Return Period	1	Kalu Oya Improvement［K1］ ● Target: Kalu Oya Main Canal ● Measure: Canal improvement (Widening, Dredging, Embankment) Length: 5.1 km
	2	Natha Canal Improvement［K2］ ● Target: From Kalu Oya to Railway Bridge ● Measure: Canal improvement (Widening, Dredging, Embankment) Length: 0.5 km
	3	Mudun Ela Diversion［K3］ ● Target: Near the confluence of Upstream of Natha Canal and Mudun Ela ● Measure: Canal Improvement (Widening, Dredging, Embankment), Removal of the existing connecting gate, Installation of new deadline facility Length: 0.3 km
	4	Natural Wetland Park［K5］ ● Target: Wetlands located in the valley bottom plain in the middle and upper reaches of the main channel and tributaries ● Measure: Prevention of invasion of houses, etc. by converting existing wetlands into parks The total length of the small dikes: 28.8km
25-year Return Period	5	Old Dutch Canal Improvement and Flood diversion channel［K4］ ● Target: From Upstream of Negombo Wetland to the proposed new flood diversion channel ● Measure: Canal Improvement (Widening, Dredging, Embankment), Excavation of an existing channel (Widening, Dredging, Embankment) Length: Old Dutch Canal = 5.0 km, Flood diversion = 0.4 km
50-year Return Period	6	Installation of Gate structure and Pumping station［K7］ ● Target: The most downstream confluence of Kelani Ganga ● Measure: Gate structure and pumping stations for the Kelani Ganga embankment project at the confluence Drainage capacity: 35m^3/s, Gate Width: 30m
	7	Improvement of natural wetland park to retarding basin［K8］

Safety Level	Priority	Summary of Countermeasure
		● Target: Natural wetland park along the Kalu Oya main river and primary tributaries ● Measure: Excavation in natural wetland park, Surrounding dike, Overflow dike Number of wetland parks: 4
-	Other	Improvement of Tank［K6］ ● Target: Upstream of Kalu Oya tributary, 3 location

(2) Storm Water Drainage Plan in Mudun Ela sub-basin

The summary of the storm water drainage plan in Kalu Oya Basin is shown in Table 6.6.23. In the mid-term plan (2030), the countermeasure of priority numbers 1 to 7 as indicated in the following table should be implemented until 2030 to mitigate flood inundation risk.

Table 6.6.23 Storm Water Drainage Plan in Mudun Ela sub-basin

Safety Level	Priority	Summary of Countermeasure
10-year Return Period	1	Mudun Ela Improvement［M1］ ● Target: Mudun Ela Main Canal (From Oliyamulla pumping station to Colombo-Kandy Road) ● Measure: Canal improvement (Widening, Dredging, Embankment) Length: 3.1 km
	2	Peliyagoda Improvement［M2］ ● Target: Peliyagoda canal connected to a pumping station ● Measure: Canal improvement (Dredging) Length: 2.8 km
	3	Improvement of Peliyagoda Pumping starion［M3］ ● Target: Peliyagoda Pumping station ● Measure: Enhancement of pump facilities (drainage capacity 0.5m^3/s to 1.0m^3/s)
	4	Installation of Gate structure［M4］ ● Target: Peliyagoda canal ● Measure: Installation of Gate structure
	5	Natural Wetland Park［M8］ ● Target: Wetlands located in the valley bottom plain in the middle and upper reaches of the main and secondary channel ● Measure: Prevention of invasion of houses, etc. by converting existing wetlands into parks The total length of the small dikes: 16.9 km
25-year Return Period	6	Upper Mudun Ela Improvement［M5］ ● Target: Upstream section from Colombo-Kandy road ● Measure: canal improvement (Dredging) Length: 3.0 km
	7	Construction of retarding basin of upper Mudun Ela［M6］ ● Target: Natural wetland park along Mudun Ela ● Measure: Excavation molding in natural wetland park, Surrounding dike, Overflow dike Number of wetland parks: 1
-	Other	Installation of two pumping stations and Improvement of the connected canal［M7］ ● Target: Local flooding risk area around upper Nalanmini Oya ● Measure: Installation of two pumping facilities (Pethiyagoda Pumping Station: 15m3/s, Koholwila Pumping Station: 5m3/s) and improvement of the connected canal (Naranmini Oya/ Koholwila canal) Number: 2 location

(3) Storm Water Drainage Plan in Bolgoda Ela Basin

The storm water drainage plan for the Bolgoda basin is summarized in Table 6.6.24. District priorities were based on the size of the defensive area's population. In the mid-term plan (2030), the countermeasure of priority numbers 1 to 5 as indicated in the following table should be implemented until 2030 to mitigate flood inundation risk.

Table 6.6.24 Storm Water Drainage plan in Bolgoda Basin

Safety Level	Priority	Summary of Countermeasure
25-year Return Period	1	Weras Ganga Right Embankment [B1] ● Target: Moratuwa-Rathmalana Area (Weras Ganga Right side) ● Measure: Canal improvement (Embankment) Length: 3.0 km
	2	Local Flood Mitigation Measure in Panape Ela Basin [B4] ● Target: Flood inundation area along Panape Ela ● Measure: Surrounding diking system of three section Length: 6.7 km (total)
	3	Local Flood Mitigation Measure in Maha Oya Basin [B2] ● Target: Near the intersection of the Maha Oya and expressway and residential area ● Measure: Canal improvement (dredging, embankment), Replacement of 2 road bridges Length: 5.9 km
	4	Local Flood Mitigation Measure in Alut Ela Basin [B3] ● Target: Assumed flood inundation area along Alut Ela ● Measure: Canal improvement (dredging, embankment), Replacement of 4 road bridges Length: 3.4 km
	5	Local Flood Mitigation Measure in Maha Oya Tributary Basin [B5] ● Target: Near the intersection of the Maha Oya Tributary and expressway and residential area ● Measure: Surrounding diking system Length: 1.0 km
50-year Return Period	6	Weras Ganga Improvement [B1] ● Target: Moratuwa-Rathmalana Area (Weras Ganga) ● Measure: Canal improvement (Dredging) Length: 2.9 km
	7	Thalpitiya Ela Improvement [B6] Temporary ● Targe: Talptiya Ela and Coastal clogged point ● Measure: Canal improvement (Dredging, Excavation of clogged point) Length: 2.8 km
-	Others	Improvement of Drainage System of Moratuwa-Rathmalana Area［B7］ ● Target: Moratuwa-Rathmalan Area ● Measure: Installation of gate structures and pumping stations associated with Weras Ganga embankment, improvement of primary canals Length: 4.0km, Gate structure: 2 locations, Pumping station: 2 locations

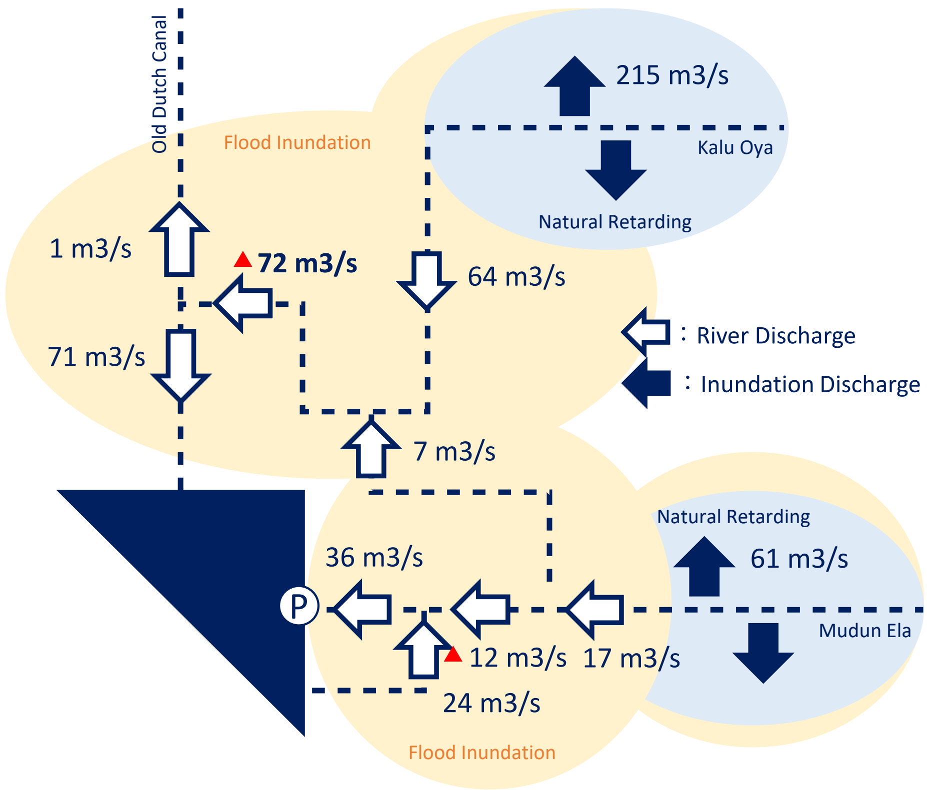
6.6.3 Effect of Storm Water Drainage Plan

The inundation map, inundation area, and the number of inundated houses when rainwater drainage measures are implemented are shown below. Damage reduction is expected if flood countermeasures are implemented for the 25-year return period. In the case of the Kalu Oya basin and the Mudun Ela sub-basin, the natural retarding effect with the natural wetland park and the other agricultural land are a prerequisite. In the case of the Bolgoda basin, the natural water flow effect in the nature reserves around the lake is a prerequisite for overall rainwater drainage measures. Under this precondition, it is assumed that some inundation will remain in households living on the edge of the expected inundation area. It is necessary to take non-structural measures such as presenting inundation risk areas using hazard maps and residence restrictions such as land use regulations for residents of the remaining assumed inundation area.

6.6.3.1 Effect of Countermeasure in Kalu Oya and Mudun Ela sub-basin

As shown in Table 6.6.25, if flood control measures are implemented, the number of affected houses will decrease from about 3,500 to about 800 in the entire Kalu Oya basin with a 25-year probability. In the entire Mudun Ela sub-basin, 4,600 units will be reduced to 2,200 units. In both basins, affected houses remain, but most of them are within the inundation depth of 0.5 m or less, so the impact can be said to be minor.

As shown in Figure 6.6.37and Figure 6.6.38, the flood control safety level will be improved by gradual improvement, and the flow capacity will be increased from the current 72 m^3/s to 107 m^3/s at the Kalu Oya reference point, and from the current 12 m^3/s to 25 m^3/s at the Mudun Ela reference point.



▲: Reference Point

Figure 6.6.37 Discharge Distribution Diagram (Without Improvement)

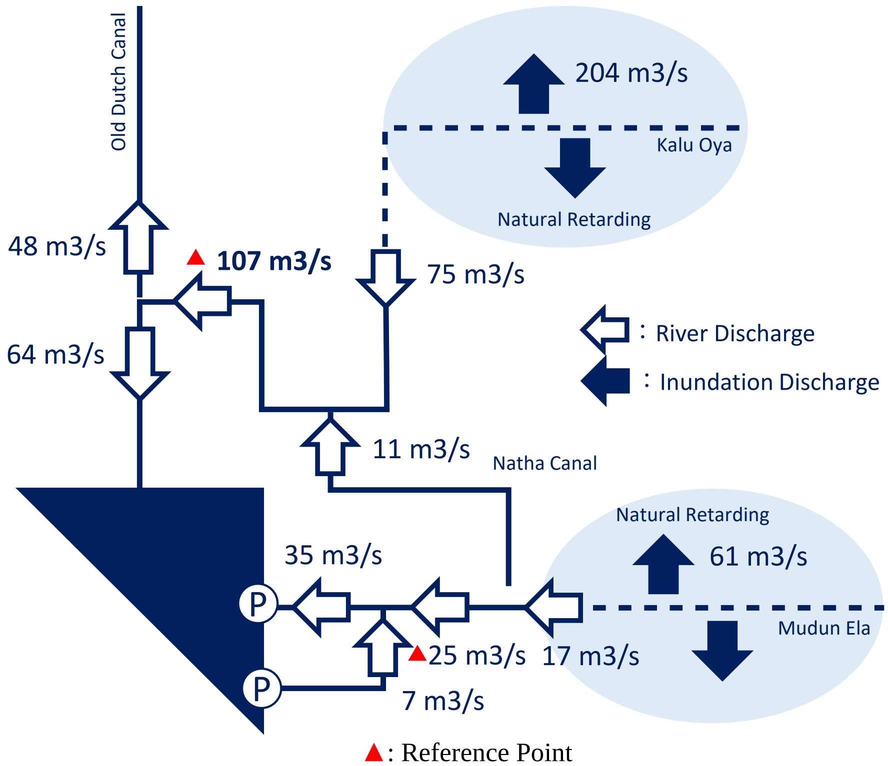
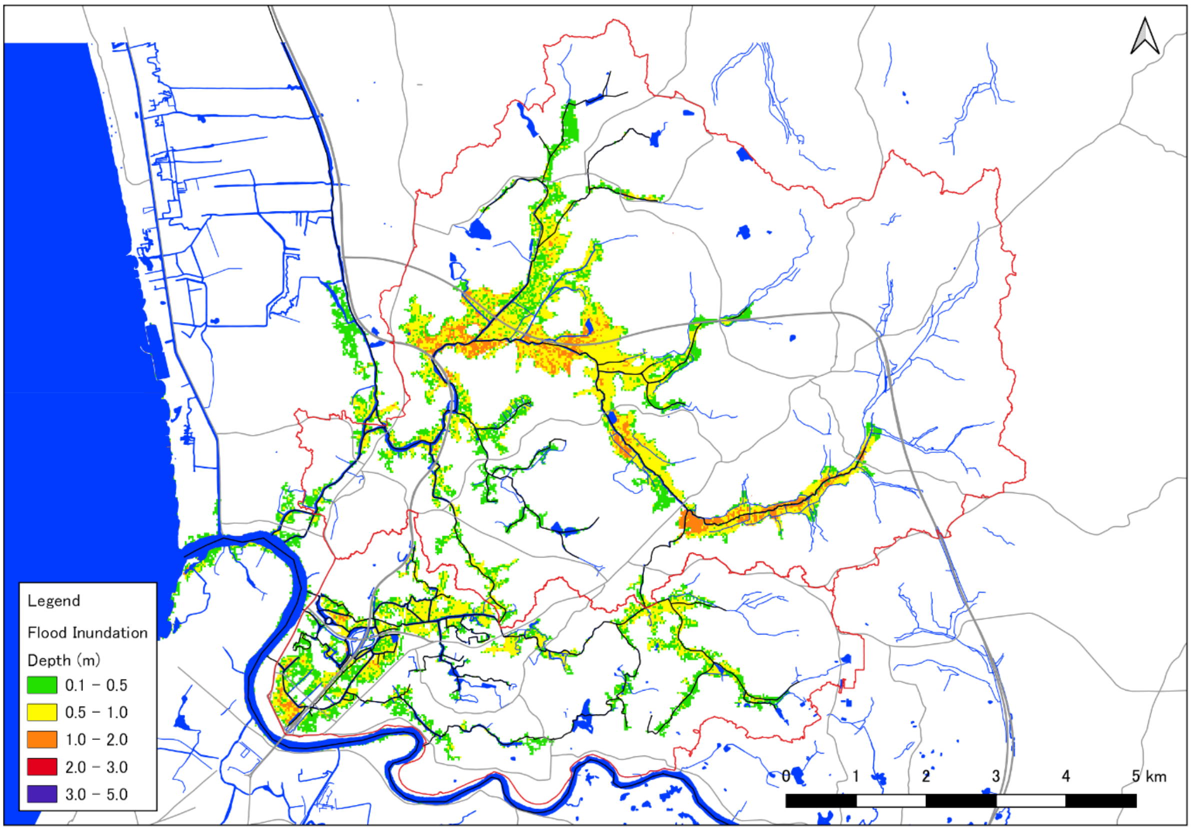


Figure 6.6.38 Discharge Distribution Diagram (With Improvement)



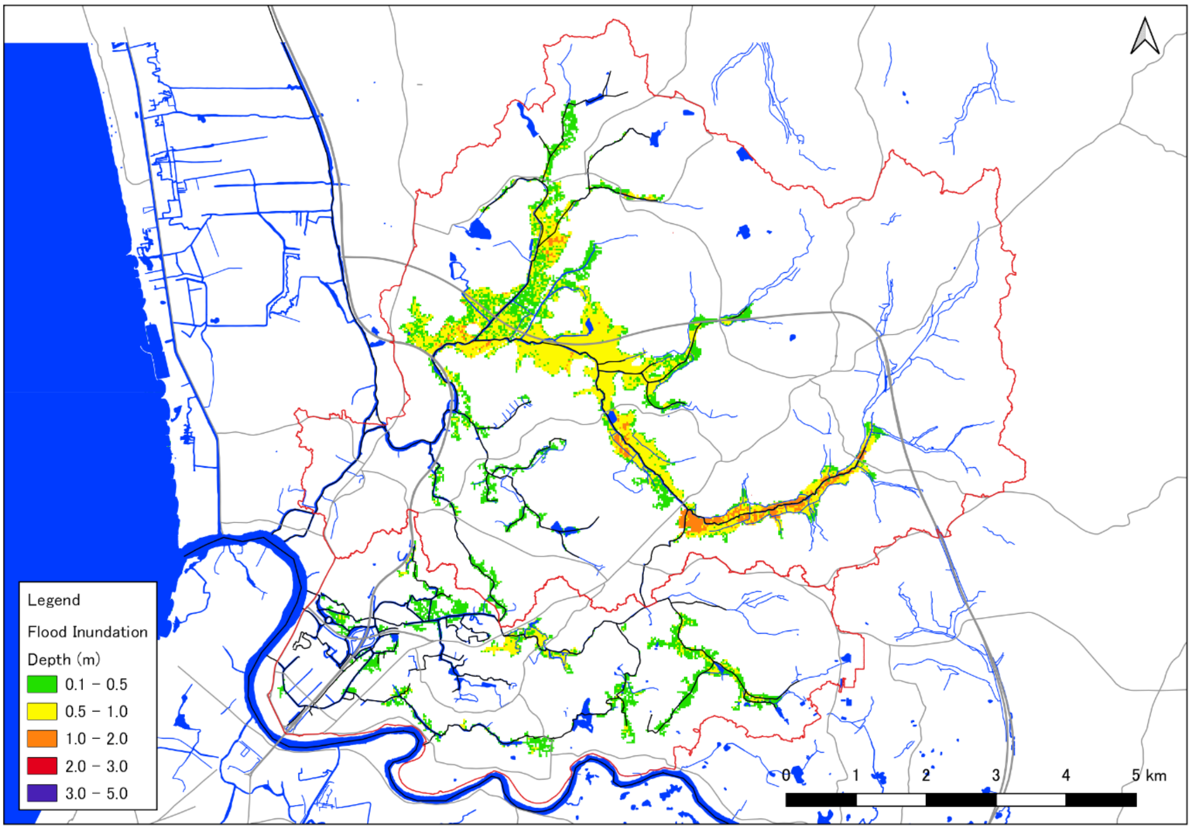
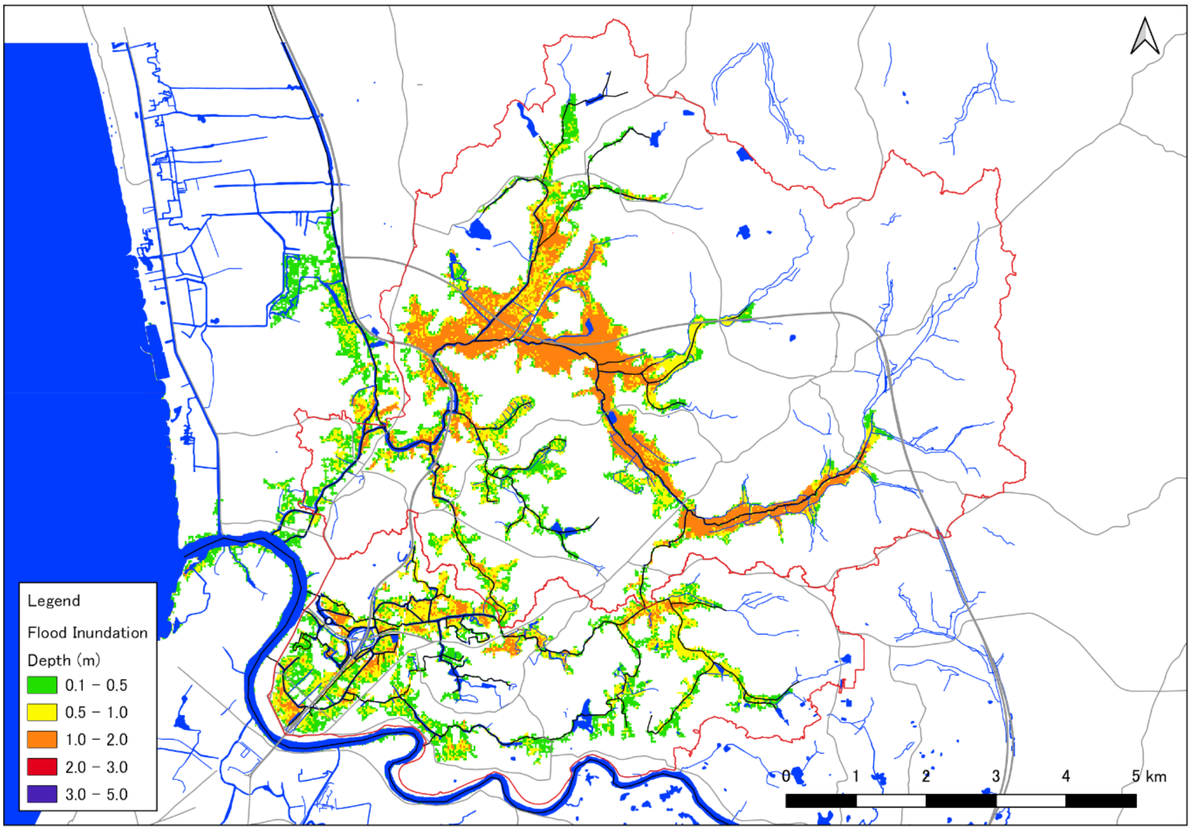


Figure 6.6.39 Assumed Flood Inundation Map (10-yr Return Period)
Upper: Without Countermeasure, Lower: With Countermeasure



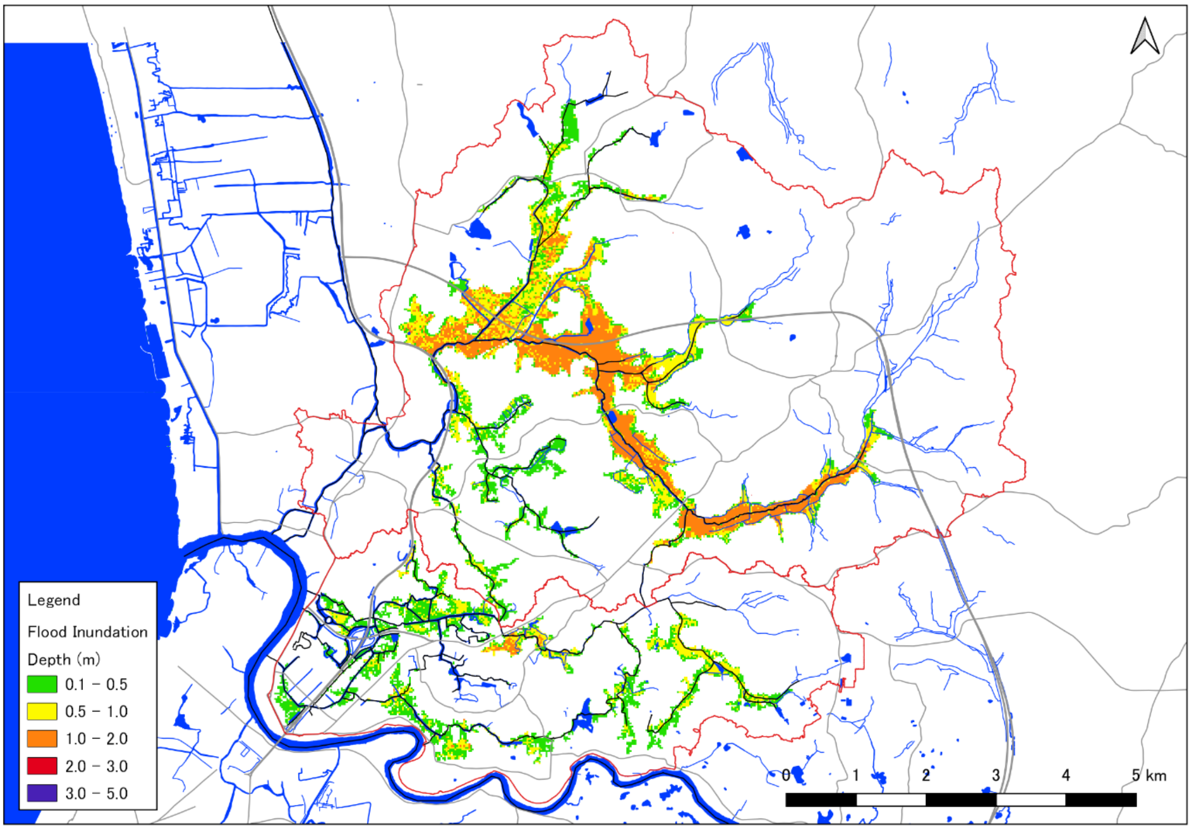


Figure 6.6.40 Assumed Flood Inundation Map (25-yr Return Period)
Upper: Without Countermeasure, Lower: With Countermeasure

Table 6.6.25 Assumed Flood Inundation Area and Affected Households in the Kalu Oya Basin

[Without Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	5.9	7.0	9.0	13.2
Lowland (Wetland)	407.9	493.9	548.4	597.3
Nature Area	2.0	2.0	2.0	4.8
Water Area	41.9	46.1	47.5	49.4
Settlement Area	153.9	235.6	310.1	482.4
Total	611.7	784.7	917.1	1,147.1

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	236	455	554	871
0.1-0.5	393	628	924	1,762
0.5-1.0	35	106	290	688
1.0-1.5	0	0	0	203
1.5-2.0	0	0	0	0
2.0-	0	0	0	0
Total	664	1,189	1,768	3,525

[With Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	5.6	6.3	8.2	11.1
Lowland (Wetland)	390.6	445.9	508.7	567.5
Nature Area	2.0	2.0	2.0	2.5
Water Area	31.9	33.3	35.8	36.6
Settlement Area	101.9	150.2	203.0	310.4
Total	532.0	637.8	757.8	928.1

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	99	253	208	286
0.1-0.5	15	55	228	519
0.5-1.0	0	0	2	18
1.0-1.5	0	0	0	0
1.5-2.0	0	0	0	0
2.0-	0	0	0	0
Total	115	309	438	824

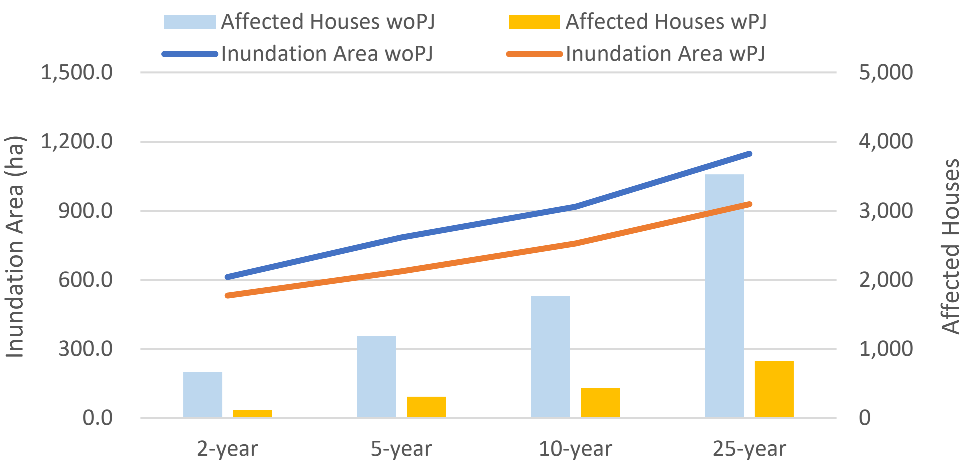


Figure 6.6.41 Assumed Flood Inundation Area and Affected Households in the Kalu Oya Basin

Table 6.6.26 Assumed Flood Inundation Area and Affected Households in the Mudun Ela sub-basin

[Without Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	0.6	1.4	2.4	4.3
Lowland (Wetland)	135.6	158.5	172.2	191.0
Nature Area	1.3	2.3	2.5	2.6
Water Area	30.6	32.3	34.8	37.8
Settlement Area	221.7	253.1	310.1	454.2
Total	389.8	447.6	522.0	689.9

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	488	596	899	1,157
0.1-0.5	1,139	1,218	1,372	2,487
0.5-1.0	303	295	402	866
1.0-1.5	8	8	8	39
1.5-2.0	0	0	0	0
2.0-	0	0	0	0
Total	1,937	2,117	2,680	4,550

[With Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	0.3	0.7	1.5	2.8
Lowland (Wetland)	62.5	85.9	112.5	146.8
Nature Area	1.3	1.6	2.5	2.5
Water Area	7.6	14.7	19.9	31.1
Settlement Area	44.4	85.9	132.6	265.8
Total	116.2	188.8	268.9	448.8

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	222	363	474	821
0.1-0.5	22	128	382	1,307
0.5-1.0	0	0	5	87
1.0-1.5	0	0	0	0
1.5-2.0	0	0	0	0
2.0-	0	0	0	0
Total	244	491	861	2,215

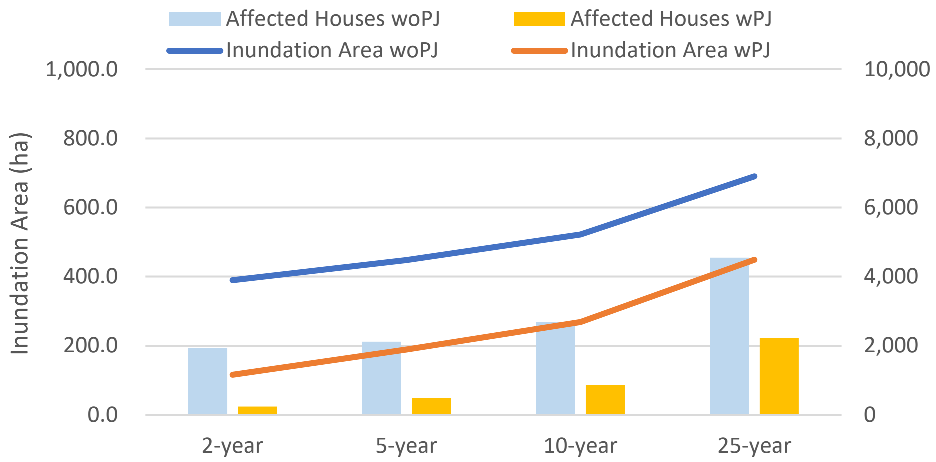
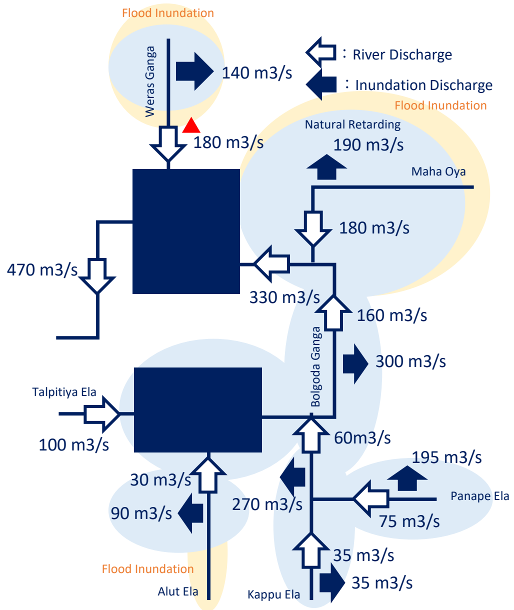


Figure 6.6.42 Estimated Flood Inundation Area and Affected Households in the Mudun Ela Sub-basin

6.6.3.2 Effect of Countermeasure in the Bolgoda Basin

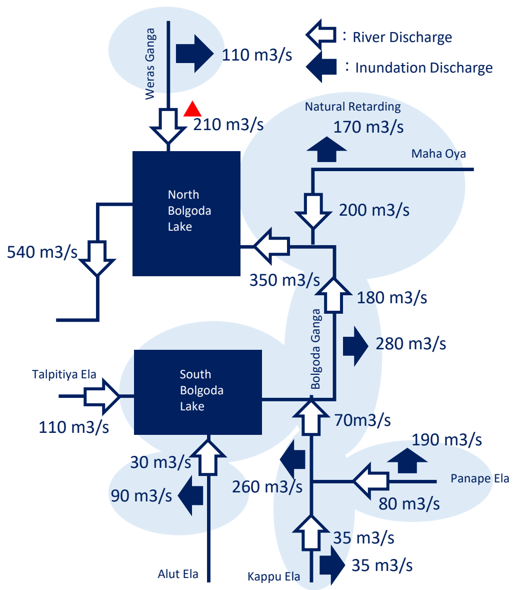
In the Bolgoda basin, it is extremely important to maintain the flood retention effect while conserving the wetland areas around the Bologoda lake. As shown in Figure 6.6.43, there is no significant change of discharge because the natural retention effects are maintained and the countermeasure works are limited to key locations. The existing flow capacity at the Weras Ganga reference point will increase from 180 m^3/s to 210 m^3/s.

As shown in Table 6.6.27, if flood control measures are implemented in the Bolgoda basin, the number of affected houses will be reduced from about 3,900 to about 2,600 in the entire Bolgoda basin. Even if measures are taken, a certain number of affected houses will remain.



▲: Reference Point

Figure 6.6.43 Discharge distribution diagram (without Improvement)



▲: Reference Point

Figure 6.6.44 Discharge distribution diagram (with Improvement)

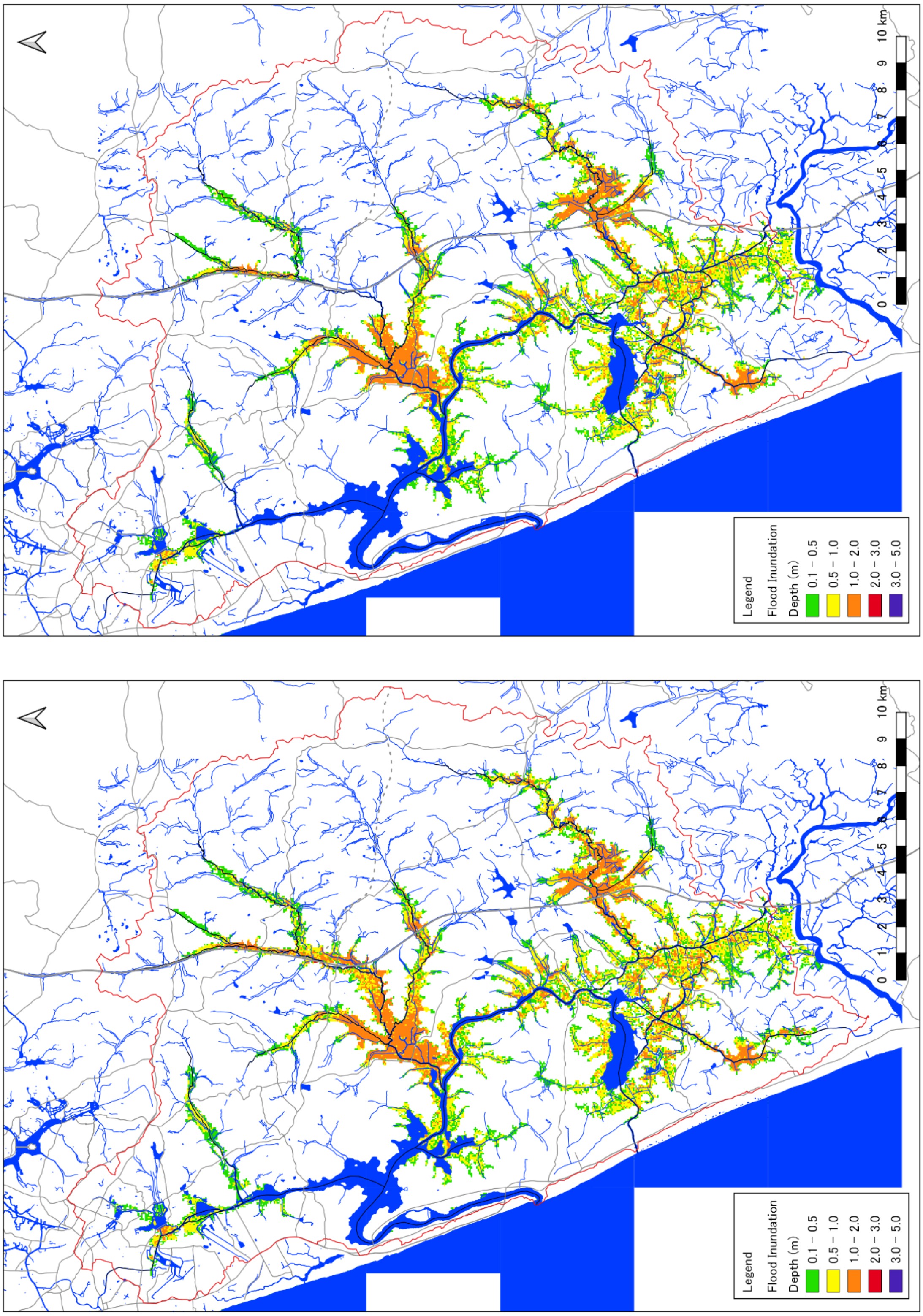


Figure 6.6.45 Assumed Flood Inundation Area Map in the Bolgoda Basin (25-Yr Return Period)
Left: Without Countermeasure, Right: With Countermeasure

Table 6.6.27 Assumed Flood Inundation Area and Affected Households in the Bolgoda Basin

[Without Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	316.3	476.0	544.4	617.5
Lowland (Wetland)	1,867.7	3,213.7	3,882.4	4,435.8
Nature Area	167.4	279.6	343.2	404.0
Water Area	427.4	542.8	606.0	649.4
Settlement Area	388.2	782.1	1,099.2	1,499.2
Total	3,167.0	5,294.2	6,475.2	7,606.0

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	40	70	55	158
0.1-0.5	252	515	1,052	1,909
0.5-1.0	32	173	373	665
1.0-1.5	36	171	487	1,018
1.5-2.0	1	42	44	129
2.0-	0	0	10	17
Total	360	971	2,021	3,897

[With Countermeasure]

(1) Inundation Area (ha)

Land use	2-year	5-year	10-year	25-year
Agricul Area	275.9	419.5	492.0	554.8
Lowland (Wetland)	1,754.6	3,049.8	3,686.3	4,216.2
Nature Area	133.6	246.4	298.0	356.2
Water Area	607.3	711.9	760.0	791.6
Settlement Area	339.6	676.1	909.8	1,251.2
Total	3,111.0	5,103.6	6,146.1	7,170.0

(2) Number of Houses

Inundation Depth (m)	2-year	5-year	10-year	25-year
0.0-0.1	57	54	44	158
0.1-0.5	242	368	626	1,152
0.5-1.0	15	166	250	452
1.0-1.5	15	117	336	791
1.5-2.0	0	19	23	57
2.0-	0	0	0	0
Total	330	724	1,280	2,610

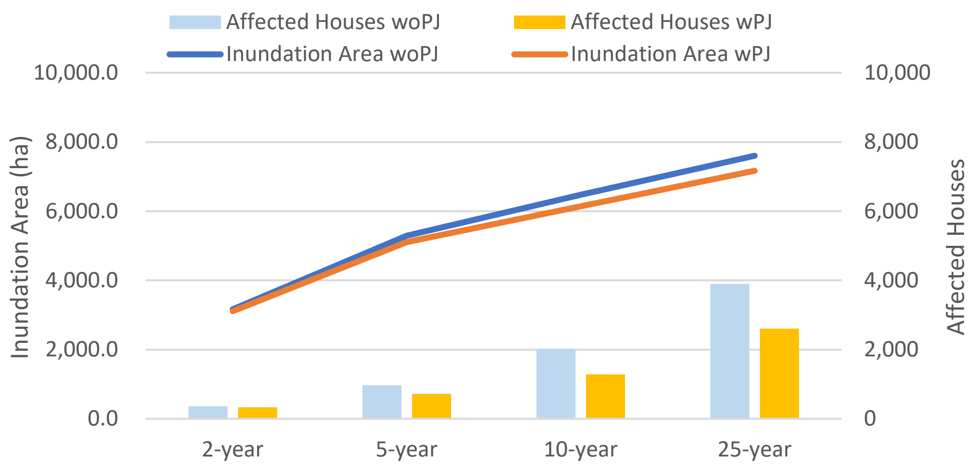


Figure 6.6.46 Assumed Flood Inundation Area and Affected Households in the Bolgoda Basin

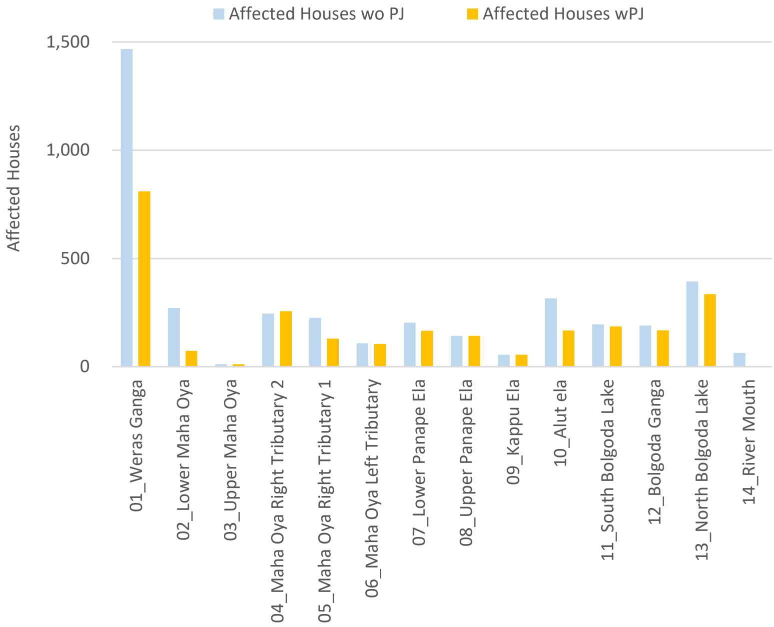


Figure 6.6.47 Estimated Affected Household for Each Sub-basin

6.7 STRUCTURAL DESIGN AND COST ESTIMATION

Regarding the structural design and cost estimates of drainage facilities, aiming to the following objectives, the study was conducted in Stage 1 (Basic study) and Stage 2 (M/P).

- To clarify the design guidelines, manuals and specifications in Sri Lanka and compare them to the Japanese ones which are adaptable to the rough design in Stage 2 (Study on storm water drainage plan) and Stage 3 (Pre-F/S)
- To clarify the cross sections which has been proposed by the previous studies and to propose standard cross sections for Stage 2
- To clarify the cost estimation method used in general local projects which can be referred to in Stage 2 and Stage 3

6.7.1 Design Guideline, Manual and Specification

6.7.1.1 Design Guideline, Manual and Specification in Sri Lanka

In Sri Lanka, there is no design guideline, manual or specification which shows the design methods or standard cross sections of structure measures. However, there are some specifications describing engineering works such as survey works and execution of construction works. Table 6.7.1 shows the collected specifications for engineering works.

Table 6.7.1 Engineering Work Specification in Sri Lanka

No.	Title of Specification	Description	Compiler/Publisher and Issued/Revised month
1	Specifications for site investigation for building and civil engineering works	Specifications for the site investigation such as boreholes, test pits, soil and rock sampling, in-situ tests, and laboratory tests are described. The sample format for the preliminary borehole log is also shown.	Construction Industry Development Authority (CIDA) January 2017
2	Specifications for irrigation and land drainage works	Specifications for general irrigation and drainage construction works and repair works including temporary works such as dewatering are explained. Those include general information on structures, and of the works, material requirements and work methods.	CIDA May 2013
3	Specifications for water supply sewerage and storm water drainage works	Specifications for sewerage and storm water drainage construction works are explained. Those include concrete works, pipes, pumps, coatings, building works, treatment plans, electrical works, and so on.	CIDA April 2002
4	Specifications for bored and cast-in-situ reinforced concrete piles	Specifications for reinforced piling works are explained. Those include site conditions, material requirements, work methods, and pile testing.	CIDA February 2016
5	Standard specifications for construction and maintenance of roads and bridges	Specifications for road and bridge construction/maintenance work are explained. Those include site clearing, earthworks, surfacing, road construction, bridge construction, and those maintenance works.	CIDA June 2009
6	Specifications for coastal and harbor engineering works	Specifications for general coastal and harbor works are explained. Those include required surveys and investigations for construction, material requirement and work methods for concrete/steel piles, reclamation, dredging, and revetments. This specification also includes the one for the operation of quarries.	CIDA June 2008

Source: JICA Study Team

6.7.1.2 Design Guideline, Manual and Specification in Japan

Guidelines and manuals which may be referred for designing structures in the master plan and the pre-feasibility study are shown in Table 6.7.2.

Table 6.7.2 Design and Engineering Work Specification in Japan

No.	Title of Specification	Description	Compiler/Publisher and Issued/Revised month
1	Manual for Government Ordinance for Structural Standard for River Administration Facilities	This structural government ordinance following the river law is a technical standard required for planning and designing the river structures such as dams, embankments and other major facilities, and the river maintenance aiming at the conservation of the environment.	Japan River Association January 2000
2	Technical Criteria for River Works and those practical guides (Survey, Planning, and Design)	This standard is compiled for the technical issues required to survey, plan, design structures and maintain rivers, slopes and seashores.	Japan River Association June 2012 (Survey) March 2019 (Planning) July 2019 (Design)
3	Guideline for Structural Analysis on River Dike	This guideline explains concepts and design methods for dike reinforcement. Seepage, erosion and earthquake were introduced as external factors influencing the safety of the dikes.	Japan Institute of Construction Engineering February 2012
4	Manual for Mechanical Design of Revetment	The concept of the design method of revetment is explained.	Japan Institute of Construction Engineering November 2007
5	Basic Guideline and Policy for Disaster Rehabilitation to maintain the beauty of mountains and rivers	This guideline and policy describe the general steps of disaster rehabilitation in consideration of the natural environment.	Ministry of Land, Infrastructure and Transport June 2018

Source: JICA Study Team

6.7.2 Design Criteria

As mentioned in Clause 6.7.1, there is no design guideline, manual or specification for designing river or drainage structures in Sri Lanka. Those structures are generally proposed based on engineers' experiences and confirmed with stability calculations. This clause describes the general design concept of a dike and a revetment of river and drainage structure in Sri Lanka and defines the design concept which is applied in this study.

6.7.2.1 Dike Height

Dike height is the one at a design high water level heightened with a freeboard.

6.7.2.2 Freeboard

The minimum freeboard and the general freeboard empirically used in SLLDC are 0.2 m and 0.5 m, respectively. In Japan, the freeboard above the design high water level is set following the Government Ordinance for Structural Standard for River Administration Facilities as shown in Table 6.7.3. However, if the river channel opening is lower than the ground level, the heightening of a crest level only for these freeboards is not required as described in the ministry notice on the technical standard of river planning for small and medium-sized rivers. JICA 2003 M/P also applied these concepts. In 2018 F/S, a freeboard was set at 1.0 m with the design discharge of 85 m^3/sec to 108 m^3/sec.

Table 6.7.3 Design Flood Discharge and Freeboard

Design Discharge (m^3/s)	Freeboard (m)
Less than 200	0.6
Equal or above 200 and less than 500	0.8
Equal or above 500 and less than 2,000	1.0
Equal or above 2,000 and less than 5,000	1.2

Source: Government Ordinance for Structural Standard for River Administration Facilities

For the target rivers in this study, as mentioned in Clause 6.4.2, the design water levels are set around the elevation of the protected ground area. Due to this, the larger the freeboards are, the higher the risks caused by the flood exceeding the design level. Hence, in this study, the freeboard is set at 0.5 m, which is generally applied in SLLDC although it is smaller than the value in Table 6.7.3.

6.7.2.3 Crown Width

The minimum crown width in consideration with operation and maintenance works empirically used in SLLDC is 3 m. In Japan, the crown width is set following the Government Ordinance for Structural Standard for River Administration Facilities as shown in Table 6.7.4. JICA 2003 M/P applied the same concept for the crown width, although 2018 F/S required only 1 m for it. It seems that maintenance vehicles would be placed on the landside road, but not on the crown in 2018 F/S.

Table 6.7.4 Design Flood Discharge and Minimum Crown Width

Design Flood Discharge (m^3/s)	Minimum Crown Width (m)
Less than 500	3
Equal or above 500 and less than 2,000	4
Equal or above 2,000 and less than 5,000	5
Equal or above 5,000 and less than 10,000	6
above 10,000	7

Source: Government Ordinance for Structural Standard for Administration Facilities

In this study, referring to Table 6.7.4 and considering maintenance operation from the top of the crest, the crest width with a maintenance road of 3 m is set at 4 m. It is noted that there is an exceptional case of the crest width of 1.0 m with steel sheet pile retaining wall at the places where factories, etc. are adjacent to river channels and land cannot be secured widely.

6.7.2.4 Slope

Generally, SLLDC uses a slope of “1 to 1.5” with turf protection. When a large flow area is required at the narrow area, vertical gabion walls (with an angle of 6 degrees to 10 degrees from the vertical) are often used, concrete retaining walls can be also seen, and infrequently steel sheet piles were used for protection. The Government Ordinance in Japan shows the general slope at “1 to 2.0” or gentler with revetment if the slope stability is sufficient. Referring to the land use condition and the existing slopes, the slope can be varied from “1 to 0.5” to “1 to 2.0” to minimize the land acquisition at the built-up areas as long as the safety of slope stability is confirmed.

Referring to those aspects, in this study, the slopes protected by gabions or stone masonries are set at “1 to 0.5” and the ones for embankments are to be “1 to 2.0.”

PVC-coated gabion wire with a diameter of approximately 3 mm including PVC coat is often seen in the target area. However, in Japan, gabion wires with a diameter of 3 mm to 4 mm are used for a temporary purpose and the ones with 5 mm or above are used for a permanent structure.

In this study, considering ease of procurement and experience of construction in Sri Lanka, the most used PVC-coated gabion wire with a diameter of approximately 3 mm including PVC coat is applied for designing gabions.

Slope protection with turf and riprap

Gabion wall

PVC-coated gabion wire mesh

Source: JICA Study Team

Photo 6.7.1 Typical Slope Protection in the Target Area

6.7.2.5 Berm

There is no design rule for the berm of the slope in SLLDC and no slopes higher than 5 m are observed in the target area. In Japan, there are many cases of the berm at dikes with a height of 5 m to 6 m. According to the government ordinance, a berm with a 3 m width or wider is required if the slope is very high and the slope stability requires it. Otherwise, a gentler single slope needs to be designed.

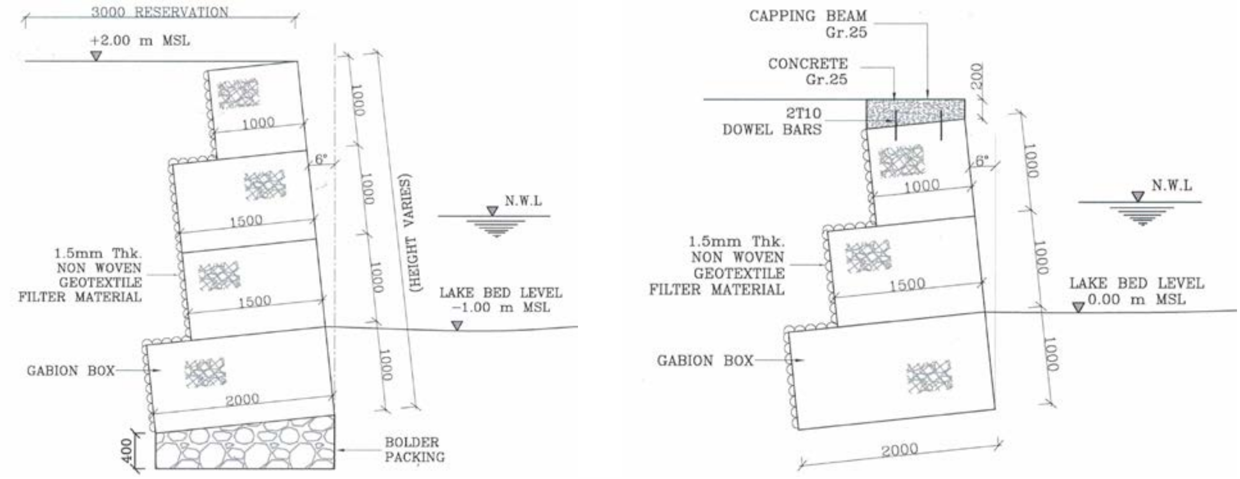
Referring to such facts, the berm with a width of 3 m was designed for the revetment whose height is over 5 m.

6.7.2.6 Design Seismic Coefficient

There is no design seismic coefficient since there is less earthquake in Sri Lanka.

6.7.2.7 Typical Cross Section

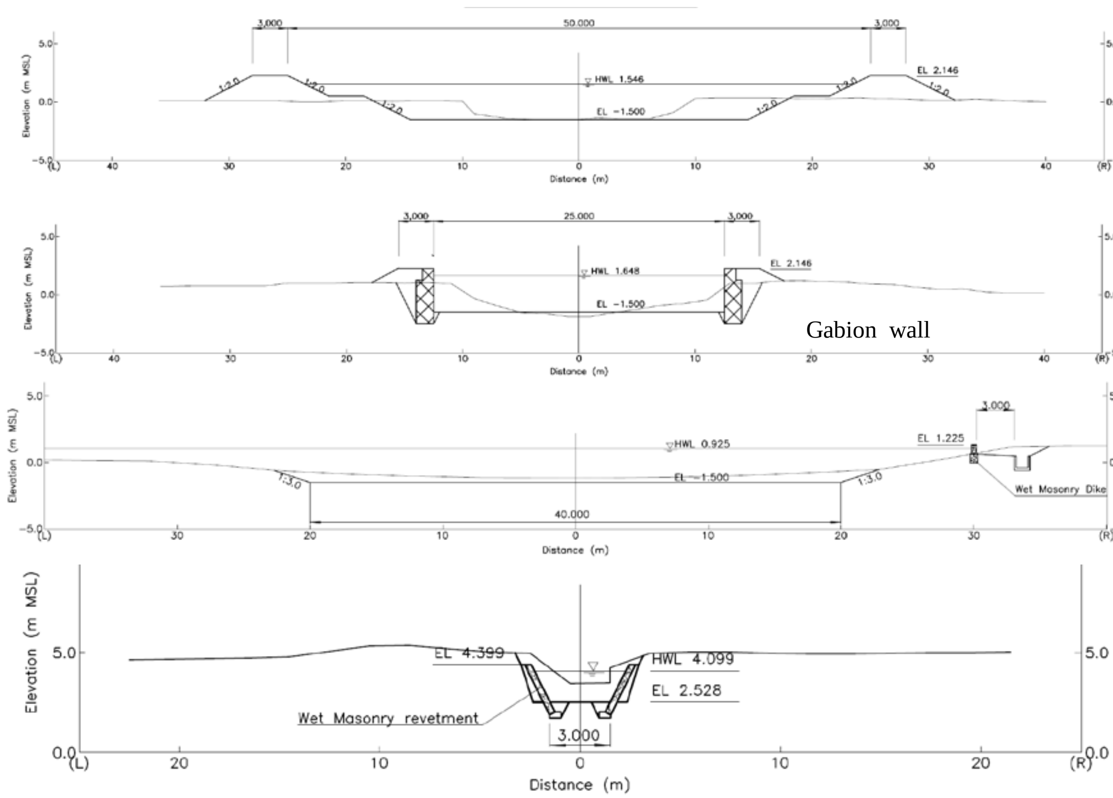
As mentioned in Clause 6.7.1.1, there are no common design standards for the slope protection of rivers and channels. However, some cross sections such as those in Figure 6.7.1 are shared in SLLDC. When slope protections are designed in SLLDC, those sections and loading conditions at each site are referred and updated sections with sufficient safety factors are proposed.



Source: SLLDC

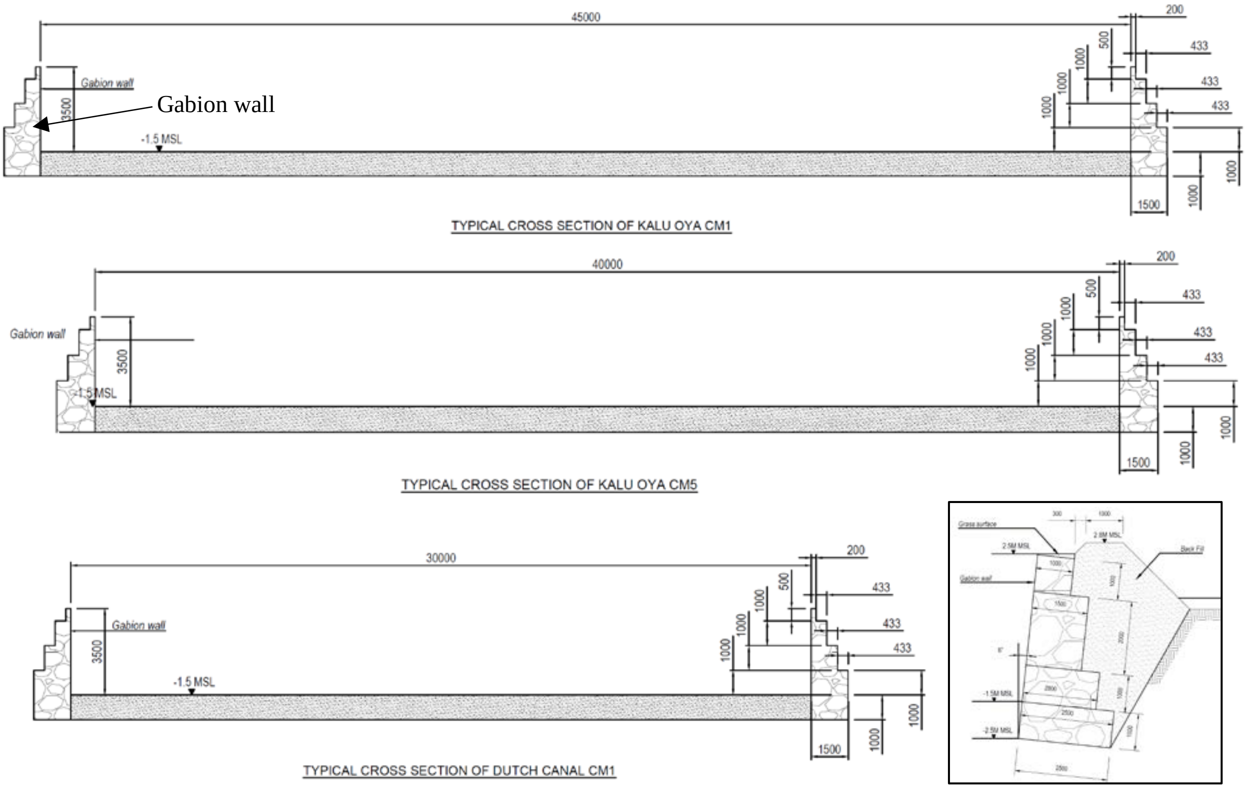
Figure 6.7.1 Typical Cross Sections in SLLDC

Figure 6.7.2 shows typical cross sections of the revetment proposed by JICA 2003 M/P and Figure 6.7.3 shows the ones by 2018 F/S. The ones for this study are introduced in Clause 6.7.3.1.



Source: JICA 2003 M/P

Figure 6.7.2 Typical Cross Sections in JICA 2003 M/P



Source: 2018 F/S

Figure 6.7.3 Typical Cross Sections in 2018 F/S

6.7.3 Rough Design

6.7.3.1 Embankment and Revetment

Referring to the design guidelines, the manuals and the specifications, the adaptable revetment structures were compared as shown in Table 6.7.5. Considering the structural feature of deformation along with the uneven settlement, the constructability, experiences of contractors, construction cost and ease of maintenance, the gabion wall is selected.

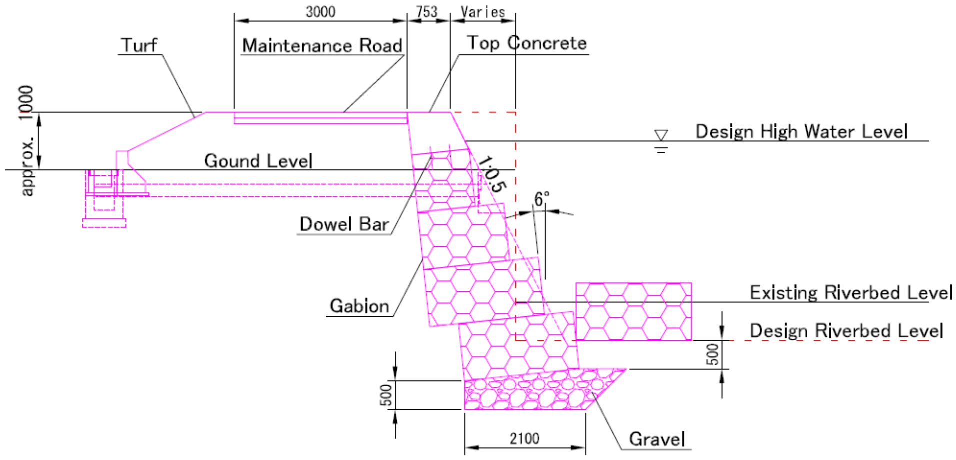
Table 6.7.5 Comparison of Revetment Type

Revetment Type		Type 1	Type 2	Type 3
		Gabion wall	Concrete retaining wall and foundation pile	Stonemasonry and foundation pile
Material		Boulder, PVC coated gabion mesh, cobblestone, concrete, steel bar	Reinforcing bar, concrete, cobblestone,	Boulder, filling concrete, back concrete, cobblestone, reinforcing bar, concrete,
Features		• Most popular type in the target areas • This type can be used for a permanent structure but is considered to last for 7 years only referring to the performance confirmed in the target area. Large-scale rehabilitation (replacement) would be required every 7 years. • The deformation of the wall caused by an uneven settlement will be fixed in every-7-year rehabilitation.	• This type can be seen at narrow channels in urban areas. • Permanent structure • Foundation piles (concrete) will be required as a measure against the uneven settlement.	• This type is infrequently seen in the target areas. • With a sufficient thickness of backfilling concrete, this type can be applied as a permanent structure. • Foundation piles (concrete) will be required as a measure against the uneven settlement.
Rough Direct Cost (LKR/m²)[1)]		57,800	170,300	131,000
		✓✓✓	✓	✓✓
Evaluation	Durability against flow	✓✓✓	✓✓✓	✓✓✓
	Landscape	✓✓	✓	✓✓
	Vegetation	✓✓	✓	✓✓
	Habitation	✓✓✓	✓	✓✓
	Constructa-bility	• <u>Simplest construction,</u> • <u>A short period of coffering is required.</u>	• Difficult construction • A long period of coffering is required for pile driving, reinforcement bar arrangement at the top of the piles, and pouring and curing of concrete at the lower part of the retaining wall.	• Difficult construction • A long period of coffering is required for pile driving, reinforcement bar arrangement at the top of the piles, pouring and curing of base concrete, and at the lower part of the stonemasonry.
		✓✓✓	✓	✓
	Economic efficiency	• <u>Lowest direct construction cost</u> • Requires large-scale rehabilitation (12,800 LKR/m²/time) for 7 times in 50 years (89,600 LKR/m² in total)	• Highest direct construction cost (3 times as high as the gabion wall type) • Low maintenance cost	• High direct construction cost (2.3 times as high as the gabion wall type) • Low maintenance cost
		Direct Construction 57,800 LKR/m² Maintenance[2)] 104,450 LKR/m² Total 162,250 LKR/m²	Direct Construction 170,300 LKR/m² Maintenance[2)] 42,575 LKR/m² Total 212,875 LKR/m²	Direct Construction 131,000 LKR/m² Maintenance[2)] 32,750 LKR/m² Total 163,750 LKR/m²
		✓✓	✓	✓✓
Image				
Evaluation result		✓✓✓	✓	✓

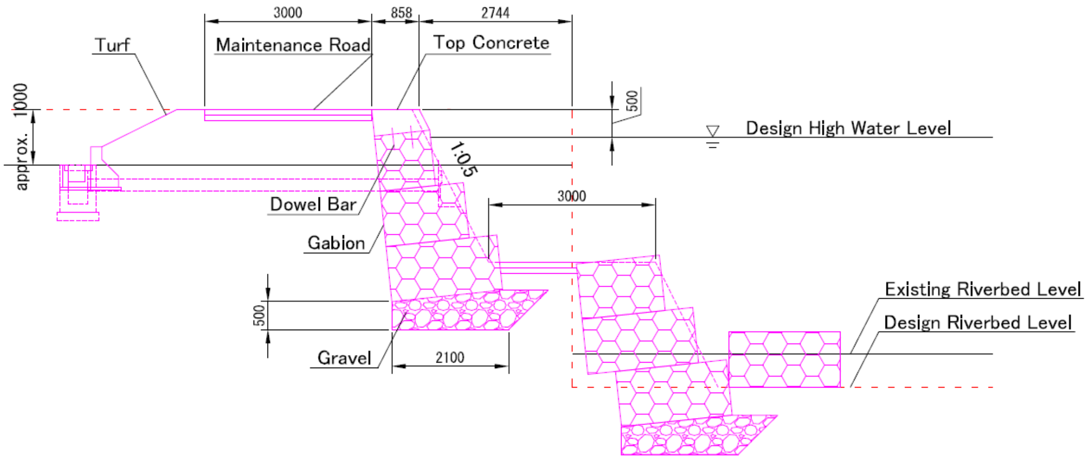
Note: ✓✓✓: excellent, ✓✓: good, ✓: poor, 1) The cost for temporary works is excluded, 2) Annual maintenance cost is assumed to be 0.5 % of the construction cost. Hence, the maintenance costs for 50 years for Type 1 2 and 3 are 57,800 x 0.5 (%) x 50 + 89,600 = 104,450 (LKR/m^2), 170,300 x 0.5 (%) x 50 = 42,575 (LKR/m^2) and 131,000 x 0.5 (%) x 50 = 32,750 (LKR/m^2), respectively.

Source: JICA Study Team

Although the gabion walls are often used as a temporary structure in Japan, they are commonly applied as permanent structures in Sri Lanka. Considering their performance in the target area, the gabion wall is considered to last 7 years in this project. Freeboard is set at 0.5m, which is generally applied in Sri Lanka. Crown width is set at 4.0m with 3.0m of the maintenance road excluding the locations where land acquisition is difficult.



(a) Without berm

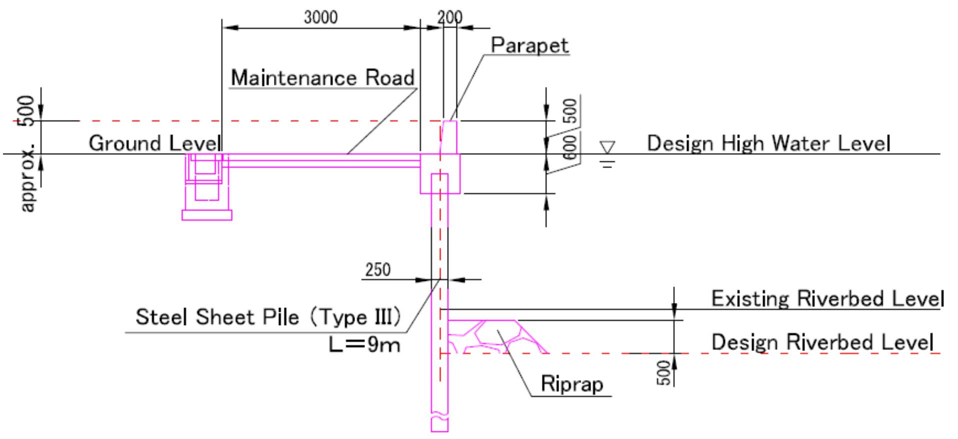


(b) With berm

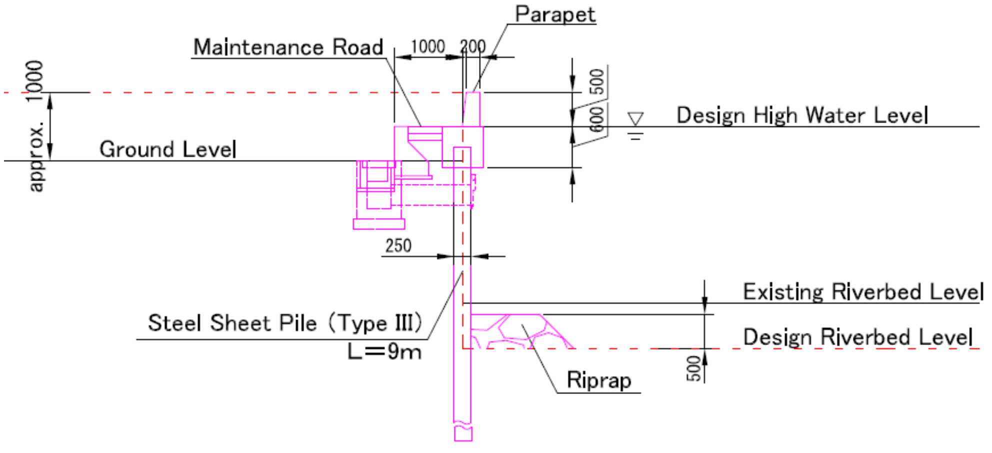
Source: JICA Study Team

Figure 6.7.4 Typical Cross Sections with Gabion

At the vicinities of factories and buildings, a steel sheet pile wall is proposed to minimize the land acquisition and assurance of the stability of the land.



(a) Where the land acquisition is not an issue



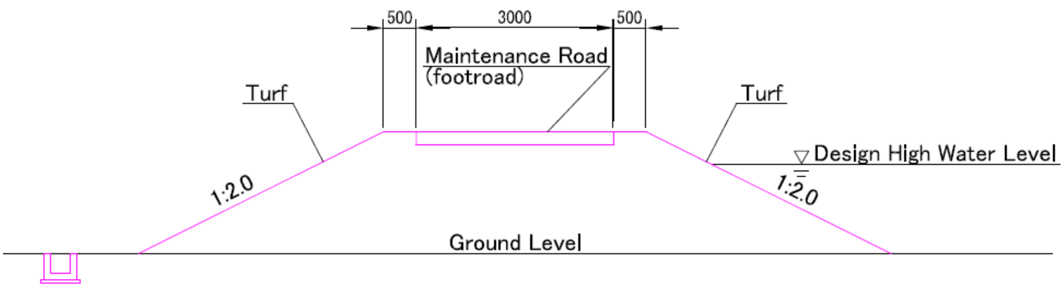
(b) Where the land acquisition is an issue

Source: JICA Study Team

Figure 6.7.5 Typical Cross Sections with Steel Sheet Piles

6.7.3.2 Dike (Surrounding Dike and Weras Ganga Right Bank Dike)

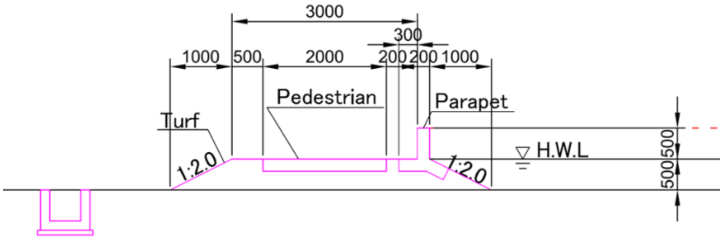
The surrounding dike at the upstream area of Kalu Oya and in the Bolgoda basin are earth dikes. Its slope is at “1 to 2” and covered with turf. Freeboard is set at 0.5 m and the crown width is 4 m with 3 m-maintenance road, as the ones for riverbanks. A berm is not required since it is not high. The typical cross section for the surrounding dike is shown in Figure 6.7.6.



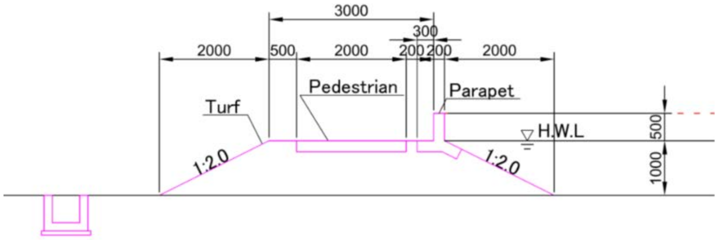
Source: JICA Study Team

Figure 6.7.6 Typical Cross Sections of Surrounding Dike

The dike at the right bank of Weras Ganga is proposed. It is proposed as earth embankment with the slope of “1 to 2.0” covered by a turf. Since the right bank of Weras Ganga is partially occupied by houses, narrow dike would be expected to have less negative impact on such houses. The lower dike is also expected to have less settlement of the dike body on the weak soil there. Hence, a concrete parapet which covers the freeboard of 0.5 m and the crest width of 3 m with a pedestrian road of 2 m are proposed. Basically, the dike is located at the ground level of 1.0 m, or at 0.5 m around the dense residential areas. The standard cross sections of the dike are shown in Figure 6.7.7.



(a) at the elevation of 1.0 m



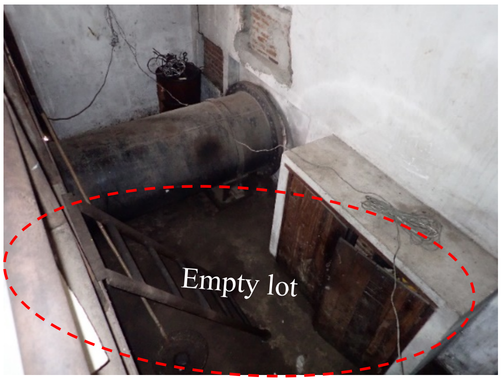
(b) at the elevation of 0.5 m

Source: JICA Study Team

Figure 6.7.7 Typical Cross Sections of Weras Ganga Right Bank Dike

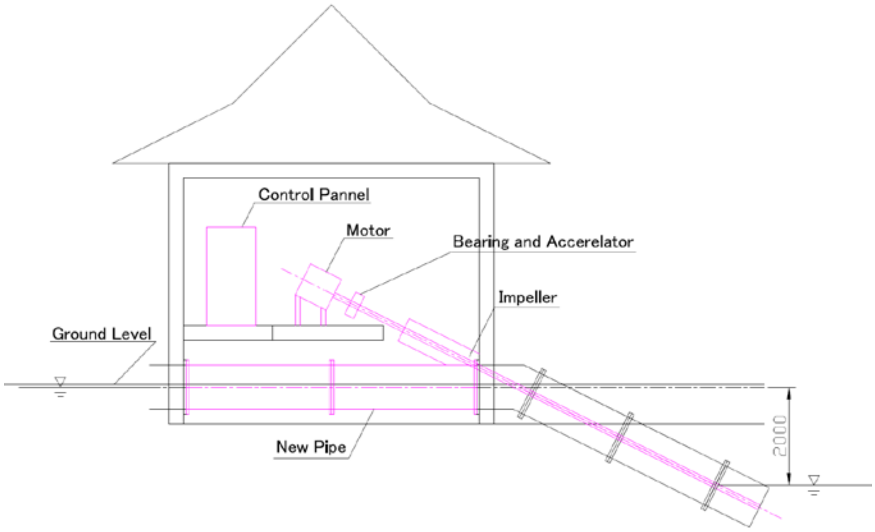
6.7.3.3 Pumping Station

At the Peliyagoda Pumping Station, a new pump with a discharge capacity of 1.0 m^3/sec and its equipment will be installed at the empty lot (refer to Photo 6.7.2). The type of this new pumping system is, as the existing one, an inclined screw pump. Although the existing pumping system with its discharge capacity of 0.5 m^3/sec will not be removed and be kept in operation, the total discharge is considered as 1.0 m^3/sec to be safe side.



Source: JICA Study Team

Photo 6.7.2 Existing Condition and Empty Lot at Peliyagoda **Pumping Station**



Source: JICA Study Team

Figure 6.7.8 Layout of New Pumping System

6.7.3.4 Closing Facility

As closing facilities, sluice gates are installed at Naranmini Oya and Natha Canal. The specification of the gates is shown in Table 6.7.6.

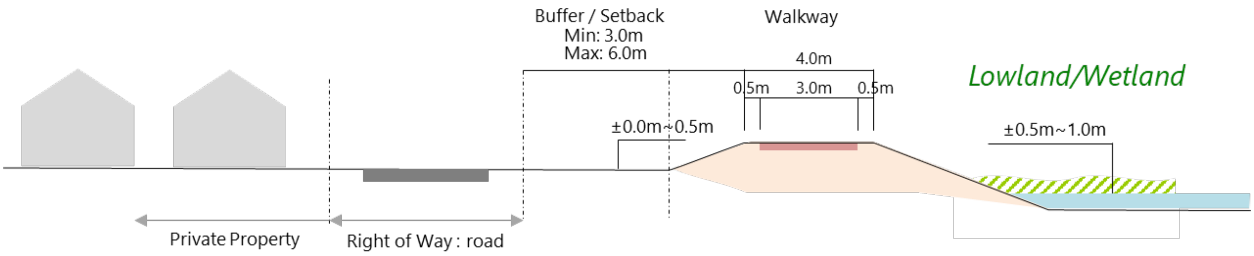
Table 6.7.6 Specification of Closing Facility

No.	Channel	Structure	Dimension
1	Naranmini Oya	Sluice gate	H = 1.5 m W = 2 m x 4 gates
2	Natha Canal	Sluice gate	H = 1.5m W = 2.5 m x 4 gates

Source: JICA Study Team

6.7.3.5 Natural Wetland Park

In order to maintain the current environment and retention effect of the natural wetland parks, core facilities such as sidewalks, small embankments and visitor centers shall be constructed. The small embankment will basically be an earth dike with its slope at “1 to 2” and covered with turf. The height of the embankment is approximately 0.5 m, the width of the crown is 4.0 m, and the width of the pedestrian is 3.0 m. No berm is required due to the height of the embankment. The standard cross section of the small bank is shown in Figure 6.7.9 (repost). The visitor center design shall be carried out at the time of detailed design.



Source: JICA Study Team

Figure 6.7.9 Concept Drawing of the Improvement of the Natural Wetland Park

6.7.3.6 Planned Retarding Basin

Dredging, sidewalks / small embankments, embankments along river channels, and overflow dikes will be constructed in the existing natural wetlands to be used as planned retarding basins. The small embankment will be basically an earth dike with its slope at “1 to 2” and covered with turf. The height of the embankment is varied from 0.5 m to 2.0 m, and the width of the crown is 4.0 m, of which the width of the pedestrian is

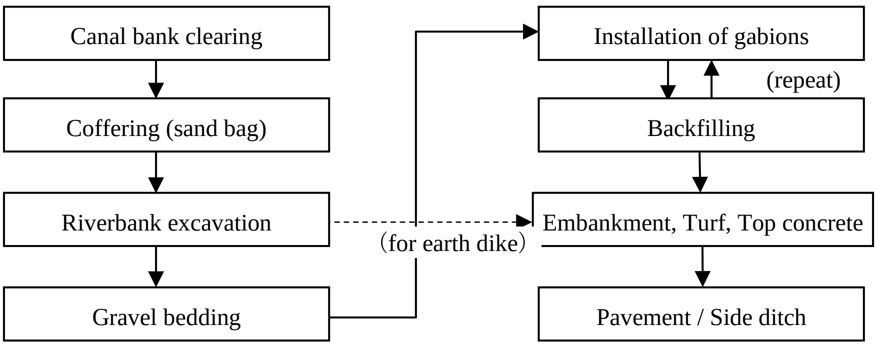
3.0 m. No berm is required due to the height of the embankment. In addition, a side-overflow dike is installed at the upstream end of each retarding basin, and a gate is installed at the downstream end. The margin of the reservoir capacity is set to approximately 15% referring to the Technical Criteria for River Works and those practical guides. In the future, the accuracy of the inflow hydro into the planned retarding basin and of the topographic survey of the retarding basin will be upgraded and an appropriate reservoir capacity will be calculated. In addition, the detailed structural design will be carried out at the detailed design stage.

6.7.4 Construction Method

6.7.4.1 Revetment and Embankment

(1) Gabion Wall and Embankment

Some parts of the target rivers and canals need embankments. The construction flow for the gabion walls and embankment are shown in Figure 6.7.10.

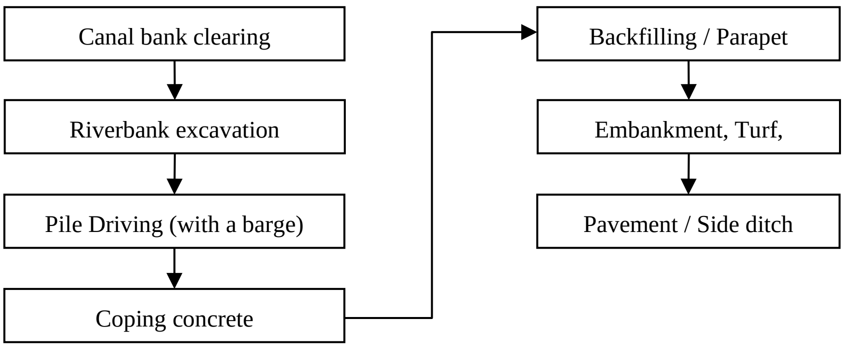


Source: JICA Study Team

Figure 6.7.10 Construction Flow of Gabion Wall and Embankment

(2) Steel Sheet Pile Wall

Construction flow for a steel sheet pile wall is shown in Figure 6.7.11



Source: JICA Study Team

Figure 6.7.11 Construction Flow of Steel Sheet Pile Wall

6.7.4.2 Improvement of Pumping Station

In this study, the rough design was prepared as shown in Figure 6.7.8 and was used for the price quote from a supplier. Detailed improvement plans, designs and construction methods will be studied in the future.

6.7.4.3 Closing Facility

In this study, the construction cost of sluice gates at Naranmini Oya and Natha Canal was calculated with area ratios of the gate bodies referring to similar projects in Sri Lanka. Detailed plan, design and construction methods will be studied in the future.

6.7.4.4 Bridge

Bridges need to be renovated in several places to obtain sufficient river sections. The construction cost was calculated based on the road plan area ratio referring to similar bridge construction projects in Sri Lanka.

6.7.4.5 Natural Wetland Park

The development of natural wetland parks shall be regarded as a government-led urban park sector project, and the detailed improvement plan and the construction plan shall be studied at the detailed design stage. In addition, since it is regarded as a project in another sector, the study on the construction plan and cost estimate is not included in this project.

6.7.4.6 Planned Retarding Basin

The planned retarding basin consists of dredging, sidewalks / small embankments, embankments along river channels, and overflow dikes. Dredging is assumed to be carried out from the land side and on the water, and the construction method of embankments is as shown in Clause 6.7.4.1. The design, the construction plan and the cost estimation of the overflow dike will be carried out at the detailed design stage.

6.7.4.7 Combination of Labor, Equipment and Material

A combination of labor, equipment and material in the derivations of the unit cost analysis results presented by SLLDC was used for this study. The hiring rates of plant and equipment presented by SLLDC are also applied for the cost estimation.

6.7.5 Overall Project Schedule

Figure 6.7.12 shows the overall project schedule of this project.

No.	Work Item	Target return period	2023	2024	2025	2026	2027	2028	2029	2030
1	FS -Mudun Ela sub-basin improvement (1)	10 years								
2	DD -Mudun Ela sub-basin improvement (1)									
3	Construction -Mudun Ela sub-basin improvement (1)									
4	FS -Weras Ganga Right Bank Dike	25 years								
5	DD -Weras Ganga Right Bank Dike									
6	Construction -Weras Ganga Right Bank Dike									
7*	FS -Moratuwa-Rathmalana area improvement*	studied in Pre-F/S								
8*	DD -Moratuwa-Rathmalana area improvement*									
9*	Construction -Moratuwa-Rathmalana area improvement									
10	FS -Kalu Oya basin improvement	25 years								
11	DD -Kalu Oya basin improvement									
12	Construction -Kalu Oya basin improvement									
13	FS -Mudun Ela sub-basin improvement (2)									
14	DD -Mudun Ela sub-basin improvement (2)									
15	Construction -Mudun Ela sub-basin improvement (2)									
16	FS - Bolgoda basin improvement (the others)									
17	DD - Bolgoda basin improvement (the others)									
18	Construction -Bolgoda basin improvement (the others)									

Note: Improvement at the Moratuwa-Rathmalana area is shown here for comparison purposes although it is not included in the M/P.

Source: JICA Study Team

Figure 6.7.12 Overall Project Schedule

6.7.6 Basic Information for Cost Estimation

6.7.6.1 Cost Estimate by SLLDC for Locally Funded Project

Generally, a project cost consists of civil works, consultant service for detailed design and construction supervision, administration cost, price and physical contingencies, compensation cost and taxes. Examples of the project cost estimated by SLLDC were collected and the following features are clarified.

- The cost for the civil work is calculated by multiplying quantities and corresponding unit prices.
- When SLLDC does not operate construction by itself and private contractors do, 17% is added to the unit prices as indirect cost and benefits.
- When SLLDC operates the construction directly, no portion is added to the unit prices but the management fee for SLLDC is added at 17% on the total cost for treasury projects, which are funded by the GOSL or 25% for the other funded projects.
- Since SLLDC can conduct detailed design and construction supervision, a subcontract is not required for small-scale projects. Since this project is very large, the budget for detailed design and construction supervision is empirically calculated at six percent (6%) of the construction cost.
- Administration cost is considered to be included above mentioned six percent (6%).
- VAT is applied and its rate is eight percent (8%).

As references, the latest unit price analysis containing unit prices for the general drainage construction/improvement works, two cost estimation results for bridge construction projects and one result for a pumping station construction project were provided by SLLDC.

6.7.6.2 Basic Conditions of Cost Estimate

(1) Price Level

The cost estimate is at the price level as of December 2022. However, since price fluctuations caused by the recent economic crisis are considered to be temporary, fluctuations in exchange rates and price increases in recent years regarding the Sri Lankan Rupee are not taken into account. Specifically, the exchange rate was set based on the average value from November 11, 2019 to February 10, 2020, and price increases after this period were not considered.

(2) Exchange Rate

The monthly average exchange rate between the Japanese yen (JPY) and the United States Dollars (USD) was referring to the central rate information issued by the Bank of Japan. The one between Sri Lankan Rupees (LKR) and the United States Dollars (USD) was referring to the central rate information issued by the Central Bank of Sri Lanka. As a result, the average rates (1 LKR = 0.603 JPY, 1 USD = 109.12 JPY, hence, 1 USD = 181.06 LKR) were applied in this project.

(3) Currency for Cost Estimates

The project cost component will consist of local and foreign currency portions. Sri Lankan Rupee will be used to express both the local and foreign currency portions. The classifications of local and foreign currency portions are given below.

1) Local Currency Portion

- All labor cost
- A part of the cost of construction materials
- A part of the cost of the equipment lease
- Value Added Tax (VAT)

2) Foreign Currency Portion

- A part of the cost of construction materials that require international quality
- A part of the cost for equipment lease and services that require international quality

The ratio of the local currency portion and foreign currency portion was defined in the M//P and it is also applied in the Pre-FS.

Table 6.7.7 Ratio of Foreign Currency Portion and Local Currency Portion for Labor, Material and Equipment

Item	Foreign Currency	Local Currency
Labor	0	100
Equipment	70	30
Material		
Fuel and Lubricant	80	20
Wood/Stone/Sand	0	100
Crushed/ Uncrushed gravel	0	100
Cement	80	10
Re-bar	90	10
Structural Steel	90	10
Chemical Product	90	10

Source: JICA Study Team

(4) The Methodology of Cost Estimate

Costs for the main construction works such as embankment and revetment are essentially estimated on a unit price basis. The cost for the Peliyagoda Pumping Station improvement is calculated based on the price quote from a supplier. The construction cost of the closing facilities, or, sluice gates at Naranmini Oya and Natha Canal was calculated with area ratios of the gate bodies referring to similar projects in Sri Lanka. The construction cost of bridges was calculated based on the road plan area ratio referring to similar bridge construction projects in Sri Lanka.

The main items of the project cost are construction cost, the cost for engineering services, contingencies, administration cost, land acquisition cost and compensation cost, and Value Added Tax (VAT).

The composition of the project cost is described below.

1) Construction Cost

(a) Direct Cost

The direct cost consists of a labor cost, a material cost and an equipment cost. The combination of these costs is proposed by referring to the latest unit price analysis.

(b) Contractor's Indirect Cost

Indirect cost and the benefit of the contractors are estimated at 17% of the direct cost and those are added to the unit prices.

(c) Preparation Cost

The cost of preparation work before and after the main construction work is required. The preparation work is for mobilization, demobilization, health and safety plan and measures, preparation of access roads, leveling for a crane, geotechnical investigations, and so on. Referring to some facts which generally show four percent (4%) to 10% of the direct and indirect cost for the preparation works, it is set at five percent (5%) in this study.

(d) Other Expense

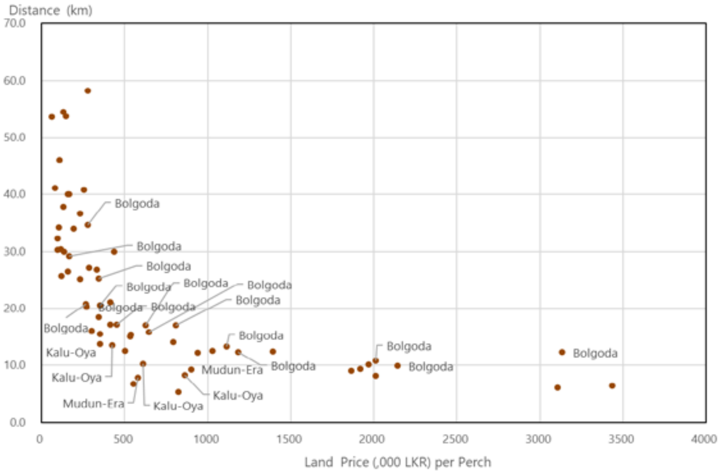
This cost estimation is based on the design at the M/P level so that the costs of detailed works and structures are not included. To cover those costs, an additional l0% on the direct and indirect costs are estimated.

2) Engineering Service

As described before, SLLDC can conduct detailed design and construction supervision for small-scale projects. Since this project is large and it covers large areas, the budget for detailed design and construction supervision is empirically estimated at 6% of the construction cost.

3) Cost for Land Acquisition and Compensation

The cost of land acquisition is usually calculated with the land value multiplied by its area after the parcellary survey and the study on the market values of the land. However, since this cost estimation is for the M/P, a simplified method is applied. Firstly, land of 1m in a residential or commercial area and of 3 m in an agricultural area or other natural areas from the top of riverbanks are considered as public land and areas exceeding those limits are to be acquired. Secondary, the land price, excluding marsh areas in the north part of Old Dutch Canal with its length of 2,070 m in the Kalu Oya basin, and paddy fields at the upstream area of Alut Ela with its length of 710 m and at the protective diking systems in the Bolgoda basin, is set at 39,400 LKR/m^2 (1 million LKR/perch) referring to Figure 6.7.13.



Source: JICA Study Team

Figure 6.7.13 Average Land Price in the Key Locations in the Western Province (2019)

The land prices of the areas excluded in the previous paragraph are as shown in Table 6.7.8 referring to the data provided by Lands and Marketing Division, SLLDC.

Table 6.7.8 Land Price of Marsh Area and Paddy Field at Selected Area (August 2019)

No.	Target area	Applied area for land price	Applied land type	Land price (LKR/perch)	Land price (LKR/sq.m)
1	North part of Old Dutch Canal (2,070 m)	Wattala (as substitution)	Marsh	20,000	590
2	Upstream area of Alut Ela (710 m)	Kalutara (as substitution)	Paddy field	10,000	390
3	Protective diking system	Bandaragama, Kalutara (as substitution)	Paddy field	10,000	390
		Kesbewa	Paddy field	15,000	590

Source: Lands and Marketing Division, SLLDC

The compensation cost is generally affected by the structure and the usage of the buildings. This study, it is obtained from the multiplication of the compensation per area and the affected area of the acquiring buildings. The compensation per area is obtained referring to the resettlement action plan for the "Rehabilitation of St. Sebastian South Canal" project, which is a part of MCUDP. Regarding the target area, if the affected area is less than 10% of the building, only an affected area is considered to be acquired. If not, the whole building is considered to be acquired. Table 6.7.9 shows the compensation per area for this project.

Table 6.7.9 Building Compensation per Area

No.	Type of building	Rate in 2013 (LKR/Sq. ft.)	Rate in 2013 (LKR/Sq. m)	GDP deflator from 2013 to 2018	Rate in 2018 (LKR/Sq. m)
1	Zinc roof on GI pipe support, Cement block wall only for the front side	170	1,800	1.2255	2,200
2	Asbestos roof with PVC gutters, Cement block walls with plastering and color washing. Cement floor, zinc roof, timber doors and timber slashed windows	1,750	18,800	1.2255	23,000
3	Cement slab roof, brick/cement walls with plastering and color washing. Cement floor, timber doors and timber windows	2,200	23,700	1.2255	29,000

Source: Resettlement Action Plan (RAP) Rehabilitation of St. Sebastian South Canal (under MCUDP), JICA Study Team

4) Administration Cost

Administration cost includes expenses for the project management office operated by the SLLDC. It is estimated at two percent (2%) of the sum of the construction cost, engineering service cost, and land acquisition and compensation cost.

5) Price Contingency

The price contingency for foreign currency was set at zero percent (0%) and the one for the local currency was set at four-point three percent (4.3%) referring to the GDP deflator.

6) Physical Contingency

The physical contingency is set at 10% of the above-mentioned costs referring to the examples in SLLDC.

7) VAT

VAT is set at fifteen percent (15%).

(5) Project Cost

The summaries of total project costs are shown in Table 6.7.10 and Table 6.7.11.

Table 6.7.10 Project Cost for Kalu Oya Basin and Mudun Ela Sub-basin

(million LKR)

Item	Kalu Oya Basin			Mudun Ela Sub-basin		
	F.C.	L.C.	Total	F.C.	L.C.	Total
Construction Cost	5,576	2,554	8,130	1,116	980	2,096
Engineering Service	335	153	488	67	41	108
Land Acquisition and Compensation	0	3,453	3,453	0	1,587	1,587
Administration cost	0	227	227	0	59	59
Physical Contingency	591	753	1,344	118	292	410
Price Contingency	0	1,372	1,372	0	312	312
VAT	0	1,700	1,700	0	439	439
Total	6,502	10,212	16,714	1,302	3,709	5,011

Source: JICA Study Team

Table 6.7.11 Project Cost for Bolgoda Basin and Total Area

(million LKR)

Item	Bolgoda Basin			Total Area		
	F.C.	L.C.	Total	F.C.	L.C.	Total
Construction Cost	2,010	4,185	6,195	8,703	7,718	16,421
Engineering Service	121	251	372	522	445	967
Land Acquisition and Compensation	0	2,628	2,628	0	7,668	7,668
Administration cost	0	237	237	0	523	523
Physical Contingency	213	832	1,045	922	1,877	2,799
Price Contingency	0	1,594	1,594	0	3,278	3,278
VAT	0	1,288	1,288	0	3,427	3,427
Total	2,344	11,015	13,359	10,147	24,936	35,083

Source: JICA Study Team

6.7.7 Applicable Japanese Technology

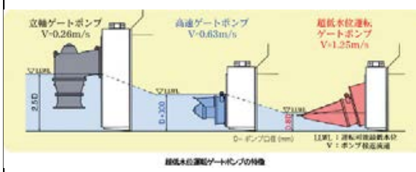
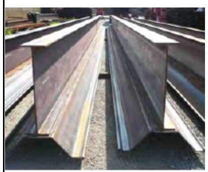
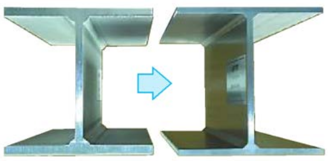
This clause studies the application of the following Japanese technologies, which are studied or used in the construction or procurement of revetment, gates and bridges.

1. Non-staging Press-in System for steel sheet pile driving at a narrow area
2. Gate pump
3. Hat-type and H-shaped combined steel sheet pile for revetment
4. Alloy-saving two-phase stainless steel material for a gate
5. High-performance steel for a bridge

6.7.7.1 Features of Target Japanese Technologies

The features of the target technologies are summarized in Table 6.7.12. Referring to this result, further study on the application of a non-staging press-in system for steel sheet pile driving at a narrow area is conducted.

Table 6.7.12 Features of Target Japanese Technologies

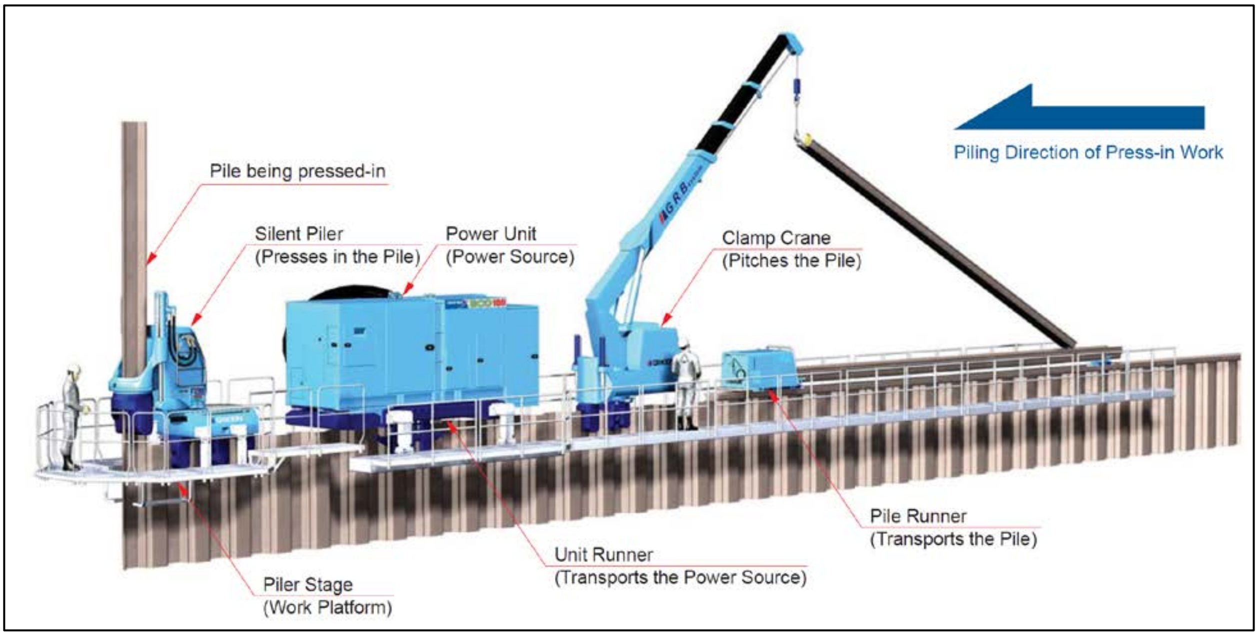
Method	Feature	Image	Applicability
Non-staging Press-in System for steel sheet pile driving at a narrow area	- A large construction yard and temporary works are not required because all the construction machines involved in the press-in process of steel sheet piles proceed on the top of the driven sheet pile as the work path. - A construction method that enables to drive steel sheet piles in the narrow area, with less disturbance to the surrounding residents and structures.		In urban areas in the target basins, construction is required adjacent to private houses and factories, so it is useful to study the applicability of this method. ✓
Gate pump	- The land area required for the pumping station has been reduced by integrating the sluice gate and pump. - There is also an extremely low water level operation gate pump that drastically lowers the operational lowest water level.		In the M/P study, there was no problem with the land area and water level regarding the installation of pump equipment. x
Hat-type and H-shaped combined steel sheet pile for revetment	- H-type steel is welded to the back of the hat-shaped sheet pile to increase the rigidity of the steel sheet pile. - Depending on the cross section, an anchoring sheet pile is not required, making it effective for construction in narrow areas.	 	In the M/P study, no cross section under the severe conditions required the Hat-type and H-shaped combined steel sheet pile. x
Alloy-saving two-phase stainless steel material for a gate	- Stainless steel with a duplex structure of austenite and ferrite. It shows high strength and corrosion resistance. - Weight reduction (40% weight reduction compared to stainless steel) and labor-saving in maintenance and management for gate doors, etc. can be done.		In the M/P study, there was no large door body that would be effective for reducing its weight and labor-saving in maintenance, despite the high unit price of the alloy-saving duplex stainless steel. x
High-performance steel for a bridge	- Expansion of bridge span length (omission of bridge piers) and maintenance-free by adopting special material of bridge (high-performance steel material for bridge)	 	The construction cost is obviously higher than that of a normal concrete bridge. x

Note: ✓: possible, x: impossible
Source: JICA Study Team

6.7.7.2 Non-staging Press-in System for Steel Sheet Pile Driving

The non-staging press-in system does not require temporary work because all the construction machines involved in the press-in process proceed with the top of the driven piles as the work path. Therefore, it does not have a big disturbance on the flow area of a channel and the surrounding buildings even in a residential dense area or the main road with a high traffic volume.

The concept figure of this method is shown in Figure 6.7.14.



Source: Pamphlet issued by GIKEN LTD.

Figure 6.7.14 Concept of Non-staging Press-in System for Steel Sheet Pile Driving

6.7.7.3 Comparison of Non-staging Press-in System and Ordinary Method

The comparison result is shown in Table 6.7.13. From this result, the non-staging press-in system is not economically efficient to apply.

Table 6.7.13 Features of Target Japanese Technologies

Item	Summary	
	Driving from the riverside on a barge	Non-staging press-in system
Target area	Steel sheet pile wall at narrow areas: (both bank, cumulative length, one sheet length = 9m) Kalu Oya: 3.11 km for each bank (6.22 km in total), Old Dutch Canal: 0.88 km for each bank (1.72 km in total), Old Dutch Canal Diversion: 0.33 km for each bank (0.66 km in total), Steel sheet pile wall at narrow areas: (left bank only, one sheet length = 6m) Mudun Ela: 0.10 km, in total: 8.7 km	
Construction Cost	Approx. 3,536 million LKR (= 45,120 (LKR/m^2) x 78,360 (m^2))	Approx. 5,131 million LKR Approx. 4,254 million LKR (Construction cost) (= 54,284 (LKR/m^2) x 78,360 (m^2)) +869 million LKR (procurement of equipment) +8 million LKR (transportation of equipment)
	✓✓	✓
Disturbance to the surrounding area	- A large land area is not required since the sheet piles are driven from the riverside. - General driving method. Considerations and attention such as monitoring of vibration and noise should be paid for smooth implementation.	- A large land area is not required since all the construction machines involved in the press-in process proceed with the top of the driven piles as the work path. - Since it is a press-in method, it suppresses vibration and noise to surrounding areas,
	✓	✓✓
Evaluation result	Monitoring can mitigate environmental inferiority, economically superior. ✓✓	Environmentally superior but too expensive ✓

Note: ✓✓: good, ✓: poor
Source: JICA Study Team

6.8 Urban Development Management for Storm Water Drainage Management

6.8.1 Principles for urban development management supports

- Urban development management would support and enhance the storm water drainage management in the Colombo Metropolitan Region in line with the development policies and goals (resilient region, livable physical environment) in the government development plans[3].
- Urban development management aims to assist the functionalities of storm water drainage management consisting of 1) water channel function to drain rainwater fluidly, 2) retention function for prolonged rainwater storage, 3) retarding function for temporal rainwater storage and 4) functions for retention and infiltration of rainwater on-site.
- Urban development management aims to play an essential role in preventing or mitigating flood risks and integrating and sustaining countermeasures toward the 2030 target year by multiple approaches such as land use control and management based on elaborated risk assessment, strategic measures in cooperation with relevant stakeholders, local community participation and cooperation.
- SLLDC aims to encourage urban development management for its core competence by 1) flood mitigation and management by storm water drainage management, 2) wetland conservation and management, 3) contribution to living environmental quality improvement, through enhancement and upgrading the functions of SLLDC and coordination and cooperation with relevant authorities.

Table 6.8.1 Required Supports by Urban Development Management for Storm Water Drainage Management and Roles of SLLDC and Relevant Authorities

Urban Storm Water Management Function	Required Supports through Urban Development Management	Function and Role of Relevant Authorities for Storm Water Drainage Management					
		SLLDC	UDA	ID/ADD	CEA	DMC	LGA
1.Water Channel Function	Development control of easement of facilities to keep channel function	●	○	●	○	--	◎
2. Retention Function	Securing retention ponds by zoning regulations or active development	●	○	●	○	--	◎
3. Retarding Function	Conservation and development control for lowlands /wetlands	●	◎	●	●	--	◎
4. Infiltration Function	Securing certain areas for parks and open spaces	◎	◎	○	○	--	●
(water quality control)	Natural environment conservation	◎	◎	○	●	--	●
(Flood Risk Management)	Development control in risk areas and guide for land use of park & open space and public facilities	◎	◎	◎	○	●	●

Legend: ● =Responsible authority、◎=cooperative or supplemental、○=indirect relationship
UDA: Urban Development Authority, ID/ADD: Irrigation Department and Agrarian Development Department, CEA: Central Environmental Authority, DMC: Disaster Management Center, LGA: Local Government Authority
Source: JICA Study Team

6.8.1.1 Urban development management issues for storm water drainage management

The issues on urban development management support for storm water drainage management are identified as follows, taking account of the effective promotion of the principles aforementioned.

(1) Urban management issues on wetlands/lowlands for sustaining retarding function

In the target basins, urban sprawls by population increase recently have caused settlement damages increased by floods, where illegal or unsuitable land fillings for settlements and agricultural cultivation have happened in lowlands and wetlands as flood-risk areas apart from low flood-risk urban settlement

[3] National Physical Planning Policy and the Plan 2050 (2018), Western Region Megapolis Master Plan 2030 (2016)

developments. (as fact: lowlands/wetlands decreased 23% areas in the Kalu Oya basin, 41% in the Mudun Ela sub-basin and 18% in the Bolgoda basin from 2014 to 2018).

To conserve and promote the wise use of lowlands and wetlands, taking account of a complex environmental function for the sustainable natural environment, agriculture land in addition to the retarding function, urban development management support issues in the target basins are outlined below.

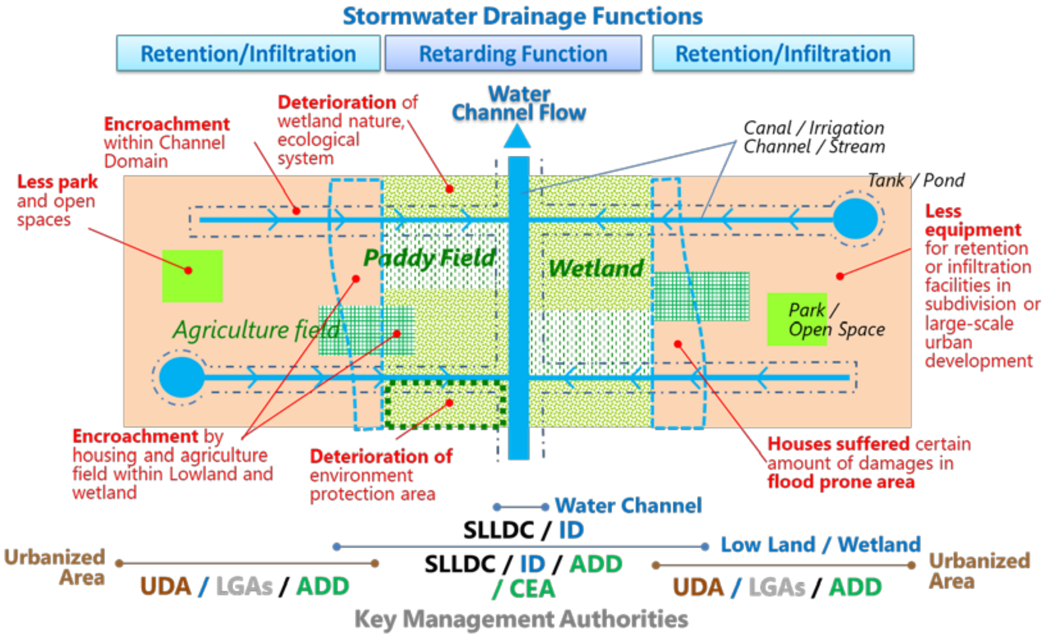
- **Effective measures requisite for preventing unsuitable landfilling:** Borderline demarcation and notice-based conservation management are institutionally positioned in lowlands/wetlands conservation, however, most of the wetlands are unbounded due to the difficulty of quantitative response for vast wetland conservation in the target basins. The situation of difficulty in specifying the physical boundaries of lowlands/wetlands for the government, private sector, and citizens may cause to exacerbate illegal development or activities without compliance with administrative procedures. Effective physical prevention measures for vast lowlands/wetlands against unsuitable landfilling have become an urgent issue.
- **Importance of wise utilization focusing on the multipurpose function of wetlands**: The living environment in most of the target basins lacks recreational facilities and park spaces. On the other hand, lowlands/wetlands occupying a certain scale in the basin (14% of the Kalu Oya & the Mudun Ela sub-basins and 21% of the Bolgoda basin), could be utilized as valuable public green spaces with recreational functions in the basins. How to utilize the lowlands/wetlands wisely becomes a critical issue to determine whether lowlands/wetlands can be sustained and conserved through potential use by a recreational space, enlightenment/education of rainwater drainage, and greenery or paddy conservation in terms of well-organized maintenance and operation.
- **Inevitable basic environmental information preparation for effective management:** In lowlands/wetlands, a comprehensive understanding of environmental functions is not sufficient in terms of quantitative identification of paddy field use, land ownership, etc. The development of basic environmental information for the management of lowlands/wetlands enabling effective and accurate planning and implementation of conservation and utilization is an urgent issue.
- **Wetland necessary to promote integrated management and strengthen the management capacity of local governments:** Although the planning committee at the local government level (Agricultural Administration Bureau, Irrigation Department, Central Environment Agency, SLLDC, and local government) manages coordination and decision making organization for conservation and utilization of lowlands/wetlands, current circumstances of the management system are not effective and efficient due to the devolution of development licenses power to vulnerable local governments under decentralization, the lack of consistent implementation among related organizations in an integrated manner. There is a need to promote goal-based collaboration for conservation and utilization on lowlands/wetlands and strengthening of local government management capacity.

(2) Urban management issues for improving urban storm water drainage functions

- **Water channel easement requisite for prevention from illegal developments:** Undesirable structures and land use within the property or easement of water channels in association with illegal waste dumping have become obstacles for efficient function and maintenance of the channels and improvement of the channel’s capacity together with deteriorations of the water landscape. The enhancement of building control and improvement in the property or easement for the water channel has become one of the critical issues for urban development management to normalize the function of water channels and to formulate attractive water and green environment.
- **Retention and infiltration measures necessary to expand into large developments:** The regulations or controls for retention and infiltration on the site development were limited to individual building development clearance/inspection. Further standards and regulations of

retention and infiltration function in large-scale development or subdivision have been required to introduce to promote supportive urban management widely for effective storm water drainage management. As the amendments of the UDA Act in July 2021[4] covers these issues where land development over a certain extent is mandated by the installation of systems for drainage, open space and infiltration. However, retention function in each lot development should be promoted as a lacking element in the improved Act even if it is voluntary based.

- **Decreasing green areas and open spaces requisite to be urgently protected and secured:** Green and open spaces have faced critical circumstances due to rapid urban sprawls especially in the Kalu Oya basin and the southern part (Kalutara District) of the Bolgoda basin with largely remained green areas with an important infiltration function. Securing green and open spaces is an essential issue to be solved immediately for resilient urban development with effective storm water drainage management.



Source: JICA Study Team

Figure 6.8.1 Conceptual Diagram of Issues for Urban Development Management for Storm Water Drainage Management

(3) Urban management issues for mitigating flood and inundation damages

- **The necessity of mainstreaming risk-sensitive land use planning and development regulations:** Some of the latest district development plans in the Colombo metropolitan area have incorporated flood risk analyses into land-use planning, but regulatory measures on risk areas in the zoning plans are not described particularly. To harness zoning and regulation to mitigate flood damage risks effectively, it is essential to analyze risk areas and exposures such as buildings and infrastructure by highly accurate flood hazard maps. Standardization of risk analysis methods and effective regulative measures into development and zoning planning processes are required to mainstream risk-sensitive development plans.

- **Needs for hazard-resistant buildings and regulations to reduce the increasing flood damages:** The flood/inundation damages including compensation costs in the Colombo metropolitan area have increased in recent years due to urbanization increased in flood/inundation risk areas. Promoting flood-resistant buildings and strengthening new development regulations in the high-risk flood areas together with peoples' understandings about them are considerable challenges to ensure the safety of living spaces and to reduce economic losses by disasters.

[4] Gazattee 2234/54, Urban Sevelopment Auhotiry Act No. 41 of 1978 of the National State Assembly, 2021-07-08

- **Comprehensive approaches necessary to be promoted against stalled resettlements:** The promotion programs for disaster-resisting building construction in disaster-risk areas of Sri Lanka have not progressed sufficiently due to a lack of people’s understanding and financial aspects of building owners. In this context, resettlement programs have been given to priority, however, the projects of resettlement also have not been satisfied due to the difficulty of substitutive lands for the resettlements. To promote successful resettlements of residents in high flood-risk areas, a comprehensive approach, including urban development, such as coordinating housing development projects throughout the basin is required.

6.8.1.2 Urban Development Management Measures for Storm Water Drainage Management

According to the issues identified on urban development management for storm water drainage management, three-pillar programs including nine sub-programs are proposed as follows, taking account of the core competence of SLLDC and coordination and cooperation with relevant authorities.

(1) Program (A) to enhance lowlands/wetlands conservation and utilization

Three sub-programs of urban development management supporting for storm water drainage management of 1) development of “Natural Wetland Park”, 2) consolidation of wetland management and 3) enhancement of LGAs’ capacity for development control and permits are proposed to address the issues on urban management for lowlands/wetlands as shown in Table 6.8.2 indicating also key roles of SLLDC, target basin, and potential funding sources.

Table 6.8.2 Program (A) to Enhance Lowlands/Wetlands Conservation and Utilization in the Basins

SLLDC Core Competence	Urban Management Supporting Sub-Programs	Key Components or Activities	SLLDC Implementation Initiative	Applied Basin			Potential Project Funding
				KO	ME	BG	
WLM/ FMM / LEI	A1. Development of Natural Wetland Park	Develop peripheral footpath/berm	●	✓	✓	–	National budget or Donor Assistance
		Develop thematic visitor centers	◎ (w/multi)	✓	✓	–	
WLM	A2. Consolidation of Wetland Management	Apply overlay regulation (enhanced) to wetlands	○ (UDA)	✓	✓	✓	National budget
		Formulate wetland inventory/database	●	✓	✓	✓	National budget
		Establish Wetland Committee at the local level	◎ (w/multi)	✓	✓	✓	National budget
WLM	A3. Enhancement of LGA’s Capacity for Development Control and Permit	Strengthen the development and control capacity of Local Government Authorities (LGAs)	○ (UDA/LGAs)	✓	✓	✓	National Budget

Note: SLLDC core competence: FMM = flood mitigation and management, WLM = wetland management, LEI= living environment improvement, Implementation initiative: ●=SLLDC initiative ◎= cooperation and collaboration with other authorities, ○= other authorities initiative, KO = Kalu Oya basin, ME=Mudun Ela sub-basin, BG=
Source: JICA Study Team

(2) Program (B) to strengthen storm water drainage functions in the basins

To address the issues on enhancing the function of storm water drainage in the basin, four sub-programs of 1) natural water retarding area designation and management as one of the storm water drainage plan, 2) canal property/easement improvement, 3) promotion of on-site retention and infiltration installation and 4) securing park and open space are proposed not only for canal facilities improvement but also for area-based improvement of retention and infiltration function in urban areas. Table 6.8.3 describes the proposed programs (B).

Table 6.8.3 Program (B) to Strengthen Storm Water Drainage Functions in the Basins

SLLDC Core Competence	Urban Management Supporting Sub-Programs	Key Components or Activities	SLLDC Implementation Initiative	Applied Basin			Potential Project Funding
				KO	ME	BG	
FFH	B1. Natural Water Retarding Area Designation and Management	Designate control and management area to retain retarding function in the Bolgoda basin	● (LLDC /relevant authorities)	--	--	✓	National budget and by all relevant authorities
FFH / LEI	B2. Canal Property / Easement Improvement	Promote environmental improvement of canals/streams	●	✓	✓	※	National budget
		Strengthen regulation on illegal activities in the easement or property	◎ (w/UDA/LGAs)	✓	✓	※	
FFH / LEI	B3. Promote On-site Retention and Infiltration Installation	Strengthen development controls by obligatory on-site equipment	○ (UDA/ LGAs)	✓	✓	✓	National budget
		Promote on-site equipment development on public facilities	◎ (w/multi)	✓	✓	✓	National budget or Donor Assistance
FFH / LEI	B4. Secure Park and Open Space	Develop and formulate an institutional mechanism for green open space protection and provision	○ (UDA/ LGAs)	✓	✓	✓	National Budget

Note: SLLDC core competence: FMM = flood mitigation and management, WLM = wetland management, LEI= living environment improvement, Implementation initiative: ●=SLLDC initiative ◎= cooperation and collaboration with other authorities, ○= other authorities initiative
Source: JICA Study Team

(3) Program (C) to mitigate damages of urban settlements in high flood-risk areas of the basins

Two sub-programs of 1) promotion of standardization for risk-sensitive land use and zoning regulations and 2) flood risk area intervention programs are proposed to address the issues of mitigating damages in flood risk areas through improving urban settlement in the high-risk flood areas. shown in Table 6.8.4.

Table 6.8.4 Program (C) to Mitigate Damages of Urban Settlements in High Flood Risk Areas of the Basins

SLLDC Core Competence	Urban Management Supporting Sub-Programs	Key Components or Activities	SLLDC Implementation Initiative	Applied Basin			Potential Project Funding
				KO	ME	BG	
FFH / LEI	C1. Promotion of Risk-sensitive Land Use and Zoning Regulations	• Formulate and organize mandate planning process for risk-sensitive land use plan in flood/inundation prone areas (with authorized risk mapping)	○ (UDA)	✓	✓	✓	National budget or Donor's Finance
		• Formulate framework/guidelines of development control measures for flood/inundation-prone areas	○ (UDA)	✓	✓	✓	
FFH / LEI	C2. Flood Risk Area Intervention Program	• Apply "Flood Risk Mitigation Zone" with specific building regulations to high-risk prone areas	○ (UDA/ NBRO)	✓	✓	✓	National budget or Donor's Finance
		• Formulate an integrated resettlement program in combination with "Urban Regeneration Program"	○ (UDA)	✓	✓	✓	National budget
		• Community awareness program for high-risk flood and possible measures	◎ (w/multi)	✓	✓	✓	National budget

Note: SLLDC core competence: FMM = flood mitigation and management, WLM = wetland management, LEI= living environment improvement, Implementation initiative: ●=SLLDC initiative ◎= cooperation and collaboration with other authorities, ○= other authorities initiative
Source: JICA Study Team

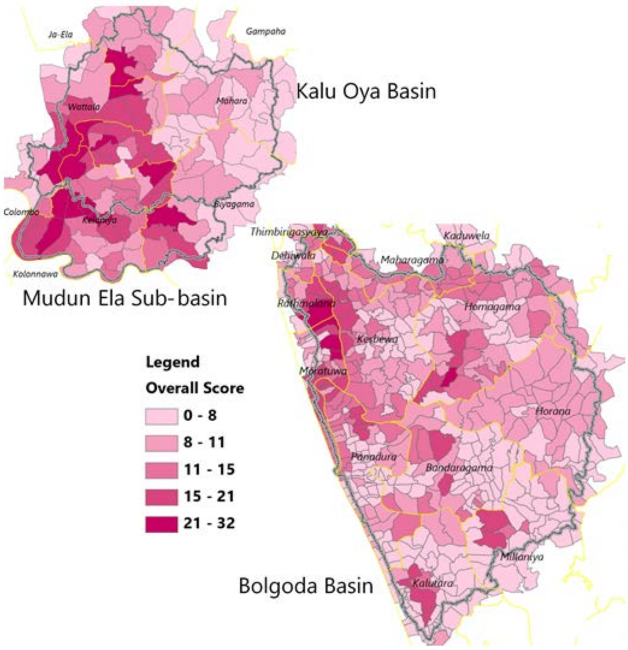
6.8.1.3 Action Plan for Urban Development Management Programs

(1) Strategic Implementation of Urban Development Management and Priority Areas

The proposed programs can be applied strategically to certain areas to address urban development management issues efficiently and effectively. The followings describe the strategic implementation of the programs for urban development management, taking into account the spatial distribution of critical areas for the management issues.

1) Approach to apply for the programs effectively to the high issue areas in the three basins

- Identification of the priority areas with higher needs for urban development management: This approach considers priority areas to apply for the programs effectively to the areas required by urgent implementation where inadequate urbanization (e.g. rapid urban growth area, large-scale infrastructure development areas and decreasing rapidly green and open spaces) causing factors of inefficient storm water drainage conditions may happen as a higher needs for appropriate urban management supports.

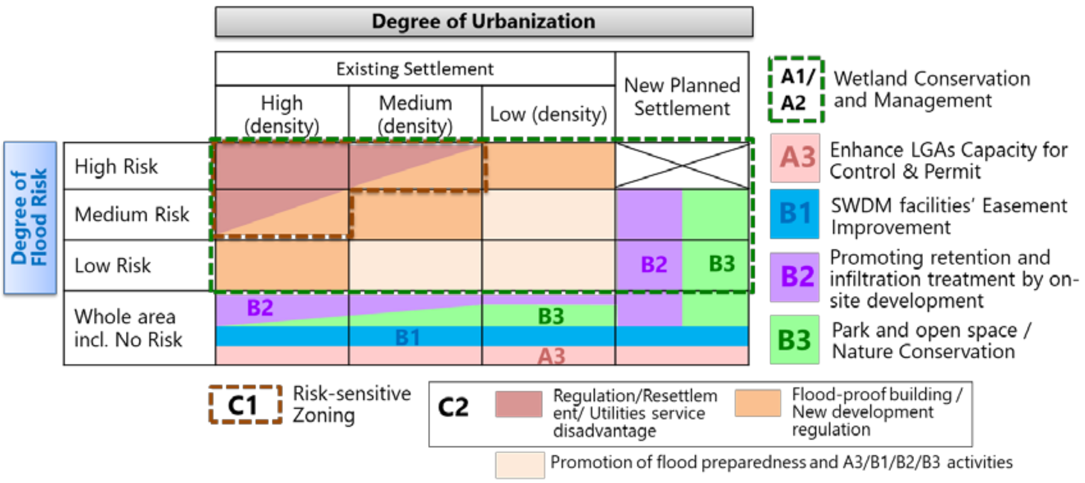


Source: JICA Study Team

Figure 6.8.2 Evaluation of GNs for Urban Management Support Needs

2) Approach to focus on definite areas with effective measures of the proposed programs

- Areas proposed by the structural measures of storm water drainage management to the target basins, where urban development management would support effectively the structural measures
- Areas with flood risk in the target basins, where graded measures of urban management support on the exposures (settlement) by the level of flood risk (water depth) can be applied to the areas. Figure 6.8.3 shows a conceptual diagram of applicable measures based on the relationship between the degree of flood risks by water depth and the degree of future settlement density.



Source: JICA Study Team

Figure 6.8.3 Conceptual Diagram of Strategic Approach for Programs of Urban Development Management Supports by Flood Risk Degrees (Example)

3) Priority areas for urban development management

(a) Assessment of the needs for urban development management for storm water drainage management

- Evaluation method: The areas are assessed quantitatively by three criteria of urban development management needs on each GN administrative evaluation unit and evaluated by integrated scores of them.
- Evaluation criteria: The evaluation criteria for GN units are 1) with or without the structural measures for storm water drainage, 2) with or without flood risk areas, 3) with or without general urban development management needs (population scale, population growth rate, industrial areas, public transportation project areas, nature protection areas)

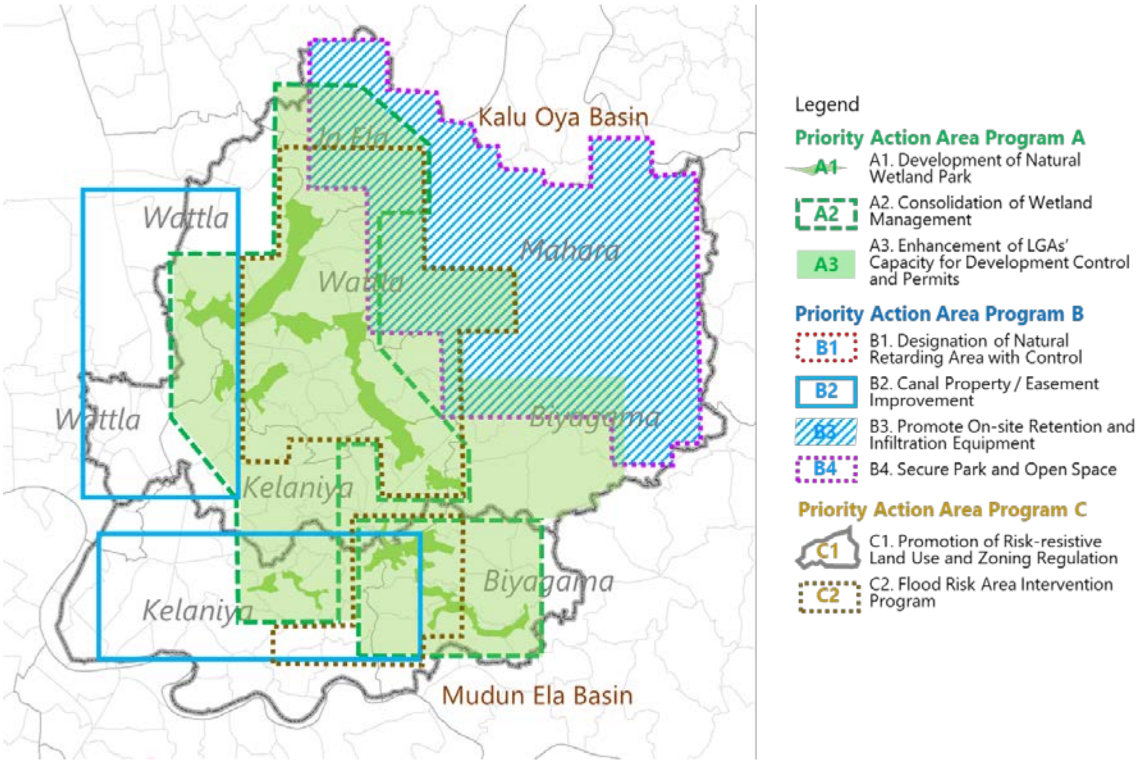
(b) Candidates of the priority areas for programs on urban development management supports

- According to the results based on the evaluation criteria and quantitative scores of each GN in the target basins, the priority areas are selected by the higher scores, and the candidate areas are proposed to be implemented by the key programs of urban development management as shown below.

Table 6.8.5 Priority Areas for Urban Development Management and Key Programs in Kalu Oya Basin and Mudun Ela Sub-basin

Urban Development Management Program	Sub-programs	Relevant DS Division including Priority Action Areas for Urban Development Management Enhancement
A. Enhancement of Conservation and Utilization of Lowlands/Wetlands	A1. Development of Natural Wetland Park	Ja Ela /Wattala / Mahara / Kelaniya / Biyagama
	A2. Consolidation of Wetland Management	Rathmalana / Moratuwa / Homagama
	A3. Enhancement of LGA's Capacity for Development Control and Permit	Ja Ela /Wattala / Mahara / Kelaniya / Biyagama
B. Strengthening Storm Water Drainage System	B1. Canal Property / Easement Improvement	Wattala / Mahara / Kelaniya /
	B2. Promote On-site Retention and Infiltration Equipment	Ja Ela /Wattala / Mahara / Biyagama
	B3. Secure Park and Open Space	Ja Ela /Wattala / Mahara / Biyagama
C. Improving Urban Settlements in High Flood Risk Areas	C1. Promotion of Risk-sensitive Land Use and Zoning Regulations	All DS Divisions as statutory planning areas in the Target Basins
	C2. Flood Risk Area Intervention Program	Ja Ela /Wattala / Mahara / Kelaniya / Biyagama

Source: JICA Study Team



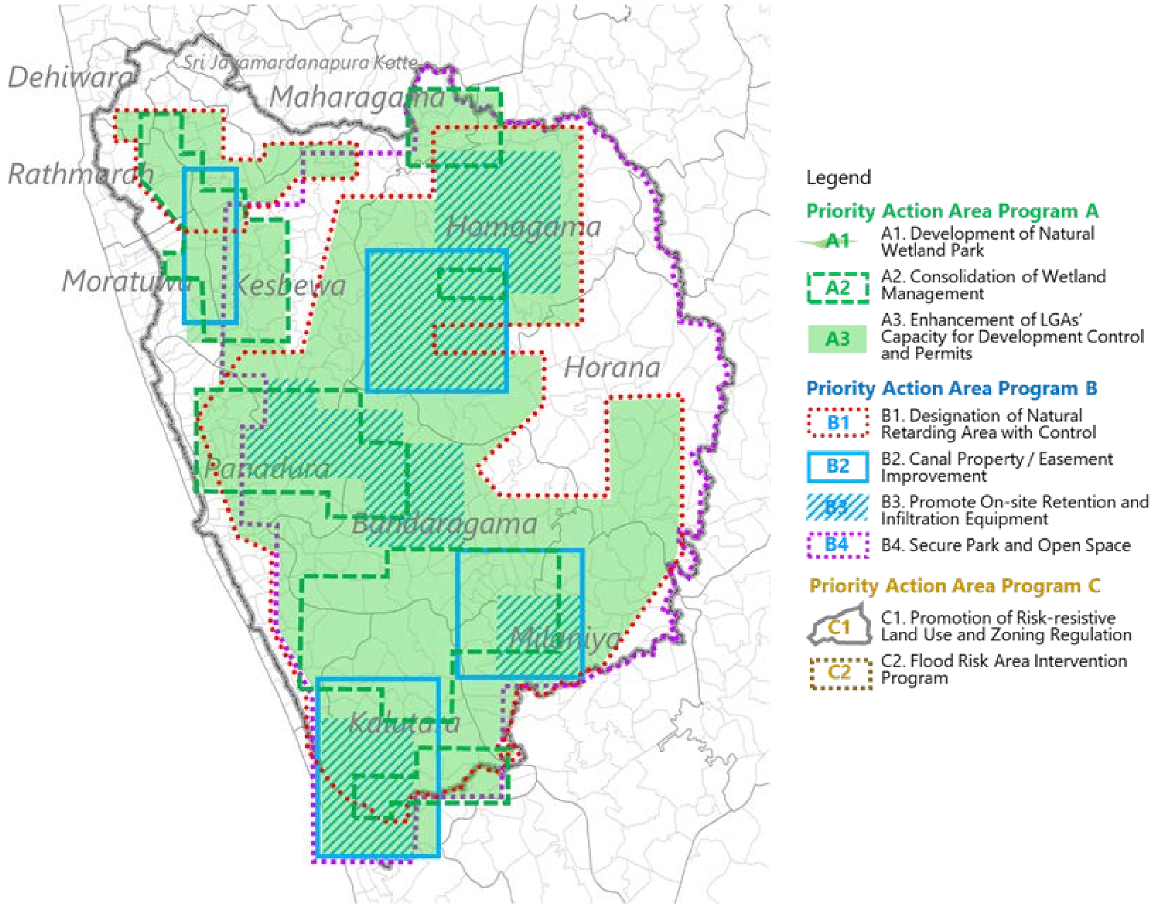
Source: JICA Study Team

Figure 6.8.4 Conceptual Diagram of Priority Areas for Urban Development Management and Key Programs in Kalu Oya Basin and Mudun Ela Sub-basin

Table 6.8.6 Priority Areas for Urban Development Management and Key Programs in Bolgoda Basin

Urban Development Management Program	Sub-programs	Relevant DS Division including Priority Action Areas for Urban Development Management Enhancement
A. Enhancement of Conservation and Utilization of Lowlands/Wetlands	A1. Development of Natural Wetland Park	Not applied for the priority action areas
	A2. Consolidation of Wetland Management	Dehiwala / Rathmalana / Moratuwa / Kesbewa / Maharagama /Homagama / Horana / Panadura / Bandaragama / Kalutara / Millaniya
	A3. Enhancement of LGA's Capacity for Development Control and Permit	Dehiwala / Rathmalana / Moratuwa / Kesbewa / Maharagama / Panadura / Homagama / Bandaragama / Kalutara / Millaniya
B. Strengthening Storm Water Drainage System	B1. Natural Water Retarding Area Designation and Management	All DS divisions as statutory planning areas in the basin
	B2. Canal Property / Easement Improvement	Rathmalana / Moratuwa / Kesebwa / Homagama / Kalutara / Millaniya
	B3. Promote On-site Retention and Infiltration Equipment	Homagama / Kesbewa / Panadura / Bandaragama / Kalutara / Millaniya
	B4. Secure Park and Open Space	Maharagama /Homagama / Kesebuwa / Horana / Panadura / Bandaragama / Kalutra / Millaniya
C. Improving Urban Settlements in High Flood Risk Areas	C1. Promotion of Risk-sensitive Land Use and Zoning Regulations	All DS Divisions as statutory planning areas in the Target Basins
	C2. Flood Risk Area Intervention Program	Dehiwala / Rathmalana / Kesbewa / Homagama / Millaniya / Kalutara

Source: JICA Study Team



Source: JICA Study Team

Figure 6.8.5 Conceptual Diagram of Priority Areas for Urban Development Management and Key Programs in Bolgoda Basin

(c) Considerations toward implementation for both Basins (Kalu Oya-Mudun Ela, Bolgoda)

- Viability of institutional arrangement at a local level: As the proposed program includes institutional arrangements such as organization improvement or enhancement of development control and regulations, the programs may apply to the whole western provincial area rather than a local government authority with weak administrative management capacity. In the case of a specific area application, a demonstration program as a trial implementation could be suitable to the specific local government authority with a certain level of administrative management capacity.
- Diffusion of programs: Successful urban development management requires not only government initiatives but also a wide range of understandings and cooperation by relevant stakeholders (e.g. local community, private sector including NGO). Programs (e.g. promotion of on-site retention and infiltration) to be applied to a wide range of areas would be enhanced by area-wide programs such as dissemination campaigns, training programs, etc.

4) Implementation bodies (Kalu Oya-Mudun Ela, Bolgoda)

The SLLDC will be one of the key bodies to initiate the relevant proposed program concerning the core competencies of the SLLDC. The SLLDC could lead the relevant programs utilizing and enhancing competitive resources of humans and technology of the SLLDC, although the program for the urban development management will require cooperative or collaborative activities with various stakeholders or activities by other authority initiatives. From this point of view, integrated storm water drainage management with common goals among relevant authorities and strengthening communication channels are indispensable to organize effective implementation bodies.

5) Implementation programs for the Kalu Oya basin and Mudun Ela sub-basin

The proposed programs for urban development management include not only the programs within the target year 2030 but also the programs' consecutive implementation beyond 2030. The programs of urban development management supporting the storm water drainage channel improvement or development in the three basins and retarding areas ensured by the natural wetland park in the Kalu Oya basin and the Mudun Ela sub-basin will be also implemented in step with the proposed phase targeting 2030 for the structural measure implementation of the storm water drainage management. On the other hand, the programs required to implement urgently coping with rapid urban sprawl and urban development will be launched in the early stage and be continued to the mid, long-term, and in the phase beyond 2030.

Table 6.8.7 Priority Programs for Urban Development Management and Key Programs of Urban Development Management in the Kalu Oya Basin and Mudun Ela Sub-basin

Urban Management Supporting Programs		Implemen-tation Initiative Body	Implementation Phase			Beyon d 2030
			Short	Mid	Long	
A. Wetland Conservation and Utilization	A1. Development of Natural Wetland Park	SLLDC				
	A2. Consolidation of Wetland Management	SLLDC				
	A3. Enhancement of LGA's Capacity for Development Control and Permit	UDA/ LGAs				
B. Supporting Storm Water Drainage Management	B1. Improvement of Canal Property/Easement	SLLDC				
	B2. Promotion of On-site Retention and Infiltration Facilities Development	UDA/ LGAs				
	B3. Securement of Park and Green Open Space	UDA/ LGAs				
C. Supporting Flood Risk Area Management	C1. Promotion of Risk-sensitive Land Use and Zoning Regulations	UDA/ LGAs				
	C2. Flood Risk Area Intervention Program	UDA/ LGAs				

Source: JICA Study Team

6) Implementation programs for the Bolgoda basin

The natural water retarding area system as the pillar program in the Bolgoda basin to be supported by the measures in relation to urban development management is described in detail in below how to implement it.

(a) Measures for retarding the natural water retarding area

<u>Institutional measures</u>

The natural retarding area in the Bolgoda basin based on the flood risk area becomes 21 times larger than the retarding area of the Kalu Oya basin and Mudun Era sub-basin in association with proposed the natural wetland park development. Taking account of the large scale of the retarding area in the Bolgoda basin, the same measure (natural wetland park development) may be distant to apply to the basin in terms of its presumed large investment cost. Therefore, statutory area designation by "natural retarding area" as the institutional measure to retain and protect the existing land use (paddy fields, wetlands, and other open spaces are required to apply to the basin.

<u>Land use control measures</u>

- Relevant existing legal tools such as SLLDC Act, National Environmental (NE)Act, and Urban Development Authority (UDA)Act can be strengthened through operational improvement (e.g. applied condition, process, and appraisal) to regulate land alteration or use change, and retain the functions of retarding areas, water purification, and ecological system.

- The abandoned agricultural lands sharing 39.6% out of the total natural retarding area, where urban development could be triggered easily due to its insecurity use status, should be regulated to avoid land alteration and land-use change through operational enhancement of development permits and procedures by SLLDC Act, Land Restriction on Alienation (LRA) Act, Agrarian Development (AD)Act, UDA Act.
- Although the land use for settlements and other urban use in the natural retarding areas is very few (0.2%), the settlements should be prevented the life-threatening and economic damages from flood risks in principle. Resettlement with necessary support with a substitute land or financial aid is one of the desirable measures though, if it is difficult, appropriate building improvement by water-resistance measures should be promoted in association with financial incentives and technical assistance.

Promotive and incentive measures for retaining and maximizing existing land use

- Conditional land improvement for agricultural production: The necessary improvement for increasing productivity of agricultural lands will be allowed such as irrigation channels, production-minimum agricultural facilities, and equipment, to sustain economic activities on agricultural production.
- Conditional development on abandoned agricultural lands: As abandoned agricultural lands left by the status quo would generate an unsuitable environment such as illegal dumps, deterioration of rural landscape, and pest increase are not desirable conditions environmentally and economically in the basin. Within conditions to retain retarding function, they deserve utilization of the land such as multi-purpose open space, parking area, and public urban spaces enabling to generate maintenance costs, otherwise need to convert wetlands if their lands enable to be compensated.

In consideration of these directions afore-mentioned to protect the land use and to utilize some area of the natural retarding areas in the Bolgoda basin, their detailed measures are proposed in Table 6.6.8.

Table 6.8.8 Proposed Non-structural Measures to retain the Existing Land Use for the Natural Water Retarding Area in the Bolgoda Basin

District		Measures for Conservation and Utilization of Lands in the Retarding Basin Areas					
		Agricultural Land		Natural Environment		Urbanized Place	
		Agriculture Lands	Abandoned Lands	Wetland	Other Natural Areas	Housing	Proposed Recreation Space
Policy		• Retain function of agriculture • Allow flexible peasant farming to whoever manages	• Utilize lands by keeping a function of retarding basin • Promote the wise use of lands by viable measures	• Conserve wetlands and other natural areas for both functions of the natural environment and retarding basin		• Promote resettlement or provision of flood-resistance house treatment	• Retain lands or convert them to spaces for sports & recreation keeping the function of retarding basin
Area to be covered		2,047 ha	2,310 ha (500 ha utilization of 2, 810 ha total)	728 ha	500 ha	15 ha	500 ha (Proposed Open Recreation Area)
Development Control & Incentives	Control & Regulations	• Prohibit land use conversion to any other use	• Allow land-use conversion to land without obstacles to retarding basin function	• Prohibit any developments involving negative impacts on the natural environment • Allow adequate activities and works to maintain the natural environment		• Prohibit expansion or a new building with land reclamation • Allow only flood-resistance treatment	• Allow minimum treatment without obstacles to retarding basin function
	Incentive Program	• Promote a cooperative production system	• Relax relevant regulations on use conversion in case of wise use without obstacles	• Promote public-private partnerships for the utilization of wetlands (e.g. ecotourism,		• Support finance for resettlement or substitute land provision	• Retain function of agriculture

		• Support favorable business finance	to retarding basin function	educational facilities, community-based volunteer activities, etc)		• Support finance for flood-resistance treatment	
Promotion of Wise and Effective	Soft program	• Promotion campaign in fields for paddy production • Quality and productivity improvement of agro-products	• Introduce "Home Vegetable Garden" place • Introduce "Multi-purpose Ground" • Recover "wetlands" by environmental program	• Promotion campaign by fields study for the ecology of wetlands • Promotion of community awareness program for the conservation of wetlands • Organizing a community club for monitoring activities of wetlands		• Awareness program for flood risks and coping for living places	• Feasibility study for open sports & recreation area • Promotion of recreational events by the local authority
	Physical program	• Improve irrigation channel for paddy fields	• Maintain drainage function • Recovery to Wetlands if viable • Access road and parking space in case of open recreation facilities use	• Maintain drainage function • Access road and parking space provision for observation	• Maintain drainage function • Recovery to Wetlands if viable	• Reform or improve buildings by the flood-resistance method • Resettlement if viable for both owner & administration	• Access road and parking space provision for open recreation spaces
Stakeholder	Water sector	SLLDC / ID	SLLDC / ID	SLLDC	SLLDC	SLLDC	SLLDC
	Agriculture sector	ADD	ADD	--	--	--	ADD in case use of abandoned agricultural lands
	Environmental sector	--	(CEA in case of wetland recovery)	CEA	CEA	--	--
	Urban sector	--	UDA	(UDA)	(UDA)	UDA	UDA
	Key local authority*	Homagama, Kesbwa, Horana, Milania	Homagama, Panadura, Bandaragama,, Milania, Kalutara	Rathmalana Kesbewa, Panadura, Bandaragam aKalutara	Bandaragama Kalutar	Horana Millaniya	As a potential area in Kalutara surroundings of Bolgoda North Lake

Note 1 : Open Recreation Area is defined by facilities for a sports and recreational space with minimum infrastructure by maintenance-free development. The proposed area (500 ha) is assumed by 30 % of the total spatial demand based on the future population of 2030 in the Bolgoda river basin applying the green park standard of Sri Lanka (one hectare per 1,000 pop)
Note 2 : SLLDC: Sri Lanka Land UDA: Urban Development Authority, ID: Irrigation Department, ADD: Agrarian Development Department, CEA: Central Environmental Authority, DMC: Disaster Management Center, Local authority: Municipal Councils
Source: JICA Study Team

(b) Proposed regulation for the Natural Retarding Area

Objective

Proposed natural retarding areas aim to secure the function of the Urban Storm Water Drainage system in the Bolgoda basin, through the designation and protection of their area based on the flood risk areas including agricultural land, wetlands, and other land use areas in the basin.

Requirements for the designation of the Area

- SLLDC has a responsibility to identify the detailed flood risk area in the Bolgoda basin at flood safety level by the probability of a 50-year (return period 1/50), where agricultural lands including abandoned areas, natural areas (wetlands, grasslands, forest), and some settlements or urbanized areas in lowland are spread.
- Relevant authorities (ID, ADD, CEA, UDA, municipalities) are required to coordinate and adjust the identified area with SLLDC.

Management of the Area

- Persons who have a right to cultivate or own the land and benefit from the land should have a responsibility to maintain and manage the agricultural land.

- Persons who own abandoned agricultural lands should be consulted on the protection or utilization of them with ADD and relevant authorities, and decide on desirable and certain use to retain the retarding function.
- Persons who own wetlands should be consulted on the protection of them with SLLDC, CEA, and relevant authorities, and decide on self-maintenance or disposal of them to a public authority with certain compensation to retain the retarding function.
- A relevant municipality should consult persons who rent or own a house or urbanized land in the designated natural retarding area on the desirable countermeasures by resettlement or flood-resistant treatment, and support technically and financially.

Regulations in the Area

SLLDC has a responsibility to issue a permit for developments described in the below items on the natural retarding areas based on the SLLDC Act through consultation with relevant authorities. Necessary improvements (e.g., irrigation for agricultural production, drainage, and land alteration for recreational use) for the operation and maintenance of agricultural lands and natural and water environments are allowed by requisite consultation by relevant authorities.

- New construction, expansion, or conversion of any buildings
- Land alteration or reclamation, excavation, quarrying
- Land-use change from existing land-use to any other uses
- Re-use of abandoned agricultural lands for agricultural purposes or other allowable uses

Buyback offers

When persons who own agricultural lands have a solid intention not to maintain it for certain reasons, they can request its buyback to SLLDC or any other relevant public authorities or lend it to a third party by certain conditions without any negative effects on retarding function after 25 years later of designation of the area.

Offering an opportunity to purchase agricultural land in the natural retarding areas

SLLDC has to offer an opportunity to cede agricultural land to other persons who have the intention to operate farming activities or purchase the agricultural land when SLLDC notices not to buy back the lands from the relevant owner.

(c) Action plan for protection and utilization of the Natural Retarding Areas (NRA) in the Bolgoda basin

Institutional arrangements for NRA (short-term program)

To establish NRA securing the retarding function in the Bolgoda basin, the following activities need to be taken place through cooperation and collaboration in operation and management with relevant authorities. SLLDC is required to take initiative to promote the establishment of NRA and necessary activities.

- Detailed survey and analyses to designate the area for NRA: The boundary of NRA can be fixed and designated based on the detailed topographic survey including an environmental baseline survey to identify land cover, vegetation, area, etc under the flood risk areas by the probability of a 50-year (return period 1/50).
- Formulation of a management plan for NRA: To organize close cooperation and collaboration for appropriate protection and utilization of the NRA due to various existing land use conditions in association with relevant jurisdictional authorities, an integrated management plan should be formulated as common activities framework.
- Establishment of NRA: Institutional arrangements such as an agreement among relevant authorities, necessary legal adjustments, and operational measures should be taken to implement the management plan of NRA.
- Establishment of a responsible organization for NRA: To monitor and coordinate activities with decision-making for integrated management of NRA, the “NRA management committee” is proposed to establish. This committee can be set within an existing coordination committee at a higher level of administration (e.g., the Planning Committee in

the province) to manage the protection and utilization of the existing land use in the wider basin area over several Districts (Colombo and Kalutara).

Strengthening relevant legal frameworks (short-mid-term program)

- Coordination and consistency with relevant legal frameworks: Relevant legal frameworks to manage and control NRA such as water management, nature conservation, agricultural land management, and urban growth management are required to review effectiveness and consistency with relevant articles in the laws and regulations and to identify issues for management of effective NRA. If there is a necessity to improve them, the recommendation for modification of relevant parts of legal documents or operational measures can be taken.
- Coordination and adjustment with zoning plans: As relevant municipalities within RNA will have each development plan in association with a “zoning plan” to stipulate building use and form regulations, the contents of the regulation for use or development between the zoning plans and RNA should be coherent each other. If there is inconsistency, necessary modification of the regulations can be taken through coordination among relevant organizations.

Programs for wise use of the lands in NRA (mid-long-term program)

- Promotion of eco-friendly agriculture development: Relevant legal frameworks to manage and control NRA such as water management, nature conservation, agricultural land management, and urban growth management are required to review effectiveness and consistency with relevant articles in the laws and regulations and to identify issues for management of effective NRA. If there is a necessity to improve them, the recommendation for modification of relevant parts of legal documents or operational measures can be taken. ADD could initiate and coordinate such eco-friendly agriculture development.
- Promotion of public-private partnership for wetlands conservation and wise use: Taking account of the extensive area of wetlands in the Bolgoda basin, its conservation and wise use require various actors’ understandings and involvement inevitably including public administration, NGOs, institutions, and private business sector. Therefore, partnerships between the public sector and private sector should be promoted to conserve the wetlands sustainably through wider actors’ participation to research and take actions for maintaining them from the financial and human resource aspects and for using them wisely such as tourism or educational purpose. SLLDC or CEA can be an authority to initiate and promote these activities.
- Promotion of “NRA school program”: To enhance people's awareness of the natural water retarding area conservation and management, relevant communities’ understanding of its significance, participation and cooperation would be essential through frequent environmental education programs in cooperation with schools, NGOs and institutions. This programs can be incorporated into school programs or adult education programs for students and communities.

Table 6.8.9 Priority Programs for Urban Development Management and Key Programs for the Natural Water Retarding Area in the Bolgoda Basin

Project and Program Components for Implementation of Natural Retarding Basing Area Management Project		Responsible Implementation Body (and supporting stakeholders)	Implementation Phase: Short-term (0-3 Y)	Mid-term (3-5 Y)	Long-term (5-10 Y)	Beyond 2030
1 Natural Retarding Basin Area Institutional Setting	1-1 Detailed baseline survey and analyses for the Natural Retarding Basin Area (NRBA) delineation	SLLDC (CEA)				
	1-2 Formulation of the NBRA management plan including stakeholders building consensus	SLLDC (relevant authorities*)				
	1-3 Legal arrangement of the area designation and rules and management	SLLDC (relevant authorities*)				
	1-4 Establishment of the basin management council for appropriate conservation and utilization of the area	SLLDC (relevant authorities*)				
2 Adjustment and Enhancement of Development Controls and Regulations	2-1 Ensure relevant controls and regulations in agriculture, water management, land and environment synchronized with NBRA	Relevant authorities*				
	2-2 Review and adjust zoning plans with urban controls and regulations for municipal councils in consistency with NRBA	Municipal Councils (UDA)				
3 Wise-use Program for the Basin Area	3-1 Promotion of environment-oriented agriculture production and market branding	ADD (SLLDC)				
	3-2 Establishment of a local partnership for collaborative conservation and utilization of the wetlands	SLLDC (relevant authorities*)				
	3-3 Formulation of "retarding basin school" program for environmental education and promotion of its understanding for relevant communities	CEA (relevant authorities*)				

Note: Relevant Authorities / municipal council, ADD, ID, CEA, UDA, DMC
Source: JICA Study Team

6.9 Selection of Priority Project for Strom Water Drainage

The priority project was selected as per below description.

- According to the record of discussion (RD) of this project, one priority sub-basin and one priority area have been decided, which are the Mudun Ela sub-basin and the Moratuwa-Rathmalana area.
- In the economic evaluation analysis in this study, it was concluded that the economic effect and investment effects of the rehabilitation plan of the Mudun Ela sub-basin and the Bolgoda basin are high.
- In particular, in the lower reaches of the Mudun Ela sub-basin, there is an interchange on the highway (CKE) to the airport, and the Oliyamulla pumping station is under construction. The investment effect will be high.
- The Moratuwa-Rathmalana area is the last remaining area of the Weras Ganga project proposed by the F / S of JICA2003M / P, and this area is a substantial metropolitan area adjacent to the Colombo City Hall (CMC). Similarly, the investment effect is high.

The business layouts in both areas are shown below, and the outlines of these businesses are summarized below.

(1) Mudun Ela sub-basin

- Main canal improvement of Mudun Ela: 3.1km
- Secondary canal of Peliyagoda canal: 3.0km
- Rehabilitation of Peliyagoda pumping station: Pumping capacity (From 0.5m3/s to 1.0m3/s)
- Gate structure (1): To separate the Natha canal basin and the Mudun Ela sub-basin
- Gate structure (2): To separate Naranmini Oya basin

(2) Moratuwa-Rathmalana Area

- Right embankment of Weras Ganga: 3.0km
- Improvement of local drainage system: CA= 588 ha
  - Kandawala drainage area: CA=141 ha, L=1,420 m (Main canal), 2,530 m (Secondary canal)
  - Talawala drainage area: CA=217 ha, L=1,150 m (Main canal), 2,610 m (Secondary canal)
  - The new canal for connecting the above two canals: 1,300 m (Main canal)
  - The new pumping station and gate structure: river mouth of Talawala canal.
  - Katubadda canal: CA=200 ha, L=1,610m (Main canal), 2,530 m
  - The pump station and gate structure: at the river mouth of Katubadda canal

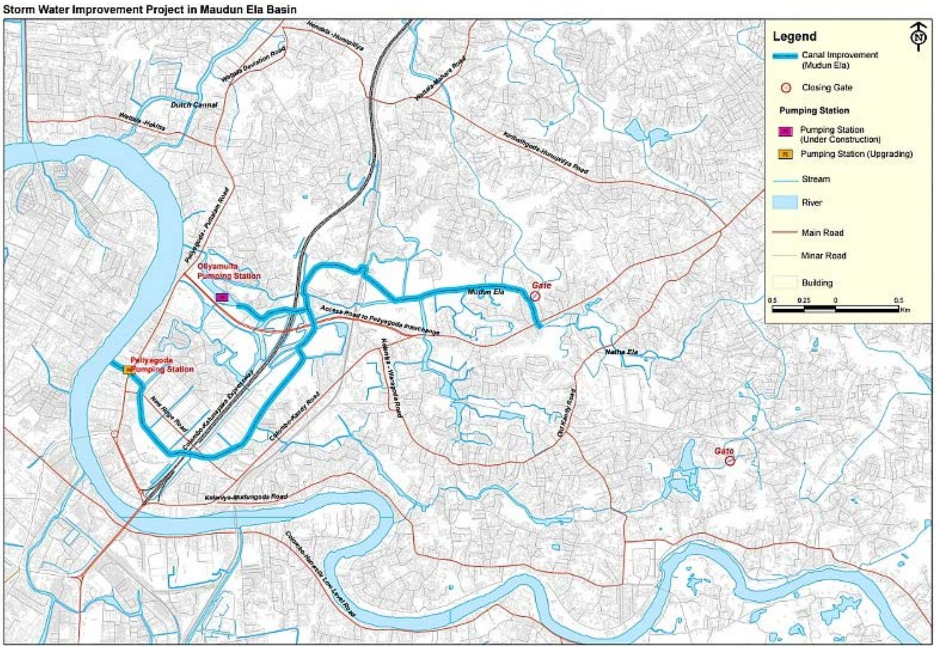


Figure 6.9.1 Location Map of Priority Project for Pre-F/S study in the Mudun Ela Sub-basin

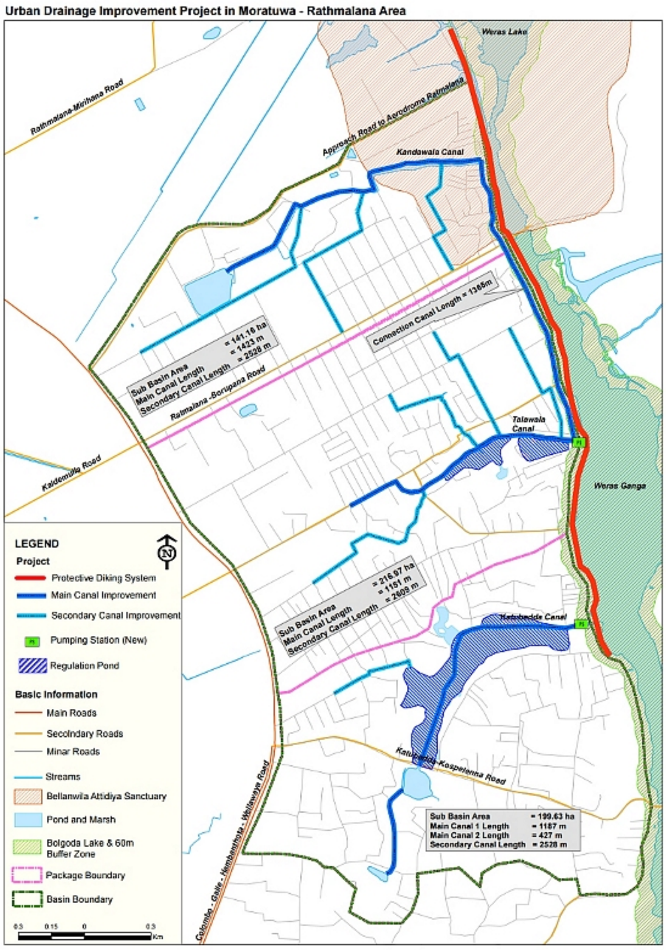


Figure 6.9.2 Location Map of Priority Project for Pre-F/S study in the Moratuwa-Rathmalana Area

6.10 Operation and Maintenance Plan

6.10.1 Institutional Development Plan

Demarcation of Responsibilities for Storm Water Drainage System among Agencies

As for planning, implementation and O&M for storm water drainage facilities, the following demarcation of responsibilities is proposed in order to develop a clear institutional arrangement considering the present situation of the related activities in the study area.

- Related organizations for the above activities are SLLDC, Local Authorities and Irrigation Department (ID), Agrarian Development Department (ADD) and Provincial Irrigation Department (PID)
- SLLDC is responsible for all the works related to storm water drainage in the declared responsible areas and Local Authorities are responsible for those in their respective local areas.
- Roadside drains are usually constructed by the Road Development Authority (RDA) together with roads. Considering the normal practice of maintenance, Local Authorities are to maintain the roadside drains in the respective local areas, except those facilities, which are attached to a high-grade road such as an expressway.
- The Local Authorities also take charge of maintenance of the roadside ditches of local roads planned and constructed by the Local Agencies.
- Regarding the agricultural canals, depending on the scale of the irrigation project, the Irrigation Department is in charge of operation and maintenance for projects with an irrigation area of 200 acres or more, and the Agrarian Development Department or Provincial Irrigation Department is in charge of operation and maintenance for projects below 200 acres.

The proposed demarcation is tabulated in Table 6.10.1.

Table 6.10.1 Proposed Demarcation of Responsibility for the Storm Water Drainage

Objective Drainage Facility	Planning	Construction	Maintenance
SLLDC declared responsible canals	SLLDC	SLLDC	SLLDC
Canals within the Local Authority territory (Long term)	Local Authorities	Local Authorities	Local Authorities
Canals within the Local Authority territory (Short term)	SLLDC	SLLDC	Local Authorities
Roadside drains of major roads	RDA	RDA	Local Authorities
Roadside ditches of local roads	Local Authorities	Local Authorities	Local Authorities
Agricultural canals for the project of 200 acres or more	ID	ID	ID
Agricultural canals for the project of below 200 acres	ADD / PID	ADD / PID	ADD / PID

In particular, it is necessary to clarify the proper management body of the canals that are being diverted from agricultural canals to urban drainage canals. It is recommended to document the management body of the drainage facility together with the location map through the District Coordination Committee, etc., which is held regularly and to clarify the management body and the scope of responsibility, including the amendment of relevant laws and regulations.

It can be understood that storm water drainage is a part of public services provided by local governments. Meanwhile, it is the current situation that the work capacity of the local authorities, except for CMC, are too small to undertake the storm water drainage works based on the above demarcation. Therefore, the above demarcation for Local Authorities is considered to be a long-term target and SLLDC's assistance in planning, implementation and O&M will be needed to achieve the target. As a short-term measure, planning and implementation of storm water drainage by SLLDC and transfer to local authorities are proposed.

6.10.2 Operation and Maintenance Plan

Operation and Maintenance (O&M) is a key issue to establish a sustainable storm water drainage system. At present, there are many drainage structures/facilities which are maintained by each responsible organization. In addition, newly updated storm water drainage systems will be proposed through this Study. The O&M activities will depend on the type and scale of the system to be maintained and the organization managing it. Based on the present situation of the O&M activities in the study area and the drainage systems to be newly proposed, practical O&M systems should be established.

6.10.2.1 Policy for Operation and Maintenance

The O&M plan for the storm water drainage scheme proposed in this study is prepared based on the following policy.

- The responsible organizations for O&M of the storm water drainage facilities are SLLDC and Local Authorities (MC, UC and PS).
- SLLDC is responsible for O&M of drainage facilities in the declared areas.
- Local Authorities are responsible for O&M of drainage facilities in their respective administrative areas.
- SLLDC should assist the local authorities in undertaking the O&M works for the drainage facilities for a few years after the transfer of those facilities to local authorities. During this period, SLLDC shall provide local authorities with technical guidance and staff training through joint operation, on-the-job training and lectures.
- As a long-term objective, local authorities promote the expansion of resources for storm water drainage works including planning, construction and O&M with a view to managing all the works by themselves.

6.10.2.2 Organization Set-up with Staff Arrangement

(1) SLLDC

SLLDC’s management capacity including the organizational set-up and staff for storm water drainage works has been developing especially through the undertaking of the large-scale storm water drainage projects such as MCUDP. However, considering the future expansion of the coverage area and the work volume, further expansion of the organizational set-up and staff is proposed as below.

- A new section is proposed within the existing Drainage & Reclamation Division such as the Urban Drainage Maintenance Section, which undertakes O&M works for storm water drainage systems in built-up areas and provision of technical guidance and staff training on O&M of storm water drainage systems to Local Authorities.

- It is proposed to set up the implementation part of the new section in the existing or new regional offices, considering the location of the new urban drainage systems constructed by SLLDC and that the actual O&M activities for the existing canals are also handled by the regional offices. Furthermore, it will be effective for the same implementation section to initiate the Local Authorities into O&M works for storm water drainage system.

- Promote capacity development of SLLDC staffs at all levels, including managers, engineers, technician/operators and other general staff to provide technical guidance, training and flood information for the local authorities

(2) Local Authority

In order to execute the O&M works of storm water drainage systems regularly, the following organizational set-up and staff expansions are proposed.

In Local Authorities, an exclusive section for storm water drainage works is not currently established. However, considering the development of storm water drainage systems in the future, it is proposed to establish a section that exclusively undertakes storm water drainage works with the key staff as proposed below.

6.10.2.3 Equipment Plan

(1) SLLDC

O&M equipment presently owned by SLLDC is not adequate to handle the O&M works for the entire responsible area as it will be extended in the future. Therefore, from the long-term aspect, it is proposed to procure some additional heavy equipment such as a dredger for the maintenance of major canals.

(2) Local Authority

In general, the major O&M work of Local Authorities is the cleaning and minor repair of the existing small drainage canals, however, Local Authorities do not have a sufficient amount of equipment for regular maintenance work of these drainage facilities. Therefore, light equipment such as tractors, small backhoes and water pumps will be necessary to implement the proper O&M of the existing urban drainage systems.

6.10.2.4 Financial Arrangement

(1) SLLDC

The financial source for all O&M activities of SLLDC is provided by the Government budget. SLLDC shall make due arrangements to acquire enough budget for required O&M works based on the work plan, staff employment/training plan and equipment plan. Based on the staff arrangement and equipment plan for the new section proposed for the SLLDC, financial arrangements are required. The purchase cost of the equipment shown in the previous sub-section is also required as an annual O&M cost.

(2) Local Authority

The annual budget for Local Authorities allocated for drainage maintenance is too small to carry out the substantial regular works. Considering the small scale of revenue of the Local Authorities, it is proposed to review this financial arrangement by the Western Provincial Council so that the local authorities can achieve the funding for the procurement of equipment and staff. This financial arrangement should be made together with the preparation of a detailed procurement plan by Local Authorities, evaluation of the plan and audit by the Western Provincial Council.

6.10.2.5 Human Resource Development Plan

Human resources development for the management of the entire storm water drainage works as well as the O&M works will be a key issue for implementation agencies, that is, SLLDC and the local authorities. As a human resources development plan, an O&M training program for SLLDC and local authorities is proposed as a short-term objective. Furthermore, as a long-term objective, an overall training program for human resource development in the storm water drainage sector is proposed for the continuous capacity building of staff at all levels in SLLDC and local authorities.

CHAPTER 7 SOCIO-ECONOMIC AND FINANCIAL SITUATIONS

7.1 Strategic Environmental Assessment (SEA)

7.1.1 Background

The JICA Guidelines for Environmental and Social Considerations (2010) underscores that “JICA applies a SEA when conducting Master Plan Studies etc., and encourages project proponents, etc. to ensure environmental and social considerations from an early stage to a monitoring stage (p.10).” In line with this requirement, a SEA study is underway as part of this M/P study.

In Sri Lanka, the Cabinet of Ministers in May 2006 approved a Cabinet Memorandum submitted by the CEA recommending that in the future, all new Policies, Plans and Programs should be subjected to SEA. CEA also prepared “A Simple Guide to Strategic Environmental Assessment.” As of September 2019, however, SEA is not yet a mandatory requirement in Sri Lanka. Thus, examples of SEA Sri Lanka are relatively limited. They include ones piloted by CEA, mainly about regional development plans, such as SEA of the Northern Province of Sri Lanka coordinated by CEA and DMC with support from UNDP and UNEP. More recently, SEA of Development of River Basin Level Flood and Drought Mitigation Investment Plans to target the Kelani Ganga basin was undertaken in 2018 as part of the World Bank-supported Climate Resilience Improvement Project. In order to accelerate its efforts to establish a legal framework for SEA, CEA recently established a SEA Unit within Environmental Management and Assessment Division and has started drafting a text for SEA regulation.

Based on this background, JICA Study Team reviewed relevant SEA reports, both in Sri Lanka and elsewhere, as well as relevant guidelines for SEA good practices to prepare a draft TOR for the SEA for this M/P. JICA Study Team then had a meeting with CEA to refine the draft TOR. The TOR, particularly the approach for stakeholder engagement for this SEA, was updated by incorporating comments from CEA. More specifically, it was agreed that CEA would be a convener for stakeholder meetings[5] to be held at CEA headquarters in Colombo. The final TOR was then sent to shortlisted consulting companies and universities who were invited to submit a proposal for this SEA, and Colombo University was selected as a successful bidder. The SEA study started in August 2019 and was to be completed by March 2020. However, the schedule of the SEA study has been delayed due to Covid-19. The Stakeholder meetings for the Kalu Oya basin were completed by March 2020, and the same for Bolgoda was completed in November 2021, and the final drafts of the SEA reports have been submitted to CEA. The results of the baseline surveys are summarized in Annex 5.

The study area partly overlaps with the study area of the JICA 2003 M/P on storm water drainage plan for the Colombo metropolitan region. According to the JICA 2003 M/P, the storm water influx to protected areas in Muthurajawela wetland due to the improvement of waterways. Therefore, the study warns that urbanization could result in a greater influx of wastewater into the wetland area unless wastewater in the urban area is properly treated. Although similar improvement of the waterway is proposed in the M/P, water flows from the wetland area to the river during the usual time. The water flows to the wetland during flooding. Still, the storm water is greatly diluted due to the increase in flow rate, and the surge in water level will be temporary. Hence, it is considered that environmental impacts on the wetland area are negligible. In the JICA 2003 M/P, no significant impacts of land acquisition and involuntary resettlement were also expected due to the proposed intervention.

The JICA 2003 M/P proposed utilizing low-lying wetlands such as wetlands and abandoned paddy as retention areas in the Bolgoda basin. Environmental and social considerations study at that time noted that the low-lying wetland ecosystem proposed for the retention area might be affected due to the influx of wastewater through waterways connecting the area with the densely populated urban area. However, no construction activity is planned for this component as the retention effect can be achieved using a natural landscape. Therefore, environmental impacts associated with this component are also considered negligible, which is also the case for the similar proposal in this M/P. The JICA 2003 M/P also concluded that no

[5] This is stakeholder meetings targeting government institutions. Interviews and other forms of engagement targeting non-government stakeholders will also be carried out in the course of SEA study.

significant impacts of land acquisition and involuntary resettlement were expected due to the proposed intervention in the Bolgoda basin as well.

The JICA 2003 M/P proposes control of unauthorized solid waste dumping, the establishment of a legal solid waste disposal site, and promoting appropriate wastewater treatment in urban areas as common issues across the river basins. The JICA 2003 M/P acknowledged the importance of these issues, which should be implemented in parallel with the implementation of flood mitigation measures.

Main concerns related to environmental and considerations associated with M/P and Pre-F/S projected to be implemented in the future will be discussed below. Recommendations of SEA to the M/P based on the study results and feedback from stakeholders will be summarized in 7.1.7.

7.1.2 Main Concerns related to Environmental and Social Considerations

The countermeasures proposed in the M/P are improvement of existing canals and rivers and construction of dikes at the minimum level, and as such, no significant environmental and social impacts are expected. As discussed later in this chapter, the main challenges related to environmental and social considerations are caused by uncontrolled development that undermines the proper functioning of existing drainage, and M/P will positively impact the environment. Degradation of water quality and abnormal overgrowth of aquatic plants also partly contribute to the degradation of drainage function, as highlighted in the JICA 2003 M/P on the storm water drainage plan for the Colombo metropolitan region.

Implementation of M/P and implementation of projects to be studied further during the pre-F/S phase will result in minor land acquisition and involuntary resettlement. Also, the project area includes areas that are declared as protected areas in Sri Lanka, but this is the type of protected area that aims to promote sustainable development. The scale of land acquisition and involuntary resettlement and the relationship with the protected area are summarized below.

7.1.2.1 Summary of Land Acquisition and Involuntary Resettlement

The expected scale of land acquisition and involuntary resettlement in the Kalu Oya basin, the Mudun Ela basin and the Bolgoda basin is shown below. The number of involuntary resettlement is provisionary estimated using the satellite imagery and field visit and the average household size of Sri Lanka. A more detailed survey will be conducted when Pre-F/S is undertaken. In the below table, structures will be considered “relocated” if 10% or more of the structure area will be affected by the project. When the affected area is less than 10% and setback or relocation within the area is feasible, the structure is not considered to be “relocated.” The above-mentioned JICA 2003 M/P did not foresee serious impacts associated with land acquisition and involuntary resettlement. Urbanization during the past 20 years and increases in the number of people living near waterways are likely the main factors leading to minor scale resettlement shown in the table.

Table 7.1.1 The List of Institutions Participated In the First Stakeholder Meetings

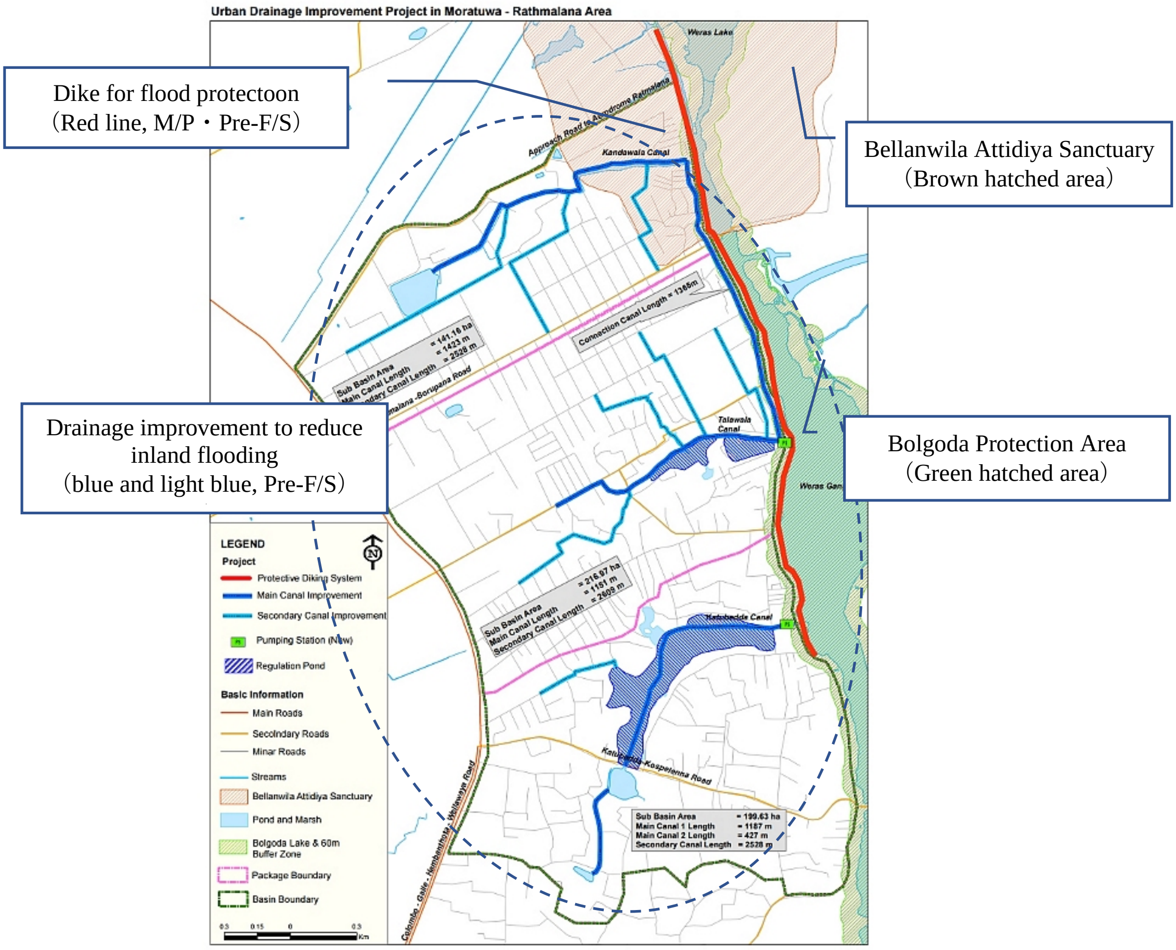
		Kalu Oya	Mudun Ela	Bolgoda
Structures to be relocated	House	39	20	43
	Storage, workshop, office	26	2	7
	Hut	11	5	7
Project Affected People to be relocated		156	80	172

Source: JICA Study Team

The impacts were assessed independently in each river basin because they are located separately. While Kalu Oya and Mudun Ela are adjacent, they are completely separated hydrologically with a closing facility. Regarding the design scales of the long-term plan in those basins, a 50-year return period was set in the Kalu Oya basin and a 25-year return period was done in the Mudun Ela basin. It means that the project scales are different from each other and projects in each river basin are likely to be implemented as separate projects. Hence, the impacts of involuntary resettlement are thus assessed separately as well. The area to be acquired in each basin is 142,569m^2 for Kalu Oya, 409,617m^2 for Mudun Ela and 23,125m^2 for Bolgoda basin.

7.1.2.2 Summary of the M/P and the Protected Area in the Study Area

M/P includes the construction of dikes to protect Moratuwa-Rathmalana from flooding, and part of the dike will be located in Bellanwila Attidiya Sanctuary (a type of protected area declared by the Wildlife Conservation Department). Protected areas in Sri Lanka are divided into eight categories ranging from the Strict Nature Reserve, which requires the highest level of protection to Sanctuary, which manages protections and development on private land. Bellanwila Attidiya Sanctuary is a sanctuary and the development project is not prohibited in this type of protected area. Indeed, a range of development is already underway in Bellanwila Attidiya Sanctuary, and the dikes proposed in the M/P is also to be constructed in areas already developed for housing area or airport. Moratuwa-Rathmalana is also covered by the Bogoda Environmental Protection Area. Protection Area is declared by CEA to protect river ecosystem. As is the case of Sanctuary, Environmental Protection Area does not prohibit development projects. The main aim of declaring an area as Environmental Protection Area is to promote sustainable development, which include proper flood management.



Source: JICA Study Team

Figure 7.1.1 The M/P and the Pre-F/S projects in the Moratuwa-Rathmalana Area and the Location of the Protected Area

The general location of Bellanwila Attidiya Sanctuary and Bolgoda Protection Area are shown in Figure 5.4.7 and Figure 5.4.8 in Annex 5.

7.1.3 Summary of the First Stakeholder Meeting

The first stakeholder meeting was held on November 5, 2019, in the Conference Room of CEA with 52 participants. The list of invited and participating institutions is shown below.

Table 7.1.2 The List of Institutions Participated In the First Stakeholder Meetings

Stakeholder Institution	Invited	Participated
Central Environmental Authority	√	√
Sri Lanka Land Reclamation and Development Corporation	√	√
Urban Development Authority	√	√
Irrigation Department	√	√
Provincial Irrigation Department (Western Provincial Council)	√	√
District Irrigation Engineering Office	-	√
Irrigation Department (Western Province: Kaluthara District)	-	√
Disaster Management Center	√	√
Coast Conservation & Coastal Resources Development Department	√	-
Marine Environmental Protection Agency	-	-
National Planning Department	√	-
National Water Supply and Drainage Board	√	√
International Union for Conservation of Nature	-	-
National Building Research Organization	√	-
Geological Survey and Mines Bureau	√	√
Forest Department	√	-
Department of Wildlife Conservation	√	√
Road Development Authority	√	√
Department of Agrarian Development	√	-
Ministry of Western Development & Megapolis	√	-
International Water Management Institute	-	-
Metro Colombo Urban Development Project	√	√
Divisional Secretariat- Rathmalana	√	-
Divisional Secretariat- Moratuwa	√	√
Divisional Secretariat- Kesbawa	√	√
Divisional Secretariat- Dehiwala	√	√
Divisional Secretariat- Horana	√	-
Divisional Secretariat- Homagama	√	√
Divisional Secretariat- Kaluthara	√	-
Divisional Secretariat- Bandaragama	√	√
Divisional Secretariat- Millaniya	√	-
Divisional Secretariat- Maharagama	√	√
Divisional Secretariat- Panadura	√	-
Divisional Secretariat- Ja- Ela	√	√
Divisional Secretariat- Wattala	√	-
Divisional Secretariat- Kelaniya	√	√
Divisional Secretariat- Biyagama	√	√
Divisional Secretariat- Mahara	√	-
Local Authority- Homagama Pradeshiya Sabha	√	-
Local Authority- Kaluthara Pradeshiya Sabha	√	-
Local Authority- Bandaragama Pradeshiya Sabha	√	√
Local Authority- Panadura Pradeshiya Sabha	√	-
Local Authority- Kelaniya Pradeshiya Sabha	√	√
Local Authority- Biyagama Pradeshiya Sabha	√	√
Local Authority- Wattala Pradeshiya Sabha	√	-
Local Authority- Mahara Pradeshiya Sabha	√	√
Local Authority- Ja Ela Pradeshiya Sabha	√	√
Local Authority- Ja Ela Urban Council	√	-
Local Authority- Kaluthara Urban Council	√	-
Local Authority- Panadura Urban Council	√	√
Local Authority- Kesbewa Urban Council	√	-
Local Authority- Wattala Urban Council	√	-
Local Authority- Moratuwa Municipal Council	√	-
Local Authority- Dehiwala- Mt- Lavinia Pradeshiya Sabha	√	-

Source: JICA Study Team


Photo 7.1.1 The First Stakeholder Meeting

At the first stakeholder meeting, the objective and proposed schedule of the Master Plan study and the SEA were presented, followed by a review and discussion on the role and responsibility of each stakeholder concerning storm water drainage. Then, stakeholders' views were sought on 11 environmental and social issues related to storm water drainage. More specifically, participants were asked to rate 1) the importance of each issue and 2) actual management practice for both the Kalu Oya basin and the Bolgoda basin. This exercise was conducted to identify important but not properly managed, environmental and social issues.

In both basins, control of property development and protection of ecosystem have been identified as the area with significant gaps between perceived importance and actual management. Stakeholders recognize the importance of these issues, but at the same time, consider that current management of these issues are not adequate. Grassroot consultations conducted as part of the SEA study also found blockage of canals and waterways due to unregulated or illegal development is causing floods in many areas. These findings indicate the importance of maintaining proper drainage function as Colombo becomes more and more urbanized. The responses of stakeholders on 11 issues for both basins are shown below.

Table 7.1.3 Identified Gap between Perceived Importance and Implementation (Kalu Oya)

	Important Issue	Importance (score)	Practice (score)	Importance (%)	Practice (%)	Gap
1	Minimize the negative impacts of storm water on the settlements and natural environment	150	67	90.91	40.61	50.30
2	Protect and conserve land and water resources relevant to Disaster Risk Reduction and Storm Water Management	155	63	93.94	38.18	55.76
3	Orderly and responsible property development	152	51	92.12	30.91	61.21
4	Prevent pollution of local waters and land	152	58	92.12	35.15	56.97
5	Minimize impervious surfaces, promote infiltration or discharge into local waters	149	46	90.30	27.88	62.42
6	Preserve the natural characteristics of stream corridors	152	58	92.12	35.15	56.97
7	Protect aquatic and riparian habitats	144	44	87.27	26.67	60.61
8	Provide recreational opportunities and aesthetic benefits	136	69	82.42	41.82	40.61
9	Community enhancement and Economic development	137	59	83.03	35.76	47.27
10	Preserve natural hydrologic and hydraulic functions of watercourses/ flood plains and wetlands	151	59	91.52	35.76	55.76
11	Facilitate excising and future institutional frameworks	153	69	92.73	41.82	50.91

During the stakeholder meeting, participants were asked to rate the level of importance and current level of practice for

each issue. The aggregate Likert values are given for each feature (1 is least important/not practiced at all and 5 is most important/well implemented) and percentage. The gap is derived by subtracting practice (%) from importance (%). The bigger gap indicates that the issue is perceived as important but not well attended to in reality.
Source: JICA Study Team

Table 7.1.4 Identified Gap between Perceived Importance and Implementation (Bolgoda Basin)

	Important Issue	Importance (score)	Practice (score)	Importance (%)	Practice (%)	Gap
1	Minimize the negative impacts of storm water on the settlements and natural environment	143	70	86.67	42.42	44.24
2	Protect and conserve land and water resources relevant to Disaster Risk Reduction and Storm Water Management	145	61	87.88	36.97	50.91
3	Orderly and responsible property development	138	49	83.64	29.70	53.94
4	Prevent pollution of local waters and land	144	53	87.27	32.12	55.15
5	Minimize impervious surfaces, promote infiltration or discharge into local waters	136	53	82.42	32.12	50.30
6	Preserve the natural characteristics of stream corridors	142	55	86.06	33.33	52.73
7	Protect aquatic and riparian habitats	137	45	83.03	27.27	55.76
8	Provide recreational opportunities and aesthetic benefits	135	70	81.82	42.42	39.39
9	Community enhancement and Economic development	123	63	74.55	38.18	36.36
10	Preserve natural hydrologic and hydraulic functions of watercourses/ flood plains and wetlands	139	63	84.24	38.18	46.06
11	Facilitate excising and future institutional frameworks	143	69	86.67	41.82	44.85

During the stakeholder meeting, participants were asked to rate the level of importance and current level of practice for each issue. The aggregate Likert values are given for each feature (1 is least important/not practiced at all and 5 is most important/well implemented) and percentage. The gap is derived by subtracting practice (%) from importance (%). The bigger gap indicates that the issue is perceived as important but not well attended to in reality.
Source: JICA Study Team

Main comments from stakeholders in relation to environmental and social considerations for storm water management and responses are summarized below.

Table 7.1.5 Comments from Stakeholders and Responses at the First Stakeholder Meeting

	Comments	Response and Measures to be Taken
1	Dredging is likely to have some impact on wetlands. Preserving natural river flow and waterways should be the priority in the preparation of the Master Plan. (CEA)	The M/P will utilize natural waterway and river flow as much as possible to minimize environmental impacts.
2	Areas with high flood risk should be "no-go" areas with no housing development work allowed. While urbanization adds pressure on housing availability in Colombo, verticalization (more high-rise buildings) should be an option. (CEA)	Verticalization of housing is beyond the mandate of SLLDC and thus cannot be considered in the M/P, but the proposal will be noted in SEA as a topic to be shared and discussed further among stakeholders.
3	Enhancing institutional and regulatory framework to prevent illegal development and landfilling. (SLLDC)	We understand the need for such a framework. The platform for stakeholder dialogue such as this SEA will be used to develop institutional partnerships among relevant stakeholders.
4	The Master Plan should be closely coordinated with the land development plan that is being developed by UDA. (UDA)	We appreciate the information sharing and cooperation of UDA. The stakeholder will be kept informed of the progress of this study through this SEA.
5	Incentives should be provided to paddy owners. Without such incentive, they are more likely to sell their land to developers, resulting in more and more development. (Water Resource Board)	Providing an incentive to paddy owners is beyond the mandate of SLLDC and thus cannot be considered in the M/P, but the proposal will be noted in SEA as a topic to be shared and discussed further among stakeholders.

	Comments	Response and Measures to be Taken
6	Heavy metals and other pollutants kept in wetland vegetation may be released to rivers and the seas if/when wetlands are lost. This, in turn, causes health threats to humans. Protecting wetlands is, therefore, quite important. (National Water Supply and Drainage Board)	We understand the importance of wetland protection. The M/P will consider measures to minimize impacts on the wetlands.

Source: JICA Study Team

Based on this feedback, consultation meetings targeting Grama Niladhari (the smallest administrative unit in Sri Lanka) have been held to understand the current status and challenges associated with storm water management at the local level.

7.1.4 Summary of the Second Stakeholder Meeting

The second stakeholder meeting took place in CEA Conference Room on February 6, 2020. A total of 56 participants from 27 government institutions and local authorities, including those who did not participate in the first stakeholder meeting, such as the National Building Research Organization (NBRO), Water Resource Board and Marine Environmental Protection Agency, attended the meeting. In the second stakeholder meeting, the preliminary design of the Master Plan, as well as the results of GN-level consultations, were presented for feedback from stakeholders. Main comments and feedback from stakeholders are summarized below.

Table 7.1.6 Comments from Stakeholders and Responses at the Second Stakeholder Meeting

	Comments	Response and Measures to be Taken
1	Master Plan should avoid creating new environmental and social problems. For example, river improvement may affect local shrimp farming and dredging may affect the availability of irrigation water. The Master Plan should not address existing problems by creating new ones. (CEA)	The scale of river improvement and other measures will be kept at a minimum level in order to minimize environmental and social impacts.
2	Blockage of canals and waterways by illegally dumped wastes is causing floods. Creating garbage collection points along the canal may help alleviate the problem (National Water Supply and Drainage Board)	Awareness-raising is more effective in reducing the illegal dumping of waste. Fencing the canal may be also useful to avoid illegal dumping in the canal. (SLLDC)
3	In addition to river improvement, it is important to clearly specify the areas where development work is prohibited. Such measures are critical to prevent informal encroachment and landfilling. (Local authority)	We understand the issues of illegal landfilling. We will discuss the matter with relevant stakeholders at this stakeholder meeting and other venues for dialogue.
4	Responses to flooding can be categorized into three options: 1) resettle residents from the high-risk area, 2) implement risk mitigation and management measures, and 3) accept a certain level of damage. If some areas are found to be at a particularly high risk of flooding, then the first option (resettlement of people in a high-risk area) should also be considered. Also, awareness-raising activities about the risk and danger of flooding will help reduce the damages of flooding. (NBRO).	For 1), it is necessary to take into account the negative impacts of involuntary resettlement. The M/P aims to strike balance between 1) and 2) and proposes measures centering structural improvement. We also understand the importance of awareness-raising, which is the topic to be considered in the future.
5	Low-lying areas are typically occupied by Informal housing. Flood damage can be reduced by using such areas as retarding basins. (local authority)	Significant negative impacts are expected if areas with a large population (regardless of their legal status) are used for retention area. It is necessary to take into account the advantages of using the area for retention as well as the negative impacts.

Source: JICA Study Team

Source: JICA Study Team

Photo 7.1.2 The Second Stakeholder Meeting

7.1.5 Summary of the Third Stakeholder Meeting (Kalu Oya)

The third stakeholder meeting was conducted on March 12, 2020, specifically targeting the Kalu Oya basin because the preparation of the M/P for the Kalu Oya basin was concluded ahead of that of the Bolgoda basin. The meeting took place at CEA and there were no “new” participants as all government stakeholders and local authorities participated in the third stakeholder meeting and attended the first and/or second stakeholder meetings. A total of 30 stakeholders from 20 institutions (the total number of participants, including JICA and the JICA study team, was 43). The proposed M/P for the Kalu Oya basin and the results of the SEA study were presented and participants supported and agreed with the proposed M/P. The main comments from stakeholders and responses are shown below.

Table 7.1.7 Comments from Stakeholders and Responses at the Third Stakeholder Meeting (Kalu Oya)

	Comments	Response and Measures to be Taken
1	It is necessary to clarify the landowner and responsible person/party of the canal for conducting dredging. The final SEA report should clarify these matters as well as an institutional arrangement for dredging (CEA).	Institutional arrangements for dredging will be elaborated in the Pre-F/S stage, in which the role and responsibility of each party will be clarified.
2	A strong legal framework is needed to deter illegal construction activities and the dumping of solid waste into canals. (local authority)	The M/P does not review the legal framework but understands its importance. The platform for stakeholder dialogue such as this SEA can be used to facilitate discussion for developing such a legal framework.
3	The impacts of saltwater intrusion should be carefully considered when digging down the canal. (RDA, CEA)	Such activities are not planned in the M/P. However, the potential impacts of saltwater intrusion and the need for assessment will be considered during the Pre-F/S stage
4	It is important that from the planning stage, inherent natural wetland characteristics should be preserved as a priority. (UDA)	The M/P does not consider activities that will significantly alter existing wetlands.
5	Flood mitigation can trigger illegal landfilling. To minimize illegal landfilling, it is necessary to make local politicians aware of this process. (local authority)	The concerns are well noted. The consultation process during the Pre-F/S stage will look at these matters to ensure that the project does not trigger illegal activities.
6	It is good that the role and responsibility of each stakeholder are clarified. A review committee should be established and maintained to monitor the progress. (DWLC)	The monitoring plan and the demarcation of responsibility will be considered during the Pre-F/S stage.

Source: JICA Study Team

Source: JICA Study Team

Photo 7.1.3 The Third Stakeholder Meeting (Kalu Oya)

7.1.6 Summary of the Fourth Stakeholder Meeting (Bolgoda Basin)

The final stakeholder meeting for the Bolgoda basin was conducted online on November 11, 2021, due to Covid-19. In preparing for an online meeting, the SEA team conducted a short survey of stakeholders, especially local authorities, to confirm that stakeholders do not have technical problems participating in online meetings. The SEA team also prepared meeting materials to be provided to stakeholders who could not participate in the meeting. Some 60 people from a total of 24 government institutions and local authorities participated in the fourth stakeholder meeting. The proposed M/P for the Bolgoda basin and the result of the SEA study were presented at the stakeholder meeting and stakeholders agreed and supported the M/P. The main comments raised by the stakeholders and responses are shown below.

Table 7.1.8 Comments from Stakeholders and Responses at the Third Stakeholder Meeting (Bolgoda Basin)

	Comments	Response and Measures to be Taken
1	How does the project plan to manage the sediment removal and improve the discharge of solid waste?	While the common issues arising out of the M/P have been elaborated in the SEA, the sediment disposal will vary in each area and will have to be dealt with appropriately. For instance, removed sediments can be used to reclaim clay pits in Alut Ela. The waste water and solid waste should be discharged according to the relevant environmental laws. It was proposed that contemporary methods such as strainers should be used to prevent polluting garbage get washed to the open seas.
2	Proposed to pay attention to the issue of the slope of the canals, and the direction of flow, when constructing dikes, in particular, to pay attention to unintended flooding in the post-construction.	While legal issues are not elaborated in the M/P, slope/ direction are critical and inseparable aspects that will be taken into consideration in such projects. Current proposals are based on 2D study models in the M/P. However, more detailed analyses will be carried out in the future stage of the project.
3	An earlier proposed development is ongoing along the left side of the Weras Ganga. The need to construct the gabion wall along the right side of the Weras Ganga should be clarified.	Improvement of the right side of the Weras Ganga is essential because of its potential flood risk. But, along a 10 m strip of the right side of the bank, around 600 unauthorized dwellings exist. Thus resettlement is a big challenge. The dike will, however, be a barrier against further reclamations of land. The proposed gabion dike will prevent human encroachment and storm water penetration. As a measure against water surges, a pumping station can be considered.
4	Does the M/P consider rainfall in the future, sea water encroachment, and rise in sea water levels?	Such forecasts of the rise of the sea levels, rain intensification have been considered in the M/P.

	Comments	Response and Measures to be Taken
5	Will the proposed master plan for the Bolgoda River Basin have an effect on the Bolgoda reserve?	The desired strategy would be to relocate all unauthorized residents within the Bolgoda reserve. However, it is not feasible given the complexity of the ground situation. Considering the critical need of the project, around 10 m strip at a maximum is earmarked for clearing although the reservation boundary runs 100 meters.
6	The abandoned clay pits of the area can be used as water retention areas.	First of all, it is necessary to declare "no development" in these mentioned areas (around clay pits). Otherwise, future developments may take place in those reservation spaces. The retentions should be identified, declared and gazetted to avoid misunderstandings, misconceptions and misappropriations. Some clay pits can be used for dumping debris and sediments.
7	Garbage dump caused flooding around the Panape Ela during the rainy season and inquired for clarification. Will the issue be addressed in this development model?	Although the canal is cleaned from time to time, it remains inadequate. Aquatic plants, as well as garbage, can cause poor drainage. Hence, the long-term solution is to keep canals and wetlands clean. This M/P will address selected issues only, thus, some will remain outside the scope of this project.
8	Local authorities need excavating machines for the district. It is suggested to make available at least one small machine for each PSD so that storm water management can be carried out promptly when the need arises.	The participating institutions could take this up with the state and the political authorities. The report will endeavor to make these recommendations, although these issues are beyond the mandate of the project.

Source: JICA Study Team

7.1.7 Recommendations of SEA

Based on the results of the third and fourth stakeholder meetings targeting the Kalu Oya basin and the Bolgoda basin, respectively, the SEA report for each basin has been finalized. The SEA concludes that the M/P will address many challenges associated with flooding and stormwater drainage. To minimize environmental and social impacts associated with the implementation of the M/P and to maximize positive impacts of the M/P, the SEA proposed the following recommendations.

Table 7.1.9 Recommendations of SEA to the Master Plan

	Area	Recommendation
1	Kalu Oya	When establishing wetland parks and retarding basins, adequate attention should be given to ensure that existing drainage patterns are not disturbed, as this would result in an accumulation of stormwater outside the wetland parks and retarding basins resulting in minor floods that would affect the surrounding communities.
2	Common	The vegetation that will be removed during canal improvements must be estimated prior to commencing these actions and a plan must be prepared as to how the estimated biomass will be managed.
3	Common	Since many of the plant species that will be removed during canal improvements are invasive alien species, the biomass management plan must have a separate set of guidelines on how to identify and process invasive alien species with the involvement of a specialist that has prior experience with managing invasive alien plant species.
4	Common	At each site where dredging will be undertaken, a sediment sample must be tested for the presence of heavy metals and other potentially toxic substances. If the sediment samples were found to have heavy metals or other toxic materials, their disposal should be carried out with special precautions to prevent leachate from such heavy metals or toxic material into the surrounding environment.
5	Common	The quantity of anticipated dredged material must be calculated before the commencement of the dredging operations. Temporary storage areas and permanent disposal sites should be identified according to the expected amount of material.
6	Common	The dredged material should be stored close to the dredging site to partially dry the material before it is transported to the permanent disposal site. Further, the route

	Area	Recommendation
		between the temporary storage site and the permanent disposal site should be preplanned to ensure that the transport of dredged material will not result in traffic congestion.
7	Bolgoda Basin	The dredged material can be used to restore the abandoned clay pits and therefore a detailed plan should be developed as to how the dredged material can be utilized within the basin for the restoration of abandoned lands.
8	Common	Ecological restoration of habitats should only use native species that are suitable for the basin, which should be identified with the help of a plant ecologist.
9	Common	Creation of access roads through wetlands should be minimized.
10	Bolgoda Basin	Boundaries of the Bolgoda EPA should be demarcated to prevent future encroachments.
11	Kalu Oya	Boundaries of the wetland parks and retarding basins should be demarcated to prevent future encroachments.
12	Bolgoda Basin	Restored areas should be used for recreation activities as this will create additional livelihoods, especially for marginalized communities.
13	Common	There would be some temporary inconvenience due to construction activities and care must be taken to implement best construction management practices with the needs of the residents being given due consideration.
14	Common	All exposed areas in banks must be vegetated to prevent soil erosion. Turfing is not recommended as it would involve the use of exotic grasses. Alternatively, native ground cover can be used.
15	Common	Provide compensation if relocation/resettlement is taking place or for any physical and human damages.
16	Common	Conduct an awareness program for all the stakeholders, particularly project affected local people, to get their support for the master plan

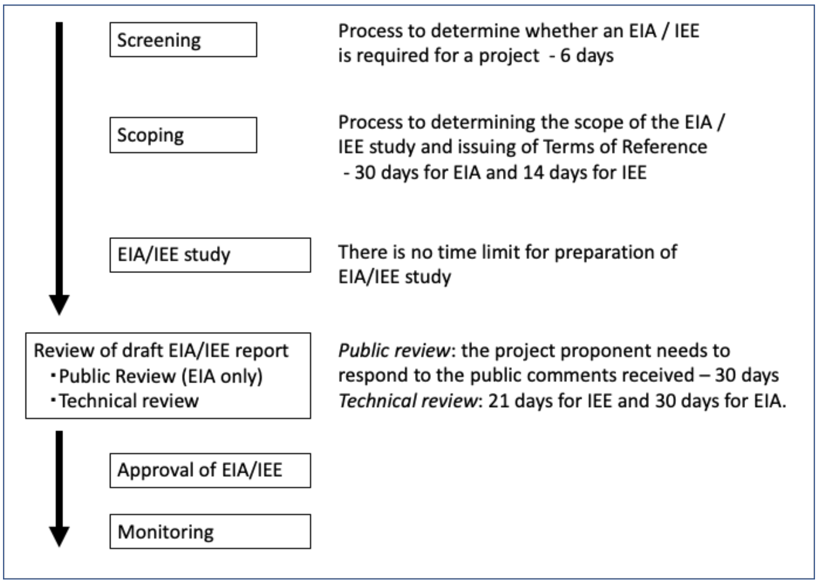
Source: JICA Study Team

The SEA also identified actions that are beyond the scope of the M/P but nevertheless important for sustainable stormwater management in the long-term and highlighted issues that should be discussed among stakeholders. The key issues identified during the SEA study are summarized below.

- To prevent paddy fields from being abandoned and developed, consider measures and incentives to support farmers and help them earn larger and more reliable income from paddy farming.
- Ensure that all institutions involved in urban planning and management activities within the basin understand the range of benefits provided by wetlands and understand how wetlands can assist in the delivery of individual, institutional objectives. Measures should be also considered to improve the quality of collaboration and knowledge sharing among relevant institutions.
- Enhance the flood and storm water management capacity of local authorities by providing them with the necessary training as well as equipment so that they are able to conduct routine maintenance of the drainage system in a systematic and timely manner, which will ensure proper drainage of stormwater and prevention of floods.
- Both household waste and collected waste are disposed of haphazardly at unsuitable locations, mostly in wetlands, leading to blockage of canals as well as contamination of water with solid waste. A sustainable solid waste management plan must be developed for the basin and implemented to ensure waste will not be disposed of haphazardly at unsuitable locations, mostly in wetlands, which leads to blockage of canals as well as contamination of water.
- Identify households, both formal and informal, located within the flood basin and have a long-term plan to mitigate flood risks and impacts, including relocating these people to safer sites.
- Release untreated wastewater from industries and sewage water from households contributes to the reduction in water quality, water pollution and increasing the nutrient loads in the water leading to eutrophication. Therefore, a basin-wide survey must be conducted to identify potential sources responsible for release of wastewater and a program must be prepared and implemented to reduce the release of wastewater by providing alternate solutions as well as implementing existing legal statutes pertaining to release of wastewater and sewage.

7.1.8 Sri Lankan Legal Framework on Environmental and Social Considerations Related to the Pre-FS

In Sri Lanka, the EIA process is mandated for large-scale development projects or projects which are located in environmentally sensitive areas. The specific types of projects requiring EIA or IEE have been prescribed in the Gazette (Gazette No. 772/22 of 24.06.1993), and all river basin development and irrigation projects, excluding minor irrigation works (as defined by Irrigation Ordinance chapter 453), are included in the list of "the Prescribed Project."



Source: JICA Study Team

Figure 7.1.2 Flow of EIA/IEE in Sri Lanka

The list of the prescribed projects includes projects involving involuntary resettlement of more than 100 families (excluding resettlement resulting from the emergency). In addition, National Involuntary Resettlement Policy in 2001 stipulated that a comprehensive Resettlement Action Plan would be required where 20 or more families are affected.

SLLDC and JICA Study Team have started a preliminary discussion with CEA about the level of environmental assessment required for Pre F/S projects in case they fall into the category of the prescribed projects. At the moment, CEA is not able to provide a clear answer because Pre F/S projects are to be finalized in the Master Plan study, which is currently ongoing. According to CEA, SLLDC can start a formal discussion with CEA on this matter only after the Master Plan is finalized.

Also, a project carried out within a Sanctuary is included in the list of the prescribed projects, and therefore, an IEE or EIA is likely to be required for a project in the Moratuwa-Rathmalana area. Whether the project requires an IEE or EIA will be determined by the screening process by CEA, and thus, it cannot be confirmed at the moment. Having said that, however, given the level of development and man-made changes already made to Bellanwila Attidiya Sanctuary since it was declared as Sanctuary, it is not very likely that the project will require an EIA.

CHAPTER 8 ECONOMIC EVALUATION

8.1 Preliminary Cost-Benefit Analysis

8.1.1 Methodology of Cost-Benefit Analysis

8.1.1.1 General

The main objective of the cost-benefit analysis is to examine the investment efficiency of the component of the Master Plan from the viewpoint of the national economy. Market prices have been converted to economic prices where the influence of market distortion is removed (so-called shadow prices). Opportunity costs are used for the costs of goods and services whose markets do not exist. Internal Rate of Return (IRR) is used here as the indicator of the efficiency of a project investment.

8.1.1.2 Preconditions

The following preconditions are assumed in the economic evaluation. Additional preconditions will be clarified as necessary.

(1) With-project and Without-project

Without-project is the case where the flood is managed by the currently existing works. With-project is the case where new projects are implemented into the currently existing works.

(2) Evaluation Period

The evaluation period covers the whole project life from the preparation of construction. It is decided in principle as 50 years after starting the construction works of the project.

(3) Standard Conversion Factor (SCF)

SCF is used for bringing such goods that are valued in the domestic price level to those are valued at the border price level with a common base. In addition, SCF is simply the inverse of the Shadow Exchange Rate Factor (SERF), which is the ratio of the shadow exchange rate to the official exchange rate by definition. It is updated using the latest data based on the SCF calculated in the recent JICA Study "Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo, Sri Lanka, 2018". 0.91 is employed here for SCF based on the calculation result shown below:

Table 8.1.1 Calculation of SCF

(Unit: million Rs.)

	2014	2015	2016	2017	2018
(1) Import Tax	**348,315**	**359,210**	**493,923**	**554,550**	**536,853**
Import Duties	77,726	108,115	156,487	136,501	96,991
VAT (Imports)	102,280	83,726	115,336	168,393	179,163
Ports & Airports Development Levy	68,646	56,733	88,822	102,360	113,950
Import Cess Levy	35,622	42,467	59,058	56,574	50,777
Special Commodity Levy	47,952	52,275	55,825	71,402	75,807
Nation Building Tax (Imports)	16,089	15,894	18,395	19,320	20,165
(2) Export Tax	**27,164**	**2,746**	**2,703**	**3,010**	**2,631**
Export Duties	24,080	33	31	30	40
Export Cess Levy	3,084	2,713	2,672	2,980	2,592
(3) Total Imports	**2,535,163**	**2,572,467**	**2,794,393**	**3,198,572**	**3,606,644**
(4) Total Exports	**1,453,176**	**1,431,431**	**1,500,766**	**1,732,440**	**1,933,533**
SCF ={(3)+(4)}/[{(3)+(1)}+{(4)-(2)}]	**0.93**	**0.92**	**0.90**	**0.90**	**0.91**
Average of SCF			**0.91**		

Source: Ministry of Finance, Central Bank of Sri Lanka, JICA Study Team

(4) Shadow Discount Rate (SDR)

12% is employed here for SDR based on the recent JICA Studies "Preparatory Survey on Landslide Disaster Protection Project of the National Road Network Phase 2 in Sri Lanka, 2019" and "Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo, Sri Lanka, 2018". SDR is used as the criteria for the economic evaluation.

(5) Taxes

Taxes are deducted from the market price since they are simply transferable items from the viewpoint of the national economy. 8% is used for Value Added Tax (VAT) because it was reduced from 15% in December 2019.

(6) Price Level

The price level is set for 2018. Price data which is not at the 2018 level is adjusted to the 2018 level with applying inflation rate (GDP deflator, refer to 3.1.4.2 Inflation).

8.1.1.3 Economic Project Benefits

Incremental benefits are included in the evaluation by comparing with-project and without-project. The benefits are calculated in the form of the cash flow of each year during the evaluation period. The benefits of a flood mitigation project are reduction or mitigation of damages caused by floods.

As for the direct damage caused by the flood, it can generally be calculated with the following formula:

[Direct Damage in the Area (Rs.)] =

[Area Size (ha)] × [Damageable Value (Rs./ha)] × [Damage Rate by Inundation Depth]

The damageable value is the maximum amount of asset value that will be damaged by the inundation. It is assumed that damage rate is a function of inundation depth (m) and the function should be estimated. Since the flood-causing inundation is a probability event, the damage value to be calculated is the annual expected value based on the probability of flood occurrence (sum of damages multiplied by each flood probability).

Estimation of indirect damages will be discussed later.

8.1.1.4 Economic Project Costs

Incremental costs are included in the evaluation by comparing with-project and without-project. The costs are calculated in the form of cash flow each year during the evaluation period. The following cost items are considered.

(1) Initial Cost

Initial cost includes costs of construction of the facility and equipment, engineering services, etc. Economic evaluation includes physical contingencies but excludes price escalation.

(2) Operation and Maintenance Cost

Operation and maintenance cost for each year is included. Price escalation is not included.

(3) Depreciation

Although a certain amount of money is allocated as depreciation on the books, it is not actually spent at that time. So, it is not included in the cost items in the economic evaluation.

8.1.2 Estimation of Economic Benefits

The benefits of the project are captured in the form of expected direct/indirect damage reduction. Damages are examined and estimated for each sector including households, manufacturing, and other industries and infrastructure/utilities as below:

8.1.2.1 Manufacturing and Other Industrial Sectors

(1) Direct Damages

The fixed assets (building, machinery, vehicle, office appliances, equipment, etc.) and inventory assets (materials and components) of factories are considered as the damageable property of the manufacturing and other sectors.

Available Data

Department of Census and Statistics published "Annual Survey of Industries 2017". which includes the fixed asset data and inventory asset data in book value in addition to the number of companies, employees, and a value added by industrial division at the national level.

Estimation of Damages

Damageable value on fixed assets and inventory assets per ha of settlement area is calculated by applying the census data and GIS data for large establishments (people engaged are 25 or more) and for small establishments (people engaged are less than 25)*. This data is applied to the results of flood simulation.

(2) Indirect Damages

Indirect damages due to business suspension are calculated by applying the value added per day of the "Annual Survey of Industries 2017".

8.1.2.2 Household Sector

(1) Direct Damages

Floods cause damages directly to houses and household assets. The number of houses for a district is estimated with “Census of Population 2012” published by the Department of Census and Statistics**. The price of standard house construction is Rs. 5.7 – 5.0 million according to the interview survey to Urban Development Authorities. The average price of household assets (TV, PC, refrigerator, rice cooker, bicycle, motorcycle, automobile, etc.) per household is estimated with percentage data of “household possessions” in “Demographic and Health Survey - 2016”.

Damageable value on houses and household assets per ha of settlement area is calculated by applying the census data and GIS data. This data is applied to the results of flood simulation.

(2) Indirect Damages

Indirect damages due to business suspension are calculated by applying the family income per day using the data in "Household Income and Expenditure Survey 2016" published by the Department of Census and Statistics.

8.1.2.3 Infrastructure and Utilities

Damageable values of infrastructure and utilities are calculated at 74.1% of the direct damage on buildings and assets of industry sector and household sector with referring to “Manual for Economic Analysis for Flood Control Projects in Japan”, Ministry of Infrastructure, Land and Transport, Japan.

8.1.2.4 Damage Rates/Business Suspension Days

Damage rates/Days designated in “Manual for Economic Analysis for Flood Control Projects in Japan” are applied as presented in the following tables.

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* Only the data for large establishments (people engaged are 25 or more) are applied to industrial parks.

** As it is assumed that the average number of families for a house with 1 - 2 stories is 1.0, the average number of families for other types of houses is 1.7 or less, it can be assumed that the other types of houses are also houses with 1 - 2 stories for simplification of calculation.

Table 8.1.2 Damage Rates/Days

Inundation (m)			House	Business Building	Household Assets	Business Fixed Assets	Business Inventories	Days off for Families (days)	Business Suspension (days)
0.00	–	0.15	0.032	0.032	0.021	0.099	0.056	4.0	3.0
0.15	–	0.65	0.092	0.092	0.145	0.232	0.128	7.5	4.4
0.65	–	1.15	0.119	0.119	0.326	0.453	0.267	13.3	6.3
1.15	–	2.15	0.266	0.266	0.508	0.789	0.586	26.1	10.3
2.15	–	3.15	0.580	0.580	0.928	0.966	0.897	42.4	16.8
3.15	–		0.834	0.834	0.991	0.995	0.982	50.1	22.6

Note: Floor elevation is assumed at 0.15 m from the ground.
Source: "Manual for Economic Analysis for Flood Control Projects in Japan", Ministry of Infrastructure, Land and Transport, Japan. 2005.

8.1.3 Estimation of Economic Costs

Transfer items such as taxes are excluded. The following items are included in the cost calculation: (1) Construction, (2) Engineering, (3) Physical contingencies, (4) Land acquisition, (5) Administration, and (6) O&M, (7) Replacement. Costs of (1) to (5) will accrue as initial costs before and/or in the construction period. O&M costs will accrue every year after the construction is completed and the facilities start to be used. It is assumed that the replacement cost accrues every seven years on the replacement of gabions for the revetment work.

8.1.4 Preliminary Economic Evaluation

Economic Internal Rate of Return (EIRR), B/C and Net Present Value (NPV) of the projects for each river basin are preliminarily calculated as follows:

Table 8.1.3 EIRR and Other Indicators of Projects for River Basins

River Basin	EIRR	B/C	NPV (million Rs.)
Kalu Oya	12.22%	1.02	134
Mudun Ela	53.79%	7.22	17,684
Bolgoda	20.72%	1.76	4,648

Source: Ministry of Finance, Central Bank of Sri Lanka, JICA Study Team

As SDR is set at 12%, all the projects for the river basins are evaluated as feasible. Though EIRR of Mudun Ela seems very high, it is because this includes the effect of the construction of the pump station. If the construction cost of the pumping station is considered, EIRR becomes 30% level.

The cashflow tables of projects for river basins are presented on the following pages.

Table 8.1.4 Cashflow Table of Projects for the Kalu Oya River Basin

EIRR Calculation: Kalu Oya RI&FD

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	34.9	3.5	0.0	0.8	39.2			39.2	0.0	-39.2
3	2024	0.0	118.5	11.9	0.0	2.5	132.9			132.9	0.0	-132.9
4	2025	0.0	97.6	9.8	1,005.5	7.2	1,120.1			1,120.1	0.0	-1,120.1
5	2026	1,617.6	47.4	166.5	1,005.5	42.5	2,879.5			2,879.5	0.0	-2,879.5
6	2027	1,617.6	47.4	166.5	1,005.5	44.2	2,881.2			2,881.2	344.0	-2,537.2
7	2028	2,633.7	47.4	268.1	0.0	60.2	3,009.5			3,009.5	688.0	-2,321.5
8	2029	1,016.2	47.4	106.4	0.0	24.4	1,194.4			1,194.4	1,248.1	53.7
9	2030	1,016.2	33.5	105.0	0.0	24.4	1,179.0			1,179.0	1,464.2	285.2
10	2031							41.0		41.0	1,680.2	1,639.2
11	2032							41.0		41.0	1,680.2	1,639.2
12	2033							41.0		41.0	1,680.2	1,639.2
13	2034							41.0		41.0	1,680.2	1,639.2
14	2035							41.0		41.0	1,680.2	1,639.2
15	2036							41.0		41.0	1,680.2	1,639.2
16	2037							41.0	359.0	400.0	1,680.2	1,280.2
17	2038							41.0		41.0	1,680.2	1,639.2
18	2039							41.0		41.0	1,680.2	1,639.2
19	2040							41.0		41.0	1,680.2	1,639.2
20	2041							41.0		41.0	1,680.2	1,639.2
21	2042							41.0		41.0	1,680.2	1,639.2
22	2043							41.0		41.0	1,680.2	1,639.2
23	2044							41.0	359.0	400.0	1,680.2	1,280.2
24	2045							41.0		41.0	1,680.2	1,639.2
25	2046							41.0		41.0	1,680.2	1,639.2
26	2047							41.0		41.0	1,680.2	1,639.2
27	2048							41.0		41.0	1,680.2	1,639.2
28	2049							41.0		41.0	1,680.2	1,639.2
29	2050							41.0		41.0	1,680.2	1,639.2
30	2051							41.0	359.0	400.0	1,680.2	1,280.2
31	2052							41.0		41.0	1,680.2	1,639.2
32	2053							41.0		41.0	1,680.2	1,639.2
33	2054							41.0		41.0	1,680.2	1,639.2
34	2055							41.0		41.0	1,680.2	1,639.2
35	2056							41.0		41.0	1,680.2	1,639.2
36	2057							41.0		41.0	1,680.2	1,639.2
37	2058							41.0	359.0	400.0	1,680.2	1,280.2
38	2059							41.0		41.0	1,680.2	1,639.2
39	2060							41.0		41.0	1,680.2	1,639.2
40	2061							41.0		41.0	1,680.2	1,639.2
41	2062							41.0		41.0	1,680.2	1,639.2
42	2063							41.0		41.0	1,680.2	1,639.2
43	2064							41.0		41.0	1,680.2	1,639.2
44	2065							41.0	359.0	400.0	1,680.2	1,280.2
45	2066							41.0		41.0	1,680.2	1,639.2
46	2067							41.0		41.0	1,680.2	1,639.2
47	2068							41.0		41.0	1,680.2	1,639.2
48	2069							41.0		41.0	1,680.2	1,639.2
49	2070							41.0		41.0	1,680.2	1,639.2
50	2071							41.0		41.0	1,680.2	1,639.2
51	2072							41.0	359.0	400.0	1,680.2	1,280.2
52	2073							41.0		41.0	1,680.2	1,639.2
53	2074							41.0		41.0	1,680.2	1,639.2
54	2075							41.0		41.0	1,680.2	1,639.2
55	2076							41.0		41.0	1,680.2	1,639.2
56	2077							41.0		41.0	1,680.2	1,639.2
57	2078							41.0		41.0	1,680.2	1,639.2
58	2079							41.0	359.0	400.0	1,680.2	1,280.2
59	2080							41.0		41.0	1,680.2	1,639.2
Total		7,901.2	474.1	837.5	3,016.6	206.4	12,435.7				EIRR:	12.22%

Discount Rate 12%

	Cost	Benefit
PV	7,200.98	7,335.26

NPV:	134.28
B/C:	1.02

Table 8.1.5 Cashflow Table of Projects for the Mudun Ela River Sub-Basin

EIRR Calculation: Mudun Ela RI&FD

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	34.3	61.8	0.0	2.5	98.5			98.5	0.0	-98.5
3	2024	623.0	30.1	123.6	583.3	16.5	1,376.6			1,376.6	0.0	-1,376.6
4	2025	623.0	18.8	77.7	583.3	14.9	1,317.7			1,317.7	0.0	-1,317.7
5	2026	152.5	4.6	29.3	135.6	4.4	326.3			326.3	0.0	-326.3
6	2027	152.5	4.6	15.7	135.6	3.6	312.0			312.0	2,918.7	2,606.7
7	2028	152.5	4.6	15.7	0.0	3.7	176.5			176.5	3,236.9	3,060.4
8	2029	152.5	4.6	15.7	0.0	3.8	176.6			176.6	3,555.1	3,378.5
9	2030	152.5	2.5	15.5	0.0	3.8	174.3			174.3	3,873.2	3,698.9
10	2031							10.0		10.0	4,191.4	4,181.4
11	2032							10.0		10.0	4,191.4	4,181.4
12	2033							10.0		10.0	4,191.4	4,181.4
13	2034							10.0		10.0	4,191.4	4,181.4
14	2035							10.0		10.0	4,191.4	4,181.4
15	2036							10.0		10.0	4,191.4	4,181.4
16	2037							10.0	187.0	197.0	4,191.4	3,994.4
17	2038							10.0		10.0	4,191.4	4,181.4
18	2039							10.0		10.0	4,191.4	4,181.4
19	2040							10.0		10.0	4,191.4	4,181.4
20	2041							10.0		10.0	4,191.4	4,181.4
21	2042							10.0		10.0	4,191.4	4,181.4
22	2043							10.0		10.0	4,191.4	4,181.4
23	2044							10.0	187.0	197.0	4,191.4	3,994.4
24	2045							10.0		10.0	4,191.4	4,181.4
25	2046							10.0		10.0	4,191.4	4,181.4
26	2047							10.0		10.0	4,191.4	4,181.4
27	2048							10.0		10.0	4,191.4	4,181.4
28	2049							10.0		10.0	4,191.4	4,181.4
29	2050							10.0		10.0	4,191.4	4,181.4
30	2051							10.0	187.0	197.0	4,191.4	3,994.4
31	2052							10.0		10.0	4,191.4	4,181.4
32	2053							10.0		10.0	4,191.4	4,181.4
33	2054							10.0		10.0	4,191.4	4,181.4
34	2055							10.0		10.0	4,191.4	4,181.4
35	2056							10.0		10.0	4,191.4	4,181.4
36	2057							10.0		10.0	4,191.4	4,181.4
37	2058							10.0	187.0	197.0	4,191.4	3,994.4
38	2059							10.0		10.0	4,191.4	4,181.4
39	2060							10.0		10.0	4,191.4	4,181.4
40	2061							10.0		10.0	4,191.4	4,181.4
41	2062							10.0		10.0	4,191.4	4,181.4
42	2063							10.0		10.0	4,191.4	4,181.4
43	2064							10.0		10.0	4,191.4	4,181.4
44	2065							10.0	187.0	197.0	4,191.4	3,994.4
45	2066							10.0		10.0	4,191.4	4,181.4
46	2067							10.0		10.0	4,191.4	4,181.4
47	2068							10.0		10.0	4,191.4	4,181.4
48	2069							10.0		10.0	4,191.4	4,181.4
49	2070							10.0		10.0	4,191.4	4,181.4
50	2071							10.0		10.0	4,191.4	4,181.4
51	2072							10.0	187.0	197.0	4,191.4	3,994.4
52	2073							10.0		10.0	4,191.4	4,181.4
53	2074							10.0		10.0	4,191.4	4,181.4
54	2075							10.0		10.0	4,191.4	4,181.4
55	2076							10.0		10.0	4,191.4	4,181.4
56	2077							10.0		10.0	4,191.4	4,181.4
57	2078							10.0		10.0	4,191.4	4,181.4
58	2079							10.0	187.0	197.0	4,191.4	3,994.4
59	2080							10.0		10.0	4,191.4	4,181.4
Total		2,008.3	104.0	355.0	1,437.8	53.3	3,958.4				EIRR:	53.79%

Discount Rate 12%

	Cost	Benefit
PV	2,843.03	20,526.73

NPV:	17,683.69
B/C:	7.22

Table 8.1.6 Cashflow Table of Projects for the Bolgoda River Basin

EIRR Calculation: Bolgoda

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	4.4	29.8	293.7	7.2	335.2			335.2	0.0	-335.2
3	2024	73.6	87.3	45.5	293.7	11.1	511.2			511.2	0.0	-511.2
4	2025	73.6	87.3	104.7	886.6	25.9	1,178.1			1,178.1	31.5	-1,146.7
5	2026	1,134.7	34.0	205.5	886.6	51.1	2,311.9			2,311.9	62.9	-2,249.0
6	2027	1,134.7	34.0	116.9	0.0	28.8	1,314.4			1,314.4	548.3	-766.1
7	2028	1,134.7	34.0	116.9	0.0	29.7	1,315.3			1,315.3	1,033.6	-281.7
8	2029	1,134.7	34.0	116.9	0.0	30.7	1,316.2			1,316.2	1,519.0	202.7
9	2030	1,134.7	34.0	116.9	0.0	31.6	1,317.2			1,317.2	2,004.3	687.1
10	2031						0.0	33.0		33.0	2,489.6	2,456.6
11	2032						0.0	33.0		33.0	2,489.6	2,456.6
12	2033						0.0	33.0		33.0	2,489.6	2,456.6
13	2034						0.0	33.0		33.0	2,489.6	2,456.6
14	2035						0.0	33.0		33.0	2,489.6	2,456.6
15	2036						0.0	33.0		33.0	2,489.6	2,456.6
16	2037						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
17	2038						0.0	33.0		33.0	2,489.6	2,456.6
18	2039						0.0	33.0		33.0	2,489.6	2,456.6
19	2040						0.0	33.0		33.0	2,489.6	2,456.6
20	2041						0.0	33.0		33.0	2,489.6	2,456.6
21	2042						0.0	33.0		33.0	2,489.6	2,456.6
22	2043						0.0	33.0		33.0	2,489.6	2,456.6
23	2044						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
24	2045						0.0	33.0		33.0	2,489.6	2,456.6
25	2046						0.0	33.0		33.0	2,489.6	2,456.6
26	2047						0.0	33.0		33.0	2,489.6	2,456.6
27	2048						0.0	33.0		33.0	2,489.6	2,456.6
28	2049						0.0	33.0		33.0	2,489.6	2,456.6
29	2050						0.0	33.0		33.0	2,489.6	2,456.6
30	2051						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
31	2052						0.0	33.0		33.0	2,489.6	2,456.6
32	2053						0.0	33.0		33.0	2,489.6	2,456.6
33	2054						0.0	33.0		33.0	2,489.6	2,456.6
34	2055						0.0	33.0		33.0	2,489.6	2,456.6
35	2056						0.0	33.0		33.0	2,489.6	2,456.6
36	2057						0.0	33.0		33.0	2,489.6	2,456.6
37	2058						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
38	2059						0.0	33.0		33.0	2,489.6	2,456.6
39	2060						0.0	33.0		33.0	2,489.6	2,456.6
40	2061						0.0	33.0		33.0	2,489.6	2,456.6
41	2062						0.0	33.0		33.0	2,489.6	2,456.6
42	2063						0.0	33.0		33.0	2,489.6	2,456.6
43	2064						0.0	33.0		33.0	2,489.6	2,456.6
44	2065						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
45	2066						0.0	33.0		33.0	2,489.6	2,456.6
46	2067						0.0	33.0		33.0	2,489.6	2,456.6
47	2068						0.0	33.0		33.0	2,489.6	2,456.6
48	2069						0.0	33.0		33.0	2,489.6	2,456.6
49	2070						0.0	33.0		33.0	2,489.6	2,456.6
50	2071						0.0	33.0		33.0	2,489.6	2,456.6
51	2072						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
52	2073						0.0	33.0		33.0	2,489.6	2,456.6
53	2074						0.0	33.0		33.0	2,489.6	2,456.6
54	2075						0.0	33.0		33.0	2,489.6	2,456.6
55	2076						0.0	33.0		33.0	2,489.6	2,456.6
56	2077						0.0	33.0		33.0	2,489.6	2,456.6
57	2078						0.0	33.0		33.0	2,489.6	2,456.6
58	2079						0.0	33.0	1,298.0	1,331.0	2,489.6	1,158.6
59	2080						0.0	33.0		33.0	2,489.6	2,456.6
Total		5,820.5	349.2	853.0	2,360.6	216.1	9,599.6				EIRR:	20.72%

Discount Rate 12%

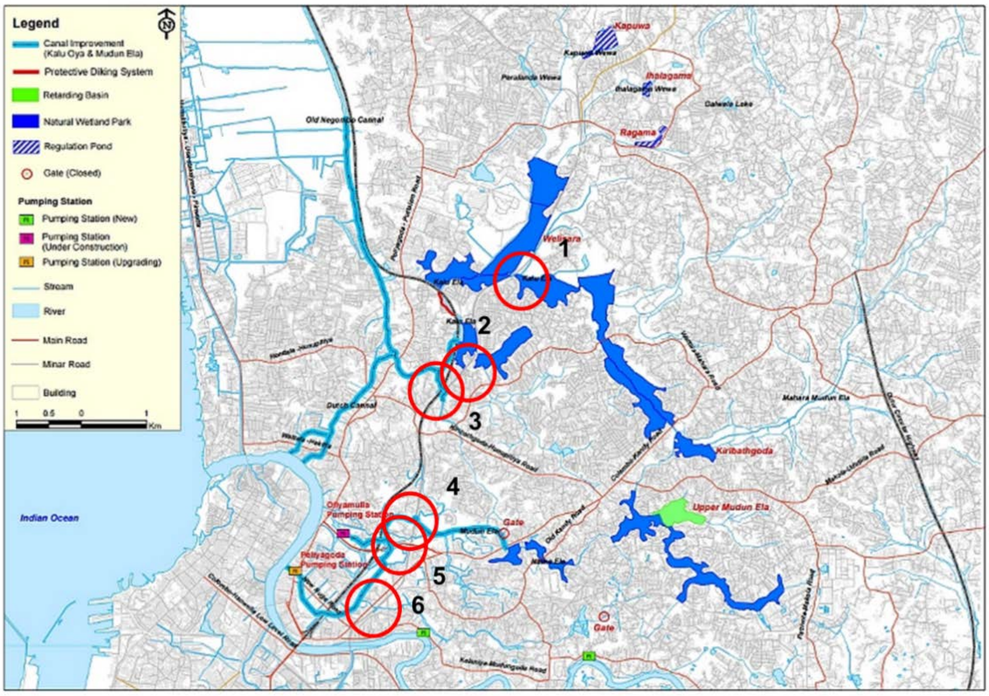
	Cost	Benefit
PV	6,096.21	10,744.13

NPV:	4,647.92
B/C:	1.76

CHAPTER 9 RECOMMENDATIONS

9.1 Specifications of the New Railway Bridge

Most of the existing railway bridges become constricted parts with respect to the waterway, which causes local flooding in the upstream part of the railway bridge. However, the repair of the railway bridge itself involves a change in the vertical alignment of the railway over a long section, so that it is practically impossible to carry out within the waterway improvement project. However, electrification of the railway passing through both the Kalu Oya and Mudun Ela sub-basins is currently underway. Hence, we recommend that SLLDC and the railway manager should discuss on that the railway bridge renovation plan at the detailed design stage of the Kalu Oya and Mudun Ela improvement project and the railway electrification project.



Source: JICA Study Team

Figure 9.1.1 Location Map of The Railway Bridges in The Kalu Oya Basin

Table 9.1.1 Recommended Railway Bridge Specifications

No.	Canal	Existing Culvert		Proposed Dimension				
	Name	Width	Height	Width	Bank Level	Freeboard	HWL	Bed Level
unit		m	m	m	m MSL	m MSL	m MSL	m MSL
1	Kalu Oya	30	2.71	40	2.46	0.5	1.96	-2.00
2	Nahena	6.25	4.36	20	2.22	0.5	1.72	-2.00
3	Natha	6	3.59	20	2.06	0.5	1.56	-1.14
4	Mudun Ela Main	15	2.26	20	2.10	0.5	1.60	-0.40
5	Mudun Ela Branch	2.6	2.66	20	2.00	0.5	1.50	-0.50
6	Naranmini Oya	5.2	2.26	20	2.00	0.5	1.50	0.00

Source: JICA Study Team

9.2 Cooperation with the Irrigation Department in the Bolgoda basin

In the Bolgoda basin, especially in the south, a lot of agricultural land remains, and ID manages some rivers there, so the following facilities should be managed coordinating with the Irrigation Department.

- Maintenance of Estuary Dredging

Regarding the Panadura estuary, which is the only outlet of the Bolgoda Ganga to the sea, coastal drift sand that accumulates near the estuary causes the water level to rise in the Bolgoda Ganga. Because of its gentle longitudinal slope of the river, it affects the upstream Weras Ganga. Therefore, we would recommend regular dredging of the sediments at the estuary in the dry season.

- Temporary excavation of Bolgoda South Lake

Although Bolgoda South Lake can be drained into the sea by the Thalpitiya Ela, sediment deposits from Kalu Ganga, which is adjacent to the south, cause estuary blockage throughout the year. Moreover, the flow in southern Bolgoda are not so large as to wash away these sediments. Therefore, to avoid the water level of Bolgoda South Lake to become dangerous during the flood season, the most rational measure is to temporarily excavate the estuary by excavation to lower the water level before the flood season.

- Repair of the connecting gate with Kalu Ganga

Irrigation gates are installed at the uppermost stream of the river channel of Mawela Ela and Keppu Ela, that borders Kalu Ganga in the south. However, the gates are not functioning due to its deterioration. For this reason, residents have complained that the flood of Kalu Ganga has been drawn in and flooded downstream. Hence, we would recommend rehabilitating the gates.

Part 2

Pre-Feasibility Study

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEX TABLES

LIST OF ANNEX FIGURES

CHAPTER 1 INTRODUCTION

1.1 Background

As a preparation for the Pre-F/S, additional data was collected and compiled. Ground elevation data and the cross section data at Mudun Ela collected in the M/P study were also applied in the Pre-F/S. The cross section data of the drainage channels at the Moratuwa-Rathmalana area which were surveyed by the SLLDC in 2020 and 2021 were supplied by the SLLDC and used for the analyses and designs. To understand the soil characteristics of the ground, the geotechnical investigation including boring, in-situ tests, and laboratory tests was subcontracted.

CHAPTER 2 HYDROLOGICAL AND HYDRAULIC ANALYSIS

2.1 Pre-feasibility Study in Mudun Ela Sub-basin

2.1.1 Proposed Countermeasures and Priority Projects in the Master Plan in the Mudun Ela Sub-basin

2.1.1.1 Proposed Countermeasures in the Master Plan

As shown in Part 1 of this report, the storm water drainage plan for the Kalu Oya basin is as follows, and the components (priority: 1-5) targeting 25-year probability scale are to be implemented as a mid-term plan by 2030 to prevent and reduce flood damage risk.

Table 2.1.1 Storm Water Drainage Plan in Kalu Oya Basin

Safety Level	Priority	Summary of Countermeasure
10-year Return Period	1	Kalu Oya improvement［K1］ ● Target: Kalu Oya main canal ● Measure: Canal improvement (Widening, Dredging, Embankment) Length: 5.1 km
	2	Natha Canal improvement［K2］ ● Target: From Kalu Oya to the railway bridge ● Measure: Canal improvement (Widening, Dredging, Embankment) Length: 0.5 km
	3	Mudun Ela Diversion［K3］ ● Target: Near the confluence of Upstream of Natha Canal and Mudun Ela ● Measure: Canal improvement (widening, dredging, embankment), removal of the existing connecting gate, installation of new deadline facility Length: 0.3 km
	4	Natural Wetland Park［K5］ ● Target: Wetlands located in the valley bottom plain in the middle and upper reaches of the main channel and tributaries ● Measure: Prevention of invasion of houses, etc. by converting existing wetlands into parks Total length of small dikes: 28.8 km
25-year Return Period	5	Old Dutch Canal Improvement and a flood diversion channel［K4］ ● Target: From Upstream of Negombo Wetland to propose a new flood diversion channel ● Measure: Canal improvement (widening, dredging, embankment), excavation of the existing channel (widening, dredging, embankment) Length: Old Dutch Canal: 5.0 km, Flood diversion: 0.4 km
50-year Return Period	6	Installation of a gate structure and a pumping station［K7］ ● Target: Confluence with Kelani Ganga (at the downstream end of Kalu Oya) ● Measure: Gate structure and pumping stations for the Kelani Ganga embankment project at the confluence Drainage capacity: 35 m^3/s, gate width: 30 m
	7	Improvement of natural wetland parks to retarding basins［K8］ ● Target: Natural wetland parks along the Kalu Oya main channel and primary tributaries ● Measure: Excavation in natural wetland parks, surrounding dike, overflow dike Number of wetland parks: 4 nos
-	Other	Improvement of tanks［K6］ ● Target: Upstream of Kalu Oya tributary, 3 locations

Source: JICA study team

Similarly, the storm water drainage plan for the Mudun Ela basin are shown in the following table, with the components (priority: 1-7) targeting a 25-year probability scale installed by 2030 to prevent and reduce flood damage risk.

Table 2.1.2 Storm Water Drainage Plan in Mudun Ela Sub-basin

Safety Level	Priority	Summary of Countermeasure
10-year Return Period	1	Mudun Ela improvement［M1］ ● Target: Mudun Ela main canal (from Oliyamula Pumping Station to Colombo-Kandy Road) ● Measure: Canal improvement (widening, dredging, embankment) Length: 3.1 km
	2	Peliyagoda improvement［M2］ ● Target: Peliyagoda canal connected to the Peliyagoda Pumping Station ● Measure: Canal improvement (dredging) Length: 2.8 km
	3	Improvement of Peliyagoda Pumping Station［M3］ ● Target: Peliyagoda Pumping Station ● Measure: enhancement of pump facilities (drainage capacity upgrade from 0.5 m^3/s to 1.0 m^3/s)
	4	Installation of a gate structure［M4］ ● Target: Peliyagoda canal ● Measure: Installation of a gate structure
	5	Natural Wetland Park［M8］ ● Target: Wetlands located in the valley bottom plain in the middle and upper reaches of the main and secondary channel ● Measure: Prevention of invasion of houses, etc. by converting existing wetlands into parks Total length of small dikes: 16.9 km
25-year Return Period	6	Upper Mudun Ela improvement［M5］ ● Target: Upstream section from Colombo-Kandy Road ● Measure: canal improvement (dredging) Length: 3.0 km
	7	Construction of retarding basin of upper Mudun Ela［M6］ ● Target: Natural wetland park along Mudun Ela ● Measure: Excavation and embankment in natural wetland park, surrounding dike, overflow dike Number of wetland parks: 1 nos
-	Other	Installation of small pumping stations［M7］ ● Target: Local flooding risk area around upper Nalanmini Oya ● Measure: Installation of the small-scale pumping facility Number: 2 locations

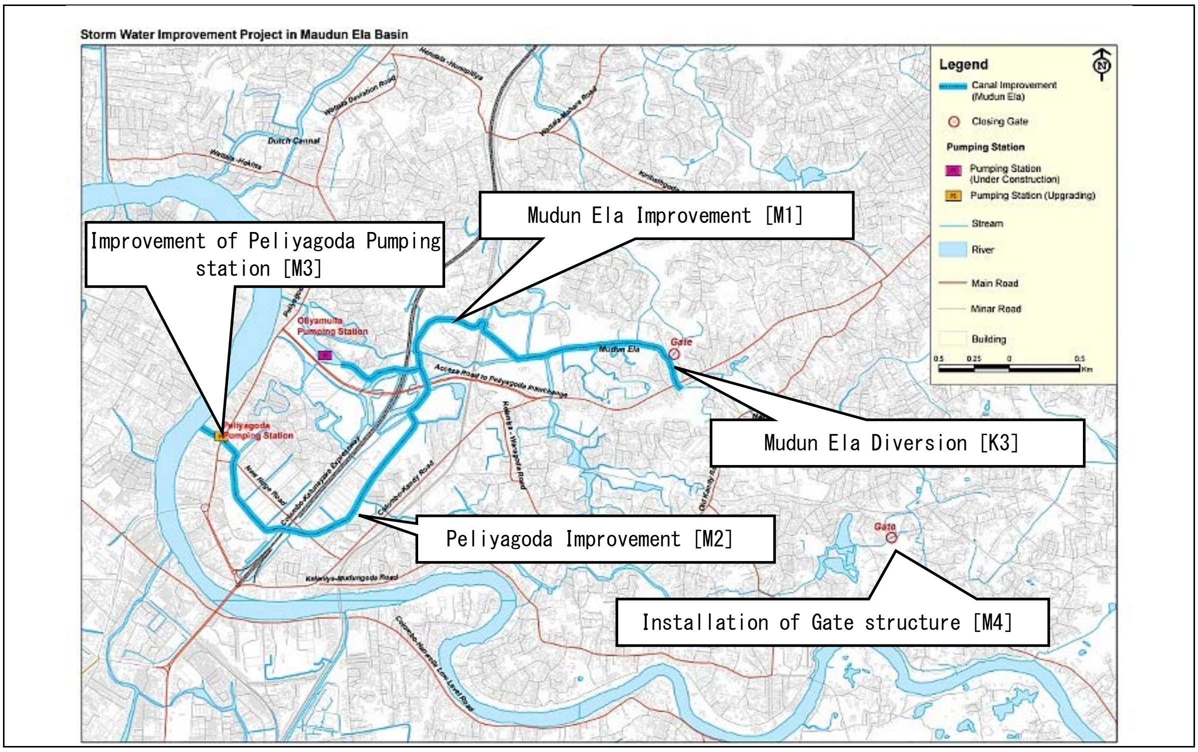
Source: JICA study team

2.1.1.2 Priority Projects for the Pre-Feasibility Study

Among the list of proposed countermeasures in the storm water drainage plan, Mudun Ela improvement [M1], Peliyagoda improvement [M2], Improvement of Peliyagoda Pumping Station [M3], Installation of a gate structure [M4], and Mudun Ela Diversion [K3] were selected. The selection policy is described below.

- According to the Record of Discussion (hereinafter referred to as “the R/D”) of this project, one priority sub-basin and one priority area have been selected, which are the Mudun Ela sub-basin and the Moratuwa-Rathmalana area.

- In the economic evaluation analysis in this study, it was concluded that the economic effect and investment effects of the rehabilitation plan of the Mudun Ela sub-basin and the Bolgoda basin are high.
- In particular, in the lower reaches of the Mudun Ela sub-basin, there is an interchange on the highway (Colombo - Katunayake Expressway) to the airport, and the Oliyamula Pumping Station is under construction. The investment effect will be high.
- The Oliyamura Pumping Station is already under construction and is one of the earliest facilities to be put into service. The effective functioning of the Oliyamura Pumping Station will contribute to the early improvement of flood mitigation. Therefore, as shown in Figure 2.1.1, canal rehabilitation, new gates, and pump station rehabilitation in the Mudun Ela sub-basin are proposed as priority projects.



Source: JICA study team

Figure 2.1.1 Location Map of Priority Project in the Mudun Ela Sub-basin

2.1.2 Storm Water Drainage Plan Proposed by SLLDC

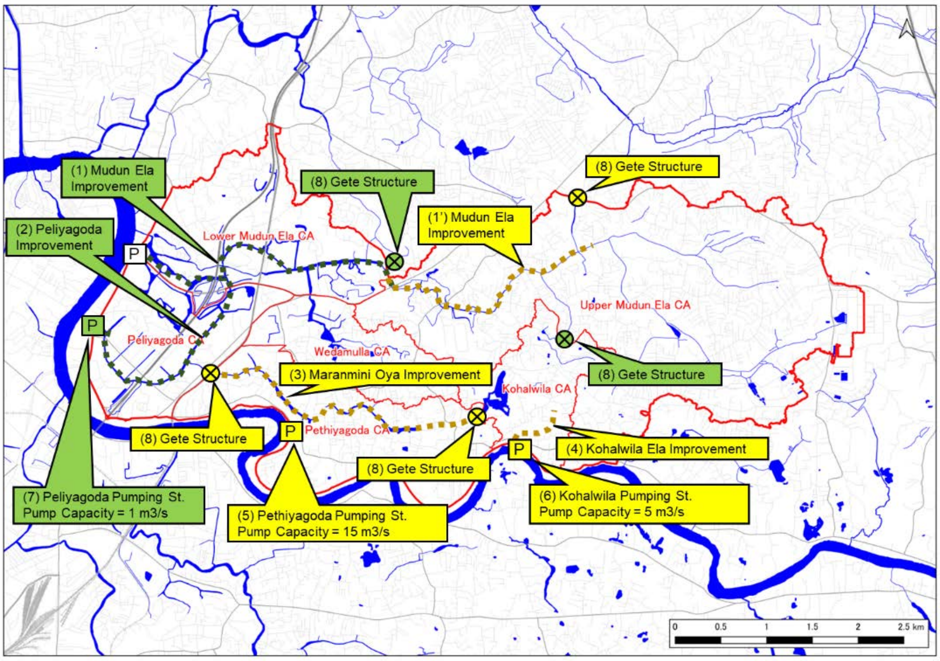
SLLDC also studies its own storm water drainage plan based on the current status of the Mudun Ela watershed development plan (see Figure 2.1.3). The relationship between these and our Pre-F/S target projects is shown below.

- The Pre-F/S targeted main and secondary canals, which are the improvement of the Mudun Ela main canal and the Peliyagoda secondary canal, and their related facilities (pumping stations and gates) were selected as priority projects.
- SLLDC is planning to divide the entire watershed into about six drainage basins for efficient management to reduce flood damage, regardless of whether it is a trunk canal or a secondary branch canal. In addition, SLLDC proposes the "rehabilitation of tertiary channels" and "two new pumping facilities" as efficient drainage measures for local floods.
- The improvement of main and secondary canals and improvement of existing pumping facilities to be considered as the Pre-F/S projects are also clearly listed as future projects to be implemented by SLLDC, hence there is no conflict between the JICA study team's proposal and SLLDC's project policy.

Table 2.1.3 Countermeasures Proposed by SLLDC

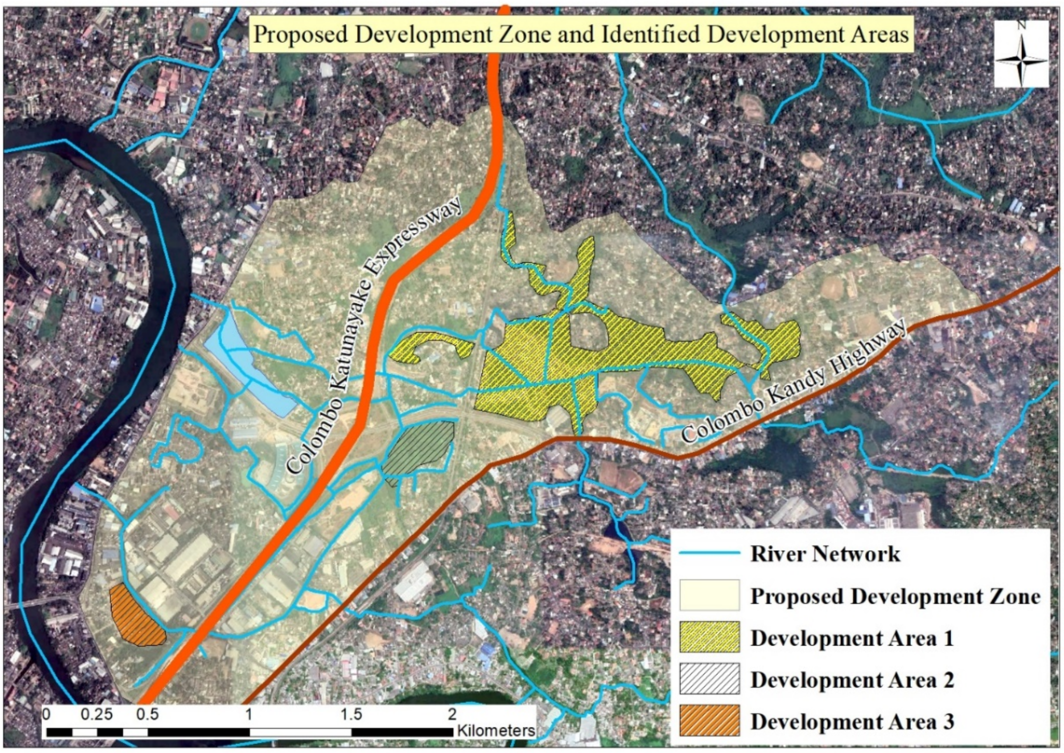
The project list proposed by SLLDC	Target project for Pre-F/S study	Remarks
(1) Mudun Ela canal improvement	Mudun Ela improvement [M1] Mudun Ela Diversion［K3］	
(2) Peliyagoda improvement	Peliyagoda Improvement［M2］	
(3) Naranmini Oya improvement	-	
(4) Koholwila improvement	-	
(5) Pethiyagoda pumping station	-	Pump capacity: 15 m^3/s *New installation
(6) Koholwila pumping station	-	Pump capacity: 5 m^3/s *New installation
(7) Pliyagoda pumping station	Improvement of Peliyagoda Pumping Station［M3］	Pump capacity: 1 m^3/s *Additional installation
(8) Gate Structure	Installation of a gate structure［M4］ *Partially included	

Source: JICA study team



Source: JICA study team

Figure 2.1.2 Storm Water Drainage Plan Proposed by SLLDC
(Green: Target Projects of the Pre-F/S)



Source: SLLDC

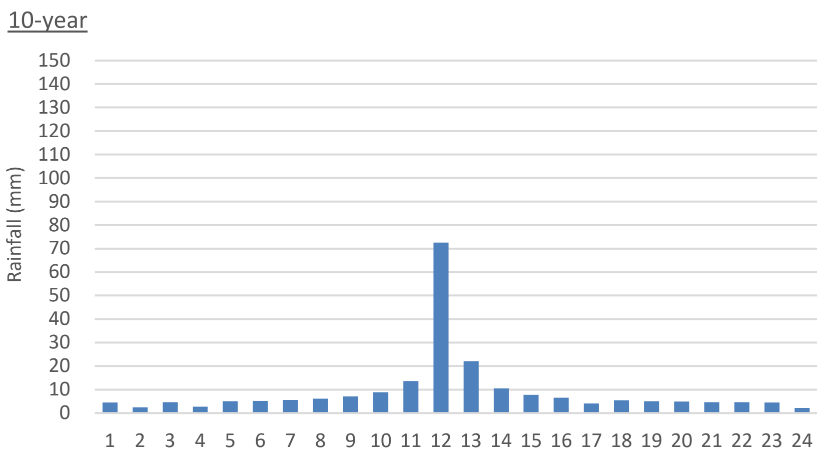
Figure 2.1.3 Urban Development Area in the Mudun Ela Sub-basin

2.1.3 Improvement Plan of Mudun Ela Sub-basin

2.1.3.1 Planning Condition

(1) Design Scale and Design Rainfall

As indicated in the M/P study, for the Mudun Ela sub-basin, the rainfall intensity curve of the Colombo station was applied to the design rainfall. The design hyetograph for the 10-year return period is shown below.



Source: JICA study team

Figure 2.1.4 Design Hyetograph in 10-year Return Period

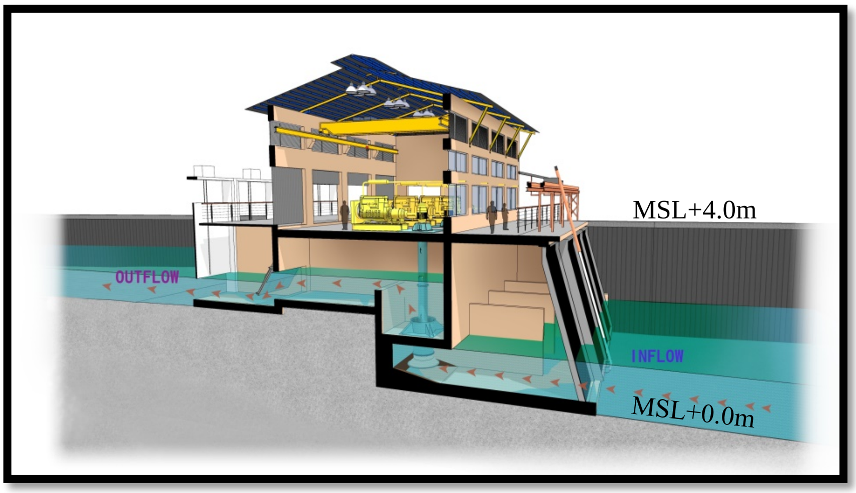
(2) Design High Water Level and Freeboard

The design high water level and design freeboard height were also set as indicated in the M/P study: 1.84 m at Mudun Ela (reference point: Candy Road Bridge) and 0.50 m for the freeboard.

1) Current Status of Oliyamura Pumping Station

The downstream end of each canal in the Mudun Ela basin is connected to Kelani Ganga, which treats drainage water through gates and pumping facilities. In addition, SLLDC is constructing a new pumping facility (Oliyamura Pumping Station) in the Oliyamura area downstream of Mudun Ela, and the target canal of Mudun Ela in the Pre-F/S will be connected to this Oliyamura Pumping Station.

The top of the dike around the regulating basin of Oliyamura Pumping Station is set at MSL +4.0 m (see Figure 2.1.5), and the low water level of the regulating basin of the 35 m^3/s pumping facility is set at MSL +0.0 m and the high water level is set at MSL +3.0 m. The water level of the Oliyamura Pumping Station is set at MSL +3.0 m.



Source: SLLDC

Figure 2.1.5 Image of Oliyamura Pumping Station

2) Boundary Condition for Water Level and Design High Water Level

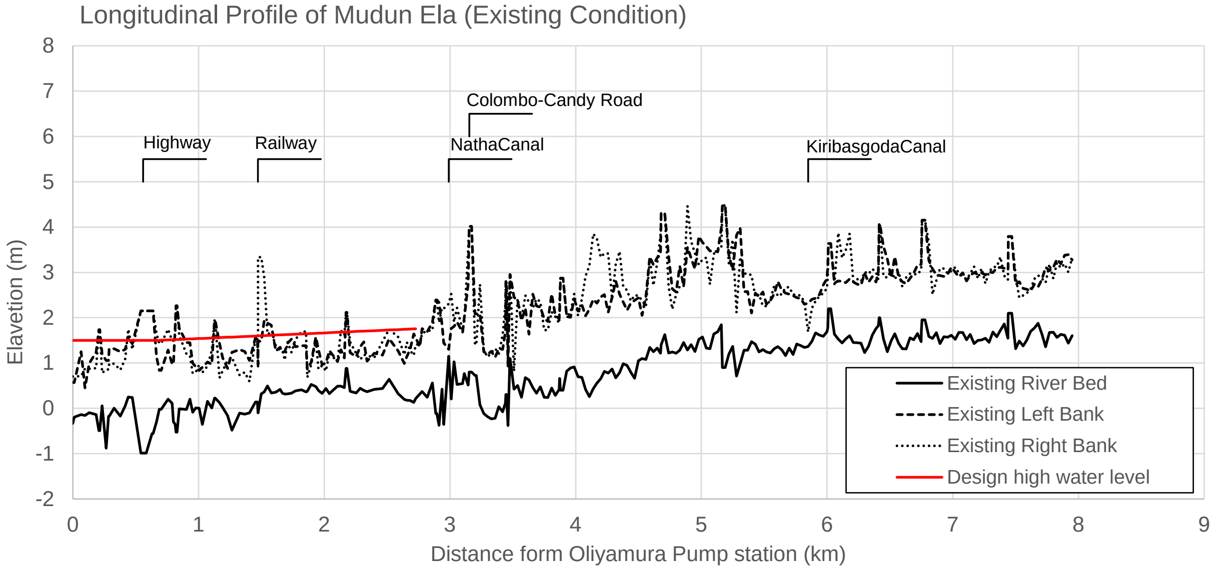
The lower Mudun Ela has no dike, and as shown in Figure 2.1.6, the ground elevation is MSL +1.0 m to +2.0 m up to around 3.0 km from the estuary. The riverbed gradient is small, and the backwater influence of the streambed level is significant. Therefore, the design high water level was established using the following procedure.

i. Implementation of hydraulic calculations considering pump operation (35m^3/s)

ii. Trial calculation of widening width and excavation depth

iii. Set the envelope curve of the water level in a hydraulic calculation to the design high water level

iv. Set the design high water level (downstream end) to MSL +1.5 m, which is about the ground height.



Source: JICA study team

Figure 2.1.6 Longitudinal Profile of Mudun Ela Main canal

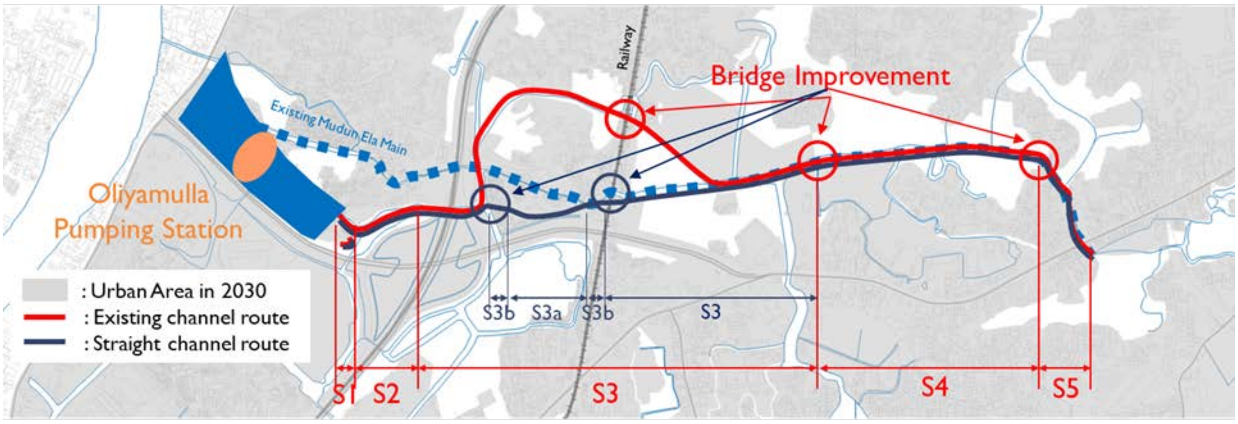
2.1.3.2 Improvement Plan for Mudun Ela Main Canal

(1) Purpose of Improvement of Mudun Ela Main Canal

The purpose of the improvement of Mudun Ela is to increase the flow capacity and effectively drain runoff from the surrounding catchment area and to effectively utilize the newly constructed Oliyamula pumping station.

(2) Policy of Setting Canal Alignment and Cross section

The river channel plan was divided into five sections (S1-S5) considering (1) current channel width, (2) major structures such as highways, and (3) future land use. Based on the hydraulic calculations in the M/P study, the planned channel width was set at approximately 20 m for S1-S4 and 15 m for S5. The same results were obtained in the hydraulic analysis in the Pre-F/S study. In addition, considering the future land use in 2030, the cross sectional area of the river channel was secured by adopting a gently sloping cross sectional form where no land use restriction is imposed.



Source: JICA study team

Figure 2.1.7 Planning Section (S1-S5) and Design Alignment

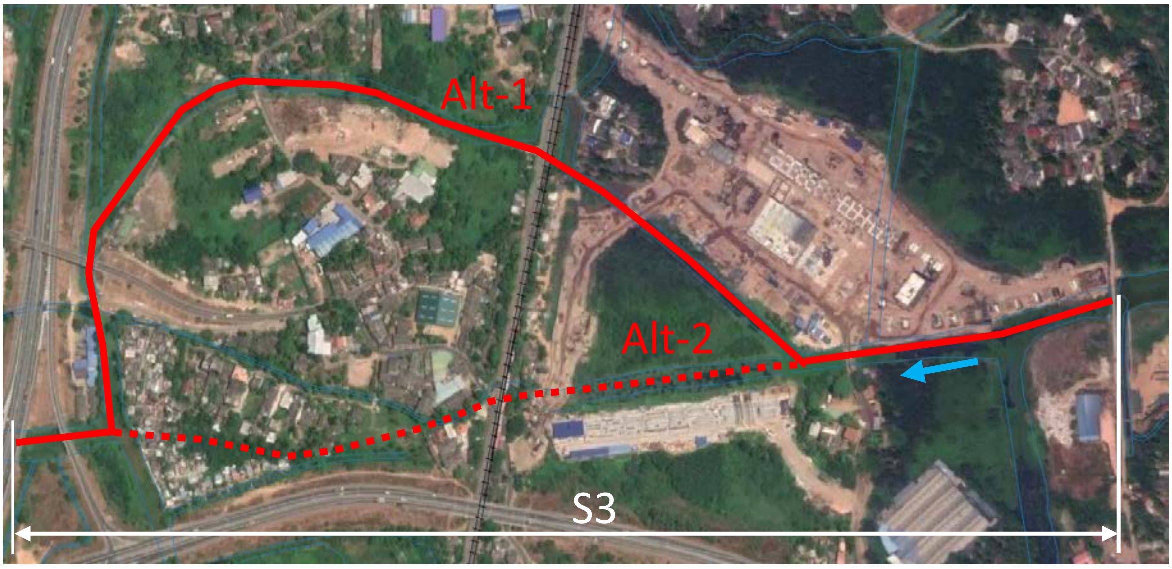
(3) The Basic Policy of Cross Sectional Design for Each Section

The basic policy for setting the cross section for each section is shown below.

Table 2.1.4 The basic Policy For Setting the Cross Section

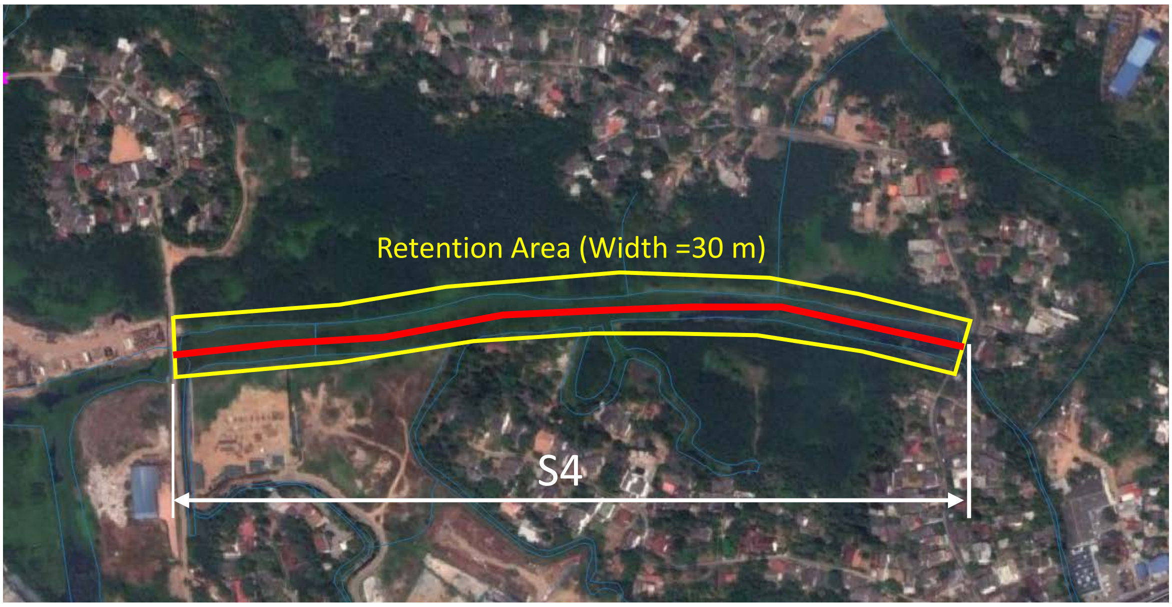
Section	Basic Policy
S1	The current river channel width is 17-18 m, so river improvement will be carried out by widening the canal. The revetment type will be steel sheet pile and gabion revetment.
S2	On the left bank side, the highway embankment will be effectively utilized to secure the current canal width and dredging will provide the necessary riverbed height. The right bank slope will be set at 1:2.0 with the embankment.
S3	The area is either residential or large-scale development, and considering the future land use plan for 2030, it is expected to be difficult to secure a wide canal width. This section will be set based on a gabion revetment structure with a canal width of 20m. In this section, two alternatives were compared: Alt-1, which utilizes the existing canal (the route proposed in the M/P), and Alt-2, which includes a shortcut. The Alt-2 proposal is hydraulically more effective in reducing water levels upstream due to the shorter length of the river, but the Alt-1 proposal is superior in terms of social impact and cost.
S4	The canal is relatively wide and has a retention function in the wetlands on both banks. However, according to SLLDC, there are plans for future development on both banks. Therefore, the SLLDC decided to widen the river by 30 m to improve the river channel in order to achieve a storage effect.
S5	The current river channel width is narrow at about 10-12 m, so river improvement will be carried out by widening the channel. Because of the proximity of houses on both sides of the river, steel sheet pile revetments will be used.

Source: JICA study team



Source: JICA study team

Figure 2.1.8 Comparison of Alternative Routes in S3



Source: JICA study team

Figure 2.1.9 Secure Retention Area in S4

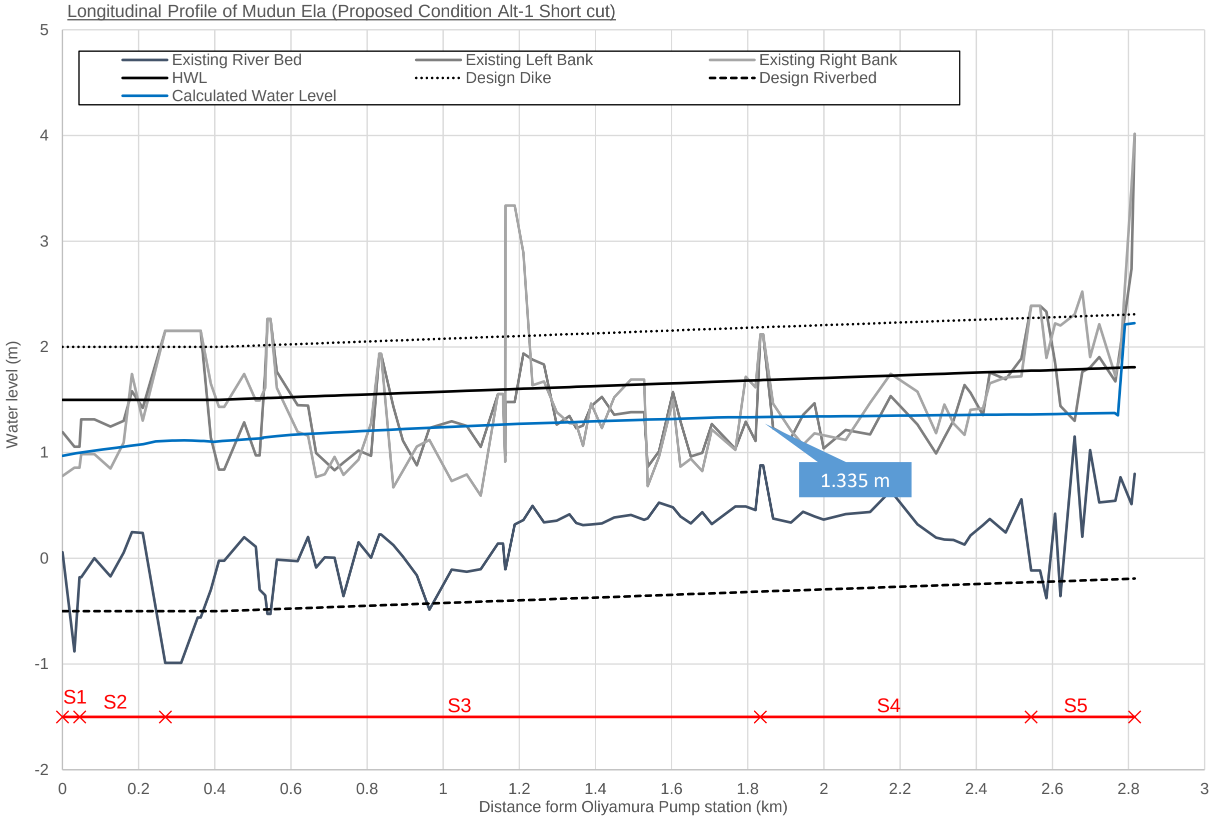
(4) The result of Hydraulic Analysis and Evaluation

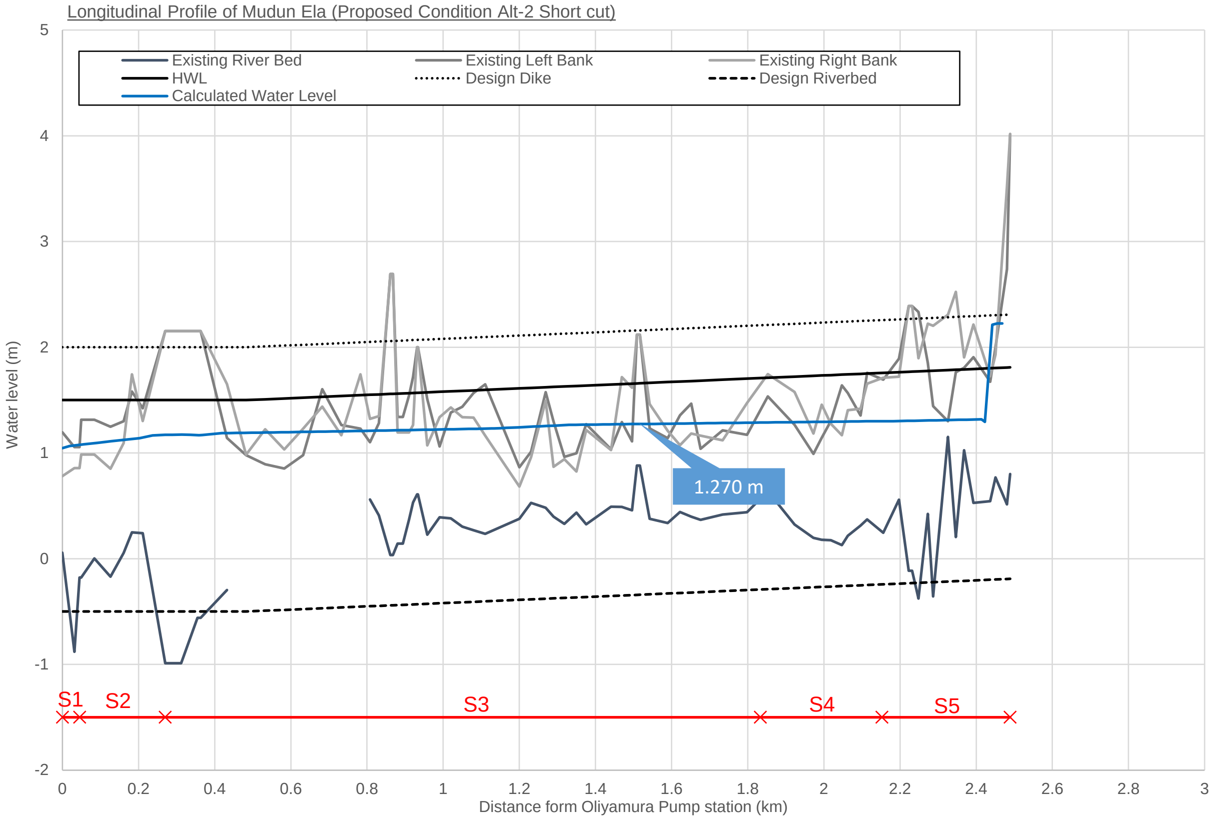
Figure 2.1.10 shows the results of hydraulic analyses of Mudun Ela using temporal cross sections according to the policy shown in Table 2.1.4. Although the proposed shortcut contributes to the reduction of the water level in the upstream section, the effect is insignificant. At the most upstream bridge point in the S3 section where the shortcut is included, the reduction is only a few centimeters from 1.335 m to 1.270 m. Since the hydraulic superiority cannot be clarified, the optimal proposal was determined by comparing the estimated construction cost and social impact, including the S3 section. The comparison results are shown in Table 2.1.5 and the route along the existing canal (Alt-1) was selected. In the other sections (S1 to S3 and S5), the calculated water level was confirmed to be below the proposed design high water level, and no problems were observed.

Table 2.1.5 Preliminary Comparison of the Existing Canal Route and Shortcut Route

Route	Relocation		Construction Cost (main channel only, million LKR)	Remarks
	Family (nos)	People (person)		
Existing canal (Alt-1)	16	64	1,060	Approx. 340 m longer than Alt-2
Straight shortcut (Alt-2)	44	156	1,083	Need to relocate large warehouses

Source: JICA study team





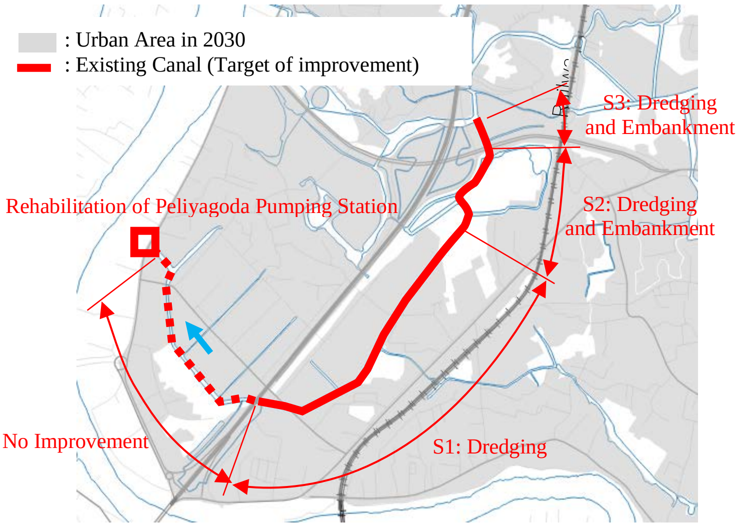
Source: JICA study team

Figure 2.1.10 Calculated Water Level (Upper: Alt-1, Lower: Alt-2)

2.1.4 Improvement Plan of Peliyagoda

2.1.4.1 Reviewing the M/P's Improvement Plan

At the time of the M/P study, since the Peliyagoda canal was relatively wide enough to accommodate the current canal width, dredging was proposed to secure the flow capacity as an improvement policy (Figure 2.1.11). As a result of the further hydraulic analyses, it was concluded that the existing channel with approximately 15 m in width, can accommodate the expected inundation reduction in the Mudun Ela sub-basin. Hence, the improvement along Peliyagoda canal, or dredging, was excluded from the component of the Pre-F/S. In another words, it is noted that the Peliyagoda canal should be well maintained and the land developer along Peliyagoda canal should be responsible for providing the proper slope protection at Peliyagoda canal when they develop the land, not to damage the canal by their development. Furthermore, as a result of the geotechnical investigation in the target area, it was found that thick layer of weak soil with zero N-value underground extends around Peliyagoda canal. Hence, it is noted that if a large-scale improvement is applied (e.g., steel sheet pile revetment, soil improvement, pilings), the cost would be excessive and not economically advantageous.

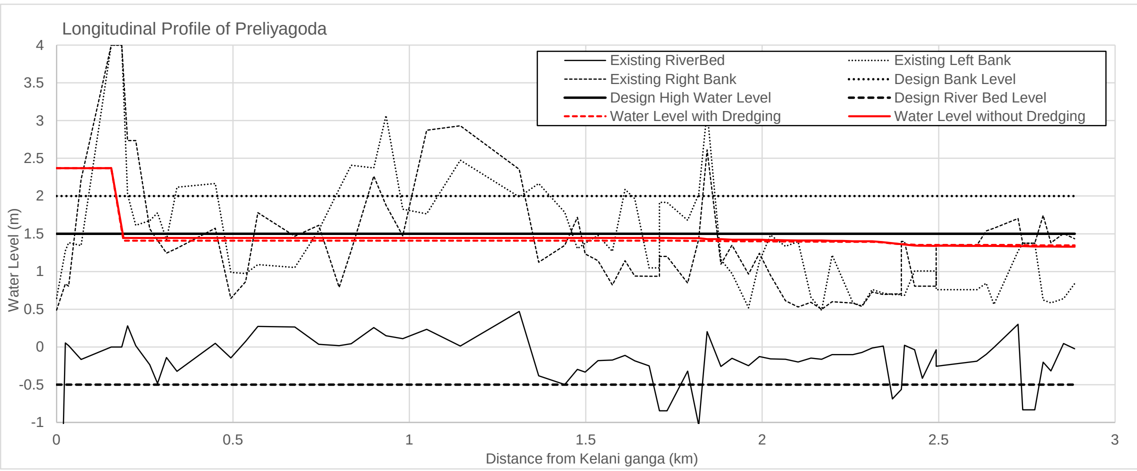


Source: JICA study team

Figure 2.1.11 Initial Improvement Policy in the M/P study

2.1.4.2 The Result of Hydraulic analysis

As a result of the hydraulic analysis of the Peliyagoda canal, it was found that the water level can be kept below the design high water level of 1.5 m even without dredging the target section, so the Peliyagoda canal improvement (dredging) was excluded from the Pre-F/S project.



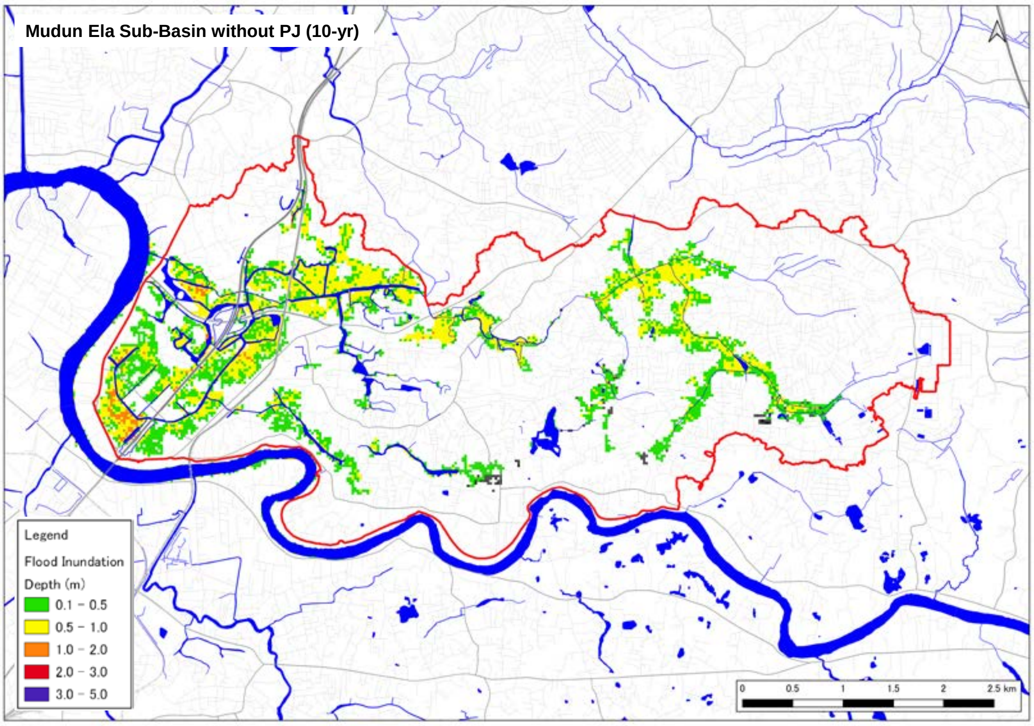
Source: JICA study team

Figure 2.1.12 Calculated Water Level at Peliyagoda Canal

2.1.5 Inundation Analysis (Effects of Priority Projects)

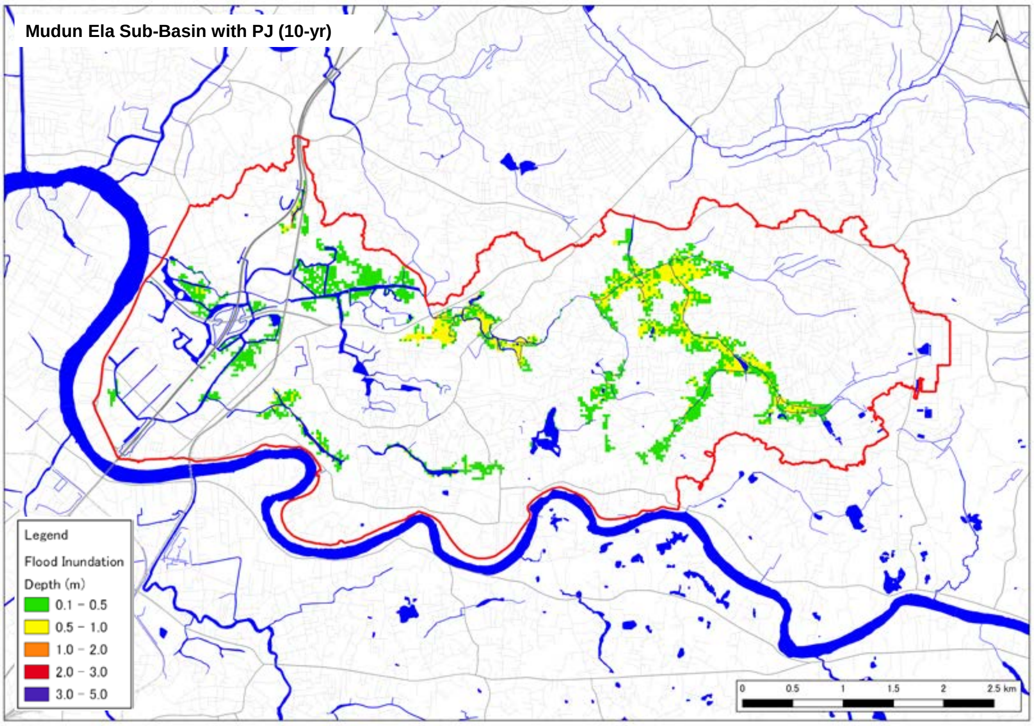
Using the inundation simulation model constructed in the M/P study, the inundation reduction effects of the Pre-F/S target projects (priority projects) were verified. The priority projects are targeted to secure the safety level of flood risk on the 10-year probability scale as immediate countermeasure projects. As shown in Figures 2.1.13 and 2.1.14, the flooded area estimated in the current situation is significantly reduced with the improvement under the 10-year probability scale rainfall condition. In particular, it was confirmed that the effect is particularly significant north of the Colombo-Candy Road, where future urban development is expected.

On the other hand, it was confirmed that the priority projects are not sufficient to achieve the 25-year probability scale of flood control safety level in the M/P targeting 2030 (Figures 2.1.15 and 2.1.16). In the future, the countermeasures proposed in the M/P, as well as SLLDC's own planned measures (such as additional pumping facilities near Kelani Ganga for local flooding) should be keenly pursued.



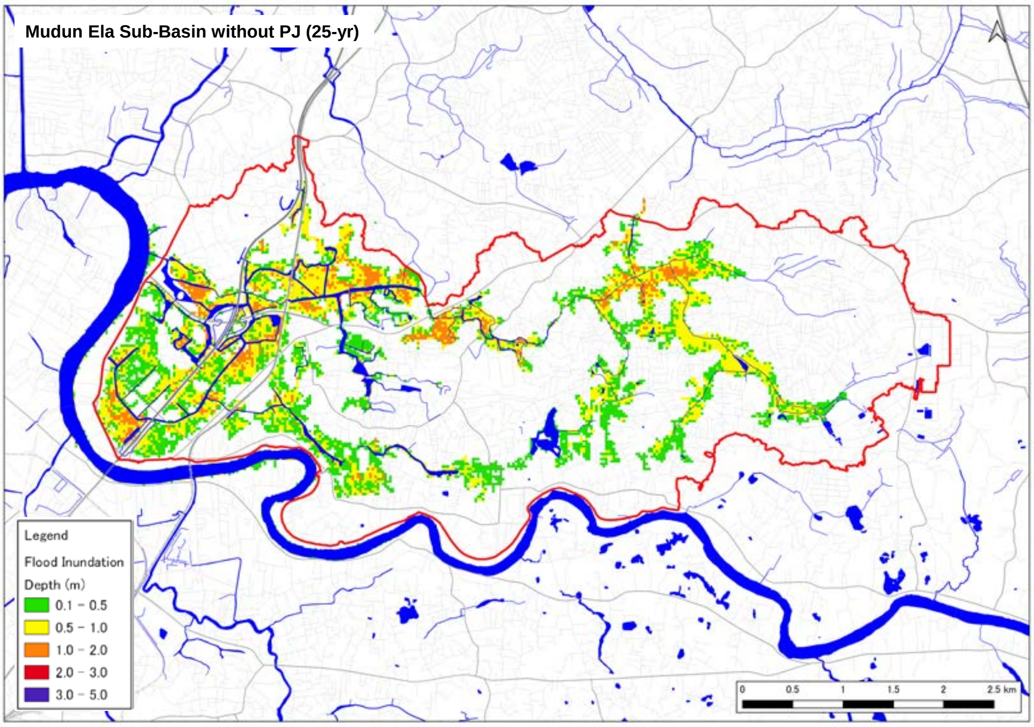
Source: JICA study team

Figure 2.1.13 Estimated Inundation Area (Without Project for 10-Year Return Period)



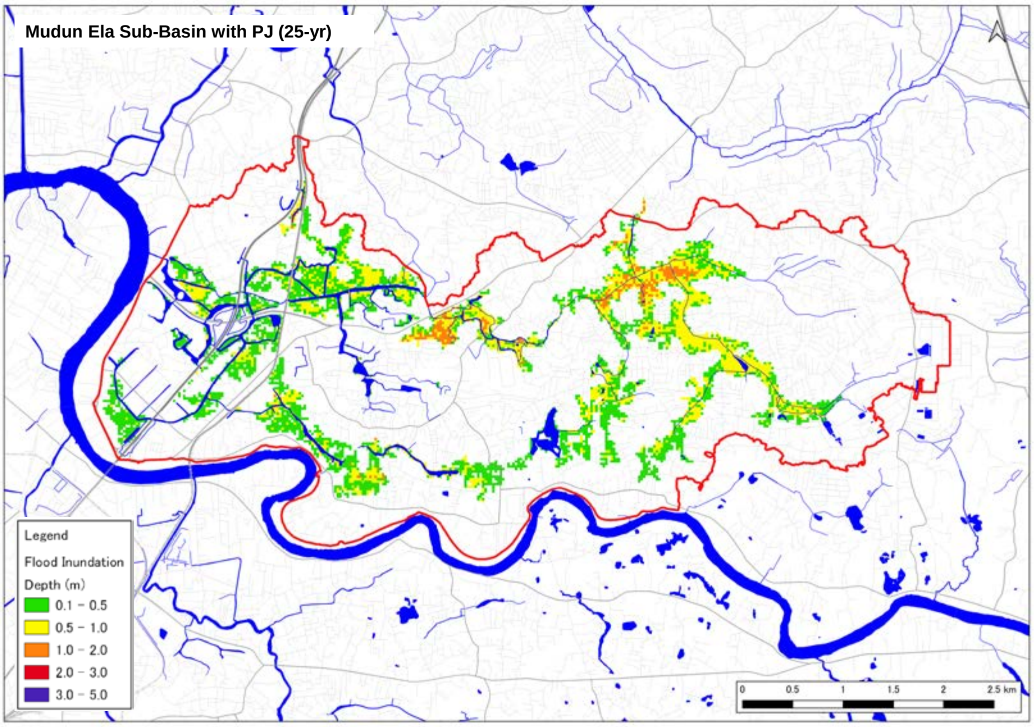
Source: JICA study team

Figure 2.1.14 Estimated Inundation Area (With Project for 10-Year Return Period)



Source: JICA study team

Figure 2.1.15 Estimated Inundation Area (Without Project for 25-Year Return Period)



Source: JICA study team

Figure 2.1.16 Estimated Inundation Area (With Project for 25-Year Return Period)

2.2 Pre-feasibility Study in the Bolgoda Basin

2.2.1 Proposed Countermeasures and Priority Projects in The Master Plan in Bolgoda Basin

2.2.1.1 Proposed Countermeasures in the M/P

As detailed in the M/P of Part 1. The storm water drainage plan for the Bolgoda basin is summarized in Table 6.6.21. The priorities were based on the population of the protected area. As the mid-term plan, the countermeasure with priority numbers 1 to 5 as indicated in the following table should be implemented until 2030 to mitigate flood inundation risk.

Table 2.2.1 Storm Water Drainage Plan in Bolgoda Basin

Safety Level	Priority	Summary of Countermeasure
25-year Return Period	1	Weras Ganga Right Bank Dike [B1] ● Target: Moratuwa-Rathmalana area (right bank side of Weras Ganga) ● Measure: Canal improvement (embankment) Length: 3.0 km
	2	Local flood mitigation measure in Panape Ela basin [B4] ● Target: Flood inundation area along Panape Ela ● Measure: Surrounding diking system at three section Length: 6.7 km (total)
	3	Local flood mitigation measure in Maha Oya basin [B2] ● Target: Near the intersection of the Maha Oya and expressway and residential area ● Measure: Canal improvement (dredging, embankment), replacement of 2 road bridges Length: 5.9 km
	4	Local Flood mitigation measure in Alut Ela basin [B3] ● Target: Assumed flood inundation area along Alut Ela ● Measure: Canal improvement (dredging, embankment), replacement of 4 road bridges Length: 3.4 km
	5	Local Flood mitigation measure in Maha Oya tributary basin [B5] ● Target: Near the intersection of the Maha Oya tributary and expressway and residential area ● Measure: Surrounding diking system Length: 1.0 km
50-year Return Period	6	Weras Ganga improvement [B1] ● Target: Moratuwa-Rathmalana Area (along Weras Ganga) ● Measure: Canal improvement (dredging) Length: 2.9 km
	7	Talpitiya Ela improvement [B6] (temporary measure) ● Targe: Talptiya Ela and a coastal clogged point of the estuary ● Measure: Canal improvement (dredging, excavation of clogged point) Length: 2.8 km
-	Others	Improvement of the drainage system of the Moratuwa-Rathmalana Area ［B7］ ● Target: Moratuwa-Rathmalana area ● Measure: Installation of gate structures and pumping stations associated with Weras Ganga embankment, improvement of primary canals Length: 4.0km, gate structure: 2 locations, Pumping station: 2 locations

Source: JICA study team

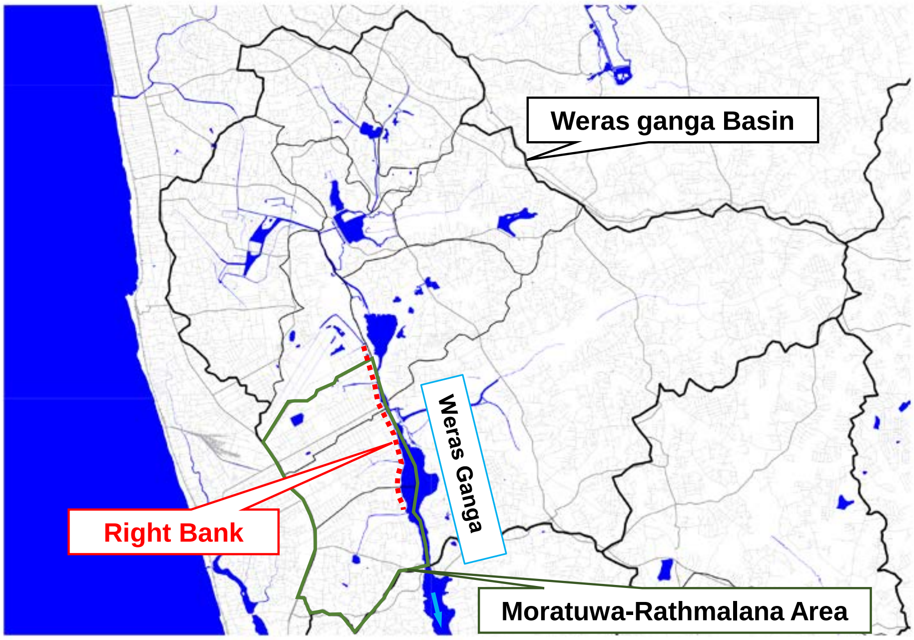
2.2.1.2 Priority Projects for the Pre-feasibility Study

According to the R/D of this project, one priority sub-basin and one priority area were selected, which are the Mudun Ela sub-basin and the Moratuwa-Rathmalana area.

The Moratuwa-Rathmalana area is the last remaining area of the Weras Ganga project proposed by the F / S of JICA2003M/P, and this area is a substantial metropolitan area adjacent to the Colombo City Hall (CMC). Similarly, the investment effect is high.

Banking on the right bank of Weras Ganga is proposed as a measure to prevent inundation due to flooding from Weras Ganga in the Moratuwa-Rathmalana area. Since the improvement of Weras Ganga basin has proceeded based on the JICA 2003 M/P and is included in the nature reserve, the drastic river rehabilitation by widening the Weras Ganga main canal is extremely difficult due to a large social impact. Hence, it is appropriate to protect against flooding by dike construction. Because river structures have already been constructed with the HWL. set to 1.5 m at other points on the left bank, the right dike construction plan will be arranged to comply with this.

Another priority project selected was the improvement of the drainage system in the Moratuwa-Rathmalana area. This drainage system improvement plan is detailed in Section 2.3.



Source: JICA study team

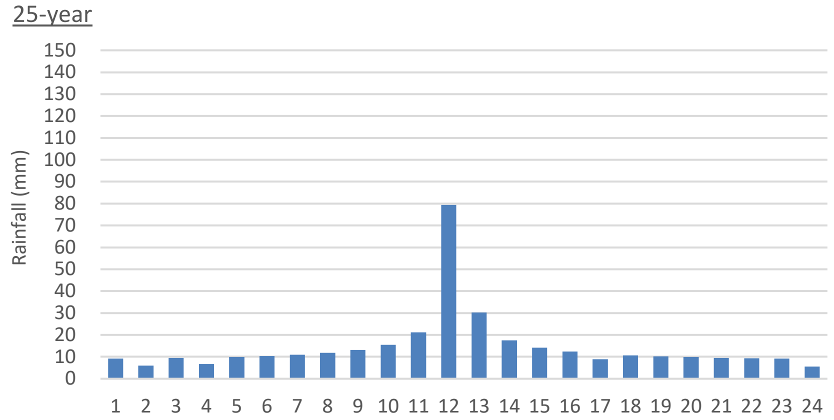
Figure 2.2.1 Location Map of Weras Ganga Right Bank

2.2.2 Weras Ganga Right Bank Dike Construction Plan

2.2.2.1 Planning Condition

(1) Design Scale and Design Rainfall

As indicated in the M/P study, for the Bolgoda basin, the rainfall intensity curve of the Rathmalana station was applied to the design rainfall. The design hyetograph for the 25-year return period is shown below.



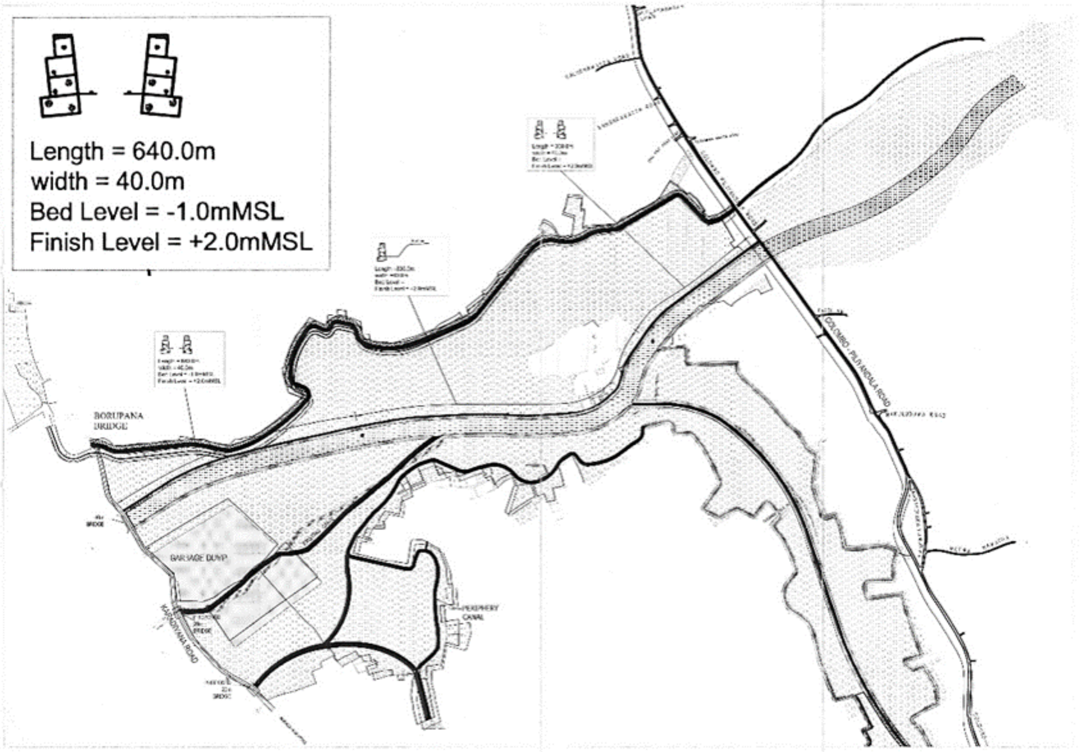
Source: JICA study team

Figure 2.2.2 Design Rainfall

(2) Design High Water Level and Freeboard

At an inflow canal in the left bank of Weras Ganga (see Figure 2.2.3), the river improvement has been implemented by SLLDC with the design dike height, the high water level, and its freeboard at 2.0 m, 1.5 m, and 0.5 m, respectively.

To comply with the existing projects, as proposed in the M/P, the same design high water level and the freeboard of the target right dike as for the left bank were adopted.



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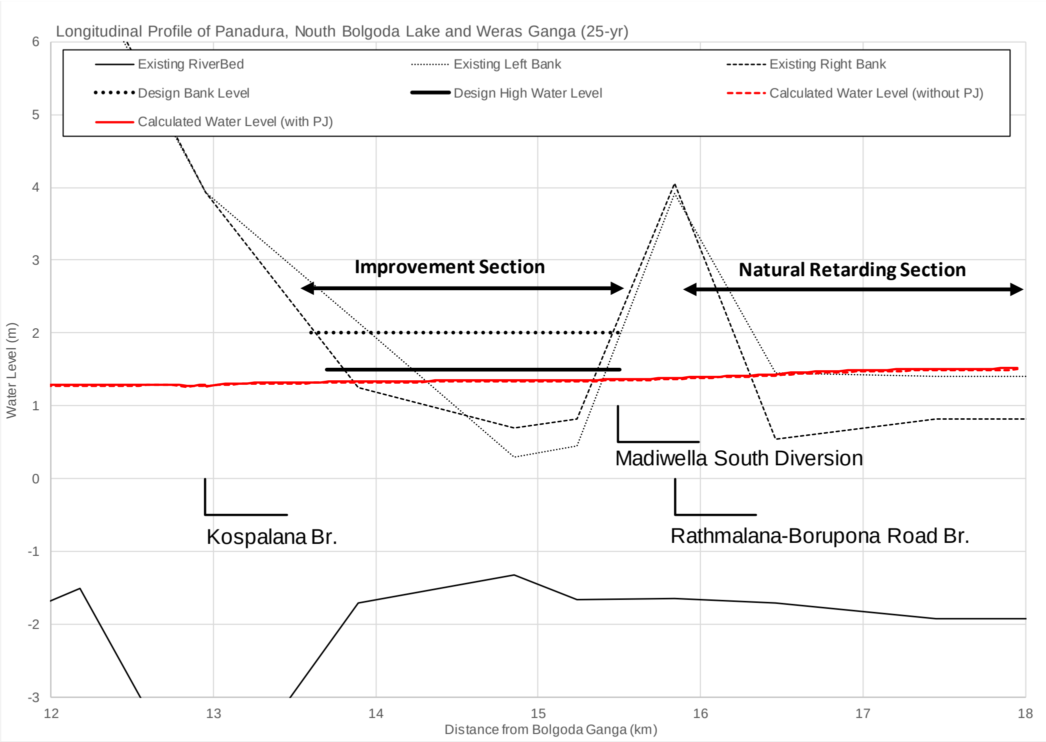
Source: SLLDC

Figure 2.2.3 Plan of Existing Canal on the Left Bank of Weras Ganga (Madiwera South Diversion Channel)

2.2.2.2 The Result of Hydraulic Analysis and Evaluation

Using the hydraulic analysis model developed in the M/P study, the effect of water level rise due to embankment construction was verified. The rise in water level due to the embankment is extremely small (approximately 1 cm), and even with the embankment, the water level is kept below the high water level. The new embankment will be aligned along the current riverbank line, and the impact of subtle differences in alignment is also extremely small. Hence, in the mid-term plan with a 25-year return period, embankment construction is proposed, while dredging of the Weras Ganga is proposed for the long-term plan with a 50-year return period.

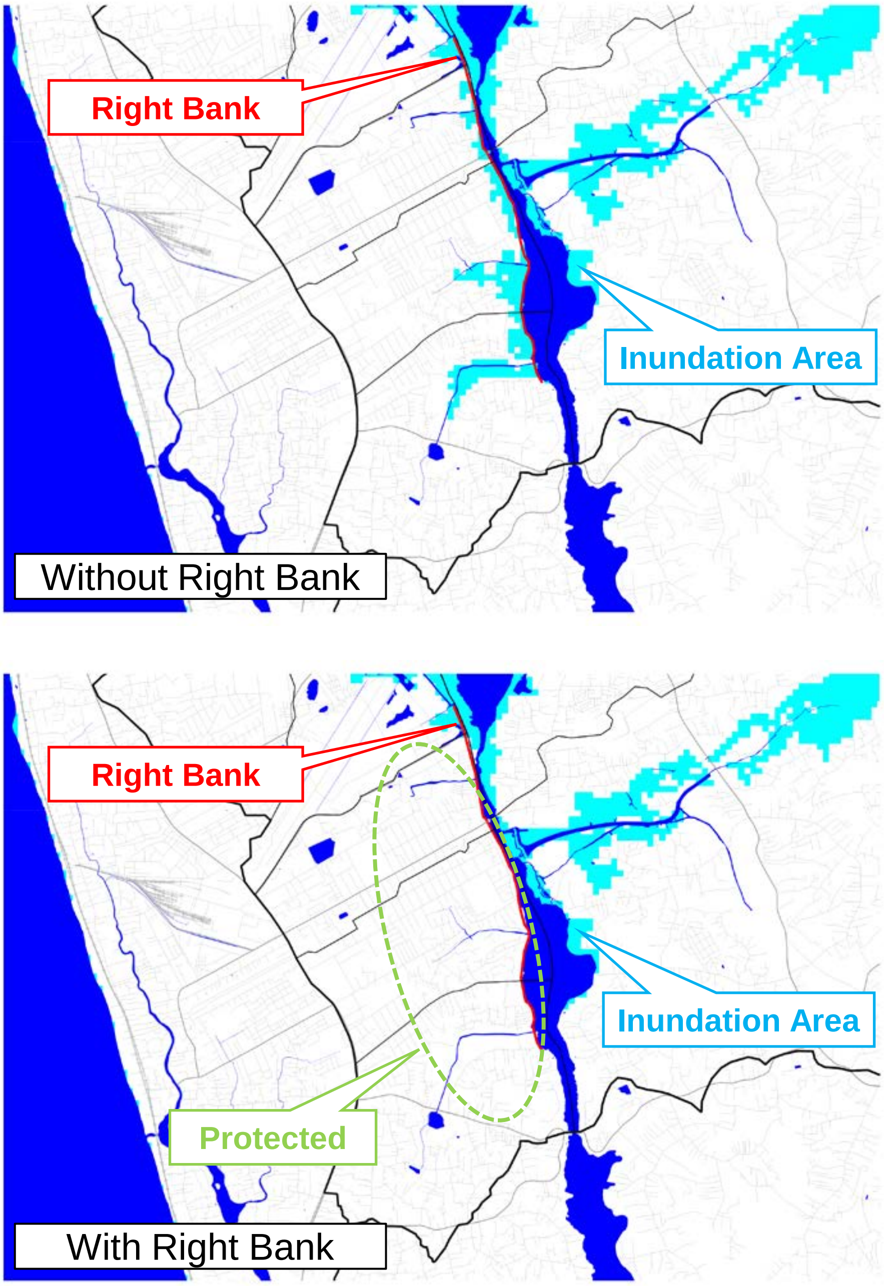


Source: JICA study team

Figure 2.2.4 Influence on Water Level Rising by Weras Ganga Right Bank Construction

2.2.3 Inundation Analysis (Effects of Weras Ganga Right Bank Dike)

The inundation reduction effect of the Weras Ganga Right Bank Dike was verified using the inundation simulation model constructed in the M/P study. This project has the goal of ensuring a flood control safety level on the 25-year probability scale. As shown in Figure 2.2.5, the 25-year probability flood inundation area in the Moratuwa-Rathmalana area was significantly reduced, indicating that the hydraulic effect of the right bank dike is extremely large. Therefore, the right bank dike is designed to prevent overflow due to rising water levels, and the alignment of the dike is set to match the existing riverbank.



Source: JICA study team

Figure 2.2.5 Estimated Effect of Flood Inundation Mitigation by Weras Ganga Right Bank Dike

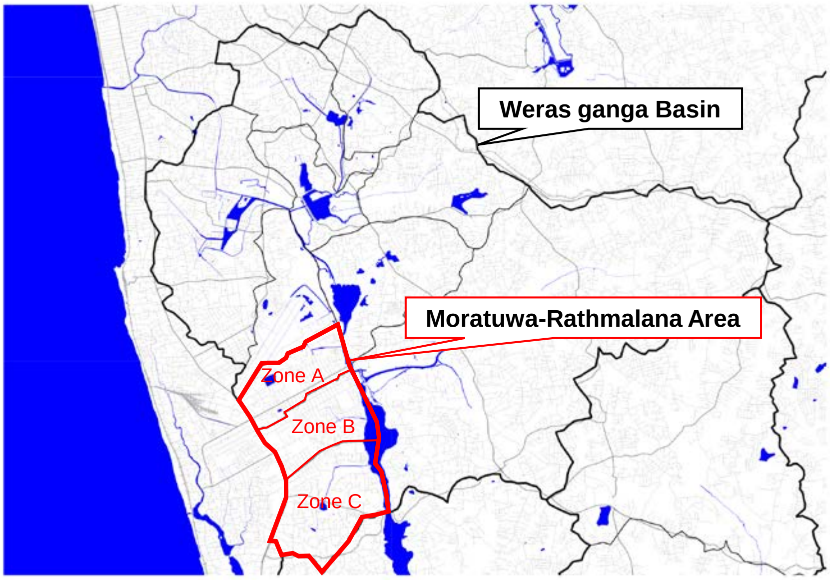
2.3 Improvement of Drainage System in Moratuwa-Rathmalana Area

2.3.1 Outline of Improvement of Drainage System Study

2.3.1.1 Target Area and Existing Drainage System

(1) Drainage area

The Moratuwa-Rathmalana area is located on the right bank of Weras Ganga, a tributary of the Bolgoda basin. There are three major canals in the area, and the catchments of these major drainage canals are referred to as Zone A, Zone B, and Zone C.



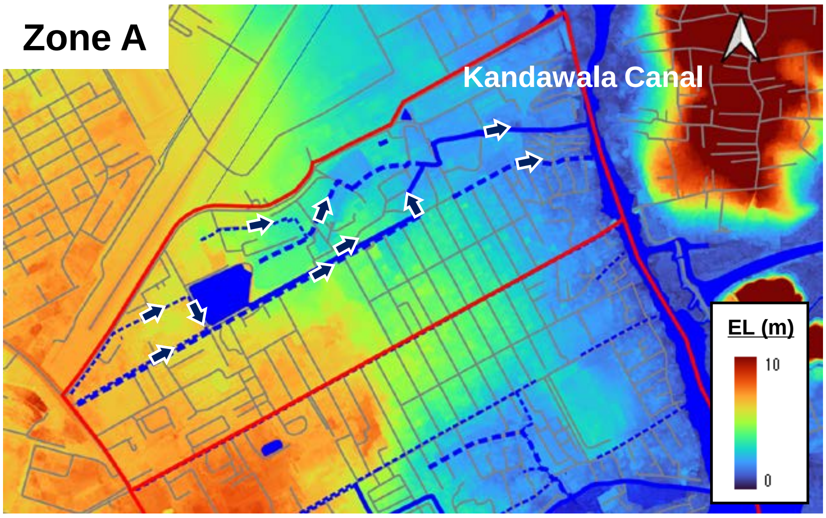
Source: JICA study team

Figure 2.3.1 Location Map of Moratuwa-Rathmalana Area

(2) Current Drainage System

The topographical features and drainage systems of the three drainage areas are as follows.

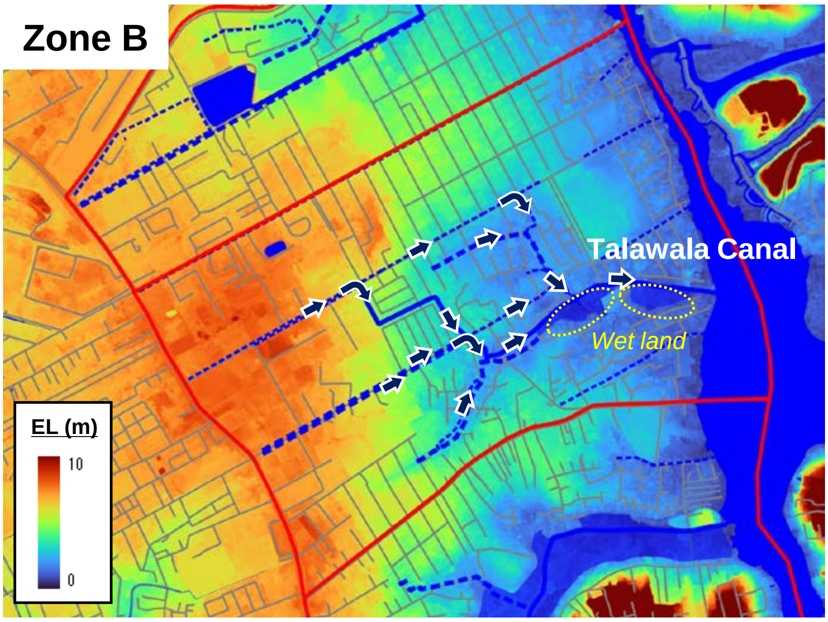
- Zone A: The main canal at the end of the stream is Kandawala Canal, which has a gentle slope topography with elevations ranging from 0 m to 7 m. Drainage water from nearby residences and facilities flows into the existing road drainage canal that runs through the center of Zone A and then connects to the main canal.



Source: JICA study team

Figure 2.3.2 Topographical Map and Main Drainage System in Zone A

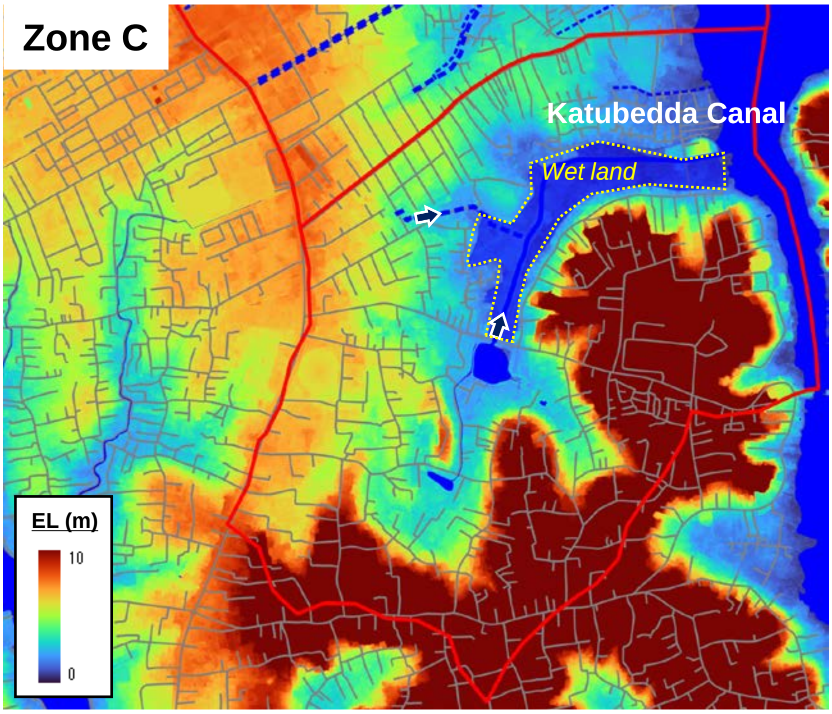
- Zone B: The main drainage canal is the Talwala Canal, which is located at an elevation of 0 m to 8 m. As in Zone A, drainage water from residences and facilities in the vicinity flows into a secondary canal via existing road drainages and finally reaches to Weras Ganga via the Talwala Canal. Compared to Zone A, the existing drainage canals tend to be located close to retaining walls and residential walls due to the dense residential population and complex road network.



Source: JICA study team

Figure 2.3.3 Topographical Map and Main Drainage System in Zone B

- Zone C: The main canal at the end of the watershed is the Katubedda Canal; the southernmost part of the watershed is hilly with an elevation of more than 10 m, and most of the canals connecting to the main channel have relatively steep slopes but there are few secondary canals in this watershed, and the drainage system is such that small-scale open channels or road drains directly connect to this natural wetland.



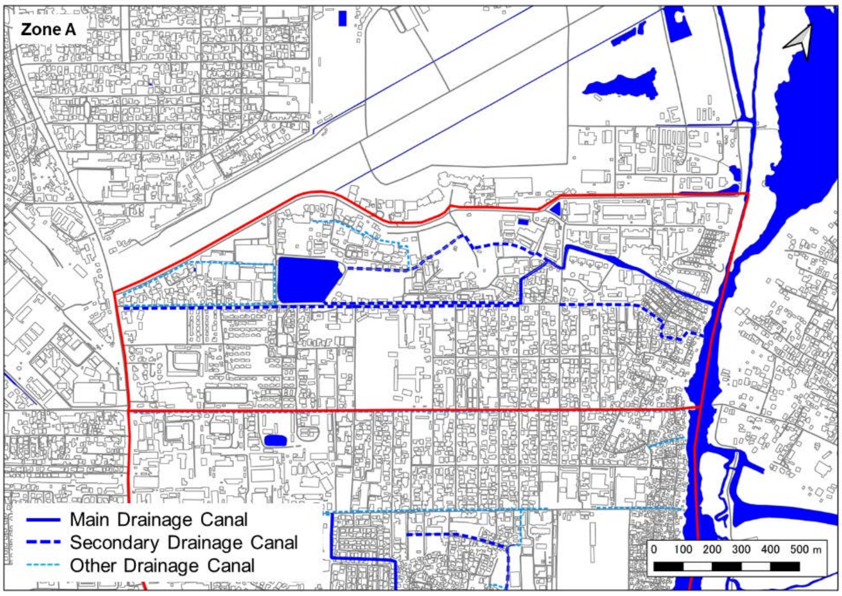
Source: JICA study team

Figure 2.3.4 Topographical Map and Main Drainage System (Zone C)

2.3.2 Hydrological and Hydraulic Analysis

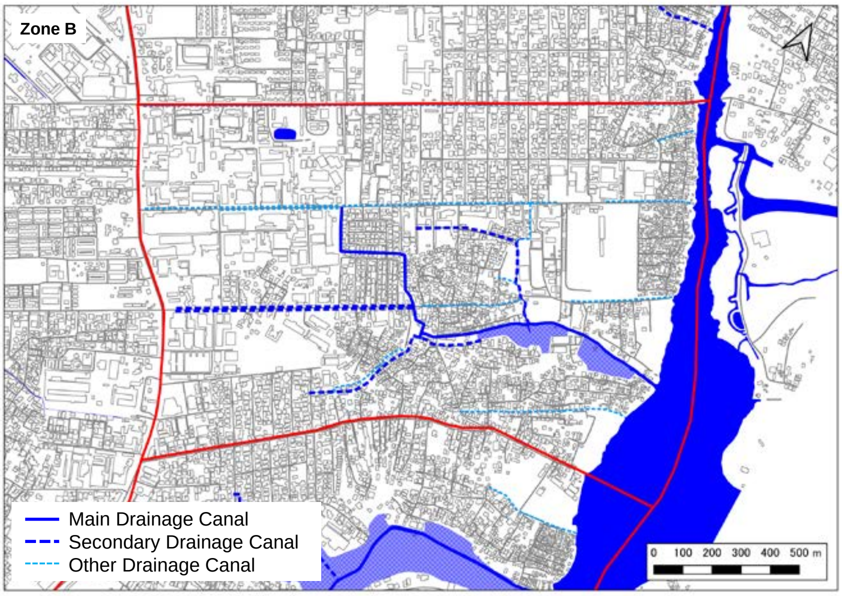
2.3.2.1 Target Canal

The main canal and secondary canals are selected as the target canals in the Moratuwa-Rathmalana area after consultation with SLLDC. Based on topographic information, the outer edges of drainage zones A to C were determined, and the locations of the main and secondary canals to be considered were clarified based on the latest survey results conducted in 2020 and 2021 by SLLDC. Their location maps are shown in Figure 2.3.5 through Figure 2.3.7. In the hydraulic analysis modeling, other canals (light blue) that are not subject to rehabilitation are included.



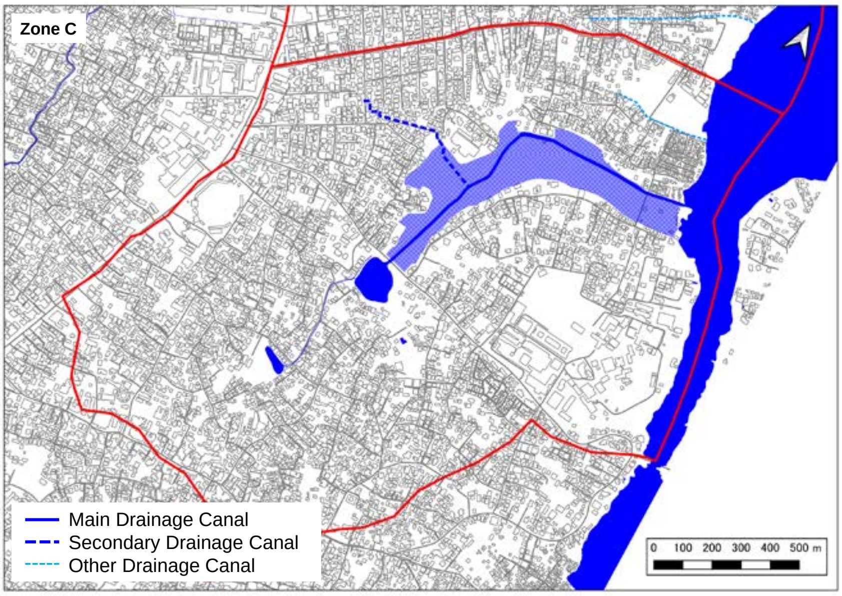
Source: JICA study team

Figure 2.3.5 Target Canals in Zone A



Source: JICA study team

Figure 2.3.6 Target Canals in Zone B



Source: JICA study team

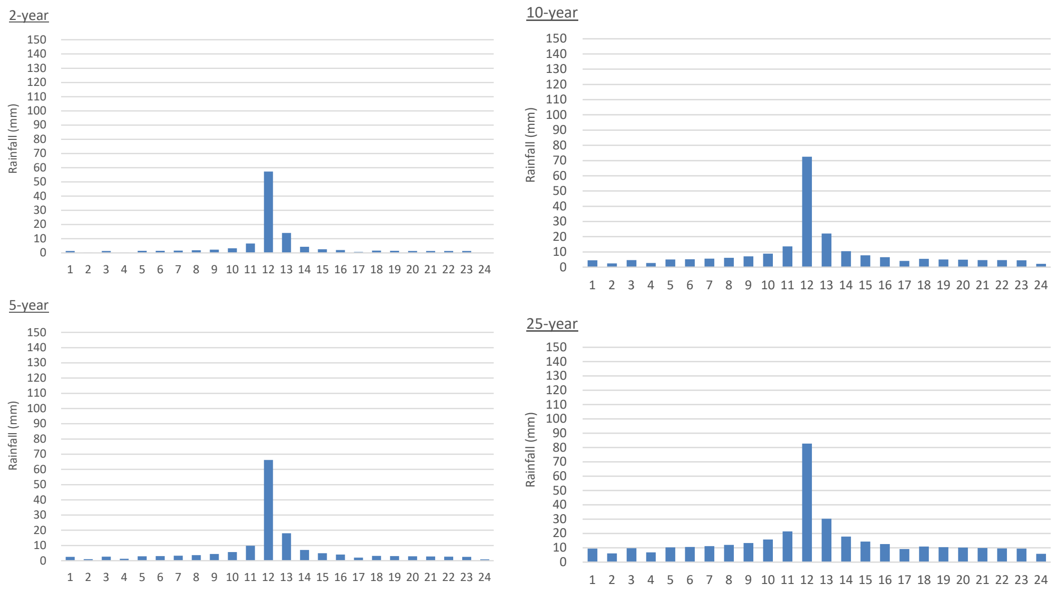
Figure 2.3.7 Target Canals in Zone C

2.3.2.2 Hydrological Analysis

The runoff volume from each sub-catchment area was estimated by the NAM (Nedbor-Afstromnings-Model) module, following the runoff analysis model established in the M/P study in the Bolgoga basin, and an overview of the NAM module is described in Part 1.

(1) Design Rainfall

In the Moratuwa-Rathmalana area, since the Rathmalana station is located in the Moratuwaa-Rathmalana area, it is reasonable to use the rainfall intensity curve of the Rathmalana station, which is also consistent with the flood control plan for the Bolgoda basin. Using the rainfall intensity curves of the Rathmalana station, centrally concentrated rainfall hyetographs by probability scales were used for the model hyetograph for the design rainfall. The model hyetographs for the 2- to 25-year probability scales are shown below.

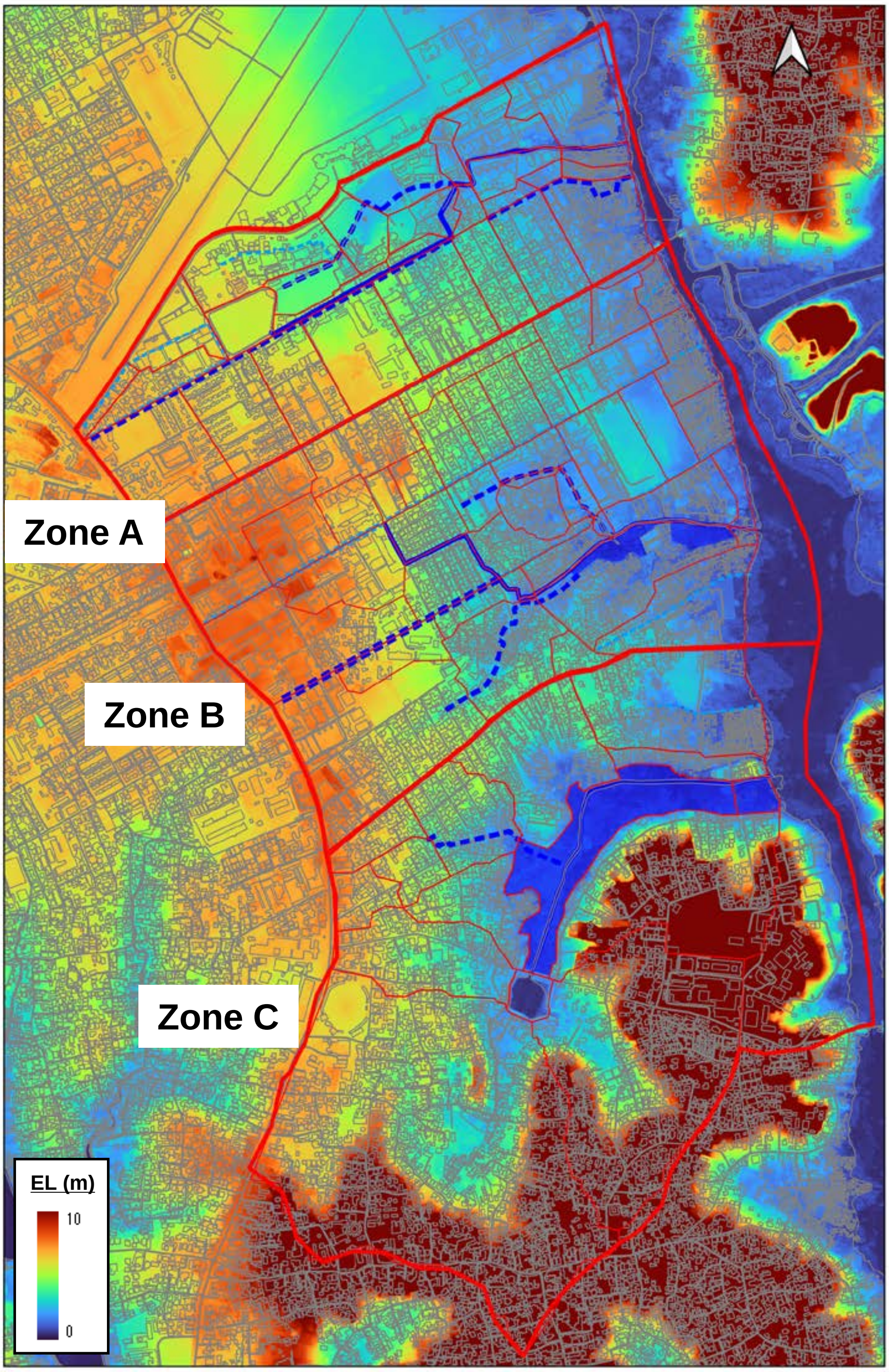


Source: JICA study team

Figure 2.3.8 Design Rainfall

(2) Setting Sub-catchment Area

Using the LiDAR data and the results of the field inspection, Zones A, B, and C were further divided into smaller drainage areas (Sub-catchment areas). Runoff analyses were conducted based on these Sub-catchment areas.

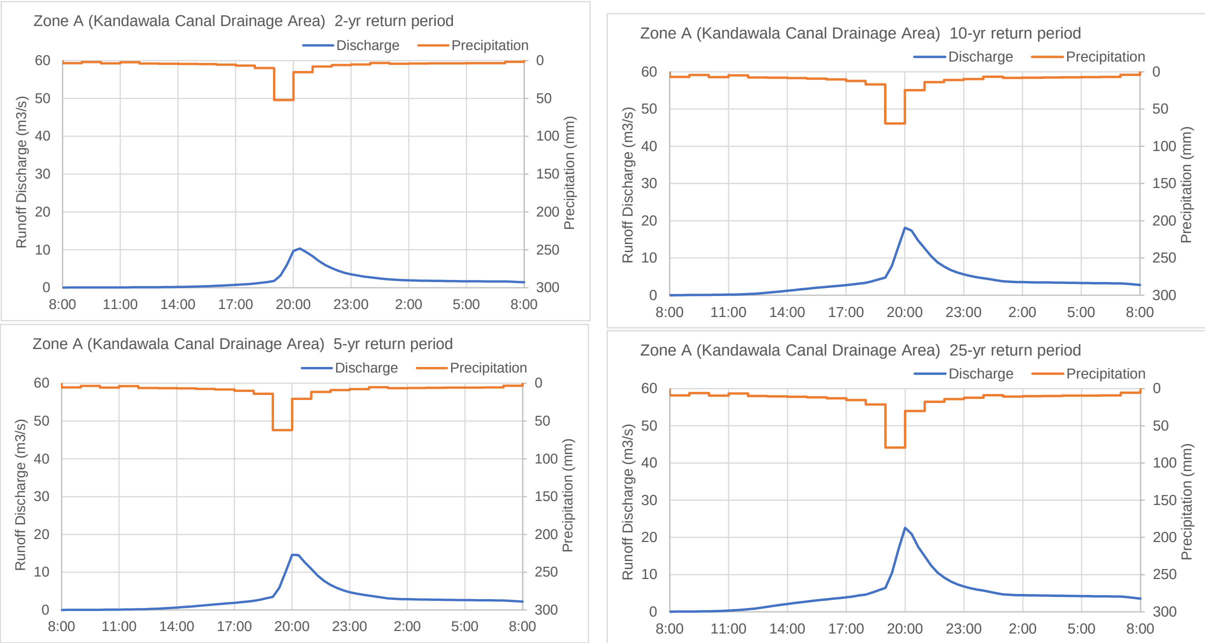


Source: JICA study team

Figure 2.3.9 Sub-Catchment areas in Moratuwa-Rathmalana Drainage Area

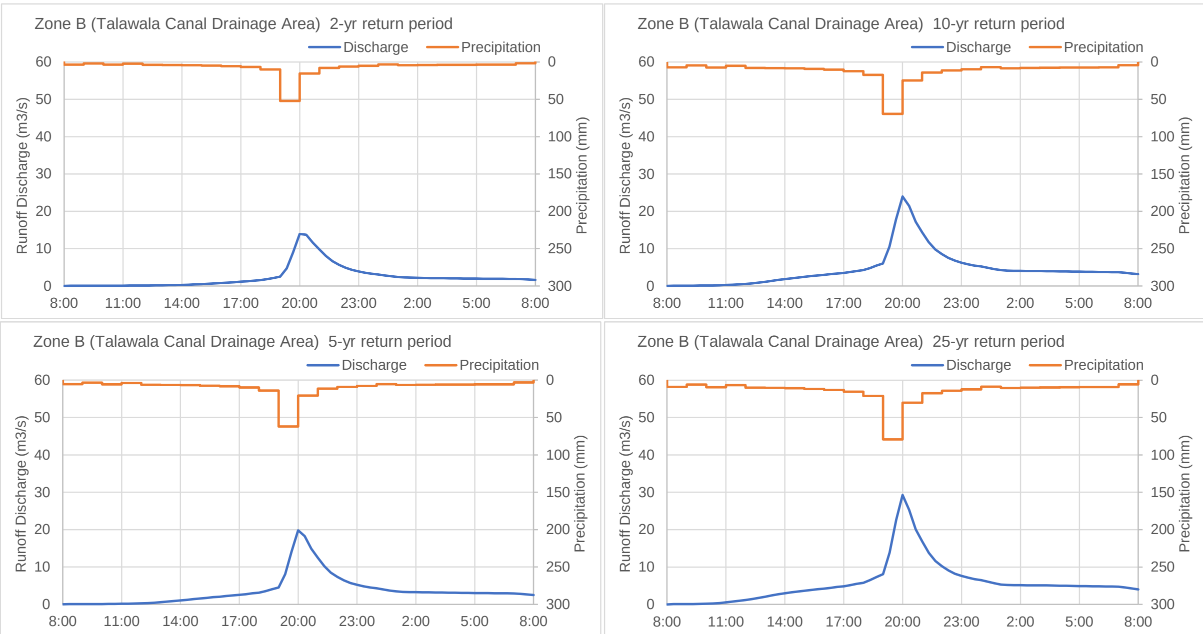
(3) Runoff Analysis

As mentioned above, the runoff analyses were performed using the NAM module of the MIKE series. The various parameters used for the land use categories and NAM parameters for each land use were the same as those used in the Bolgoda basin in the M/P study. The results of the runoff analyses were shown below. The discharges shown here are the values at the end of the main canals for each Zone.



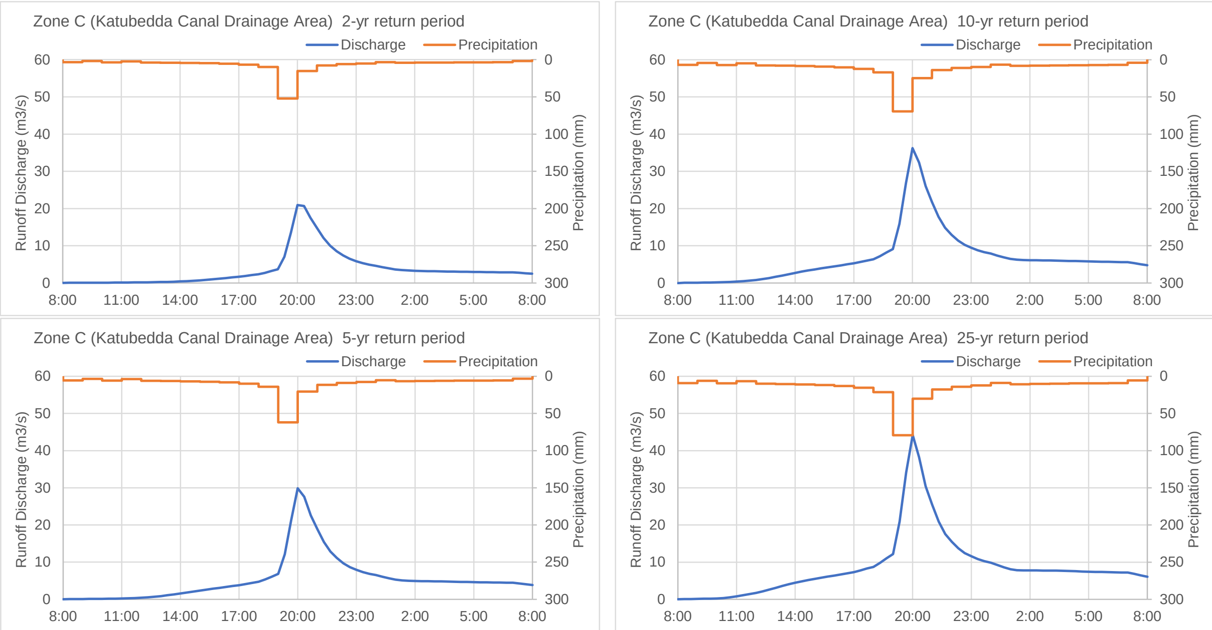
Source: JICA study team

Figure 2.3.10 Runoff Analysis Result in Zone A



Source: JICA study team

Figure 2.3.11 Runoff Analysis Result in Zone B



Source: JICA study team

Figure 2.3.12 Runoff Analysis Result in Zone C

2.3.2.3 Hydraulic Analysis

The water level simulation for each drainage canal and the inundation analysis to evaluate the risk of inundation followed the hydraulic and inundation analysis model developed in the M/P study in the Bolgoga basin. These simulations were analyzed by the MIKE-11 and MIKE-FLOOD modules. An overview of the MIKE series is given in Part 1.

(1) Boundary Condition of End Each of Main Canal

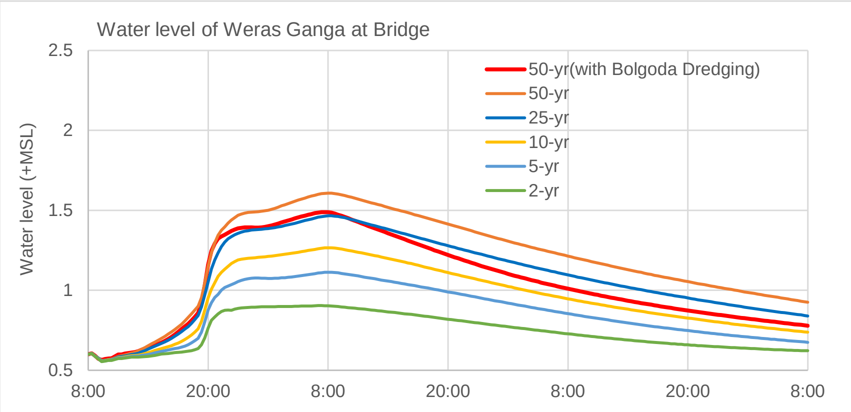
1) Boundary condition and design high water level of Weras Ganga in the entire Bolgoda model

Since the end of the Bolgoda basin into which the Weras Ganga flows is the sea, a spring mean high tide level of 0.6 m was set as the boundary condition at the end of the Bolgoda basin in the M/P study. The water level condition of the Weras Ganga can be referred to from the hydraulic analysis of the Bolgoda basin model.

In addition, SLLDC has completed or is in the process of implementing river improvements in the left branch of the Weras Ganga. Complying with this, the design high water level and the design bank level of the Weras Ganga are set at 1.5 m and 2.0 m, respectively.

2) Water level of Weras Ganga for each probability scale

The water levels of Weras Ganga for each probability scale calculated in the M/P study are shown in the following figure. In the future plan the water level of the Weras Ganga is reduced to 1.5 m at the 50-year probability scale with dredging.

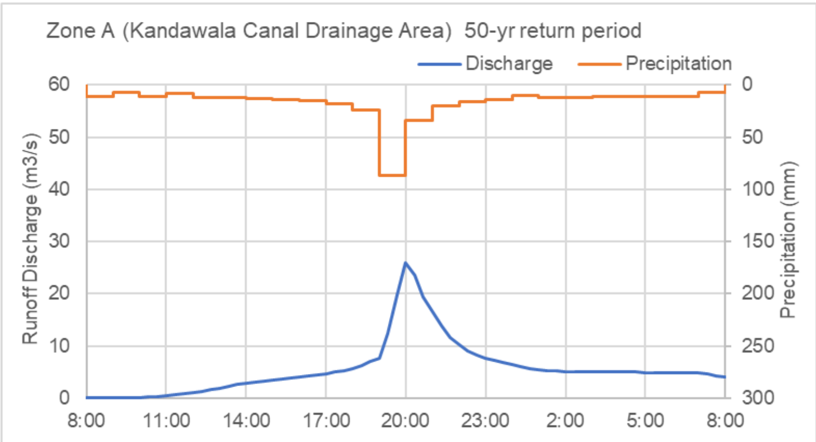


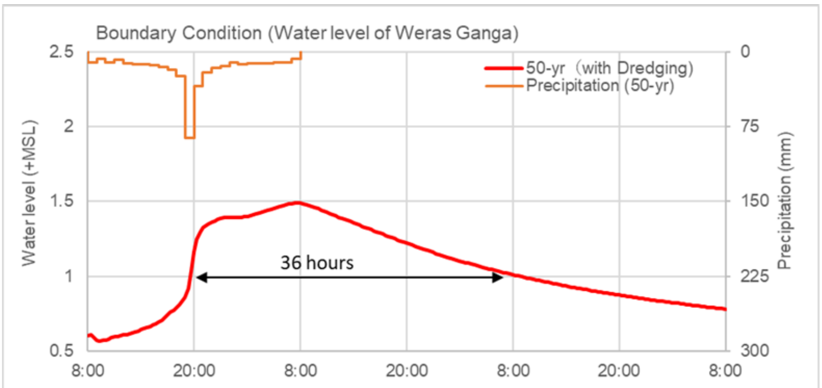
Source: JICA study team

Figure 2.3.13 Water Level for Each Probability Scale

3) Assumed inundation duration

Since the Moratuwa-Rathmalana area is included in the Weras Ganga basin, the same rainfall conditions should be applied to the Moratuwa-Rathmalana area as the one in Weras Ganga. Based on the water levels calculated in the M/P study, the expected inundation time in the target area is about 36 hours (duration of above 1m inundation depth). On the other hand, the peak outflow from the target area mostly disappears in about 3 hours, indicating that the water level in Weras Ganga rises after the peak outflow from the target area. Therefore, to prevent flood inundation from Weras Ganga, the gate should be closed even after the peak outflow from the target area. In this case, no pumping facilities are required.





Source: JICA study team

Figure 2.3.14 Comparison Between Water Level Hydrograph of Weras Ganga and Runoff Hydrograph of Moratuwa-Rathmalana Area

4) Setting Boundary Condition

Based on the above, the relationship between the design scale and boundary condition of the downstream end for the drainage plan in the target area can be as follows. Specifically, the boundary condition of the downstream end is the water level of the Weras Ganga main river for each probability scale.

Table 2.3.1 RelationshipBetween Design Scale and Peak Water Level at Weras Ganga

Design Scale of Target Area	Design Scale of Weras Ganga Basin	Peak Water Level at Weras Gang as a boundary condition of the downstream end of each Zone.
2-year return period	2-year return period	0.904 m
5-year return period	5-year return period	1.113 m
10-year return period	10-year return period	1.266 m
25-year return period	25-year return period	1.466 m

Source: JICA study team

2.3.2.4 Inundation Analysis

(1) Building Inundation Analysis Model

The inundation analysis model used in the Bolgoda basin in the M/P study was utilized here. However, unlike the Bolgoda basin, the grid size was changed from 50 m to 20 m size due to the smaller area covered. The main calculation conditions in the flood inundation model were shown in Table 2.3.2.

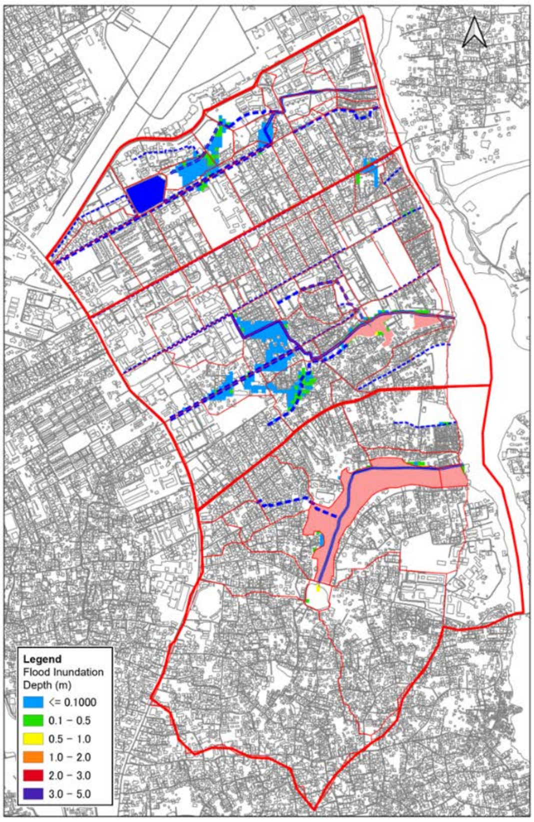
Table 2.3.2 Comparison of Main Calculation Conditions

Items	Bolgoda Basin Model	Moratuwa-Rathmalana Area Model
Grid Size	50m	20m
DEM (Digital Elevation Model)	Averaged elevation for each grid will be arranged using LiDAR data.	Same as Bolgoda basin model
Roughness Coefficient of flood plain.	0.100	Same as Bolgoda basin model

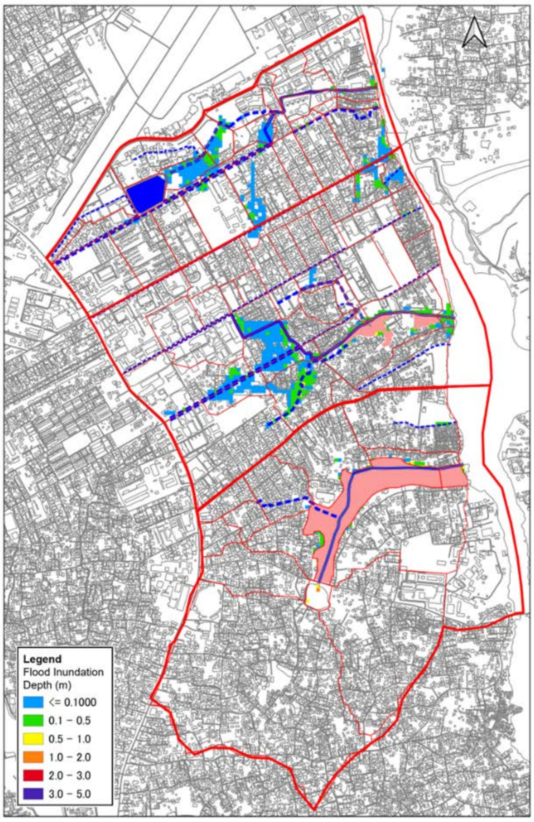
Source: JICA study team

(2) The result of Inundation Analysis

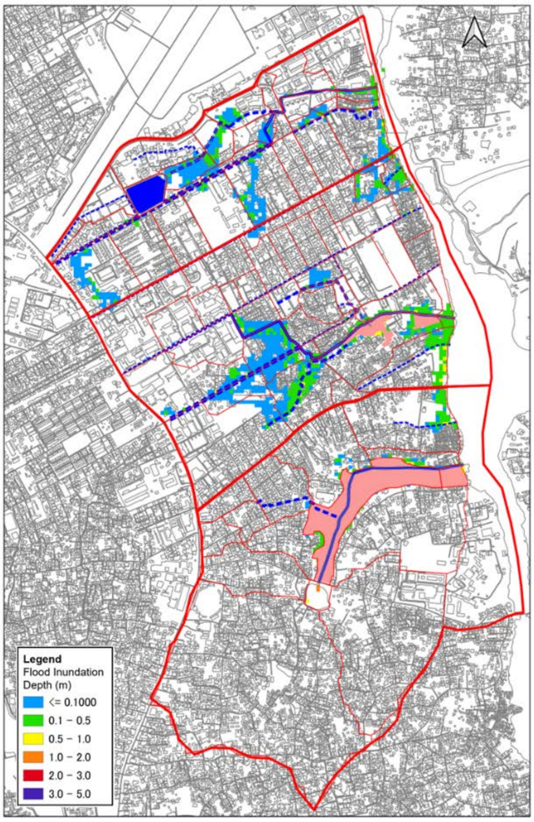
As a result, the estimated inundation area maps are shown in



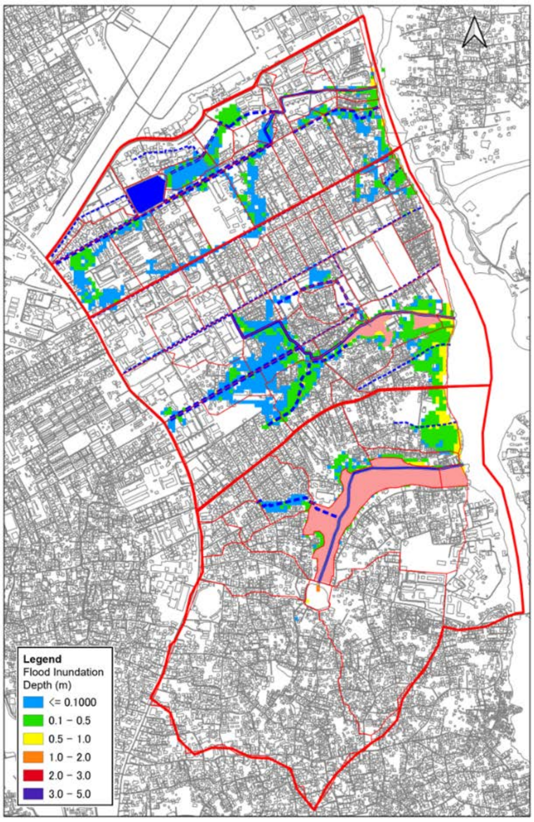
2-yr return period



5-yr return period

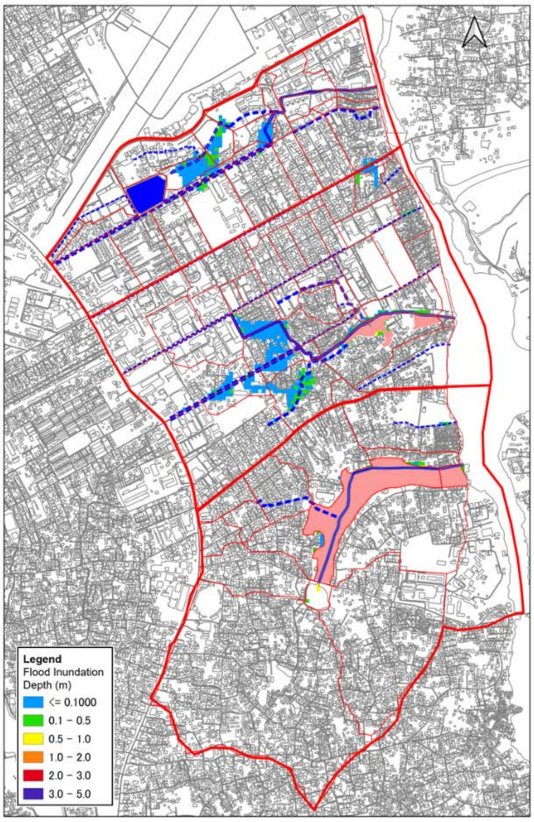


10-yr return period

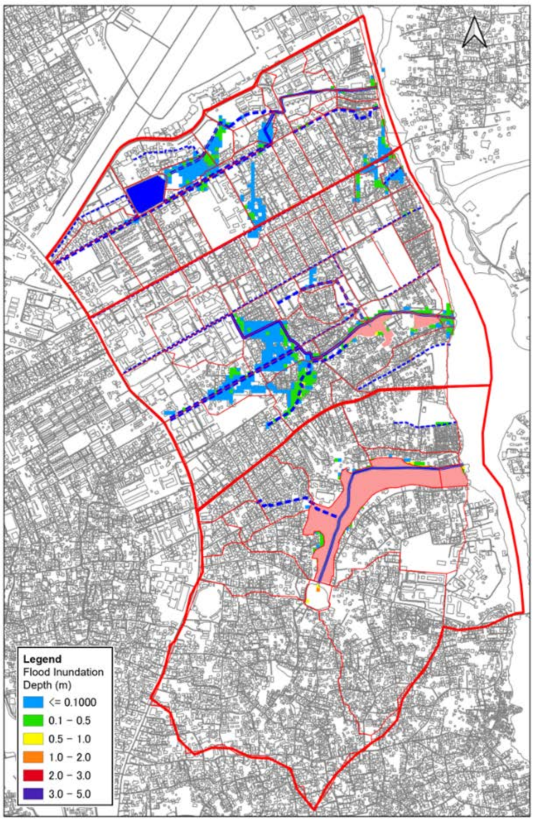


25-yr return period

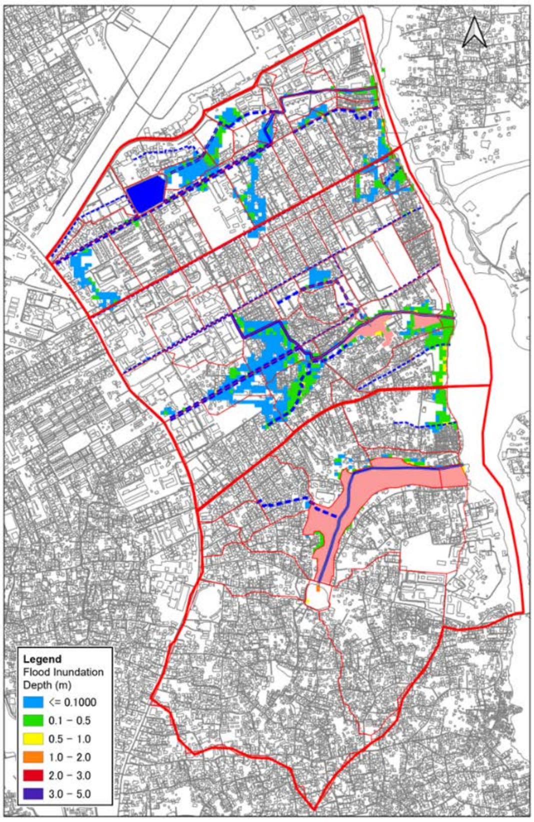
Figure 2.3.15.



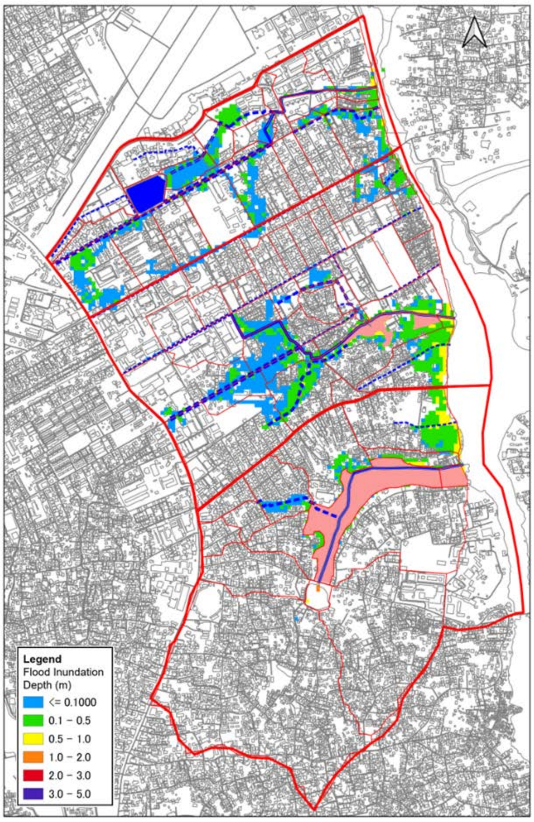
2-yr return period



5-yr return period



10-yr return period



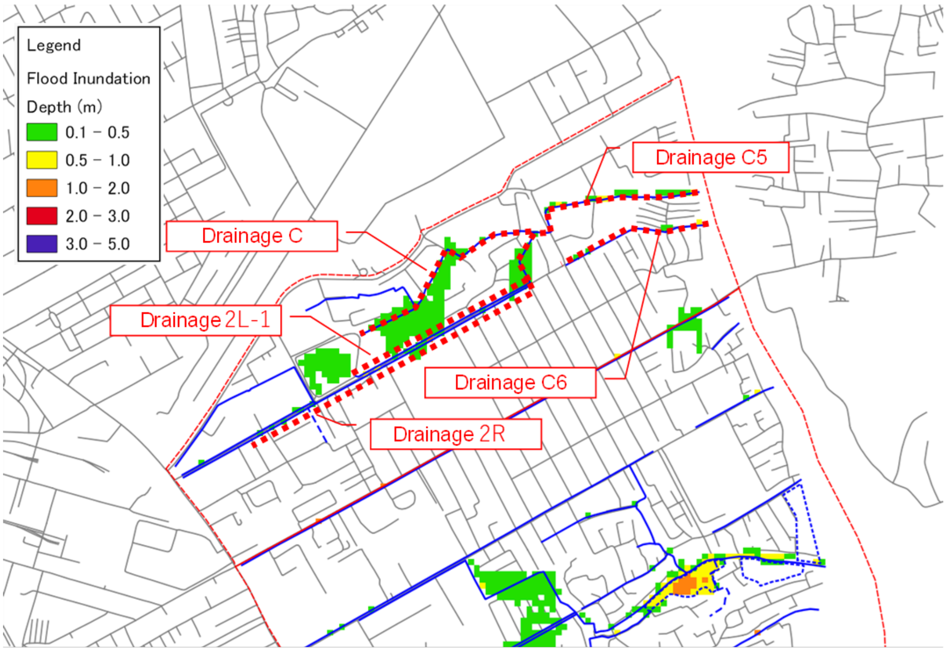
25-yr return period

Figure 2.3.15 Estimated Inundation Areas for Each Probability Scale

2.3.2.5 Evaluation of Inundation Risk and Setting Target Canal for Improvement

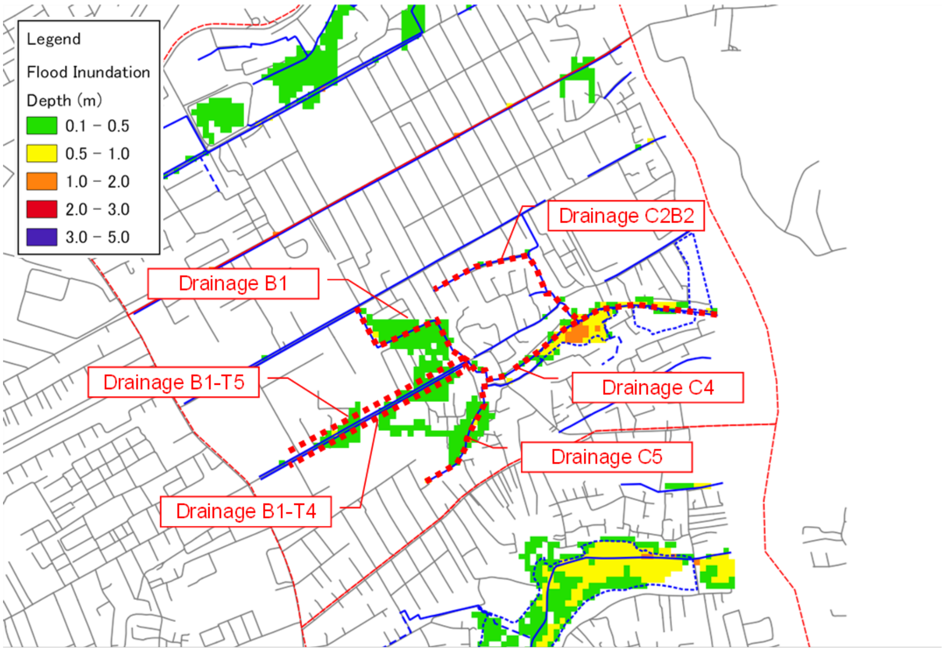
(1) Zone A and Zone B

The existing targeted main and secondary canals mostly have 2-year probability flood control safety level. Therefore, for Zone A and Zone B, it was decided to conduct analyses targeting drainage canals indicated in red in the figure for rehabilitation.



Source: JICA study team

Figure 2.3.16 Target Canals for Improvement in Zone A (Inundation area under 2-year flood scale)

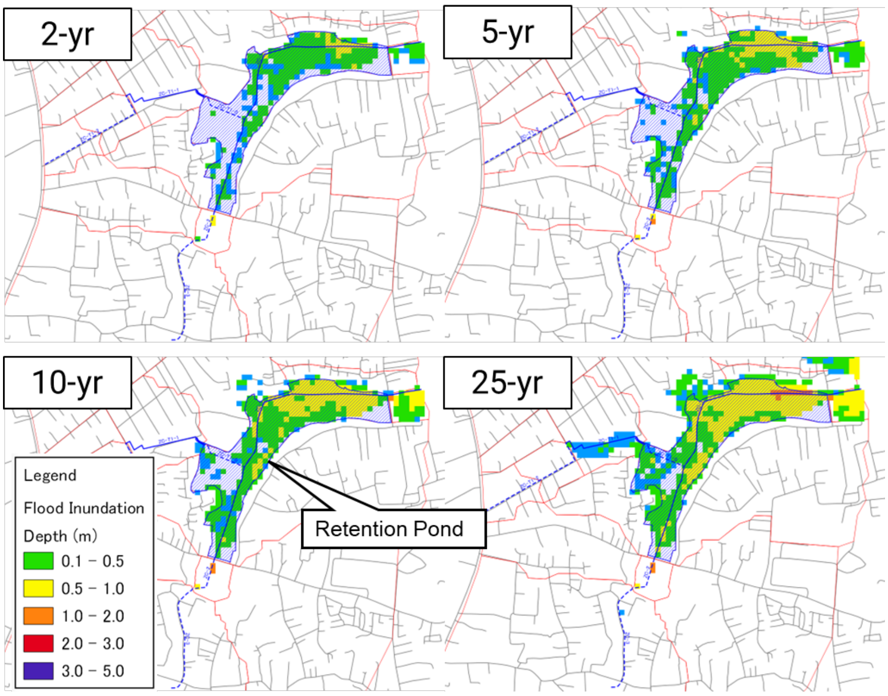


Source: JICA study team

Figure 2.3.17 Target Canals for Improvement in Zone B (Inundation area under 2-year flood scale)

(2) Zone C

The target canals in Zone C have sufficient flow capacity, as the large regulating reservoirs that extend downstream are extremely effective in lowering the water level in each canal. Therefore, Zone C was excluded from the further study on the canal improvement plan.



Source: JICA study team

Figure 2.3.18 Target Canals for Improvement in Zone C (Inundation area under 2-year flood scale)

2.3.2.6 Design Scale

(1) Design Scale of Neighborhood River Basin

In the neighboring basins, the maximum design scale is a 10-year probability scale, as shown in the table below. On the other hand, the JICA 2003 M/P sets the design scale for the same target area at a 2-year probability scale.

Table 2.3.3 Design Scale of Neighborhood River Basin

River Basin and Drainage Area	Design Scale
Weras Ganga basin	50-year return period
Bolgoda Canal basin	10-year return period
Nugegoda-Pttanapitiya basin	10-year return period
Moratuwa-Rathmalana drainage area	2-year return period (2003 M/P)

Source: JICA study team

(2) Alternative of Design Scale

Referring to the design scale of neighborhood basins and the results of previous studies (JICA 2003 M/P), it would be appropriate to set the design scale of the target area at 2 to 10 years return period. Therefore, the design scale of the target area was determined by estimating the risk of inundation at several probability scales (Table 2.3.4) and the scale of facilities expected to reduce the inundation risk, as well as by considering the social impact of each of these factors.

Table 2.3.4 Alternative of Design Scale Combination

Classification	Alt-1	Alt-2	Alt-3	Alt-4	Alt-5
Main canal	No Imp.	5-yr	10-yr	10-yr	25-yr
Secondary canal	2-yr	2-yr	5-yr	10-yr	25-yr

Source: JICA study team

(3) Setting the Specification for Canal Improvement

The canal improvement specification (width, depth, and longitudinal gradient) for each alternative were set by "the uniform flow calculation" to determine the longitudinal and cross sectional forms that can safely carry the probability-scale flow discharge obtained from the runoff analysis. In general, uniform flow calculations are used to set up the specifications for small drainage canals such as those used in this study. The basic concept of setting the improvement specification is bulleted below.

- To minimize land acquisition, the existing waterway will be rehabilitated.
- Excessive channel widening will not be undertaken to minimize the social impact of additional land acquisition.
- Similarly, excavation and dredging should be done to minimize the impact on neighboring facilities such as residences.
- Conversely, if there is sufficient land (e.g., wetlands), a gentle slope should be adopted.
- Based on the above, an appropriate combination of channel width, depth, and the slope is determined in an equal flow calculation trial.
- Roughness coefficients were set according to the channel shape as follows:
  Box culvert: 0.02/ Gently sloping bank: 0.03.

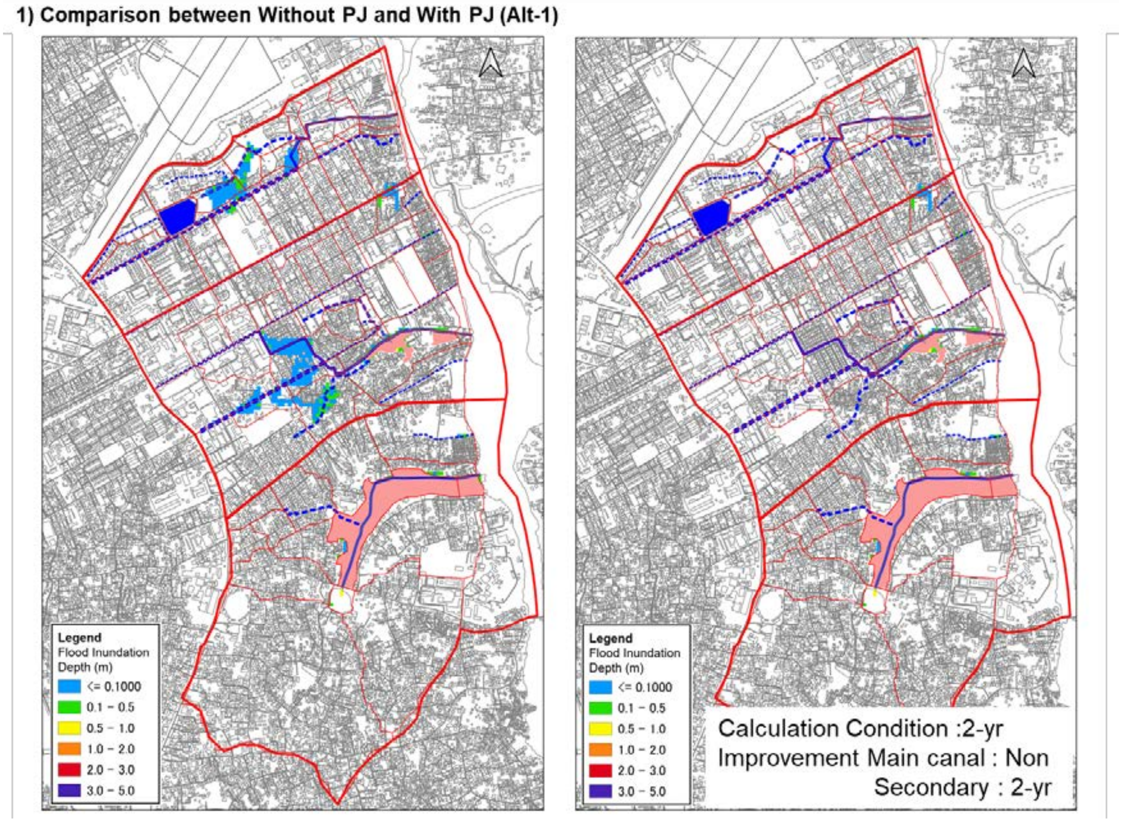
Table 2.3.5 Manning Formula (Uniform Flow Calculation)

$$V=\frac{1}{n}\ I^{1/2}R^{2/3},\quad Q = AV$$

Q: Discharge (m3/s) n: Roughness coefficient
A: Flow Area (m2) I: Gradient
V: Velocity (m) R: Hydraulic radius (m)

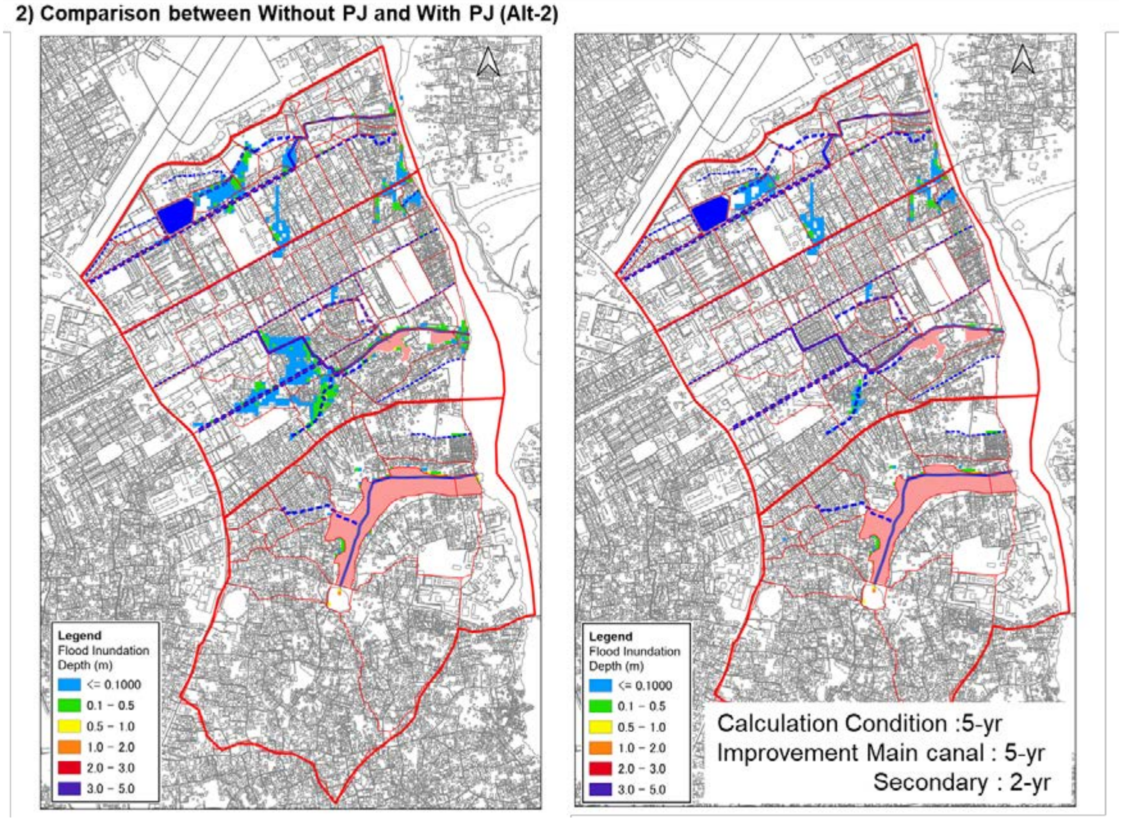
(4) Result of Hydraulic Analysis

The constructed inundation simulation model was used to verify the effectiveness of each alternative in reducing the inundation risk of canal improvement. The following figures show the estimated inundation area. The estimated inundation areas in the current situation (left: without improvement) are different from each alternative because the applied probability scales are different. The scale of facilities to be improved differs among the alternatives, but the assumed inundation area after improvement is reduced to almost the same level, indicating a certain level of inundation risk reduction effect.



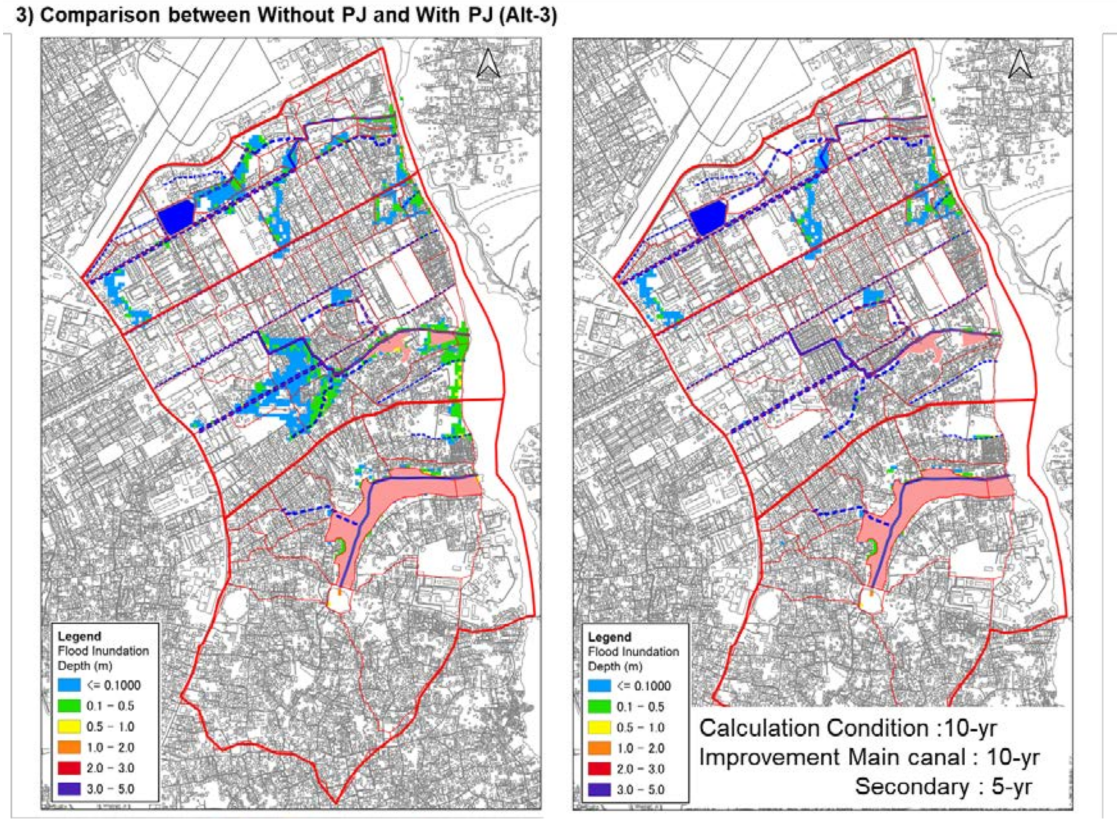
Source: JICA study team

**Figure 2.3.19 Reduction in Flooding Area due to Drainage Canal Improvement (Alt-1)
(Left: without improvement, Right: with improvement)**



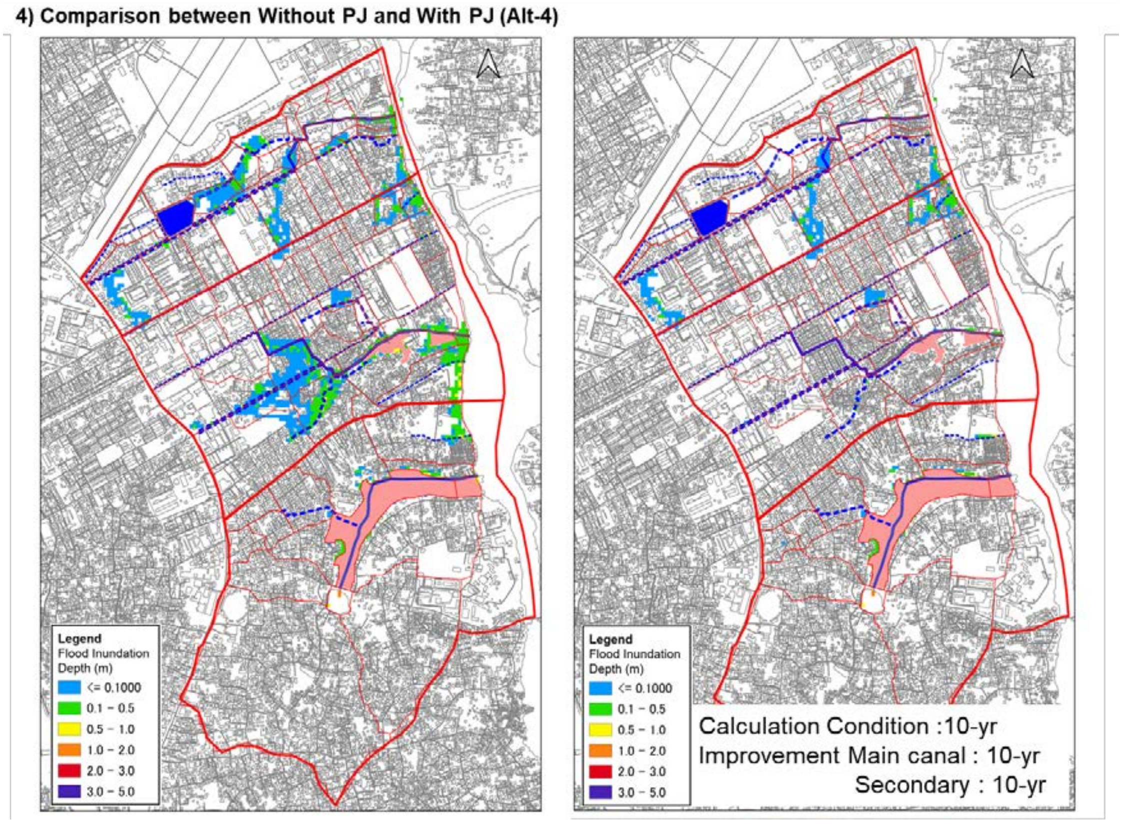
Source: JICA study team

**Figure 2.3.20 Reduction in Flooding Area due to Drainage Canal Improvement (Alt-2)
(Left: without improvement, Right: with improvement)**



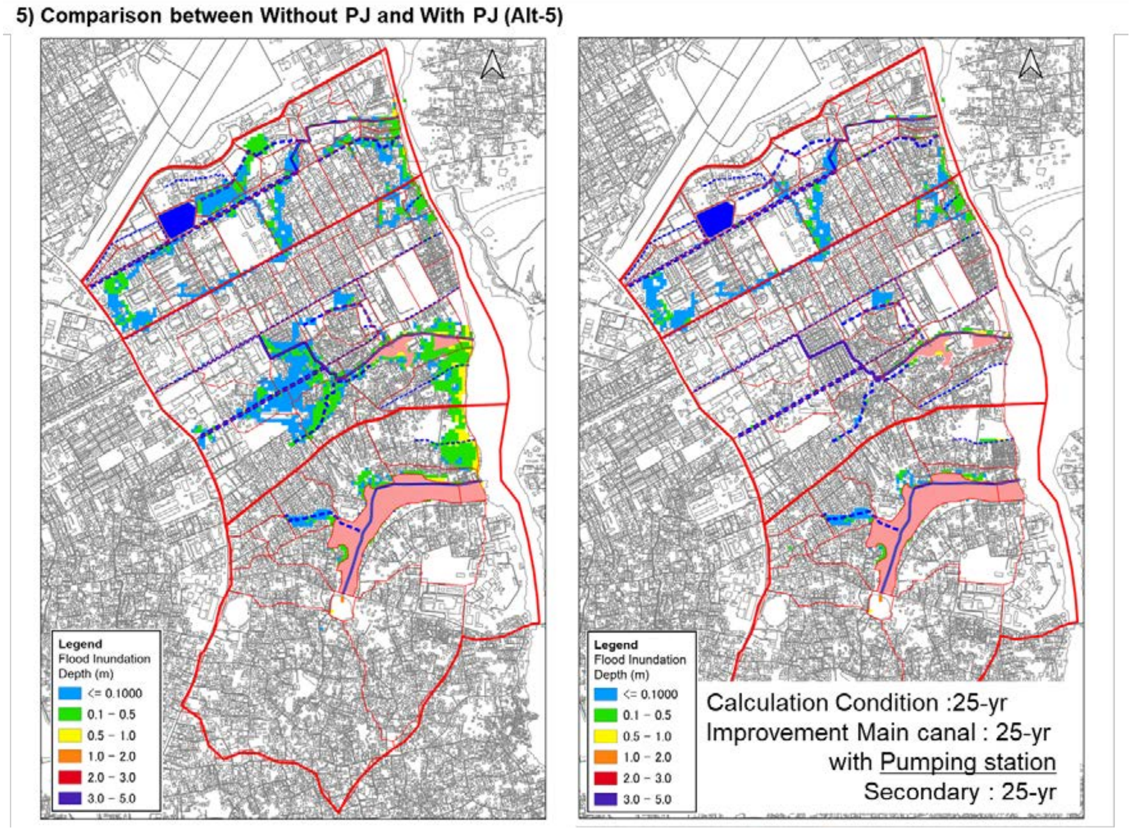
Source: JICA study team

Figure 2.3.21 Reduction in Flooding Area due to Drainage Canal Improvement (Alt-3) (Left: without improvement, Right: with improvement)



Source: JICA study team

Figure 2.3.22 Reduction in Flooding Area due to Drainage Canal Improvement (Alt-4) (Left: without improvement, Right: with improvement)



Source: JICA study team

Figure 2.3.23 Reduction in Flooding Area due to Drainage Canal Improvement (Alt-5)
(Left: without improvement, Right: with improvement)

(5) Rough Economic and Social Impact Evaluation

1) Rough Economic Evaluation

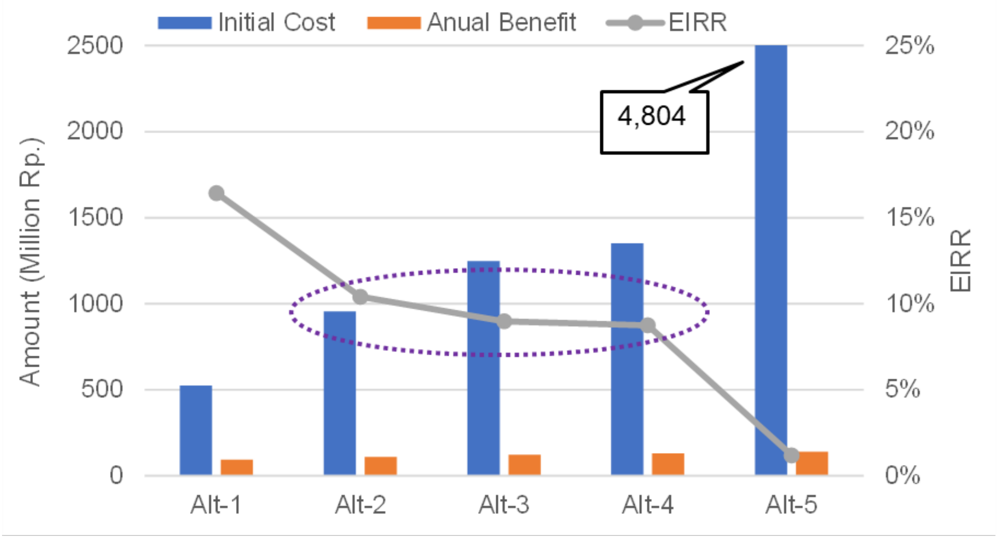
The rough EIRR values were calculated from the estimated construction costs and estimated damages for each alternative. As shown in Table 2.3.6, in the case of Alt-1, the EIRR was calculated to be large because the construction cost was considerably small, while Alt-2 through Alt-4 did not show such a large difference, with EIRR ranging from 8 to 10%, so the superiority based on economic evaluation cannot be clearly demonstrated. Alt-5 has a very small EIRR due to the additional construction cost for the pumping facility, and clearly Alt-5 should be rejected.

As shown in Table 2.3.4, the range of the probability scale is generally between 2 and 10 years, referring to the design scale of the neighboring river basin. However, the river basins for which the 10-year probability scale is adopted are not at the small-scale drainage area. Those are classified as so-called “river basins”. In this regard, applying the 10-year probability to the secondary canal, as in Alt-4, may result in an excessive design scale. Therefore, this rough economic evaluation concludes that it would be appropriate to apply either Alt-2 or Alt-3.

Table 2.3.6 Rough EIRR for Alternative Comparison

Item		Alt-1	Alt-2	Alt-3	Alt-4	Alt-5
Design Scale (Safety level)	Main Canal	No Imp.	5-yr	10-yr	10-yr	25-yr
	Secondary Canal	2-yr	2-yr	5-yr	10-yr	25-yr
Construction Cost (Million Rs)		526	956	1,250	1,352	4,804
Annual Averaged Damage (Million Rs)		94	110	124	131	142
Tentative EIRR (Million Rs)		16.44%	10.41%	8.98%	8.75%	1.20%

Source: JICA study team



Source: JICA study team

Figure 2.3.24 Tentative EIRR

2) Rough Social Impact

The rough social impacts focused on the relocation of houses due to the acquisition of land for canal improvement works. A detailed social impact assessment is provided in Chapter 8, and the results of the estimation of the number of houses affected by the construction of Alt-2 and Alt-3 are shown in Table 2.3.7. In this table, a total of 5 houses are assumed to be relocated in Alt-2 and a total of 14 houses in Alt-3. Although there is a relative difference in the number of houses that will need to be relocated, the number is not excessive in as a drainage canal improvement project such as this project that involves land acquisition. Therefore, although Alt-2 is superior in terms of relative evaluation, Alt-3 still has a possibility to be adopted in terms of promoting the project, increasing the flood control safety level of this area, and gaining the understanding of residents.

Table 2.3.7 Estimated number of houses affected by construction works

Item	Alt-2	Alt-3
Zone A	2	11
Zone B	3	3
Total	5	14

Source: JICA study team

(6) Decision on Design Scale

As a drainage improvement project, it is necessary to consider not only the numerical aspects of the economic evaluation and the social impacts but also the awareness of residents. Therefore, if the differences in economic and social impacts are little, it is appropriate to select a project with a higher flood control safety level. Based on these matters and after discussion with SLLDC, it was concluded that it is appropriate to adopt Alt-3 for the design scale of the Moratuwa-Rathmalana area, which is to improve the main canal with 10-year probability scale and the secondary channel with 5-year probability scale of flood control safety level.

2.3.3 Storm Water Drainage Plan

2.3.3.1 Storm Water Drainage Plan in Zone A

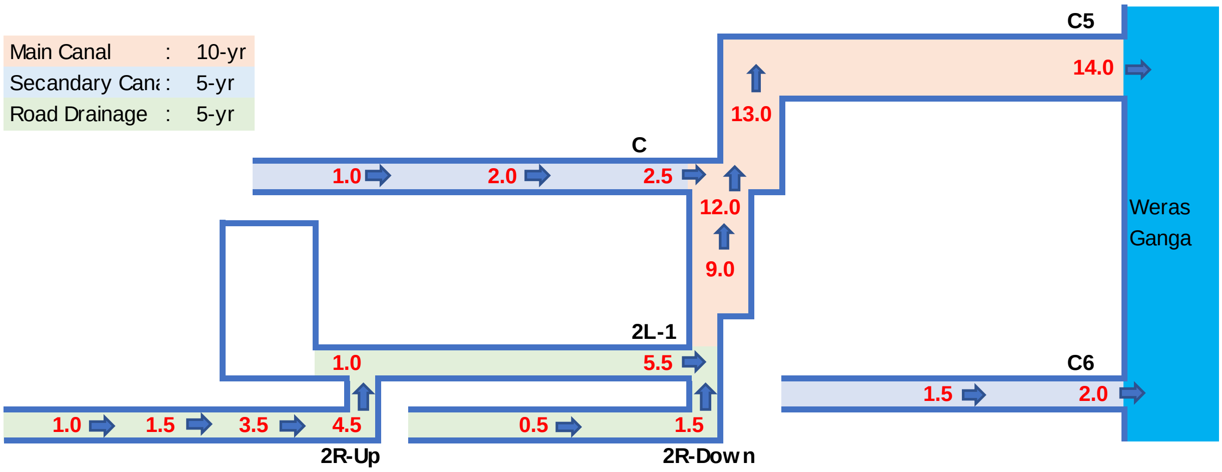
(1) Drainage Route and Design Discharge in Zone A

1) Drainage Route

In order to minimize the land acquisition, it was decided to improve the existing canal at the current drainage location. The drainage route is shown in Figure 2.3.27 (1) to (5).

2) Design Discharge

The design discharges for the target drainages canal were proposed based on the runoff calculations using the analysis model presented in "Section 2.3.2 Hydrologic and Hydraulic Analysis". The discharge distribution diagram was shown below. The longitudinal and cross sectional profiles were obtained using this discharge as a given condition through a trial of uniform flow calculation.



Source: JICA study team

Figure 2.3.25 Discharge Distribution Diagram in Zone A

(2) Longitudinal and Cross Sectional Plan

As with the flat plan, the longitudinal gradient was set to match the existing conditions, and the cross sectional forms were set to avoid excessive widening, since the basic plan was to improve the existing drainage canals. The longitudinal profile is shown in Figure 2.3.28 (1) to (5), and the cross sectional specifications for each section are shown on the drainage routes in Figure 2.3.27 (1) to (5).

2.3.3.2 Storm water Drainage Plan in Zone B

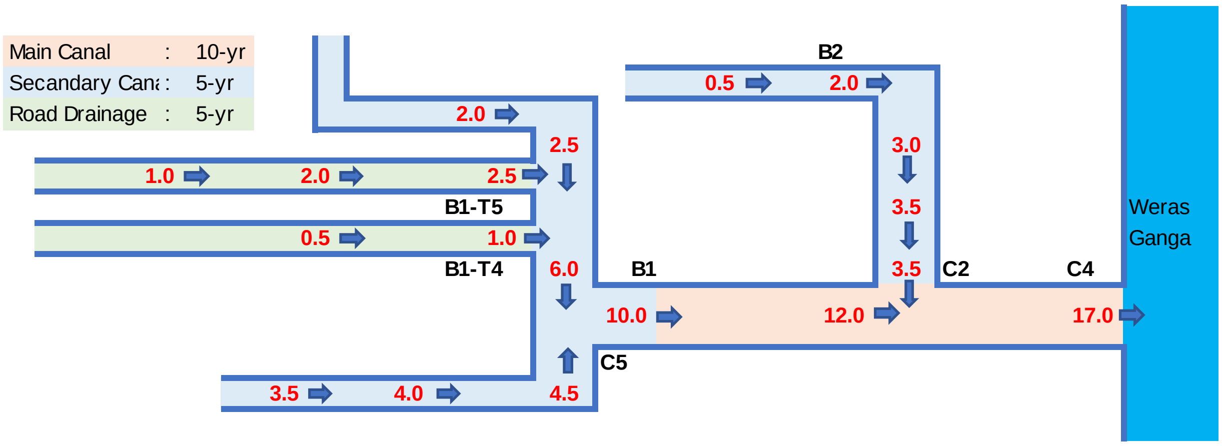
(1) Drainage Route and Design Discharge in Zone B

1) Drainage Route

In order to minimize land acquisition, it was decided to improve the existing canal at the current drainage location. The drainage route is shown in Figure 2.3.29 (1) to (5).

2) Design Discharge

The design discharges for the target drainages canal were proposed based on the runoff calculations using the analysis model presented in "Section 2.3.2 Hydrologic and Hydraulic Analysis". The discharge distribution diagram is shown below. The longitudinal and cross sectional profiles were obtained using this discharge as a given condition through a trial of uniform flow calculation.

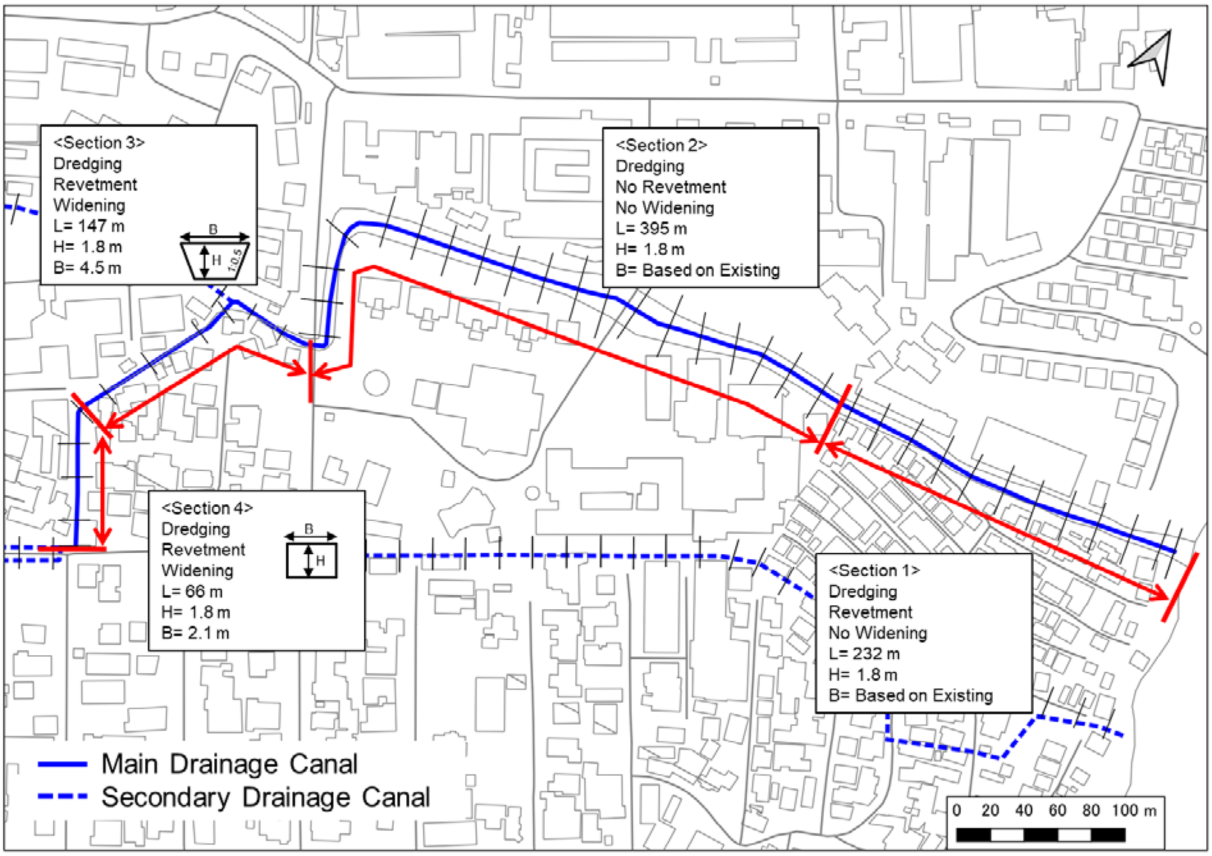


Source: JICA study team

Figure 2.3.26 Discharge Distribution Diagram in Zone B

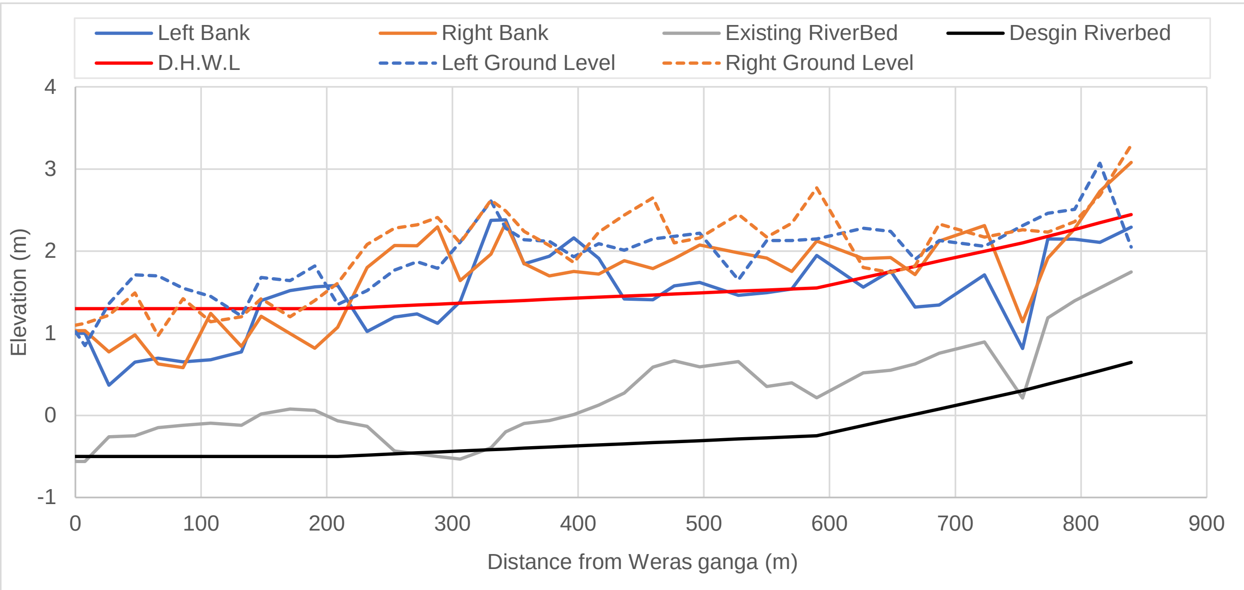
(2) Longitudinal and Cross Sectional Plan

As with the flat plan, the longitudinal gradient was set to match the existing conditions, and the cross sectional forms were set to avoid excessive widening, since the basic plan was to improve the existing drainage canals. The longitudinal profile is shown in Figure 2.3.30 (1) to (6), and the cross sectional specifications for each section are shown on the drainage routes in Figure 2.3.29 (1) to (5).



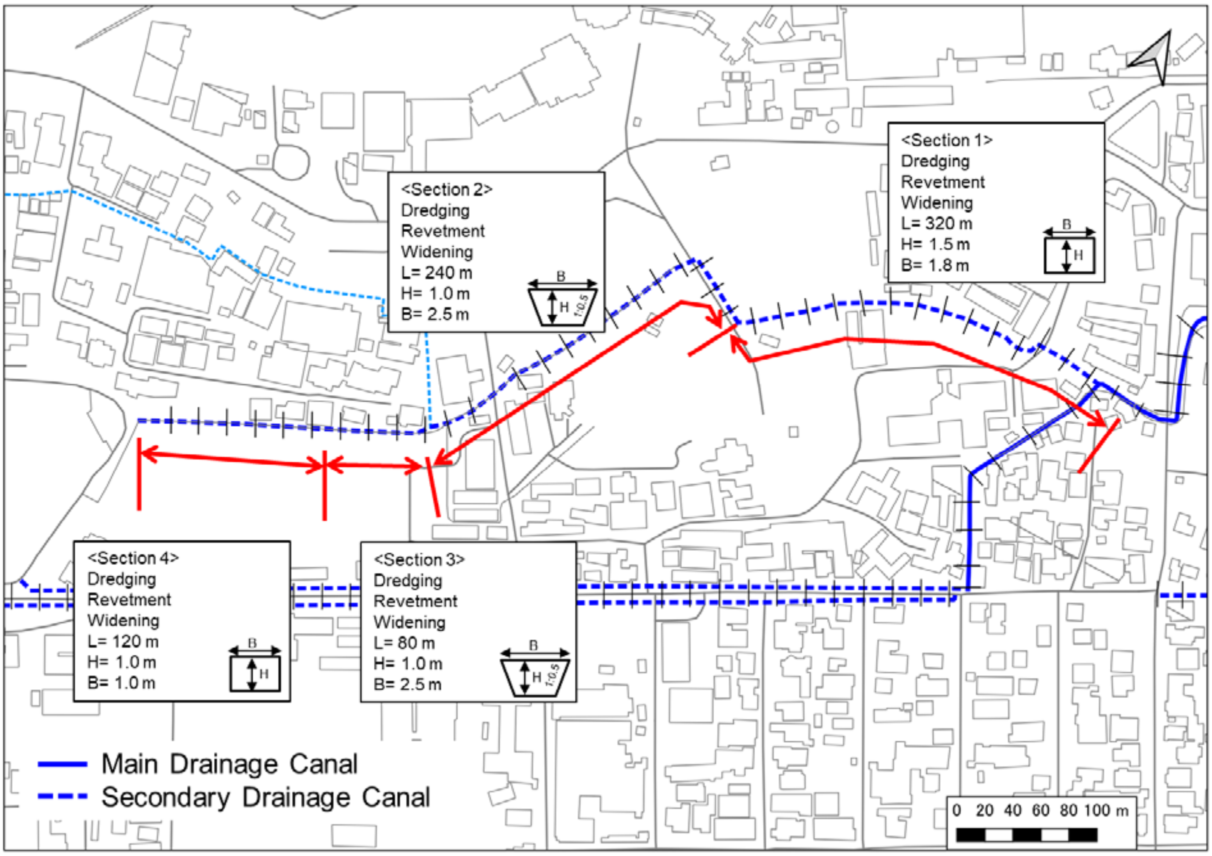
Source: JICA study team

Figure 2.3.27(1) Drainage Route and Cross Sectional Specification (Zone A/ C5)



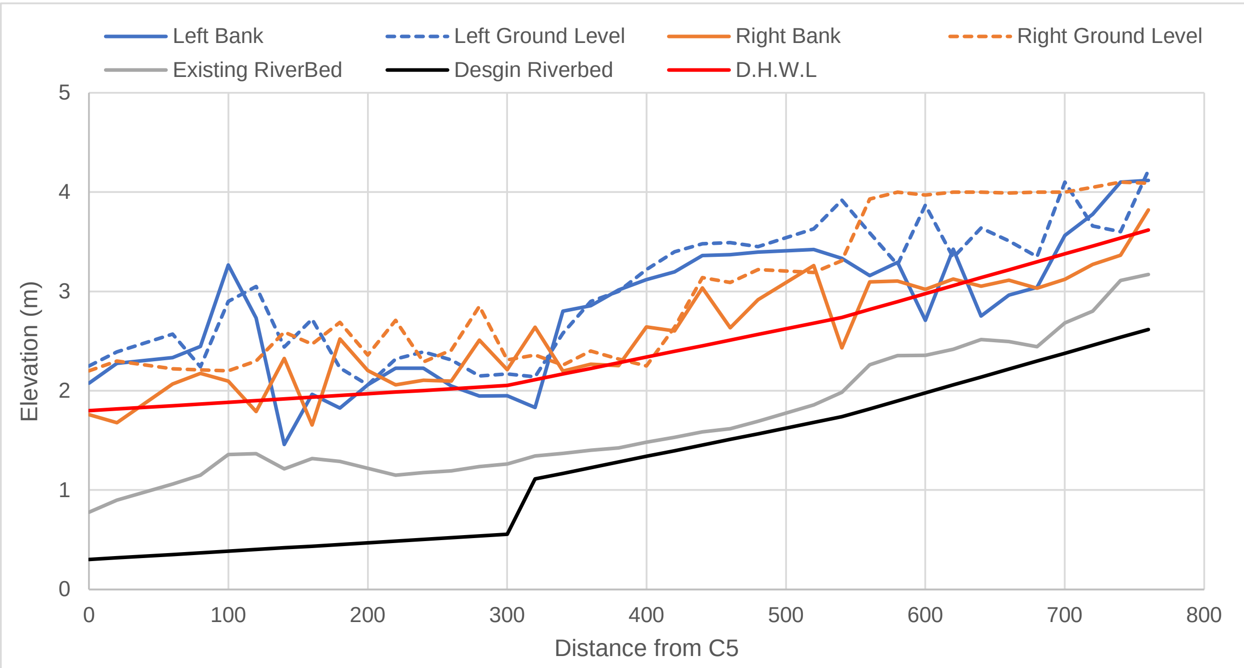
Source: JICA study team

Figure 2.3.28(1) Longitudinal Profile (Zone A/ C5)



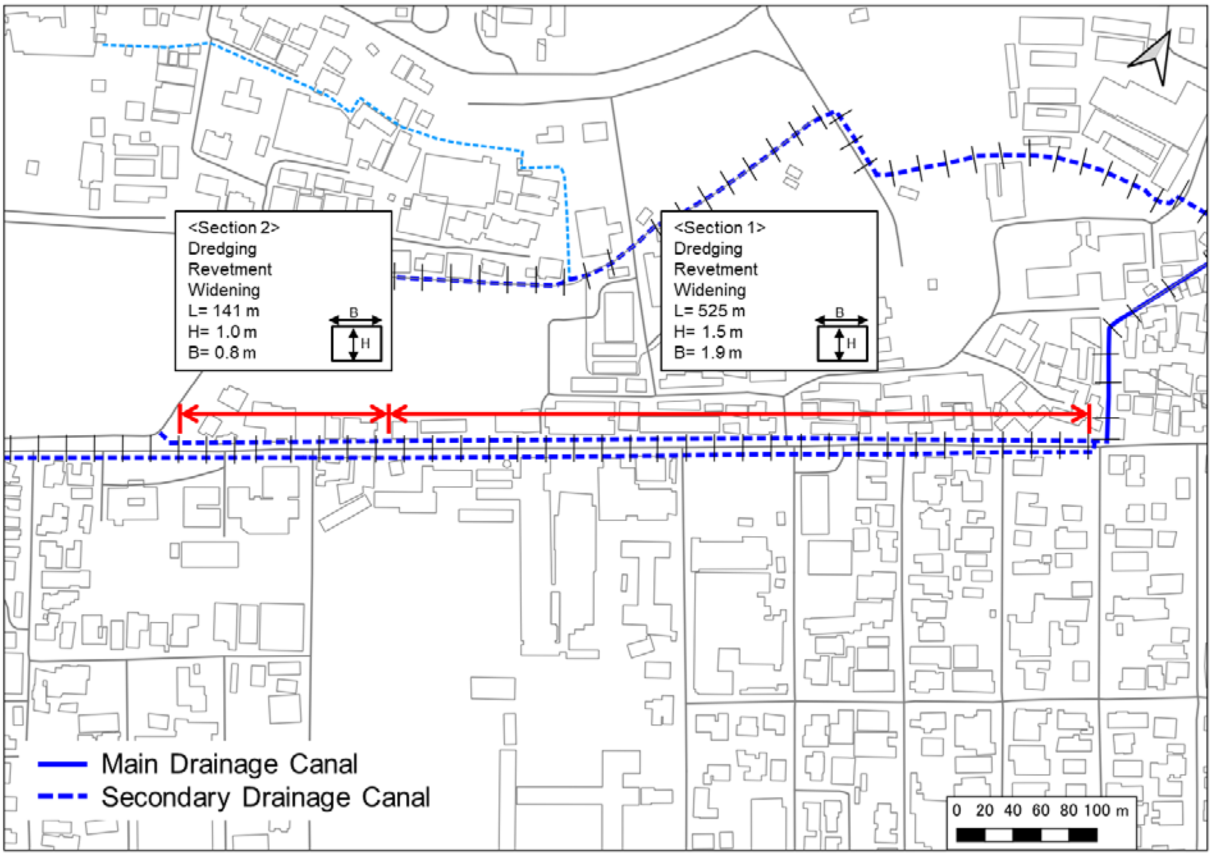
Source: JICA study team

Figure 2.3.27(2) Drainage Route and Cross Sectional Specification (Zone A/ C)



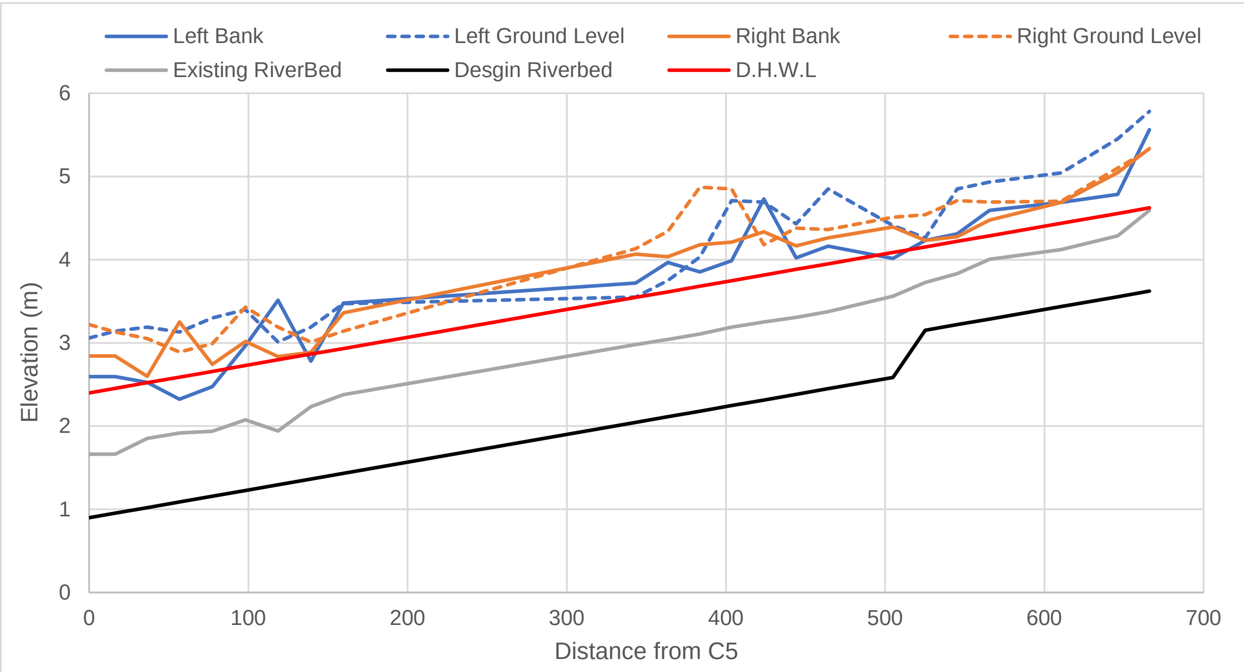
Source: JICA study team

Figure 2.3.28(2) Longitudinal Profile (Zone A/ C)



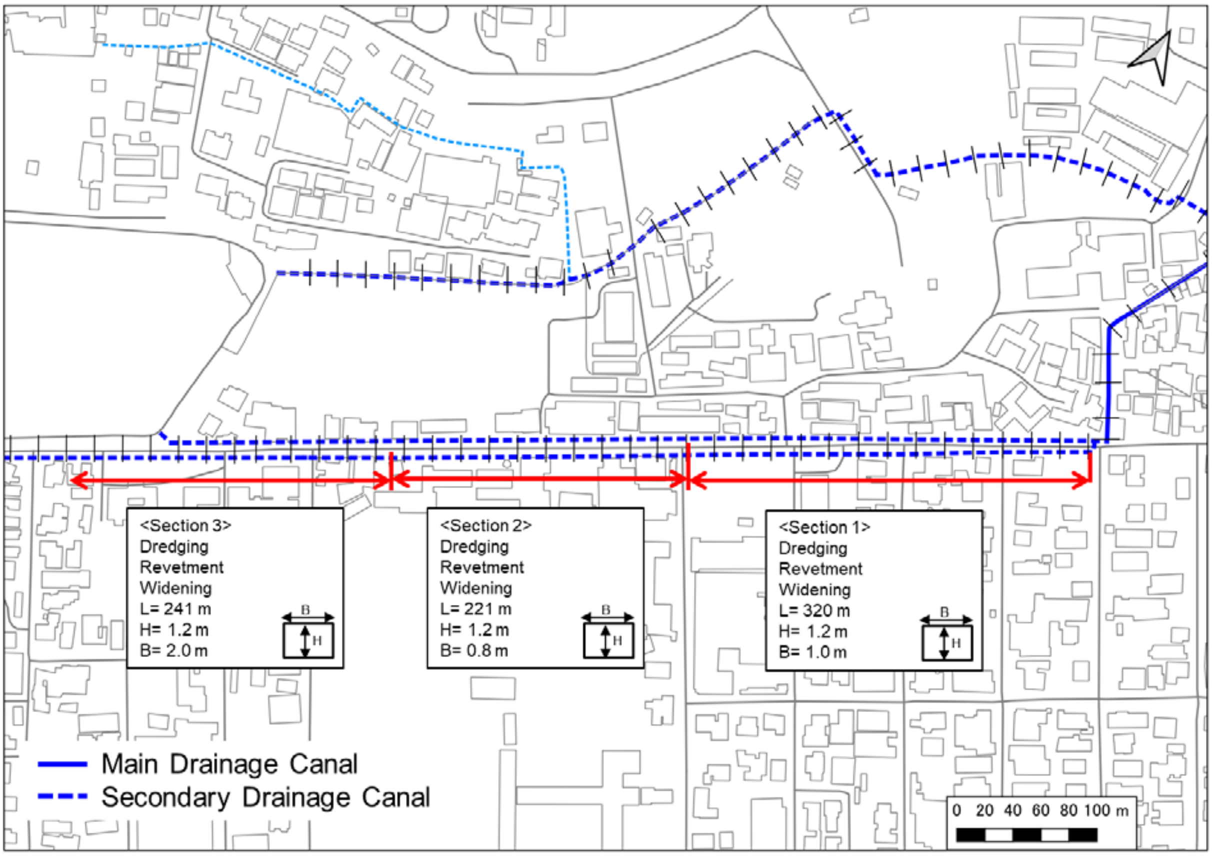
Source: JICA study team

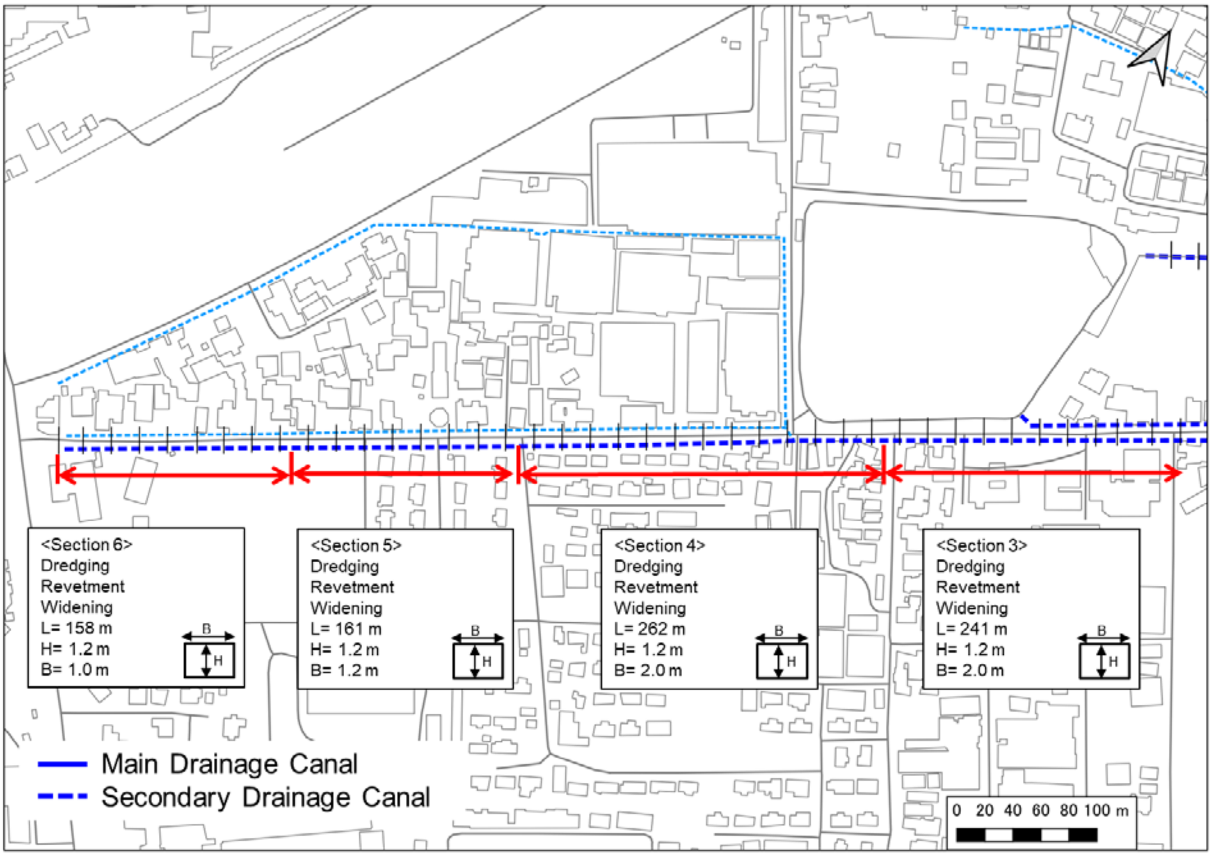
Figure 2.3.27(3) Drainage Route and Cross Sectional Specification (Zone A/ 2L-1)



Source: JICA study team

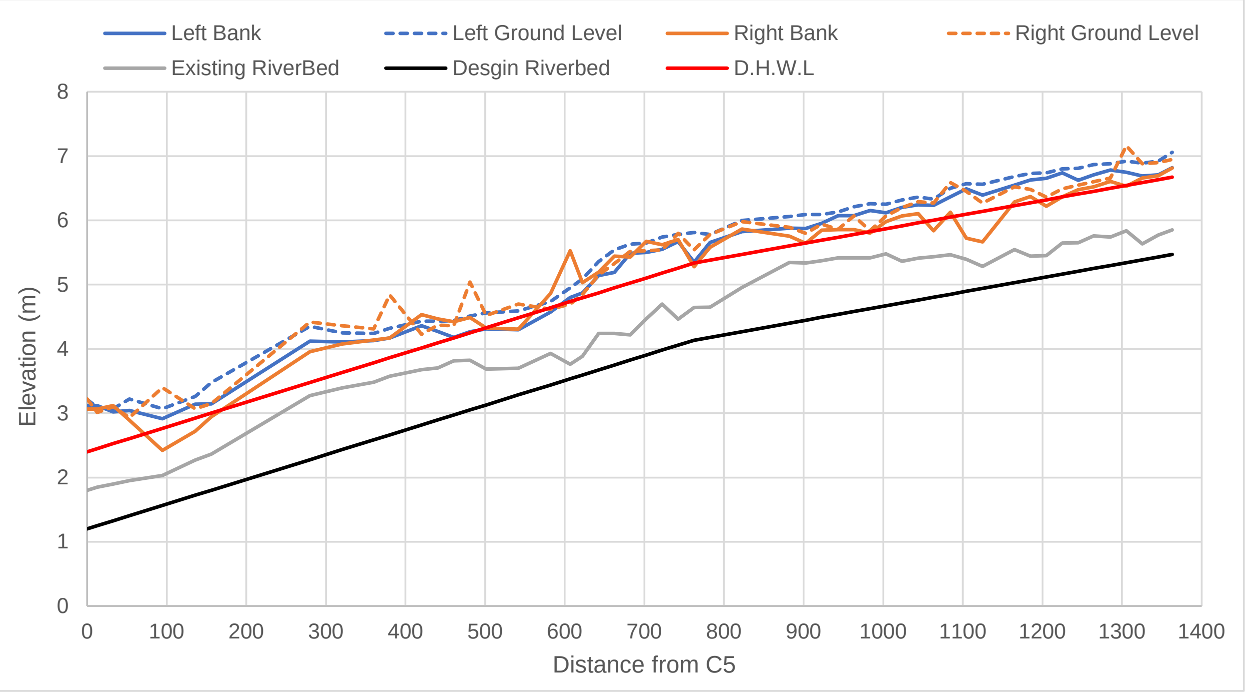
Figure 2.3.28(3) Longitudinal Profile (Zone A/ 2L-1)





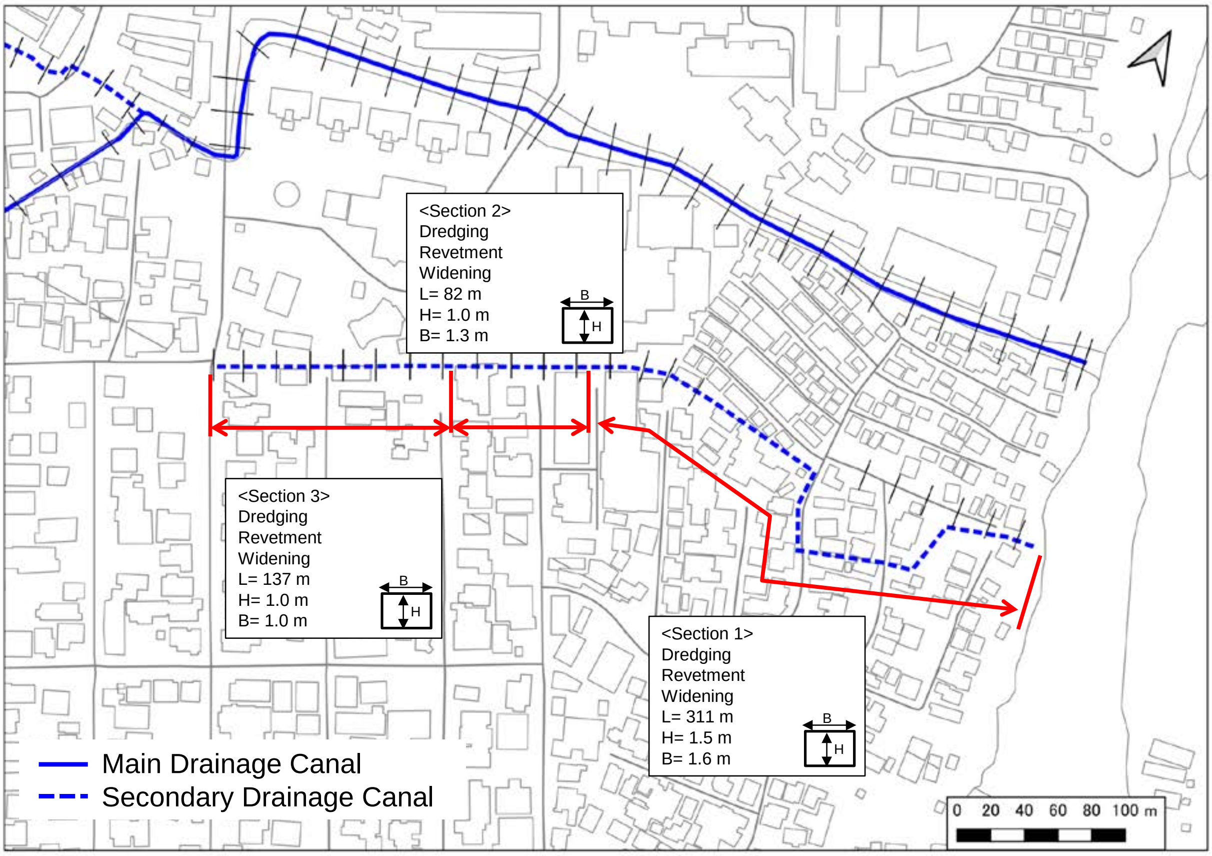
Source: JICA study team

Figure 2.3.27(4) Drainage Route and Cross Sectional Specification (Zone A/ 2R)



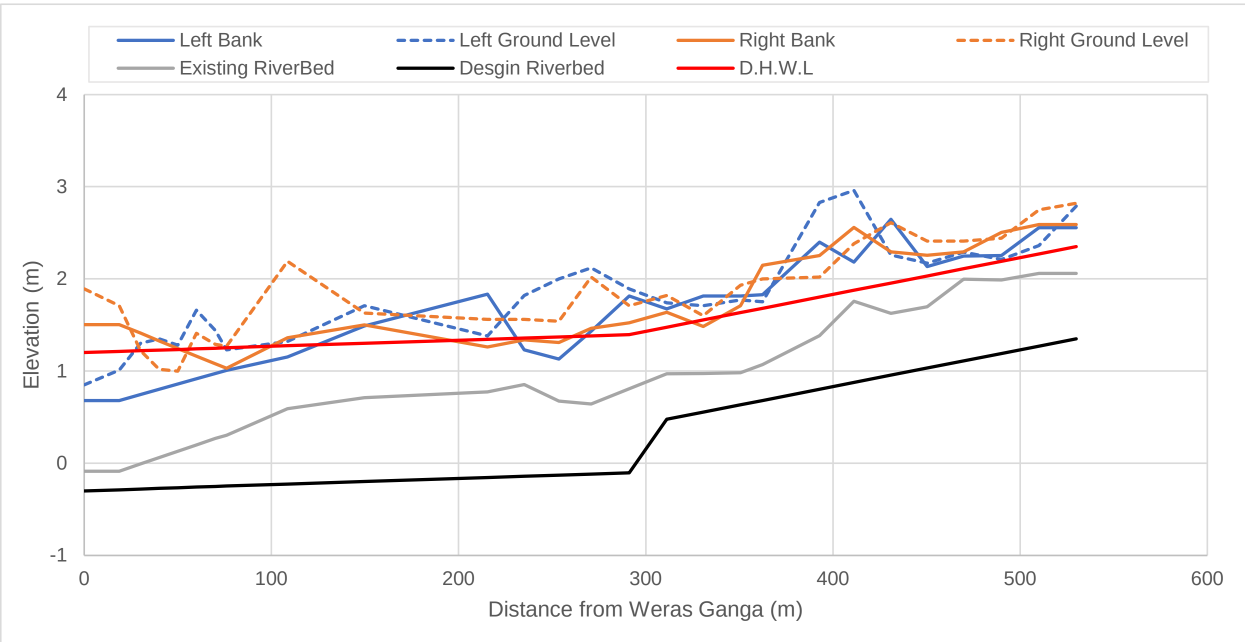
Source: JICA study team

Figure 2.3.28(4) Longitudinal Profile (Zone A/ 2R)



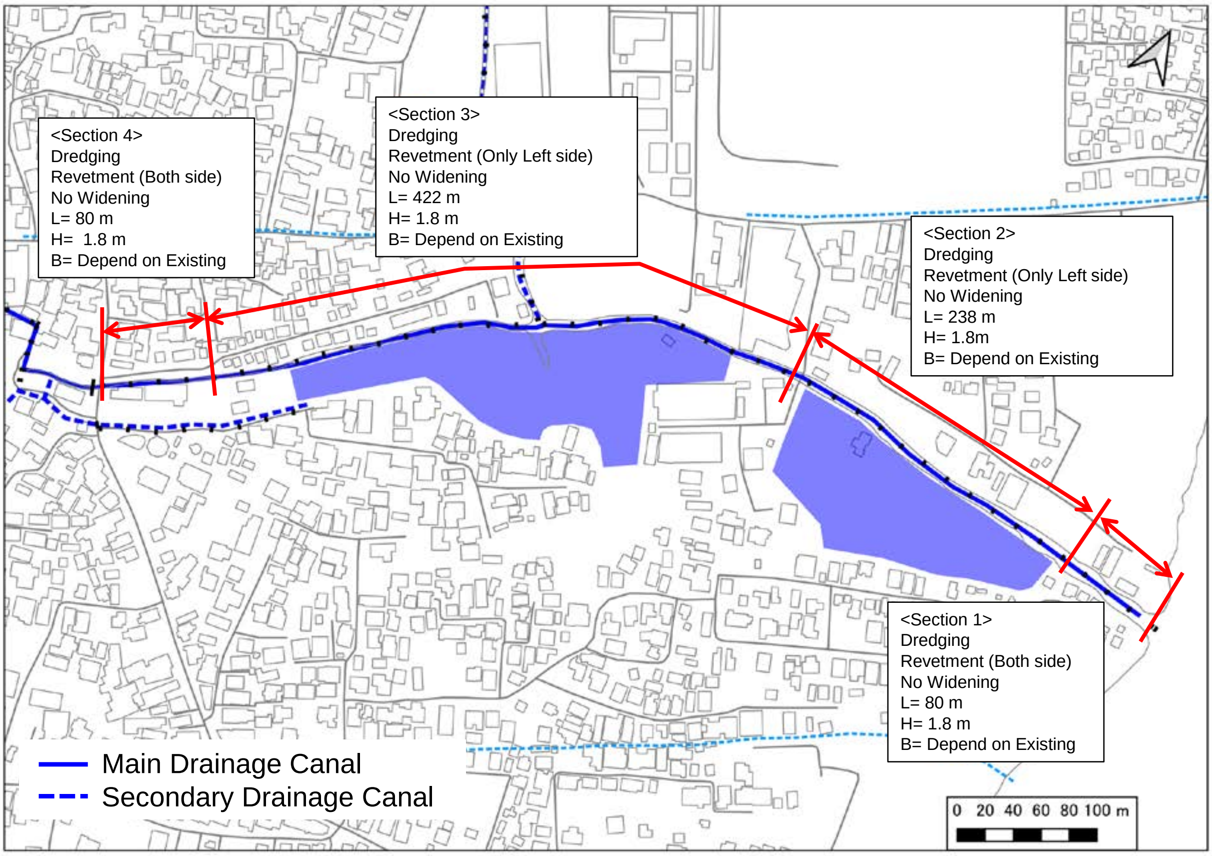
Source: JICA study team

Figure 2.3.27(5) Drainage Route and Cross Sectional Specification (Zone A/ C6)



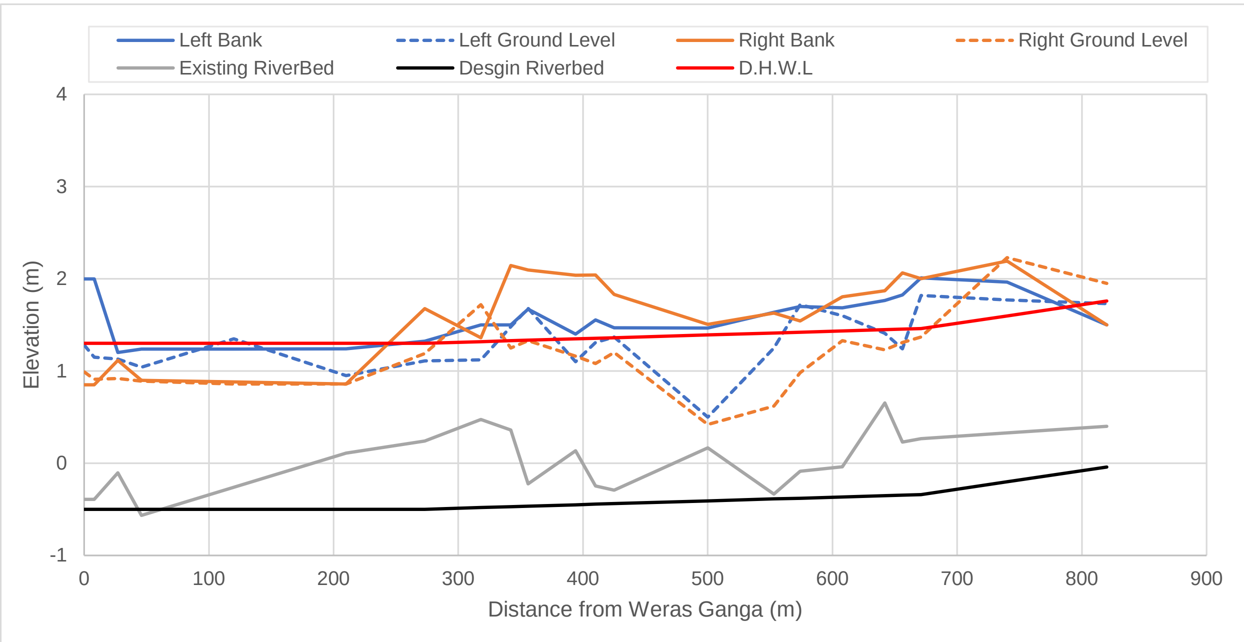
Source: JICA study team

Figure 2.3.28(5) Longitudinal Profile (Zone A/ C6)



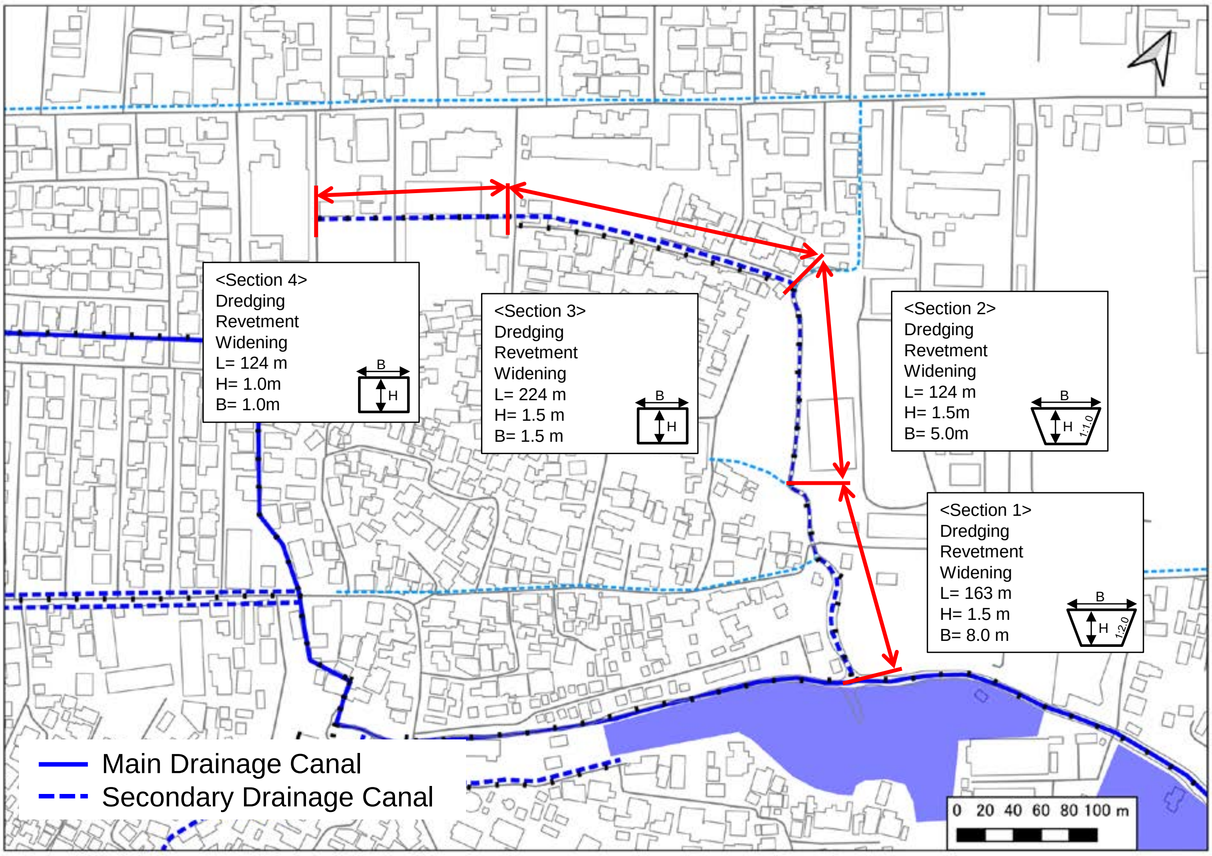
Source: JICA study team

Figure 2.3.29(1) Drainage Route and Cross Sectional Specification (Zone B/ C4)



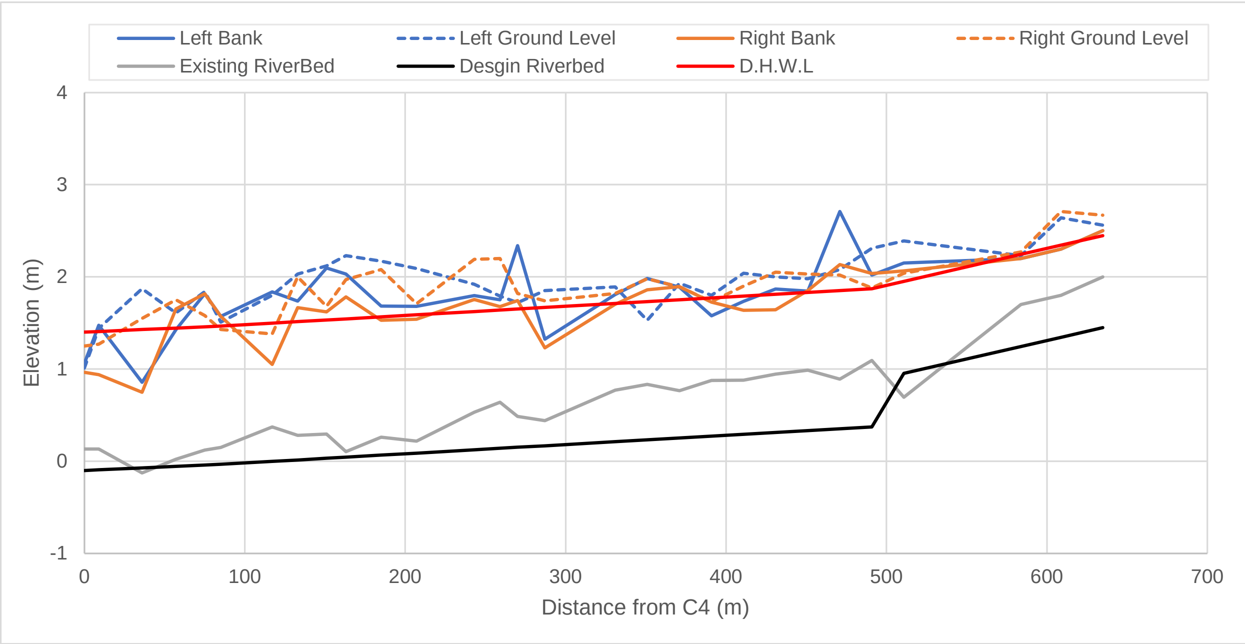
Source: JICA study team

Figure 2.3.30(1) Longitudinal Profile (Zone B/ C4)



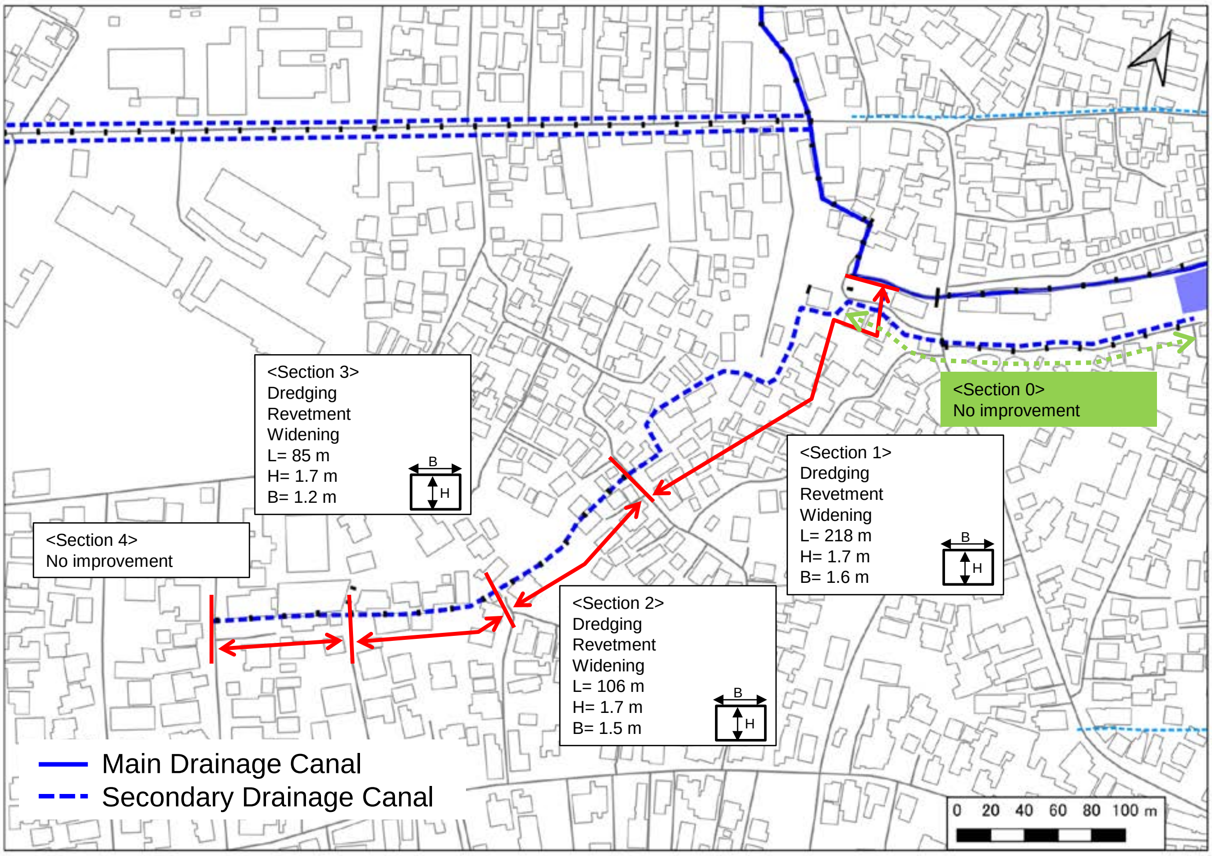
Source: JICA study team

Figure 2.3.29(2) Drainage Route and Cross Sectional Specification (Zone B/ C2B2)



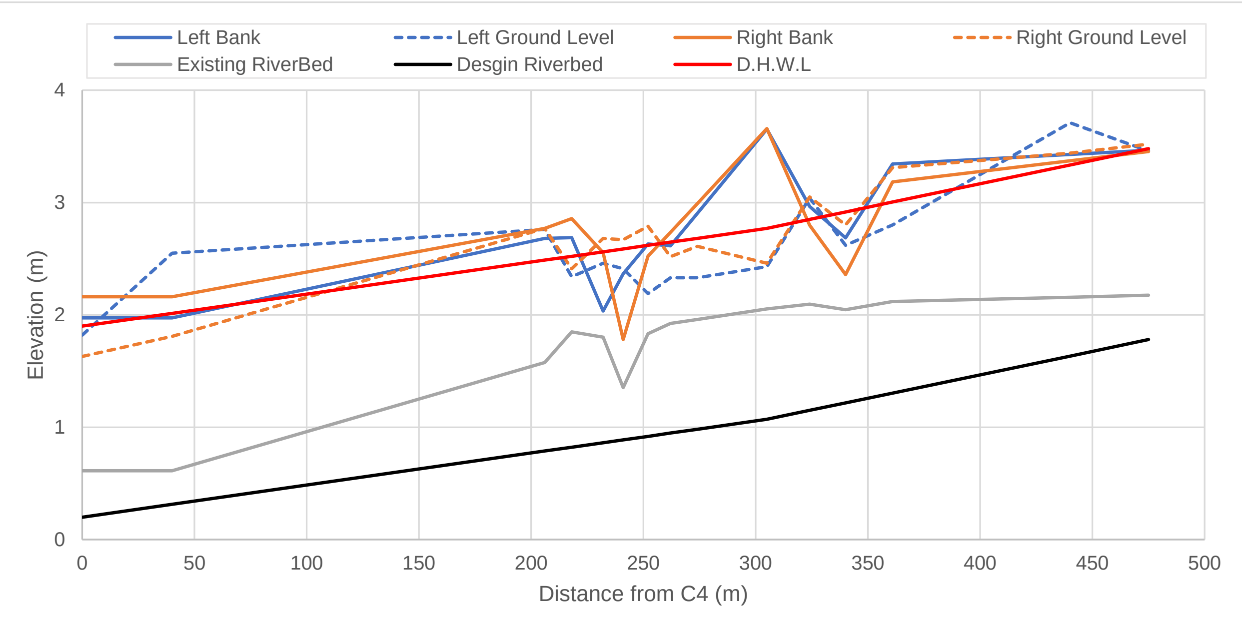
Source: JICA study team

Figure 2.3.30(2) Longitudinal Profile (Zone B/ C2B2)



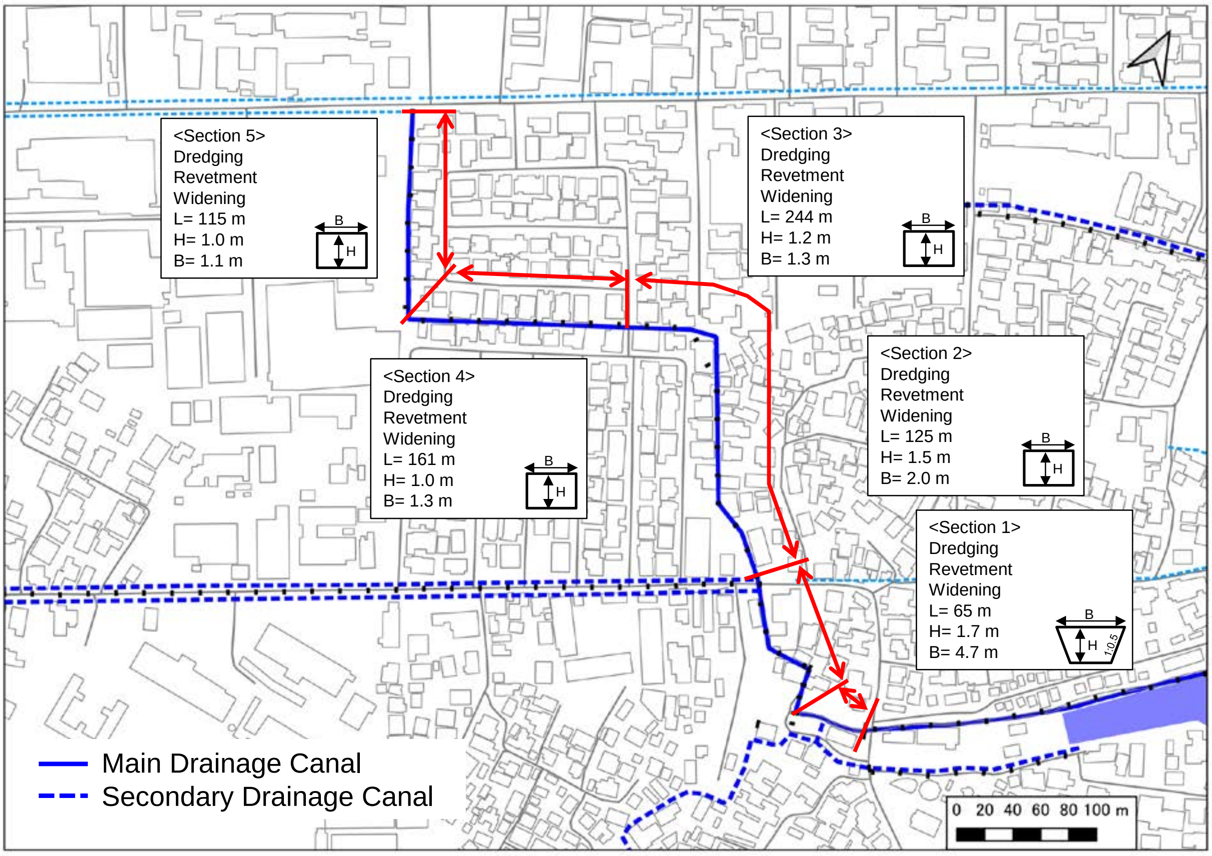
Source: JICA study team

Figure 2.3.29(3) Drainage Route and Cross Sectional Specification (Zone B/ C5)



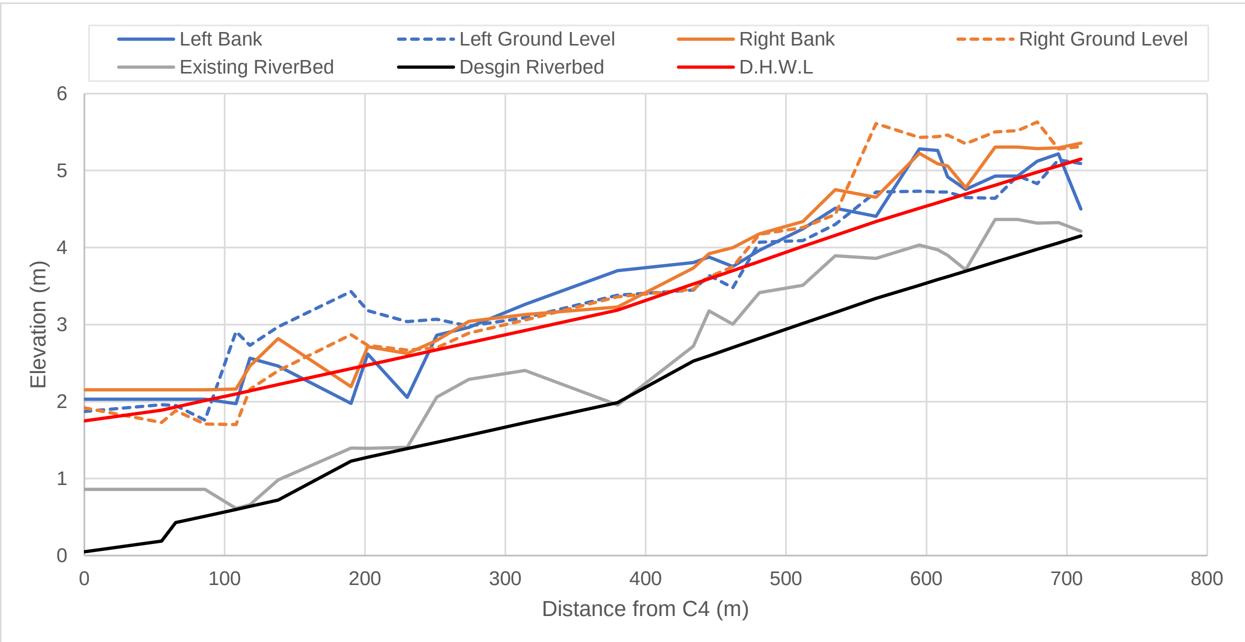
Source: JICA study team

Figure 2.3.30(3) Longitudinal Profile (Zone B/ C5)



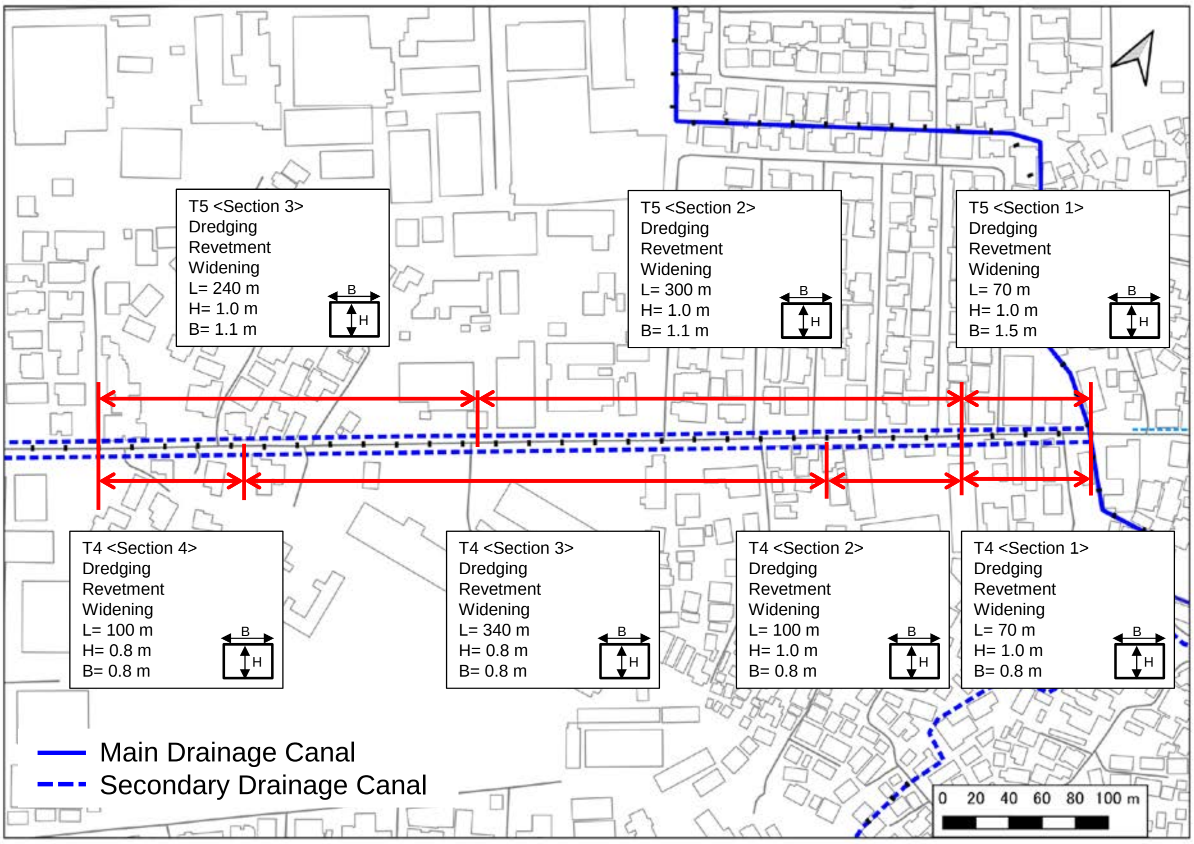
Source: JICA study team

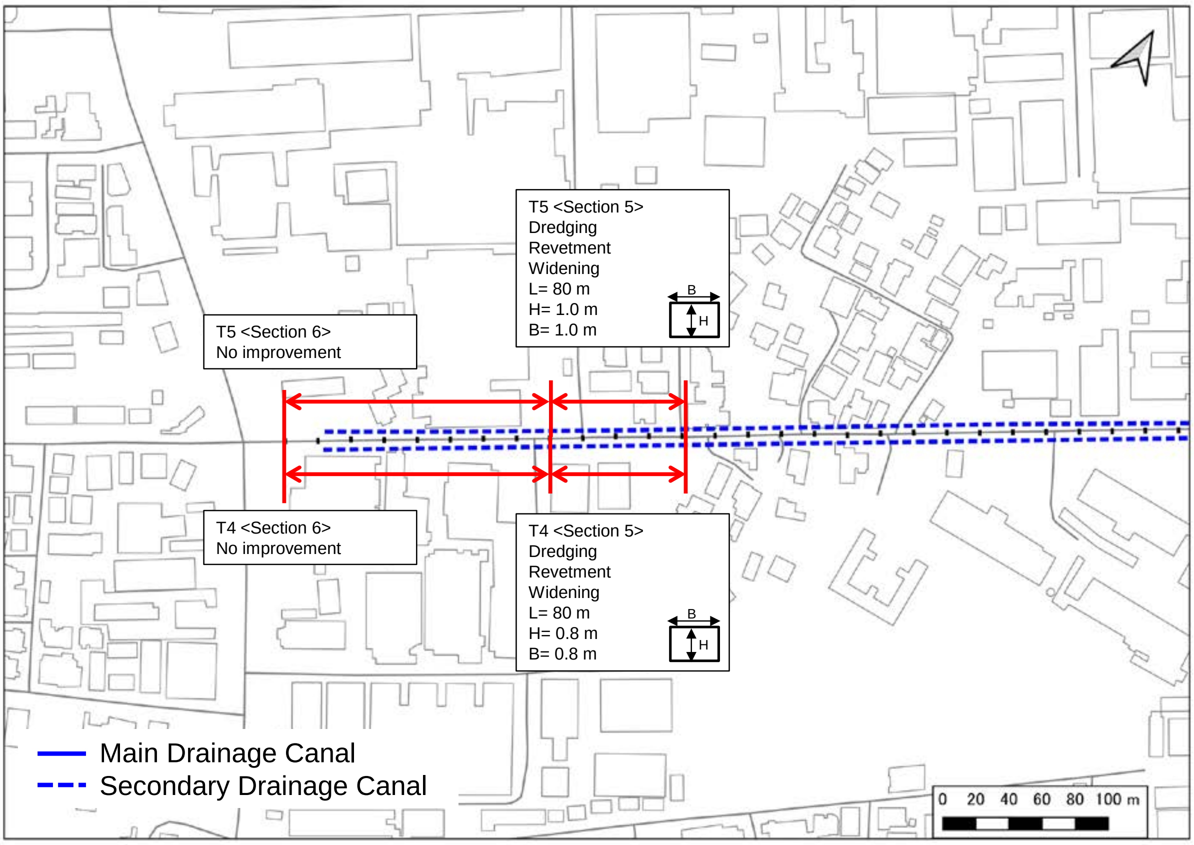
Figure 2.3.29(4) Drainage Route and Cross Sectional Specification (Zone B/ B1)



Source: JICA study team

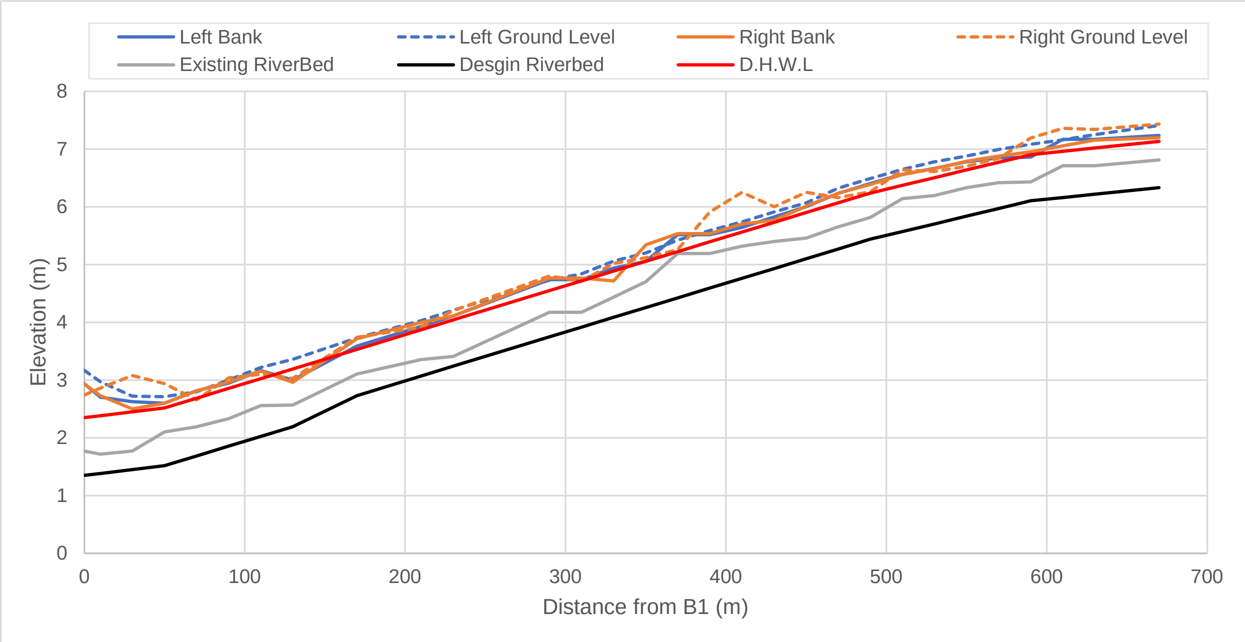
Figure 2.3.30(4) Longitudinal Profile (Zone B/ B1)





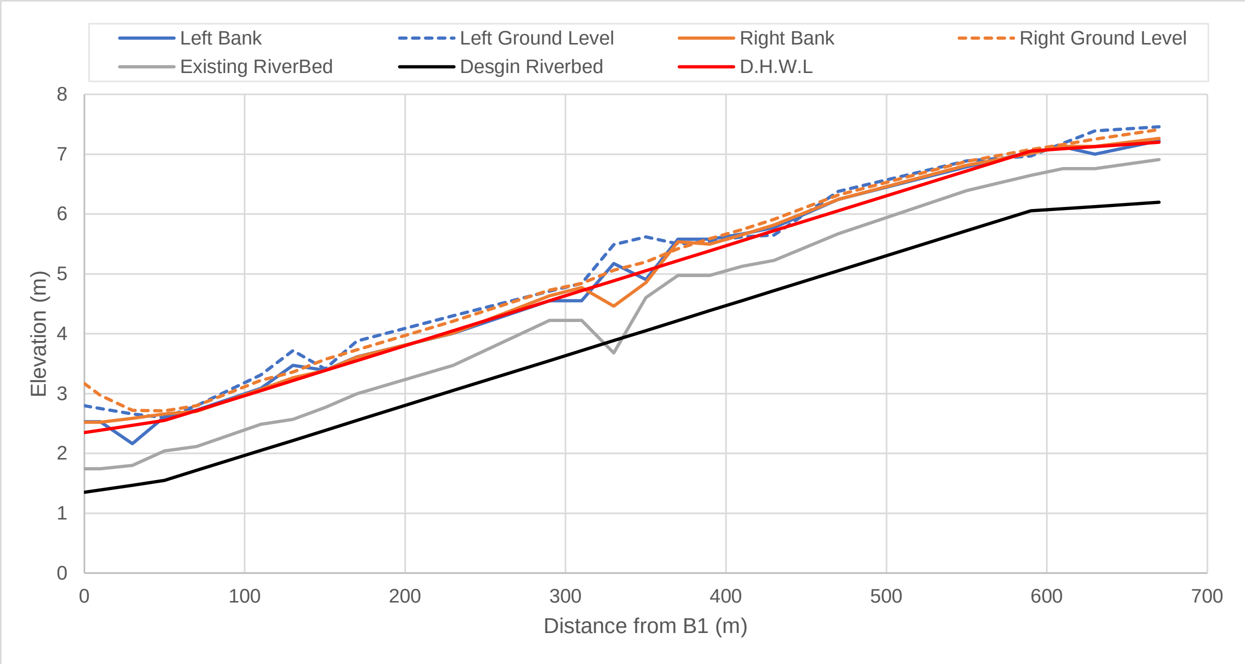
Source: JICA study team

Figure 2.3.29(5) Drainage Route and Cross Sectional Specification (Zone B/ T4T5)



Source: JICA study team

Figure 2.3.30(5) Longitudinal Profile (Zone B/ T4)



Source: JICA study team

Figure 2.3.30(6) Longitudinal Profile (Zone B/ T5)

CHAPTER 3 PRELIMINARY DESIGN

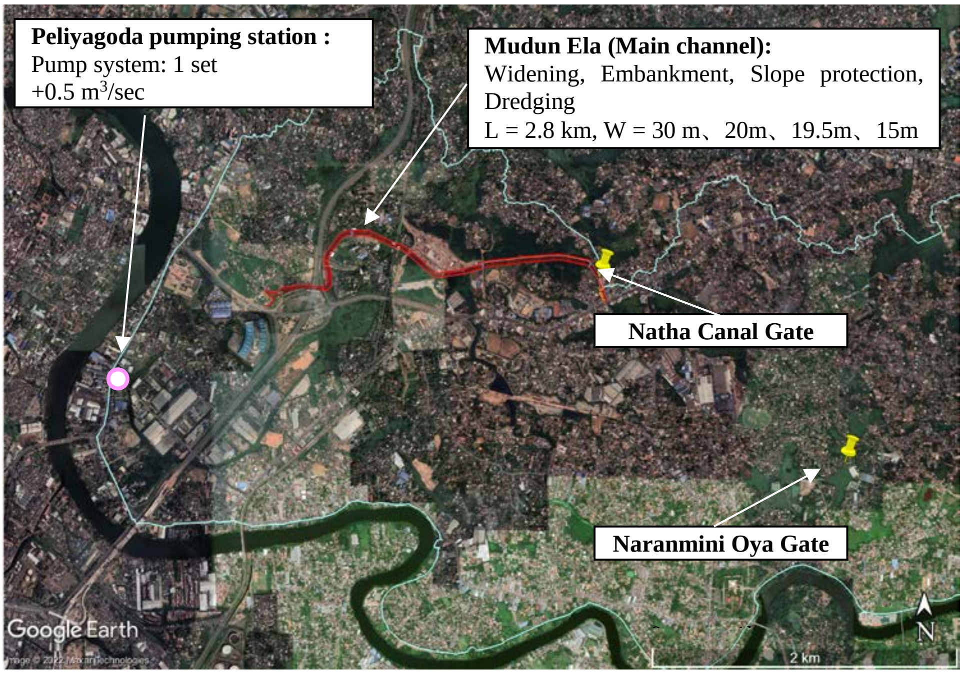
3.1 UPDATED LAYOUT OF THE PRIORITY PROJECTS BY THE HYDROLOGICAL AND HYDRAULIC ANALYSES

Table 3.1.1, Figure 3.1.1 and Figure 3.1.2 show the layout plan concept and layout of the priority projects reviewed in the hydrological and hydraulic analyses in Chapter 2.

Table 3.1.1 Layout Plan Concept and Layout of the Priority Projects

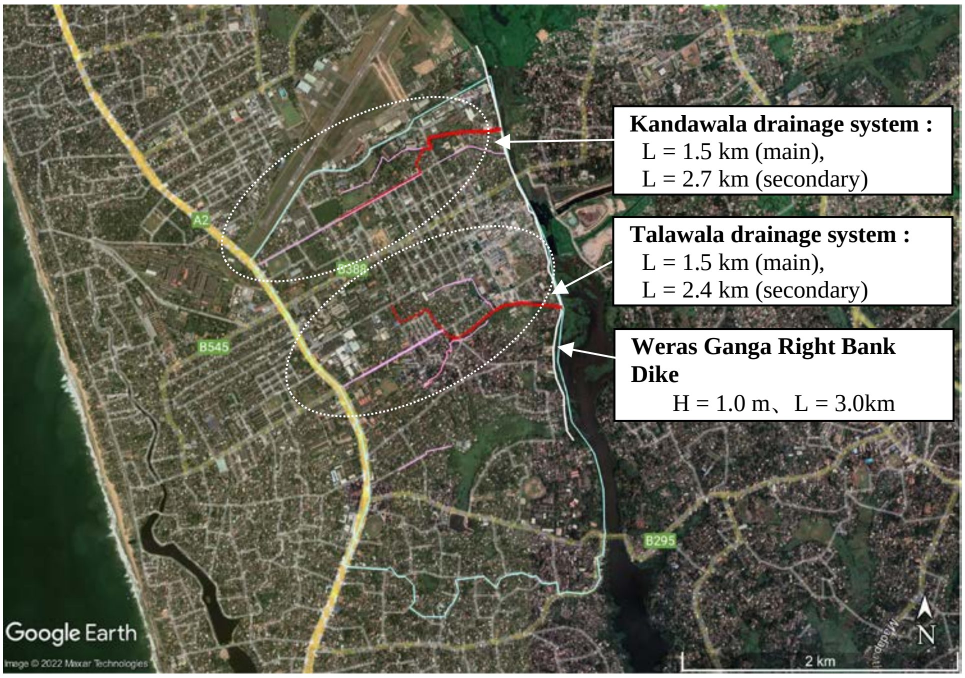
項目	Mudun Ela Sub-basin	Moratuwa-Rathmalana Area
Summary of the priority project component	[Channel improvement] ・ Connecting existing channels at the mainstream of Mudun Ela basin and Oliyamulla Pumping station at the lowest end. ・ Slope protection at “1 to 0.5” in general, ”vertical” (narrow area), “1 to 2.0” (open area) ・ Channel length: 2.8 km ・ Channel width: 30 m, 20m, 19.5m, 15m [Pumping station improvement] ・ Procurement and Installation of one pumping system to increase the discharge capacity by 0.5 m^3/sec.	[Drainage canal improvement] ・ Target channel: Main and secondary drainage canals ・ U-shaped ditch (vertical) in general, gabion retaining wall (1 to 0.5), and gentle slope with turfing (1 to 2.0) were applied considering the canal width, canal height, and surrounding land use conditions. [Weras Ganga Right Bank Dike] ・ Earth dike ・ Dike Length: 3.0 km ・ Slope: 1 to 2.0
Focusing point	[Channel improvement] ・ The channel can be wide close to the highway at the lower reach. ・ Relatively wide channel width should be kept considering the future development in the middle stream. ・ The application of a steel sheet pile retaining wall should be considered to reduce the number of resettlement.	[Drainage canal improvement] ・ Since the canals run in a dense residential area, the effect on the surrounding environment such as resettlement should be considered. [Weras Ganga Right Bank Dike] ・ Since Weras Ganga is identified as Bolgoda Protection Area and partially as Bellanwila Attidiya Sanctuary, construction should avoid the water area as much as possible and attention should be paid to the surrounding environment.
Layout concept	[Channel improvement] ・ Utilization of the embankment of the highway as a river bank in the lower reach. ・ The river width of 30 m was secured in the middle reach considering future development. ・ Application of the steel sheet pile retaining wall in the dense residential area in the upper reach.	[Drainage canal improvement] ・ The original layout of the existing drainage canal is basically secured and improvement was proposed to minimize the effect on the surrounding area. [Weras Ganga Right Bank Dike] ・ Smooth alignment at the elevation of 1.0 m (above ordinary water surface level, in general), and 0.5 m at the dense residential area (to a minimum)

Source: JICA Study Team



Source: JICA Study Team

Figure 3.1.1 Layout of the Proposed Facilities in the Mudun Ela Improvement Project



Source: JICA Study Team

Figure 3.1.2 Layout of the Proposed Facilities in the Moratuwa-Rathmalana Area Drainage Project

3.2 Preliminary Design of the Drainage Facilities

Design guidelines, manuals, and specifications for the preliminary design of the drainage facilities in the Mudun Ela Improvement and Moratuwa-Rathmalana Area Drainage Improvement are listed in this section.

3.2.1 Design Guideline, Manual and Specification

3.2.1.1 Design Guideline, Manual and Specification in Sri Lanka

In Sri Lanka, there is no design guideline, manual nor specification which shows the design methods or standard cross-sections of structure measures. However, there are some specifications describing engineering works such as survey works and execution of construction works. Table 3.2.1 shows the collected specifications for engineering works.

Table 3.2.1 Engineering Work Specification in Sri Lanka

No.	Title of Specification	Description	Compiler/Publisher and Issued/Revised month
1	Specifications for site investigation for building and civil engineering works	Specifications for the site investigation such as boreholes, test pits, soil and rock sampling, in-situ tests, and laboratory tests are described. The sample format for the preliminary borehole log is also shown.	Construction Industry Development Authority (CIDA) January 2017
2	Specifications for irrigation and land drainage works	Specifications for general irrigation and drainage construction works and repair works including temporary works such as dewatering are explained. Those include general information on structures, and of the works, material requirements, and work methods.	CIDA May 2013
3	Specifications for water supply sewerage and storm water drainage works	Specifications for sewerage and storm water drainage construction works are explained. Those include concrete works, pipes, pumps, coatings, building works, treatment plans, electrical works, and so on.	CIDA April 2002
4	Specifications for bored and cast-in-situ reinforced concrete piles	Specifications for reinforced piling works are explained. Those include site conditions, material requirements, work methods, and pile testing.	CIDA February 2016
5	Standard specifications for construction and maintenance of roads and bridges	Specifications for road and bridge construction/maintenance work are explained. Those include site clearing, earthworks, surfacing, road construction, bridge construction, and those maintenance works.	CIDA June 2009
6	Specifications for coastal and harbor engineering works	Specifications for general coastal and harbor works are explained. Those include required surveys and investigations for construction, material requirement, and work methods for concrete/steel piles, reclamation, dredging, and revetments. This specification also includes the one for the operation of quarries.	CIDA June 2008

Source: JICA Study Team

3.2.1.2 Design Guideline, Manual and Specification in Japan

Guidelines and manuals which can be referred to for designing structures are shown in Table 3.2.2.

Table 3.2.2 Design and Engineering Work Specification in Japan

No.	Title of Specification	Description	Compiler/Publisher and Issued/Revised month
1	Manual for Government Ordinance for Structural Standard for River Administration Facilities	This structural government ordinance following the river law is a technical standard required for planning and designing the river structures such as dams, embankments and other major facilities, and the river maintenance aiming at the conservation of the environment.	Japan River Association January 2000
2	Technical Criteria for River Works and those practical guides (Survey, Planning, and Design)	This standard is compiled for the technical issues required to survey, plan, design structures and maintain rivers, slopes and seashores.	Japan River Association June 2012 (Survey) March 2019 (Planning) July 2019 (Design)
3	Guideline for Structural Analysis on River Dike	This guideline explains concepts and design methods for dike reinforcement. Seepage, erosion and earthquake were introduced as external factors influencing the safety of the dikes.	Japan Institute of Construction Engineering February 2012
4	Manual for Mechanical Design of Revetment	The concept of the design method of revetment is explained.	Japan Institute of Construction Engineering November 2007
5	Basic Guideline and Policy for Disaster Rehabilitation to maintain the beauty of mountains and rivers	This guideline and policy describe the general steps of disaster rehabilitation in consideration of the natural environment.	Ministry of Land, Infrastructure and Transport June 2018

Source: JICA Study Team

3.2.2 Design Criteria

As mentioned below, there is no design guideline, manual nor specification for designing river or drainage structures in Sri Lanka. Those structures are generally proposed based on engineers' experiences and confirmed with stability calculations. This clause describes the general design concept of a dike and a revetment of river and drainage structure in Sri Lanka and defines the design concept which is applied in this study.

3.2.2.1 Dike Height

Dike height is the one at a design high water level heightened with a freeboard as specified in the M/P.

3.2.2.2 Freeboard

In the Mudun Ela basin, as specified in the M/P, the design water levels are set around the elevation of the protected ground area. Due to this, the larger the freeboards are, the higher the risks at the lower reaches caused by the flood exceeding the design level. Hence, in this study, the freeboard is set at 0.5 m, which is generally applied in SLLDC although it is smaller than the value in the government ordinance in Japan.

Table 3.2.3 Design Flood Discharge and Freeboard

Design Discharge (m^3/s)	Freeboard (m)
Less than 200	0.6
Equal or above 200 and less than 500	0.8
Equal or above 500 and less than 2,000	1.0
Equal or above 2,000 and less than 5,000	1.2

Source: Government Ordinance for Structural Standard for River Administration Facilities

In the Moratuwa-Rathmalana area, the sizes of the drainage canals are much smaller than the ordinary rivers, and as in the Mudun Ela basin, the design water levels are set around the ground elevation. Hence, no freeboard was designed for the drainage canal in the Moratuwa-Rathmalana area.

3.2.2.3 Crown Width

In the Mudun Ela basin, referring to the government ordinance in Japan, and considering maintenance operation from the top of the crest, the crest width with a maintenance road of 3 m is set at 4 m. It is noted that there is an exceptional case of the crest width of 1.0 m with steel sheet pile retaining wall at the places where factories, etc. are adjacent to river channels and land cannot be secured widely.

Table 3.2.4 Design Flood Discharge and Minimum Crown Width

Design Flood Discharge (m3/s)	Minimum Crown Width (m)
Less than 500	3
Equal or above 500 and less than 2,000	4
Equal or above 2,000 and less than 5,000	5
Equal or above 5,000 and less than 10,000	6
above 10,000	7

Source: Government Ordinance for Structural Standard for Administration Facilities

The Weras Ganga right bank dike in the Moratuwa-Rathmalana area is designed along the Weras Ganga. Although it is located very close to the water surface of the river, the crest width with a pedestrian road of 2 m is set at 3 m considering the influence on the surrounding houses and residents.

For the drainage improvement in the Moratuwa-Rathmalana area, since the size of the drainage canals are much smaller than the ordinary rivers and those run in the dense residential area, the government ordinance in Japan was not applied and the crest widths were set at 3 m, 1 m or zero reflecting the surrounding land use,

3.2.2.4 Slope

As specified in the M/P, the slope protected by gabions is set at “1 to 0.5” and the one for embankments is to be “1 to 2.0.” Considering ease of procurement and experience of construction in Sri Lanka, the most used PVC coated gabion wire with a diameter of approximately 3 mm including PVC coat is applied for designing gabions.

3.2.2.5 Berm

In the M/P, the berm with a width of 3 m was designed for the revetment whose height is over 5 m. However, since the height of the slope is less than 5m in the Pre-F/S, no berm was applied.

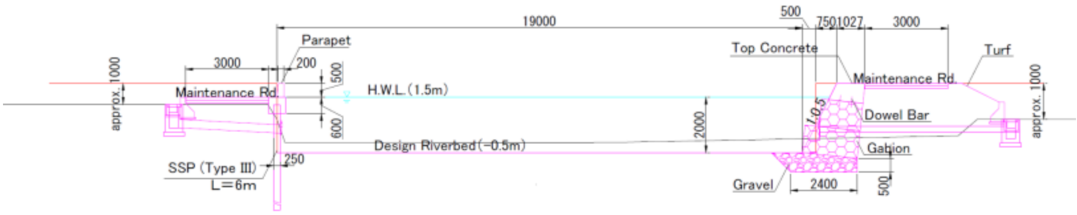
3.2.2.6 Design Seismic Coefficient

There is no design seismic coefficient since there is less earthquake in Sri Lanka.

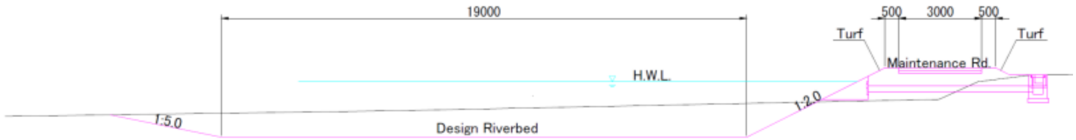
3.2.3 Preliminary Design

3.2.3.1 Standard Cross section in the Mudun Ela Sub-basin

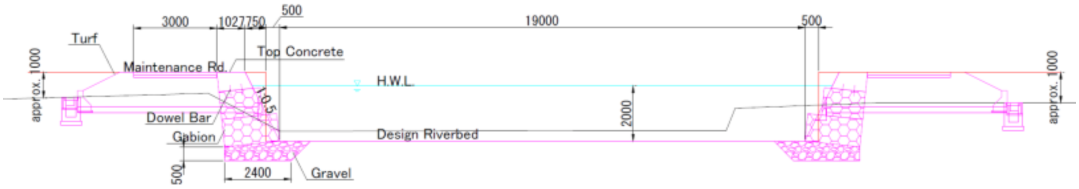
The standard cross sections for the Mudun Ela basin channel improvement are shown in Figure 3.2.1 and Figure 3.2.2.



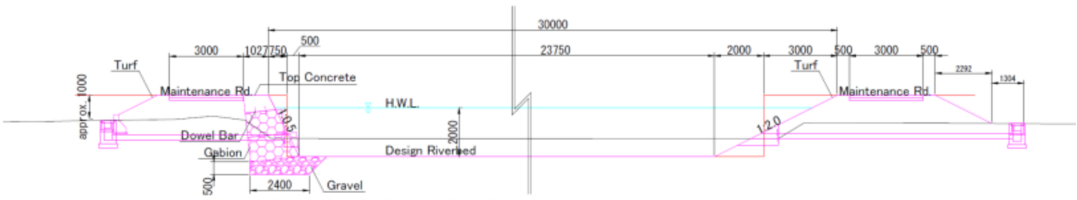
Standard Cross Section between 0+000 to 0+045



Standard Cross Section between 0+045 to 0+270



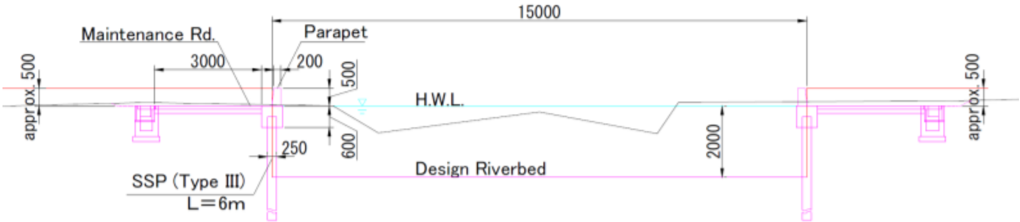
Standard Cross Section between 0+270 to 1+833 (Left bank starts at 0+380)



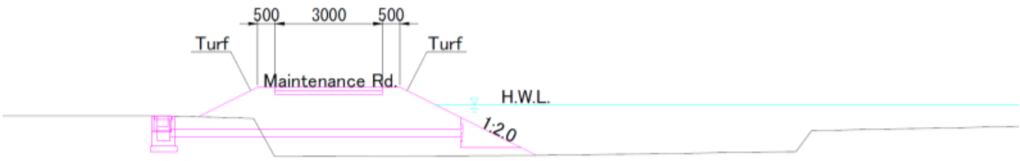
Standard Cross Section between 1+833 to 2+544

Source: JICA Study Team

Figure 3.2.1 Standard Cross Sections in Mudun Ela (1)



Standard Cross Section between 2+544 to 2+816



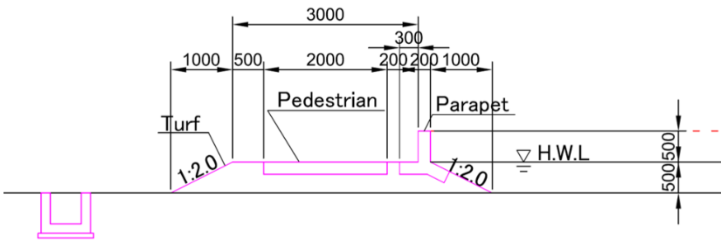
Standard Cross Section between at Left Bank, for 120m

Source: JICA Study Team

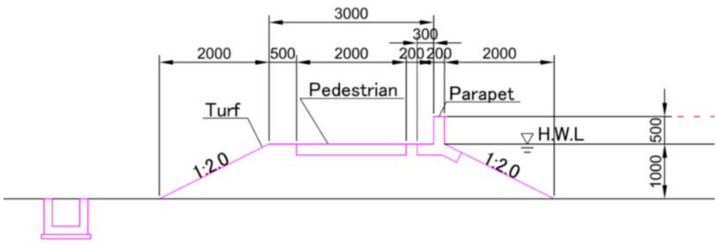
Figure 3.2.2 Standard Cross Sections in Mudun Ela (2)

3.2.3.2 Standard Cross Section of the Weras Ganga Right Bank Dike in the Moratuwa-Rathmalana Area

The earth embankment with a slope of "1 to 2.0" covered by turf is proposed for the Weras Ganga right bank dike. A concrete parapet covers the freeboard of 0.5 m. The crest width with a pedestrian road of 2 m is set at 3 m considering the influence on the surrounding houses and residents. Basically, the dike is located at the ground level of 1.0 m, or 0.5 m around the dense residential areas. The standard cross sections of the dike are shown in Figure 3.2.3.



(a) at the elevation of 1.0 m



(b) at the elevation of 0.5 m

Source: JICA Study Team

Figure 3.2.3 Typical Cross Sections of Weras Ganga Right Bank Dike

3.2.3.3 Standard Cross Section of the Drainage Canals in the Moratuwa-Rathmalana Area

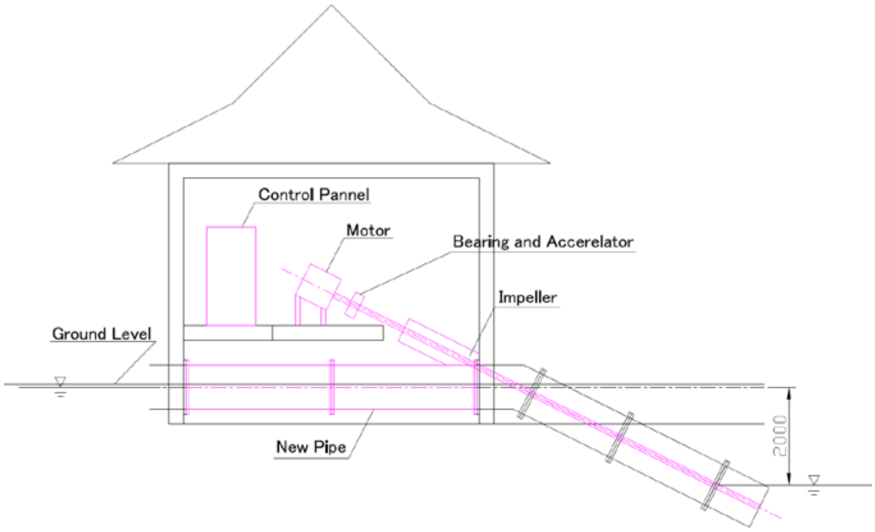
The U-shaped ditches are basically proposed for the improvement of drainage canals in the Moratuwa-Rathmalana area. Gabion walls, steel sheet pile walls and gentle slopes covered with turf are also proposed depending on the surrounding land use. The total number of the standard cross sections of the eleven drainage canals in the Moratuwa-Rathmalana area are shown in the appendix.

3.2.3.4 Pumping Station

At the Peliyagoda Pumping Station, a new pump with a discharge capacity of 1.0 m^3/sec and its equipment will be installed at the empty lot (refer to Photo 3.2.1). The type of this new pumping system is, as the existing one, an inclined screw pump. Although the existing pumping system with its discharge capacity of 0.5 m^3/sec will not be removed and be kept in operation, the total discharge is considered as 1.0 m^3/sec to be safe side.

Source: JICA Study Team

Photo 3.2.1 Existing Condition and Empty Lot at Peliyagoda Pumping Station



Source: JICA Study Team

Figure 3.2.4 Layout of New Pumping System

3.2.3.5 Closing Facility

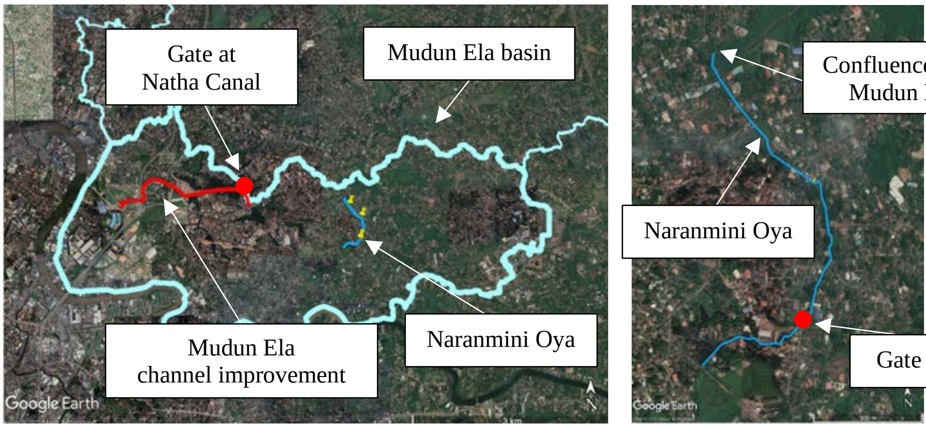
As proposed in the M/P, closing facilities, a sluice gates are proposed at Naranmini Oya and Natha Canal. The specification of the gate is shown in Table 3.2.5. The proposed installation location is shown in Figure 3.2.5.

Regarding the gate at Naranmini Oya, it can be installed at another location along Naranmini Oya depending on the development situation at the detailed design stage.

Table 3.2.5 Specification of the Gate at Natha Canal and Naranmini Oya

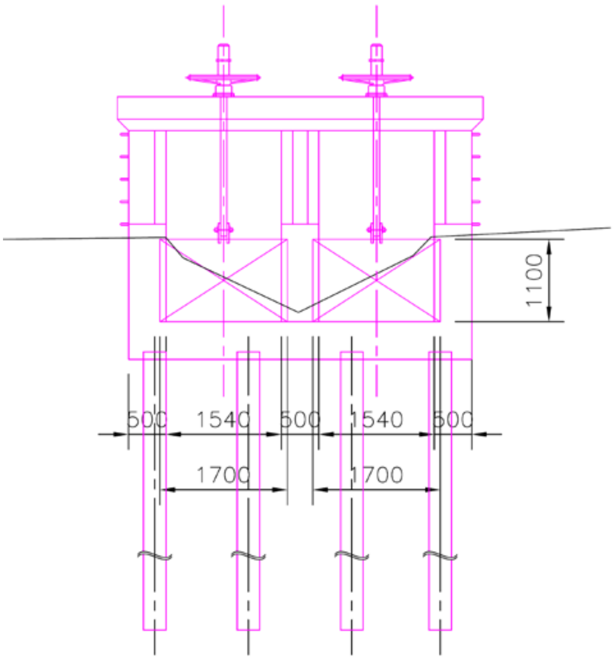
No.	Channel	Gate type	Specification
1	Naranmini Oya	Slide gate	H = 1.1 m W = 1.7 m x 2 gates
2	Natha Canal	Slide gate	H = 1.5 m W = 2.5 m x 4 gates

Source: JICA Study Team



Source: JICA Study Team

Figure 3.2.5 Layout of Gates at Naranmini Oya and Natha Canal



Source: JICA Study Team

Figure 3.2.6 Concept Design of Naranmini Oya Gate

CHAPTER 4 PROCUREMENT AND CONSTRUCTION PLAN

4.1 Summary of the Project Scope

Table 4.1.1 shows the drainage facilities to be constructed as priority projects in the Mudun Ela Sub-basin, the Weras Ganga Right Bank, and the Moratuwa-Rathmalana area.

Table 4.1.1 Project Summary for the Priority Project

Basin / Area	Features of the Drainage Facilities
Mudun Ela	**Improvement of Drain:** - Improvement of Main channel in Mudun Ela, Length: 2,816 m **Replacement of the Bridge:** - At the Main channel in Mudun Ela: 3 bridges **Improvement of the Pumping Station:** - Expansion: 0.5 m^3/s (Existing 0.5 m^3/s, Expansion to 1.0 m^3/s) **Installation of the gate:** - At the Naranmini Oya secondary drain - Natha Canal
Weras Ganga Right Bank	**Weras Ganga Right Bank:** - 3 km, height: 0.5m、Embankment of 1.0m height with a parapet of 0.5m
Moratuwa-Rathmalana	**Improvement of Drain:** - Kandawala Drain: 141 ha (Catchment Basin), Main channel: 1,506 m、Secondary Drain 2,653 m - Talawala Drain: 217ha (Catchment Basin), Main channel: 1,530 m、Secondary Drain: 2,424 m

Source: JICA Study Team

4.2 Construction Plan

4.2.1 Condition for the Formulation of the Construction Plan

4.2.1.1 Geographical Condition

The Mudun Ela sub-basin is located in the suburbs within a 30-minute drive northeast of Colombo city center, and it is the starting point of the highway connecting Bandaranaike International Airport and Colombo. The area is located in the lower reaches of the Kelani Ganga, and it is a low-lying area with an elevation of 0 m to 2 m along the coast. The Moratuwa-Rathmalana area is also located about an hour's drive south of Colombo city center, and it is along the main highway connecting Galle and Colombo. The basin is surrounded on three sides by water: the Indian Ocean to the west, Bolgoda Lake to the south, and Weras Ganga to the east. The area is likely to be the Mudun Ela sub-basin, it is a low-lying area with an elevation of 0 m to 2 m along the coast, with wetlands in the vicinity of Weras Ganga.

4.2.1.2 Climate Condition

The Colombo area, the target area of the Project, is classified as a tropical rainforest climate, with a rainy season from April to June and from October to November, when monthly rainfall is high. Temperature varies from 23°C to 32°C, and rarely exceeds this range throughout the year. The average monthly precipitation in the Colombo and Rathmalana area is shown below.

Table 4.2.1 Average Monthly Precipitation (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
CMB	78	98	128	261	315	179	72	107	258	369	316	193	2,374
RTN	53	65	131	230	331	208	63	103	262	448	323	206	2,424

Note CMB: Colombo、RTN: Rathmalana
Source: Colombo Weather Station

4.2.1.3 Workable Days

The number of workable days in a year was calculated from the weather conditions based on rainfall records at the target sites during the period 2011-2018, and the total days of Sundays and holidays in Sri Lanka. Table 4.2.2 shows the number of days of rainfall for each month, assuming that rainfall of 10 mm/day or more is a day when construction is suspended. Under these conditions, the number of workable days was calculated as shown in Table 4.2.3.

Table 4.2.2 Rainfall days of 10mm/day or more

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2	3	4	7	8	6	2	3	7	9	9	5	65

Source: JICA Study Team

Table 4.2.3 Workable Days

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
23	19	23	19	20	22	24	24	21	20	20	22	21

Source: JICA Study Team

4.2.2 Construction Method

4.2.2.1 Mudun Ela Sub-basin

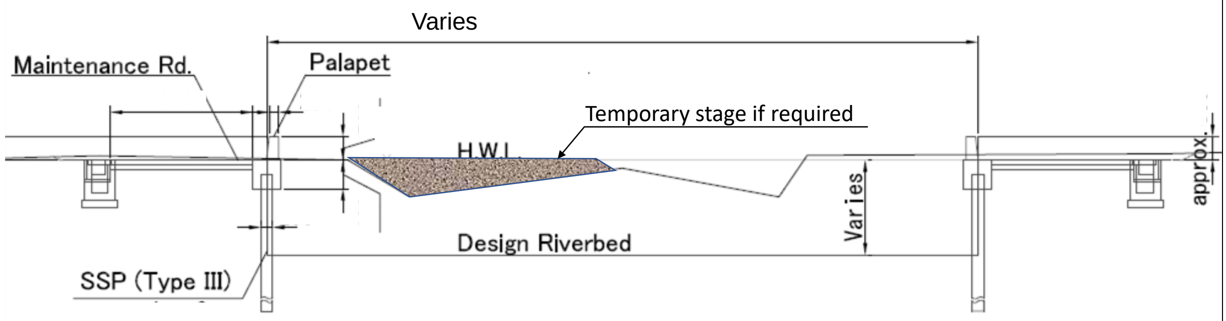
The slope protection works for the drains in the Mudun Ela sub-basin have three types as shown in the following table. The construction method for each is shown below.

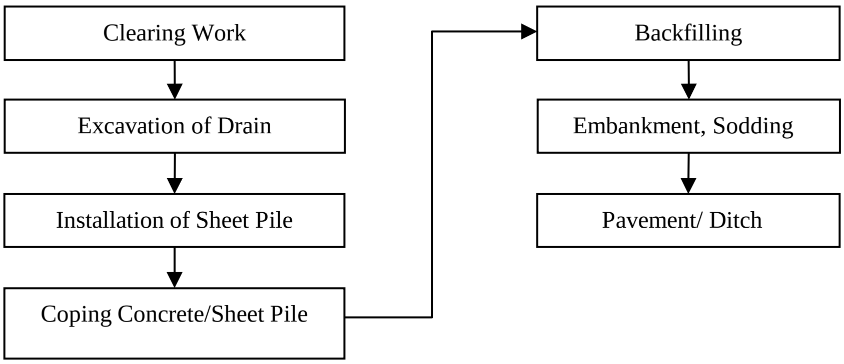
Steel Sheet Pile: Slope protection by steel sheet piles. Construction can be done by barge in the river, or from the riverbank side if there is enough space for the construction on the riverbank side. If barges are not possible, half of the river should be reclaimed for construction.

Gabion: Protection of slopes by Gabion. The gabion is placed after a certain section is temporarily sealed with sandbags or steel sheet piles.

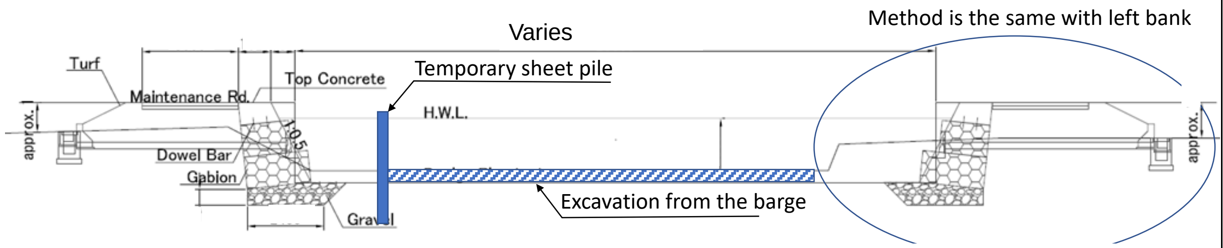
Embankment: The slope is 1:2.0 and the method is used in sections where construction sites are relatively available.

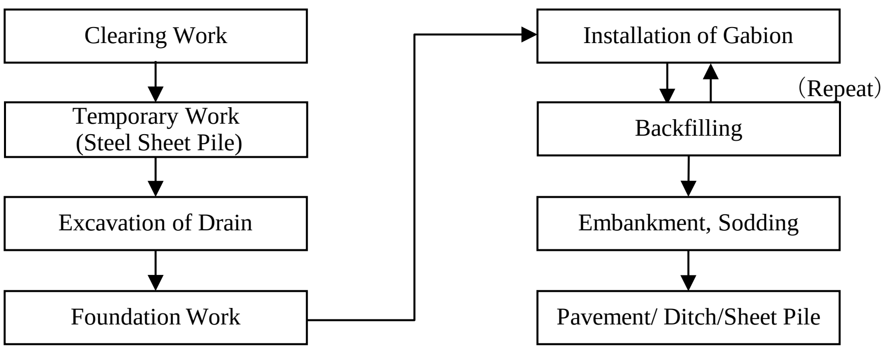
Steel Sheet Pile

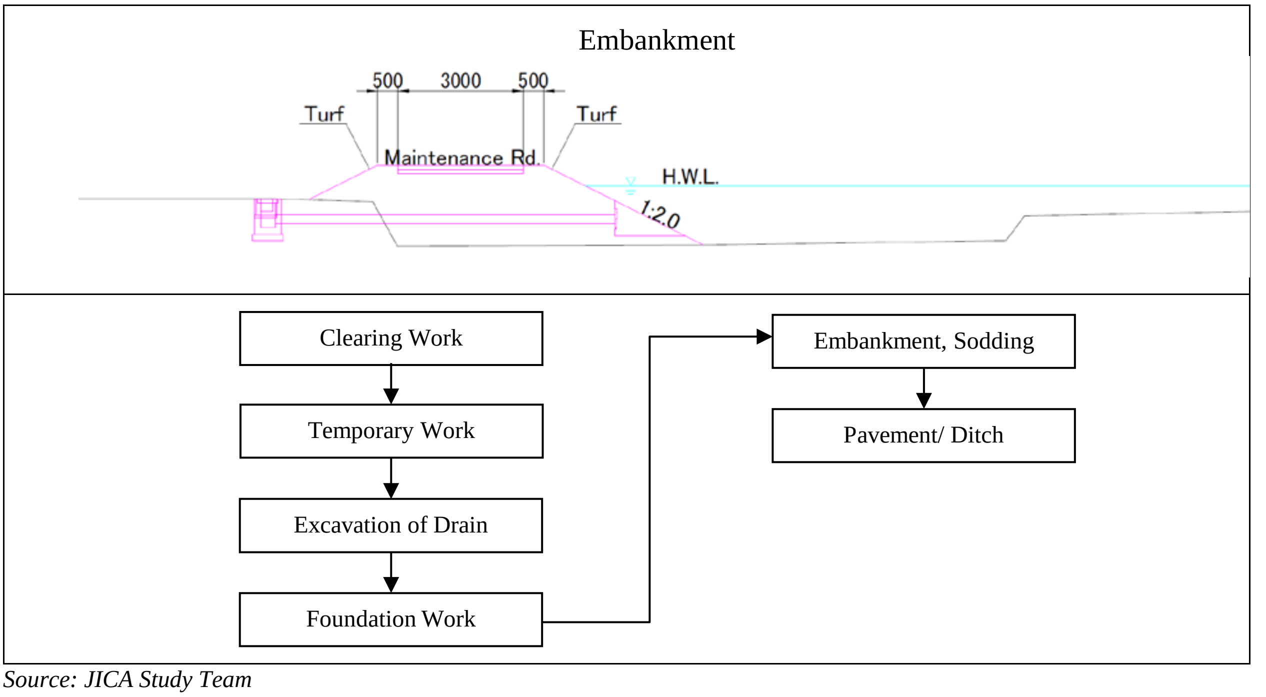




Gabion







Source: JICA Study Team

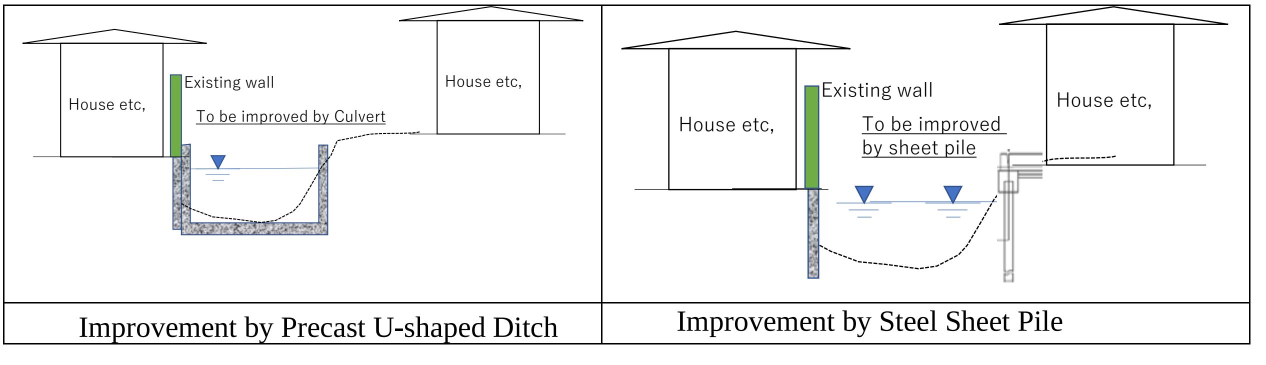
Figure 4.2.1 Typical Slope Protections and Those Construction Methods

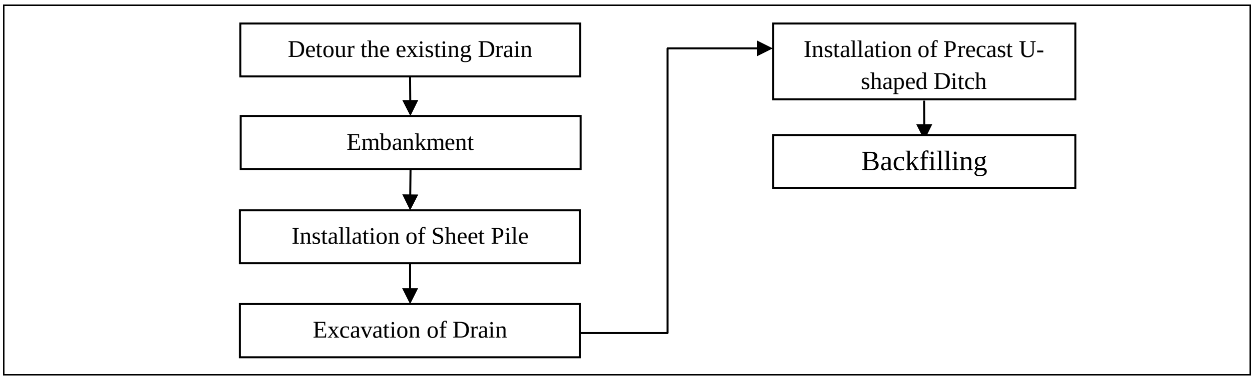
4.2.2.2 Weras Ganga Right Bank

The Weras Ganga Right Bank Dike is a small-scale embankment structure and it will be constructed in a similar construction method to the embankment in the Mudun Ela sub-basin.

4.2.2.3 the Moratuwa-Rathmalana area

In the Moratuwa-Rathmalana area, the drains will basically be U-shaped ditches and the construction will be applied for an open cut. For wider drains, slope protection will be applied as in the Mudun Ela sub-basin mentioned above. However, in the Moratuna-Rathmalana area, the construction method in a narrow construction space needed to be considered since the drains are located at the places where houses and buildings are on both sides closely. Where the construction spaces are very limited, precast U-shaped ditches will be installed with a support of steel sheet piles, or steel sheet pile revetments are used where sites are not available. In addition, if existing houses or walls exists just next to the drain, it is desirable to construct the building so as not to touch it as much as possible. The typical cross section is shown in Figure 4.2.2. The areas where steel sheet pile is required due to the limited construction space, and the areas of the drain where steel sheet pile revetment is required are shown in the Appendix.





Source: JICA Study Team

Figure 4.2.2 Construction Method at the Limited Construction Space in the Moratuwa-Rathmalana area

4.2.3 Construction Plan

4.2.3.1 Daily Work Progress

The number of days required to work on each of the major work items associated with the construction of the drainage facility was assumed as shown in the table below.

Table 4.2.4 Daily Work Progress

Work Item	Daily Work Progress
Preparatory Work	10 Days
Temporary Works(Steel Sheet Pile)	13.2 m/day
Earth Work	330 m^3/day
Structure Work (Steel Sheet Pile)	11.2 m/day
Structure Work (Gabion)	12 m^3/day
Concrete Work	70 m^3/day
U-Shaped Drain	17 m/day
Maintenance Road	250 m^2/day
Dreading Work	250 m^3/day
Other Related Works	10 Days

Source: Production Rate issued by Ministry of Land, Infrastructure, Transport and Tourism, and JST has estimated based on the hearing to SLLDC

4.2.3.2 Construction Period

Considering the construction volume of drainage facilities shown in Table 4.2.4, as well as the daily work progress and workable days for construction described above, the construction periods in the Mudun Ela sub-basin, at the Weras Ganga right bank and in the Moratuwa-Rathmalana area were estimated as shown in Figures 4.2.3 through 4.2.7.

Work Item	Qty	Unit									
Type-3 (or (1)) / Length=45m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	90	m	0.3								
Earth work(Excavation, backfill)	744	m3	0.2								
Structure work(Sheet pile)	90	m	0.4								
Structure work(Gabion)	158	m3	0.7								
Concrete work(cap)	90	m	0.1								
Concrete work(top)	34	m3	0.1								
U-shape drain (in-situ)	90	m	0.3								
Pavement work	270	m2	0.1								
Dredging works(Excavation)	304	m3	0.1								
Other miscellaneous works	1	set									
			Year	1st year							
Type-2 (or (2)) / Length=225m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	225	m	0.9								
Earth work(Excavation, backfill)	1,404	m3	0.3								
U-shape drain (in-situ)	225	m	0.7								
Pavement work	675	m2	0.2								
Dredging works(Excavation)	5,130	m3	1.0								
Other miscellaneous works	1	set									
				1st year				2nd year			
Type-1 (or (3)) / Length=1536m			months	1	2	3	4	1	2	3	4
Preparatory work	1	set									
Temporary work (Sheet pile)	3,072	m	5.6								
Earth work(Excavation, backfill)	45,812	m3	3.3								
Structure work(Gabion)	10,941	m3	21.7								
U-shape drain (in-situ)	3,072	m	4.3								
Pavement work	9,216	m2	0.9								
Dredging works(Excavation)	11,754	m3	1.2								
Other miscellaneous works	1	set									
				1st year				2nd year			
Type-3 (or (4)) / Length=711m			months	1	2	3	4	1	2	3	4
Preparatory work	1	set									
Temporary work (Sheet pile)	1,422	m	5.2								
Earth work(Excavation, backfill)	10,295	m3	1.5								
Structure work(Gabion)	2,489	m3	9.9								
U-shape drain (in-situ)	1,422	m	4.0								
Pavement work	4,266	m2	0.9								
Dredging works(Excavation)	10,466	m3	2.0								
Other miscellaneous works	1	set									

Source: JICA Study Team

Figure 4.2.3 Construction Period in Mudun Ela Sub-basin (1)

Type-3 (or (5)) / Length=272m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	544	m	2.0								
Earth work(Excavation, backfill)	5,470	m3	0.8								
Structure work(Sheet pile)	544	m	2.3								
Concrete work(cap)	544	m	0.2								
Concrete work(top)	544	m3	0.4								
U-shape drain (in-situ)	544	m	1.5								
Pavement work	1,632	m2	0.3								
Dredging works(Excavation)	3,261	m3	0.7								
Other miscellaneous works	1	set									
Type-3 (or (L1)) / Length=120m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	120	m	0.5								
Earth work(Excavation, backfill)	186	m3	0.1								
U-shape drain (in-situ)	120	m	0.4								
Pavement work	360	m2	0.1								
Other miscellaneous works	1	set									

Source: JICA Study Team

Figure □.1 Construction Period in Mudun Ela Sub-basin (2)

				1st year			
Wares Ganga River: Right Bank Dike			months	1	2	3	4
Preparatory work	1	set	0.3				
Embankment	10,730	m3	1.6				
Turf	12,212	m2	5.9				
Concrete for Wall	785	m3	0.6				
Concrete Pavement	604	m3	0.5				
Wares Ganga River: U-Ditch							
Preparatory work	1	set	0.3				
Excavation	3229.6	m3	0.5				
Turf	3250	m2	1.6				
Concrete for U-ditch	727.62	m3	6.4				

Source: JICA Study Team

Figure 4.2.2 Construction Period in Weras Ganga Right Bank

Work Item	Qty	Unit									
A-2R / Length=1263m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	2,726	m	9.9								
Earth work(Excavation, backfill)	16,419	m3	2.4								
U-shape drain (in-situ)	1,363	m	3.9								
Other miscellaneous works	1	set									
			Year								
A-2L-1 / Length=666m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	1,332	m	4.8								
Earth work(Excavation, backfill)	4,968	m3	0.8								
U-shape drain (in-situ)	666	m	1.9								
Other miscellaneous works	1	set									
A-C / Length=760m			months	1	2	3					
Preparatory work	1	set									
Earth work(Excavation, backfill)	6,346	m3	1.0								
U-shape drain (in-situ)	760	m	2.2								
Pavement work	1,520	m2	0.3								
Other miscellaneous works	1	set									
				1st year				2nd year			
A-C5 / Length=1069m			months	1	2	3	4	1	2	3	4
Preparatory work	1	set									
Earth work(Excavation, backfill)	40,194	m3	2.9								
Structure work(Sheet pile)	48	m	0.3								
Structure work(Gabion)	7,008	m3	9.3								
Concrete work(cap)	48	m	0.1								
U-shape drain (in-situ)	66	m	0.2								
Pavement work	1,293	m2	0.3								
Dredging works(Excavation)	3,155	m3	0.6								
Other miscellaneous works	1	set									
A-C6 / Length=530m			months	1	2	3					
Preparatory work	1	set									
Earth work(Excavation, backfill)	8,109	m3	1.2								
U-shape drain (in-situ)	530	m	1.5								
Pavement work	318	m2	0.1								
Other miscellaneous works	1	set									

Source: JICA Study Team

Figure 4.2.3 Construction Period in the Moratuwa-Rathmalana area (1)

B-C2B2 / Length=511m			months	1	2	3					
Preparatory work	1	set									
Earth work(Excavation, backfill)	3,066	m3	0.5								
U-shape drain (in-situ)	224	m	0.7								
Other miscellaneous works	1	set									
				1st year				2nd year			
B-C4 / Length=820m			months	1	2	3	4	1	2	3	4
Preparatory work	1	set									
Earth work(Excavation, backfill)	26,404	m3	3.9								
Structure work(Gabion)	11,116	m3	14.7								
Structure work(Sheet pile)	52	m	0.3								
Concrete work(cap)	52	m	0.1								
Pavement work	687	m2	0.2								
Dredging works(Excavation)	22,140	m3	4.3								
Other miscellaneous works	1	set									
B-C5 / Length=408m			months	1	2	3					
Preparatory work	1	set									
Temporary work (Sheet pile)	232	m	0.9								
Earth work(Excavation, backfill)	11,685	m3	1.7								
U-shape drain (in-situ)	408	m	1.2								
Other miscellaneous works	1	set									
B-B1 / Length=710m			months	1	2	3	4				
Preparatory work	1	set									
Temporary work (Sheet pile)	274	m	1.0								
Earth work(Excavation, backfill)	44,233	m3	6.4								
Structure work(Gabion)	228	m3	0.9								
U-shape drain (in-situ)	653	m	1.9								
Pavement work	47	m2	0.1								
Other miscellaneous works	1	set									
B-B1T4 / Length=670m			months	1	2	3					
Preparatory work	1	set									
Temporary work (Sheet pile)	680	m	2.5								
Earth work(Excavation, backfill)	5,809	m3	0.9								
U-shape drain (in-situ)	670	m	1.9								
Other miscellaneous works	1	set									
B-B1T5 / Length=670m			months	1	2	3					
Preparatory work	1	set									
Temporary work (Sheet pile)	1,340	m	4.9								
Earth work(Excavation, backfill)	7,940	m3	1.2								
U-shape drain (in-situ)	670	m	1.9								
Other miscellaneous works	1	set									

Source: JICA Study Team

Figure 4.2.4 Construction Period in the Moratuwa-Rathmalana area (2)

4.3 Procurement Plan

4.3.1 Procurement of Construction Materials

The following table summarizes the procurement conditions of construction materials and equipment for the construction of drainage facilities, that was based on the interview results to the local contractors and SLLDC. The local construction company in Sri Lanka has the experience to construct similar types of drainage facilities in the priority project although pump facilities shall be imported from the neighboring countries. As a conclusion, there is no problems about the procurement of construction materials and equipment, including the ones imported from the neighboring countries.

Table 4.3.1 Procurement of Construction Materials

Item		Procurement
Workers		There are several local contractors with construction experience equivalent to the drainage facilities proposed for the Project. The local contractor will be responsible for procuring the workers.
Construction Material	Steel	Steel is imported, processed at domestic plants, and used at construction sites, where prices have recently increased due to the pandemic of COVID-19. The unit price of steel products in 2022 is 3.4 to 3.8 times higher than the one in 2019. Future changes are unclear, but at present there are no problems with construction by SLLDC.
	Cement	Import from neighboring countries. For the same reason as steel products, prices have soared recently, and cement-related unit prices in 2022 are nearly three times the ones in 2019. Future changes are unclear, but at present there are no problems with the construction of similar scale projects in Sri Lanka.
	Earthwork / Gravel	Available from earth borrow pits and quarries within 35km of Colombo city center. In order to reduce costs, it is desirable to select a nearby procurement point at the time of construction.
	Sand	Although it is possible to procure sand from rivers in eastern Sri Lanka, the use of M-sand (Manufacturing Sand) is commonly used, and it is inexpensive for construction work in the vicinity of Colombo.
	U-Shaped Ditch	U-shaped ditches for road gutters can also be precast products, and the Moratuwa-Rathmalana area has the advantage of using precast due to the presence of suppliers. Although there are concerns about rising material costs, there have been no problems with the construction of similar scale construction at this time.
	Concrete Sheet Pile	Although some sites use it to prevent erosion of bridge abutments, it is not used in river and waterway construction from the viewpoint of construction price.
	Temporary Steel Sheet Pile	Import from neighboring countries
	Pump, Gate (Steel)	Import from neighboring countries
Construction Equipment		Major heavy equipment used in construction, such as excavators and dump trucks, are owned by local contractors.

Source: Hearing from SLLDC and local construction company

4.3.2 Procurement of the Contractor

The source of funds for the Project has not been determined yet and it may be considered at this moment to be implemented by the local government funds. Therefore, the procurement of contractors in the Study was based on Local Competitive Bidding (LCB). In recent years, international contractors have been procured through International Competitive Bidding (ICB) for drainage projects funded by the World Bank, which include drainage pump stations and canal rehabilitation. The local contractor is performing the work as a subcontractor to this international contractor. On the other hand, the Oliyamulla pumping station (30 m^3/s), which is currently under construction, is funded by the local government and is being constructed by the local contractor.

In interviews with SLLDC, it is recognized that the procurement of the pumps must be imported, but the local contractors have sufficient experience in general civil engineering work and can perform the work.

4.3.3 Consideration of Contract Packages

After consultation with the SLLDC, the two basins shall be divided into separate packages, and the following package demarcation was proposed based on the method of dividing procurement packages by construction type rather than geographical divisions for sub-basins within each basin. Although dividing the packages will reduce the size of the work per package, SLLDC must be careful not to raise the bidding price too high in order to increase competitiveness. In addition, the SLLDC was structured on the premise that work such as bridges, for which the contractor has sufficient experience in foundation work, would be placed separately.

Table 4.3.2 Construction Packages

Basin	Packages
Mudun Ela Sub-basin	Package-1: Improvement of Drains
	Package-2: Construction of Gate and Pump
	Package-3: Replacement of Bridges
Weras Ganga Right Bank	Package-1: Construction of Right Bank
Moratuwa-Rathmalana area	Package-1: Improvement of Drains

Source: JICA Study Team

CHAPTER 5 PRELIMINARY COST ESTIMATION

5.1 Basic Condition of Cost Estimation

5.1.1 Price Level

The cost estimate is at the price level as of December 2022. However, since price fluctuations caused by the recent economic crisis are considered to be temporary, fluctuations in exchange rates and price increases in recent years regarding the Sri Lankan Rupee are not taken into account. Specifically, the exchange rate was set based on the average value from November 11, 2019 to February 10, 2020, and price increases after this period were not considered.

5.1.2 Exchange Rate

The monthly average exchange rate between the Japanese Yen (JPY) and the United States Dollar (USD) was referring to the central rate information issued by the Bank of Japan. The one between Sri Lankan Rupees (LKR) and the United States Dollars (USD) was referring to the central rate information issued by the Central Bank of Sri Lanka. As a result, the average rates (1 LKR = 0.603 JPY, 1 USD = 109.12 JPY, hence, 1 USD = 181.06 LKR) were applied in this project.

5.1.3 Currency for Cost Estimates

The project cost component will consist of local and foreign currency portions. Sri Lankan Rupee will be used to express both the local and foreign currency portions. The classifications of local and foreign currency portions are given below.

(1) Local Currency Portion

- All labor cost
- A part of the cost of construction materials
- A part of the cost of the equipment lease
- Value Added Tax (VAT)

(2) Foreign Currency Portion

- A part of the cost of construction materials that require international quality
- A part of the cost for equipment lease and services that require international quality

The ratio of the local currency portion and foreign currency portion was defined in the M//P and it is also applied in the Pre-F/S.

Table 5.1.1 Ratio of Foreign Currency Portion for Labor, Material and Equipment

Item	Foreign Currency
Labor	0
Equipment	70
Material	
Fuel and Lubricant	80
Wood/Stone/Sand	0
Crushed/ Uncrushed gravel	0
Cement	80
Re-bar	90
Structural Steel	90
Chemical Product	90

Source: JICA Study Team

5.1.4 The Methodology of Cost Estimate

The cost for the main construction works such as embankment and revetment is essentially estimated on a unit price basis. The cost for the Peliyagoda Pumping Station improvement is calculated based on the price quote from a supplier. The construction cost of the closing facilities, or, sluice gate at Naranmini Oya was calculated with area ratios of the gate bodies referring to similar projects in Sri Lanka. The construction cost of bridges was calculated based on the road plan area ratio with reference to similar bridge construction projects in Sri Lanka.

The main items of the project cost are construction cost, the cost for engineering services, contingencies, administration cost, land acquisition cost and compensation cost, and Value Added Tax (VAT).

The composition of the project cost is described below.

5.1.4.1 Construction Cost

(1) Direct Cost

The direct cost consists of a labor cost, a material cost and an equipment cost. The combination of these costs is proposed by referring to the latest unit price analysis.

1) Contractor’s Indirect Cost

Indirect cost and the benefit of the contractors are estimated at 17% of the direct cost and those are added to the unit prices.

2) Preparation Cost

The cost of preparation work before and after the main construction work is required. The preparation work is for mobilization, demobilization, health and safety plan and measures, preparation of access roads, leveling for a crane, geotechnical investigations, and so on. Referring to some facts which generally show four percent (4%) to 10% of the direct and indirect cost for the preparation works, it is set at five percent (5%) in this study.

3) Other Expense

This cost estimation is based on the design at the M/P level so that the costs of detailed works and structures are not included. To cover those costs, an additional l0% on the direct and indirect costs are estimated.

(2) Engineering Service

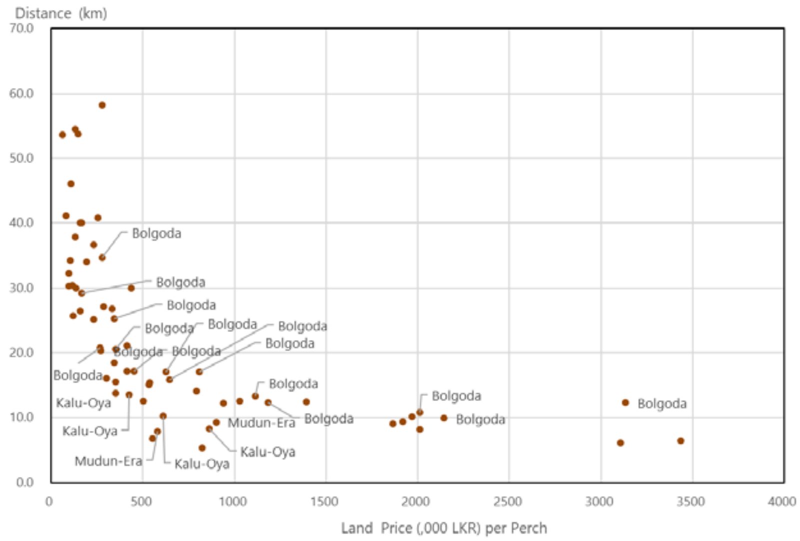
As described before, SLLDC can conduct detailed design and construction supervision for small-scale projects. Since this project is relatively large and it covers large areas, the budget for detailed design and construction supervision is empirically estimated at 6% of the construction cost.

(3) Cost for Land Acquisition and Compensation

The cost of land acquisition is usually calculated with the land value multiplied by its area after the parcellary survey and the study on the market values of the land. However, since this cost estimation is for the Pre-F/S, a simplified method is applied as explained below.

- In the Mudun Ela sub-basin, land of 1m in a residential or commercial area and of 3 m in an agricultural area or other natural areas from the top of riverbanks are considered public land and areas exceeding those limits are to be acquired.
- Since the canals in the Moratuwa-Rathmalana area pass through areas where buildings such as houses and factories are densely built, and most of them are small-scale canals, the concept of public land for ordinary river channels as described above is not considered to be applicable. Therefore, land acquisition costs were required, except for public roads, wetlands and other lands that SLLDC manages.

The land unit price is set at 39,400 LKR/m^2 (1 million LKR/perch) in Mudun Ela, 44,000 LKR/m^2 (1.1 million LKR/perch) referring to Figure 5.1.1.



Source: JICA Study Team

Figure 5.1.1 Average Land Price in the Key Locations in the Western Province (2019)

The compensation cost is generally affected by the structure and the usage of the buildings. In this study, the compensation cost is obtained from the multiplication of the compensation per area and the affected area of the acquiring buildings. The compensation per area is obtained referring to the resettlement action plan for the "Rehabilitation of St. Sebastian South Canal" project, which is a part of MCUDP. Regarding the target area, if the affected area is less than 10% of the building, only an affected area is considered to be acquired. If not, the whole building is considered to be acquired. Table 5.1.2 shows the compensation per area for this project.

Table 5.1.2 Building Compensation per Area

No.	Type of building	Rate in 2013 (LKR/Sq. ft.)	Rate in 2013 (LKR/Sq. m)	GDP deflator 1) from 2013 to 2018	Rate in 2022 1) (LKR/Sq. m)
1	Zinc roof on GI pipe support, Cement block wall only for the front side	170	1,800	1.2255	2,200
2	Asbestos roof with PVC gutters, Cement block walls with plastering and color washing. Cement floor, zinc roof, timber doors and timber slashed windows	1,750	18,800	1.2255	23,000
3	Cement slab roof, brick/cement walls with plastering and color washing. Cement floor, timber doors and timber windows	2,200	23,700	1.2255	29,000

1): Following the concept of Clause 4.1.1 Price Level, the GDP fluctuations after 2020 were not considered. (using the deflator up to the end of 2018)
Source: Resettlement Action Plan (RAP) Rehabilitation of St. Sebastian South Canal (under MCUDP), JICA Study Team

(4) Administration Cost

Administration cost includes expenses for the project management office operated by the SLLDC. It is estimated at two percent (2%) of the sum of the construction cost, engineering service cost, and land acquisition and compensation cost.

(5) Price Contingency

The price contingency for foreign currency was set at zero percent (0%) and the one for the local currency was set at four-point three percent (4.3%) referring to the GDP deflator.

(6) Physical Contingency

The physical contingency is set at 10% of the above-mentioned costs referring to the examples in SLLDC.

(7) VAT

VAT is set at fifteen percent (15%).

5.2 Project Cost

The summaries of total project costs are shown in Table 5.2.1 and Table 5.2.2.

Table 5.2.1 Project Cost for the Priority Projects

(million LKR)

Cost	Mudun Ela channel improvement			Weras Ganga Right Bank Dike			Moratuwa-Rathmalana drainage canal improvement		
	F.C.	L.C.	計	F.C.	L.C.	計	F.C.	L.C.	計
Construction	595	495	1,091	70	86	156	362	364	726
Consulting	36	30	65	4	5	9	22	22	44
Land acquisition and compensation	0	870	870	0	978	978	0	549	549
Administration	0	47	47	0	26	26	0	30	30
Physical contingency	63	149	212	7	112	120	38	100	138
Price contingency	0	95	95	0	52	52	0	66	66
Tax	0	200	200	0	29	29	0	134	134
Total	694	1,886	2,580	82	1,288	1,371	422	1,265	1,687

Source: JICA Study Team

Table 5.2.2 Project Cost for Mudun Ela Projects (by Package)

(million LKR)

Cost	Mudun Ela channel improvement (Package 1)			Mudun Ela channel improvement (Package 2)			Mudun Ela channel improvement (Package 3)		
	F.C.	L.C.	計	F.C.	L.C.	計	F.C.	L.C.	計
Construction	362	434	796	53	16	69	180	45	225
Consulting	22	26	48	3	1	4	11	3	14
Land acquisition and compensation	0	870	870	0	0	0	0	0	0
Administration	0	40	40	0	2	2	0	5	5
Physical contingency	38	142	180	6	2	8	19	5	24
Price contingency	0	88	88	0	2	2	0	5	5
Tax	0	148	148	0	12	12	0	40	40
Total	422	1,747	2,169	62	35	97	210	104	314

Source: JICA Study Team

The following tables are the project costs reflecting the recent price surge caused by the economic crisis, applying the unit price in Sri Lanka Rupee used in SLLDC (available since September 2022).

Table 5.2.3 Project Cost for the Priority Projects (w/ Present Unit Price)

(million LKR)

Cost	Mudun Ela channel improvement			Weras Ganga Right Bank Dike			Moratuwa-Rathmalana drainage canal improvement		
	F.C.	L.C.	計	F.C.	L.C.	計	F.C.	L.C.	計
Construction	1,612	896	2,508	171	144	315	816	591	1,406
Consulting	97	54	150	10	9	19	49	35	84
Land acquisition and compensation	0	1,427	1,427	0	1,604	1,604	0	1,145	1,145
Administration	0	139	139	0	46	46	0	63	63
Physical contingency	171	462	633	18	192	210	86	200	286
Price contingency	0	836	836	0	162	162	0	226	226
Tax	0	472	472	0	60	60	0	268	268
Total	1,880	4,285	6,165	200	2,217	2,417	951	2,527	3,479

Source: JICA Study Team

Table 5.2.4 Project Cost for Mudun Ela Projects (by Package, w/ Present Unit Price)

(million LKR)

Cost	Mudun Ela channel improvement (Package 1)			Mudun Ela channel improvement (Package 2)			Mudun Ela channel improvement (Package 3)		
	F.C.	L.C.	計	F.C.	L.C.	計	F.C.	L.C.	計
Construction	1,244	801	2,045	73	21	94	296	74	370
Consulting	75	48	123	4	1	6	18	4	22
Land acquisition and compensation	0	1,427	1,427	0	0	0	0	0	0
Administration	0	128	128	0	2	2	0	9	9
Physical contingency	132	450	582	8	3	10	31	9	41
Price contingency	0	814	814	0	5	5	0	17	17
Tax	0	387	387	0	17	17	0	67	67
Total	1,450	4,055	5,505	85	49	134	345	181	526

Note: GDP deflator was applied for Package 2 and 3 calculations.
Source: JICA Study Team

CHAPTER 6 IMPLEMENTATION SCHEDULE

6.1 General Condition for Formulation of Implementation Schedule

In the M/P, the detailed design of the priority projects was set in 2023 and the implementation of them are proposed in 2024 and 2025. Referring to it and the result of the Pre-F/S, the revised implementation schedule was proposed in this chapter.

According to SLLDC, before the detailed design and implementation, a project proposal has to be approved by the Department of National Planning, then the proposal is submitted to the Department of External Resources (hereinafter referred to as “ERD”) under the Ministry of Finance. ERD is the organization which select the appropriate fund source, such as funds from the Sri Lankan Government, World Bank, or Asian Development Bank and so on. For the priority projects selected for the Pre-F/S, the detailed designs are expected to be conducted within 2023. Hence, all such logistic works should be started soon after the completion of the Pre-F/S study.

6.2 Implementation Schedule

The implementation schedule for the priority projects is shown in Table 6.2.1 and Table 6.2.2.

Table 6.2.1 Implementation Schedule (Mudun Ela Sub-basin)

Year	2023				2024												2025											
Month	1	4	7	10	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
F/S		■																										
D/D			■	■																								
Package 1 (Channel improvement)																												
Implementation (Section 1, L = 45m)					■	■	■	■	■	■	■	■	■	■														
Implementation (Section 2, L = 225m)								■	■	■	■	■	■	■	■													
Implementation (Section 3, L = 1,536m)						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
Implementation (Section 4, L = 711m)									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Implementation (Section 5, L = 272m)																					■	■	■	■	■	■	■	■
Implementation (Section 6, L = 120m)					■	■																						
Package 2 (Gate, Pumping station improvement)																												
Natha Canal, Naranmini Oya gate installation					■	■	■	■	■	■	■	■	■	■	■	■												
Peliyagoda pumping station improvement					■	■	■	■	■	■	■	■	■	■	■	■												
Package 3 (Bridge construction)																												
Bridge construction											■	■	■	■	■	■	■	■	■									

Source: JICA Study Team

Table 6.2.2 Implementation Schedule (Weras Ganga Right Bank Dike and Moratuwa-Rathmalana area)

Year	2023				2024												2025											
Month	1	4	7	10	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
F/S		■																										
D/D			■	■																								
Weras Ganga Right Bank Dike																												
Right Bank Dike with U-ditch (L = 3,000 m)					■	■	■	■	■	■	■	■	■	■														
M-R area Drainage improvement																												
Main drainage channel (Zone A C5)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■									
Main drainage channel (Zone A 2L-1)					■	■	■	■	■	■	■	■	■	■														
Secondary drainage channel (Zone A 2R)															■	■	■	■	■	■	■	■	■	■	■	■		
Secondary drainage channel (Zone A C)																				■	■	■	■	■	■			
Secondary drainage channel (Zone A C6)																				■	■	■	■	■	■	■	■	■
Main drainage channel (Zone B C4)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Secondary drainage channel (Zone B C2B2)																■	■	■	■	■	■	■	■					
Secondary drainage channel (Zone B C5)																						■	■	■	■	■	■	■
Secondary drainage channel (Zone B B1)																■	■	■	■	■	■	■	■					
Secondary drainage channel (Zone B B1T4)																							■	■	■	■	■	■
Secondary drainage channel (Zone B B1T5)																					■	■	■	■	■	■	■	■

Source: JICA Study Team

CHAPTER 7 OPERATION AND MAINTENANCE PLAN

7.1 Policy for Operation and Maintenance

The following basic policies for the operation and maintenance (hereinafter referred to as "the O&M") were presented in the Master Plan study. An O&M plan for the storm water drainage facilities proposed in the Pre-F/S stage is also formulated based on the following basic policies.

- The responsible organizations for O&M of the storm water drainage facilities are SLLDC and Local Authorities (Municipal Council: MC, Urban Council: UC, Pradeshiya Sabha: PS).
- SLLDC is responsible for the O&M of drainage facilities in the declared areas.
- Local Authorities are responsible for the O&M of drainage facilities in their respective administrative areas.
- SLLDC should assist the local authorities in undertaking the O&M works for the drainage facilities for a few years after the transfer of those facilities to local authorities. During this period, SLLDC shall provide local authorities with technical guidance and staff training through joint operation, on-the-job training and lectures.
- As a long-term objective, local authorities promote the expansion of resources for the storm water drainage works including planning, construction and the O&M with a view to managing all the works by themselves.

7.2 Institutional Arrangement for O&M Works

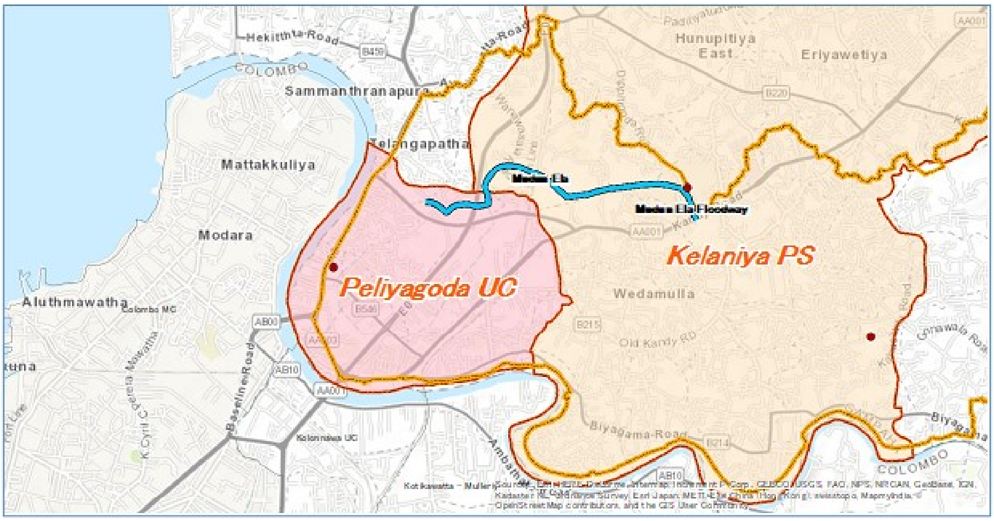
The continuous main responsible organization for O&M works of the storm water drainage facilities will basically be local authorities in their respective administrative areas. On the other hand, considering the importance of the facility and necessary budget measures, if it becomes an SLLDC-designated facility (designated area), the Drainage & Reclamation Division of SLLDC will carry out continuous O&M works. Therefore, it is particularly important to clarify the future responsible organization at the project implementation stage (detailed design stage).

SLLDC has established the Drainage & Reclamation Division as the main responsible section for O&M works of the storm water drainage facilities. Whereas, storm water management by local authorities is not easy due to budget and human resource limitations, except for large local authorities with sufficient budget and human resources such as Colombo MC. This chapter focuses on O&M works especially in local governments.

7.2.1 Local Authorities Relevant to the Pre-feasibility Study Project

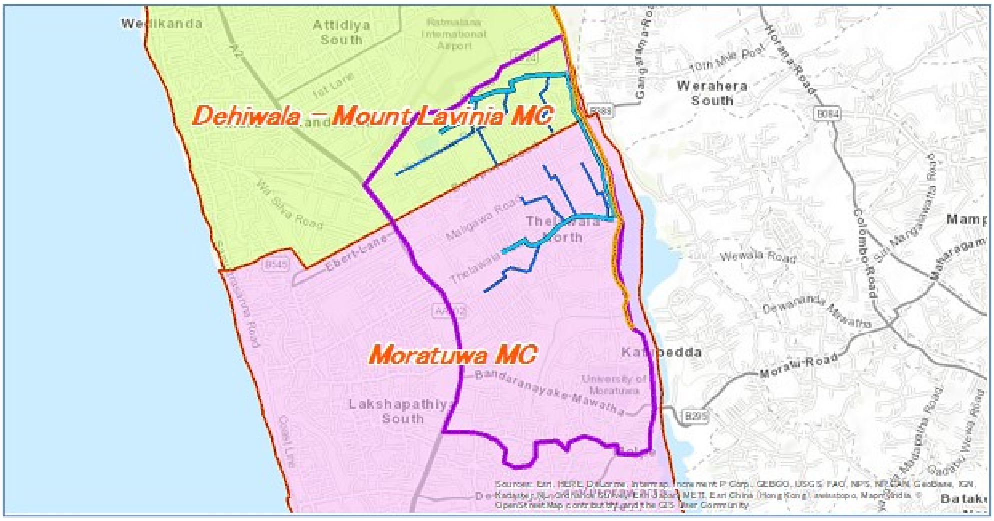
Two drainage improvement schemes, "the Mudun Ela Sub-basin scheme" and "the Moratuwa- Rathmalana Area scheme" are proposed as the Pre-F/S Project. Figure 7.2.1 and Figure 7.2.2 show the locations of local authorities relevant to each scheme of storm water drainage facilities for the Pre-F/S Project.

The storm water drainage facilities of the Mudun Ela sub-basin scheme (Figure 7.2.1) are located in two local authorities, "Peliyagoda UC (Urban Council)" and "Kelaniya PS (Pradeshiya Sabha)", and the facilities of Moratuwa-Rathmalana Area scheme (Figure 7.2.2) are located in two local authorities, "Dehiwala – Mount Lavinia MC (Municipal Council)" and "Moratuwa MC". The institutional arrangement and financial status of these relevant local authorities are described in the following sections.



Source: JICA Study Team

Figure 7.2.1 Location of Local Authorities Relevant to Mudun Ela Sub-basin Scheme



Source: JICA Study Team

Figure 7.2.2 Location of Local Authorities Relevant to the Moratuwa-Rathmalana Area Scheme

7.2.2 Institutional Arrangement of Relevant Local Authorities

The general profile of local authorities (Peliyagoda UC, Kelaniya PS, Dehiwala - Mount Lavinia MC and Moratuwa MC) relevant to the Pre-F/S Project is summarized in Table 7.2.1. The number of staff in relevant LAs is shown in Table 7.2.2 and the organizational structures of each relevant LA are shown in Figure 7.2.3 through Figure 7.2.6.

Table 7.2.1 General Profile of Relevant Local Authorities

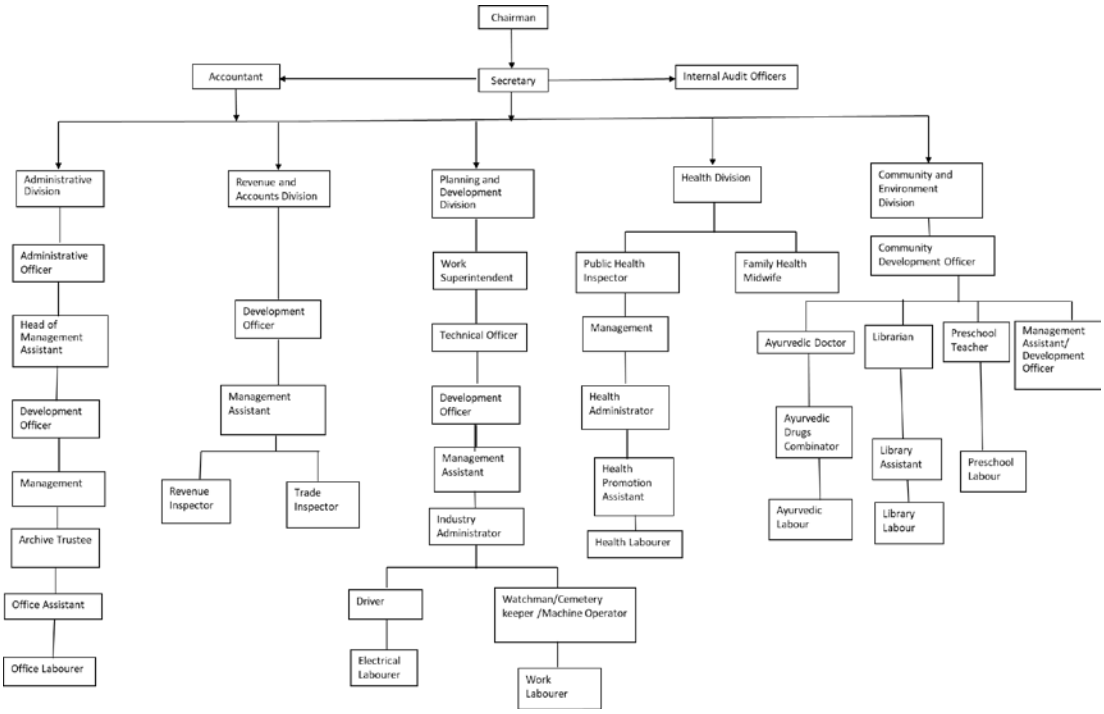
	Peliyagoda UC	Kelaniya PS	Dehiwala - Mount Lavinia MC	Moratuwa MC
Province	Western	Western	Western	Western
Divisional Secretariat	Kelaniya DS	Kelaniya DS	Dehiwala DS / Rathwalana DS	Moratuwa DS
Area (km2)	1.94	21.85	21.17	23.40
Population	30,999	147,314	194,838	167,255
Population density (pop./km2)	15,962	6,742	9,203	7,148
Number of Councilors	16	40	48	48
Number of Staff	132	159	1,787	821
GN Division 数	7	37	28	42

Source: Programme Budget 2022 of each LA

Table 7.2.2 Current Staff Allocation in Local Authorities Relevant to the Project

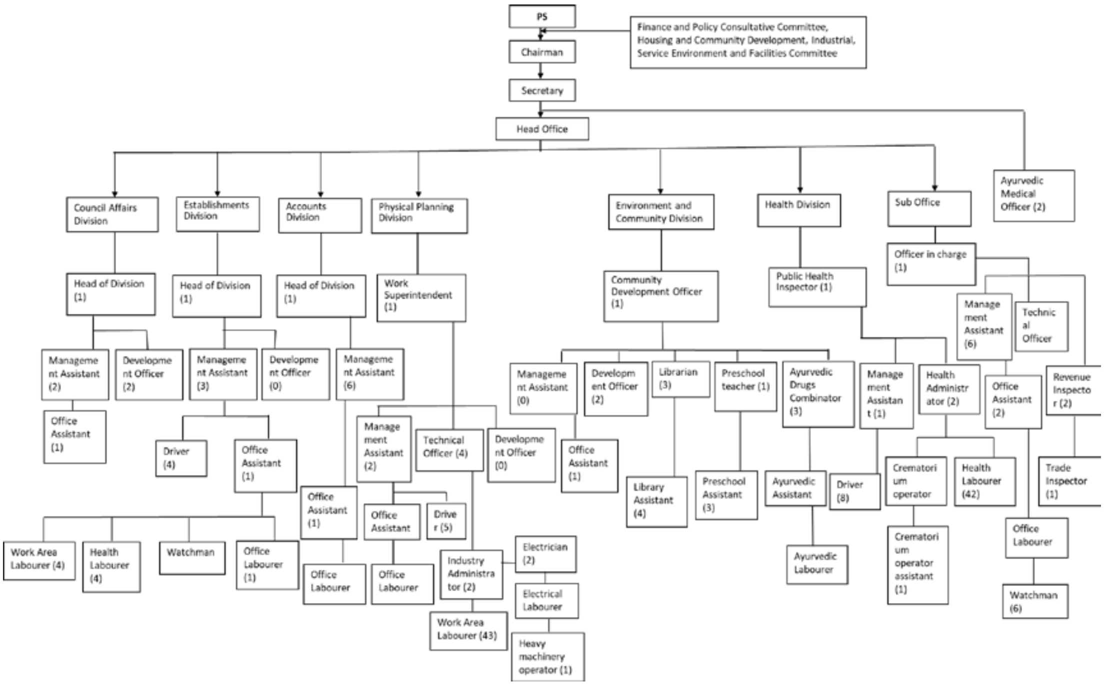
	Peliyagoda UC	Kelaniya PS	Dehiwala - Mount Lavinia MC	Moratuwa MC
Chief Engineer	0	0	1	0
Engineer	0	0	6	3
Technical Officer	2	5	8	6
Work / Field Labourer	15	51	495	152
Health Labourer	41	42	653	297
Others	74	61	624	363
Total	132	159	1,787	821

Source: Programme Budget 2022 of each LA



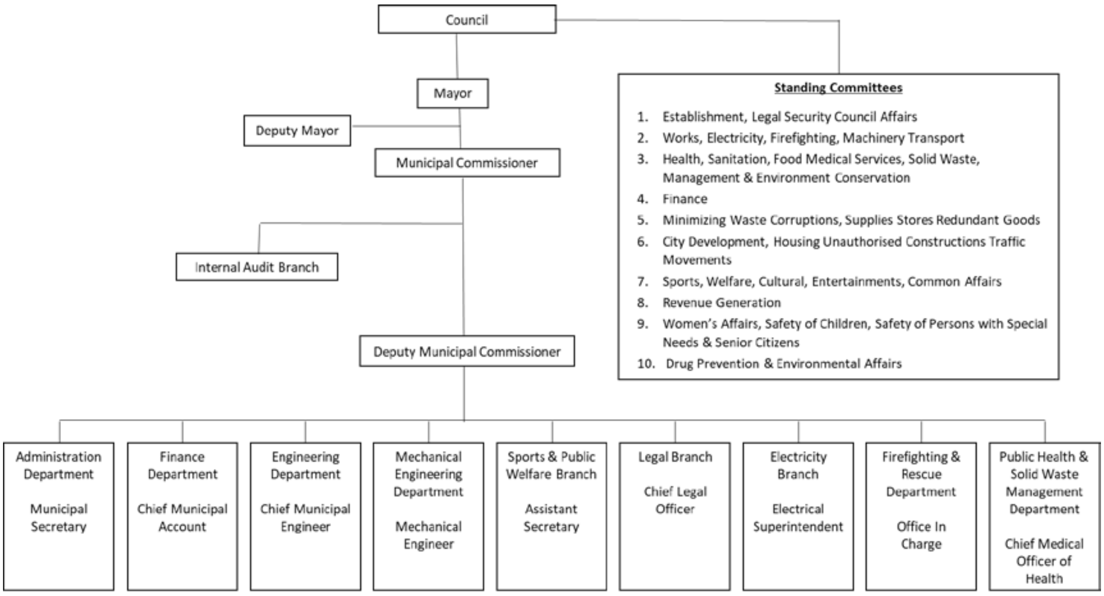
Source: Peliyagoda UC Programme Budget 2022

Figure 7.2.3 Organization Structure of Peliyagoda UC



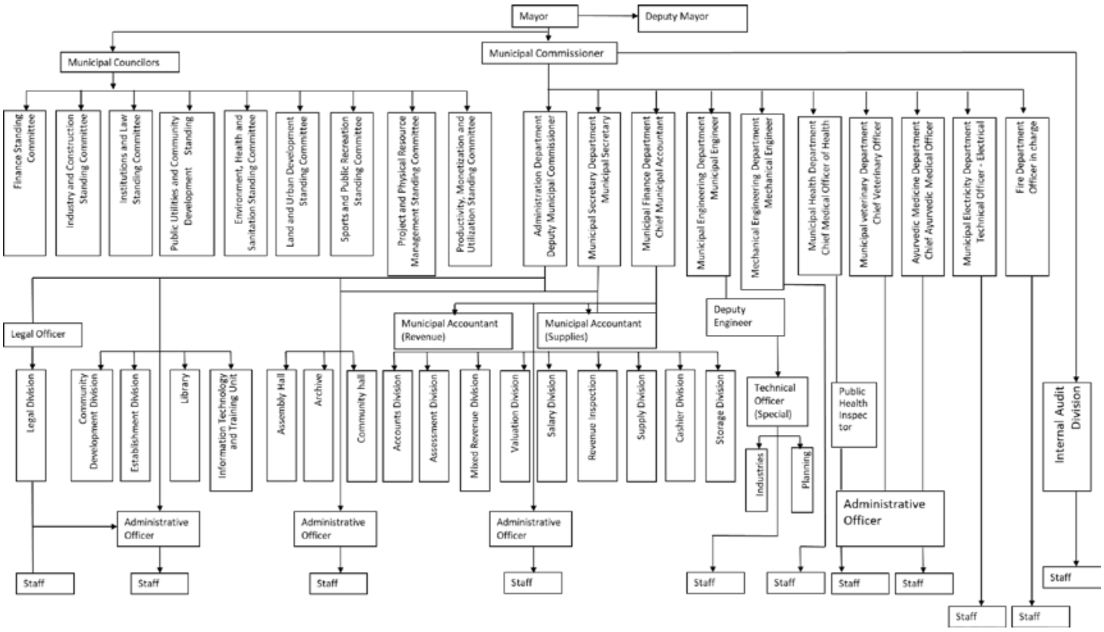
Source: Kelaniya PS Programme Budget 2022

Figure 7.2.4 Organization Structure of Kelaniya PS



Source: Dehiwala - Mount Lavinia MC Programme Budget 2022

Figure 7.2.5 Organization Structure of Dehiwala - Mount Lavinia MC



Source: Moratuwa MC Programme Budget 2022

Figure 7.2.6 Organization Structure of Moratuwa MC

(1) Peliyagoda UC

The total number of Peliyagoda UC staff is 132, including 2 technical officers. No Engineer is available in Peliyagoda UC. There is no specific section in charge of drainage, but “Planning and Development Division” and “Health Division” are taking care of O&M activities for drainage, mainly for roadside drains. Peliyagoda UC has experience in the relocation of families. The Planning Section under the Planning and Development Division will be assigned for land acquisition and resettlement if the Project is implemented.

Since Peliyagoda UC is understaffed in the area of storm water drainage, Peliyagoda UC should focus on O&M activities for the Project, with assistant from SLLDC, Dehiwala - Mount Lavinia MC and Moratuwa MC where resident Engineers are available.

(2) Kelaniya PS

The total number of Kelaniya PS staff is 159, including 5 technical officers. No engineer is available in Kelaniya PS. There is no specific section in charge of drainage, but “Physical Planning Division” and “Health Division” are taking care of O&M activities for drainage, mainly for roadside drains. Kelaniya PS has experience in the relocation of families. The Planning Section under the Physical Planning Division will be assigned for land acquisition and resettlement if the Project is implemented.

Since Kelaniya PS is understaffed in the area of storm water drainage, Kelaniya PS should focus on O&M activities of the Project, with assistance from SLLDC, Dehiwala - Mount Lavinia MC and Moratuwa MC where resident Engineers are available.

(3) Dehiwala - Mount Lavinia MC

The total number of employees of Dehiwala - Mount Lavinia MC is 1,787, including 1 Chief Municipal Engineer, 6 Engineers, 8 technical officers. An Engineering Department exists under the Chief Municipal Engineer, but Public Health & Solid Waste Management Department is taking care of O&M activities for drainage and sewage management.

Dehiwala - Mount Lavinia MC has the Public Health & Solid Waste Management Department as an organization in charge of O&M on drainage facilities. However, Dehiwala - Mount Lavinia MC has a shortage of engineers and technical officers specialized in storm water drainage and its O&M works. Equipment for O&M works is also limited.

(4) Moratuwa MC

The total number of employees of Moratuwa MC is 821, including 3 engineers and 6 technical officers. O&M activities for drainage facility has been done by Municipal Engineering Department under Municipal Engineer. There are no engineers and technical officers undertaking only drainage works.

Moratuwa MC has the Municipal Engineering Department as an organization in charge of O&M on drainage facilities. However, Moratuwa MC has a shortage of engineers and technical officers specialized in storm water drainage and its O&M works. Equipment for O&M works is also limited.

7.2.3 Financial Status of Relevant Local Authorities

The financial status in 2022 of Peliyagoda UC, Kelaniya PS, Dehiwala - Mount Lavinia MC and Moratuwa MC, related to the Pre-F/S Project is shown in Table 7.2.3.

Table 7.2.3 Annual Budget of Related Local Authorities in 2022

Item	Peliyagoda UC		Kelaniya PS		Dehiwala - Mount Lavinia MC		Moratuwa MC	
	2022 (Rs.1,000)	Share (%)	2022 (Rs.1,000)	Share (%)	2022 (Rs.1,000)	Share (%)	2022 (Rs.1,000)	Share (%)
Revenue	**175,711**	**129%**	**510,693**	**137%**	**2,086,856**	**124%**	**1,049,405**	**107%**
Rates and Taxes	51,000	37%	79,300	21%	433,766	26%	217,833	22%
Rents	4,876	4%	29,148	8%	51,004	3%	13,717	1%
Licenses	3,650	3%	3,850	1%	22,976	1%	14,300	1%
Service Charges	3,835	3%	8,047	2%	72,760	4%	34,085	3%
Warrant Costs & Fines	1,112	1%	2,461	1%	300	0%	393	0%
Other Sales	450	0%	2,731	1%	450	0%	11,252	1%
Interest Income	2,900	2%	3,275	1%	60,000	4%	6,555	1%
Miscellaneous Revenue	22,127	16%	262,500	70%	532,300	32%	150,119	15%
Project Revenue	0	0%	0	0%	0	0%	400	0%
Government transfers for Recurrent expenses	85,761	63%	119,380	32%	913,300	54%	600,750	61%
Capital Revenue	**116**	**0%**	**0**	**0%**	**0**	**0%**	**2,354,002**	**239%**
Total Revenue	**175,827**	**129%**	**510,693**	**137%**	**2,086,856**	**124%**	**3,403,407**	**346%**
Recurrent Expenditure	**136,217**	**100%**	**374,003**	**100%**	**1,682,690**	**100%**	**983,985**	**100%**
Salaries and Wages	80,695	59%	175,497	47%	1,041,549	62%	620,167	63%
Travelling	1,481	1%	2,375	1%	8,736	1%	8,400	1%
Supplies	19,530	14%	46,080	12%	160,534	10%	66,374	7%
Repairs & Maintenance of Capital Assets	7,366	5%	45,600	12%	145,080	9%	176,742	18%
Administrative Cost	16,766	12%	60,070	16%	231,135	14%	56,355	6%
Welfare	4,287	3%	42,530	11%	36,588	2%	15,956	2%
Miscellaneous Expenditures	2,831	2%	1,750	0%	43,805	3%	24,691	3%
Others	3,010	2%	1	0%	0	0%	8,500	1%
Financial Cost	250	0%	100	0%	15,263	1%	6,801	1%
Capital Expenditure	**39,610**	**29%**	**136,601**	**37%**	**404,070**	**24%**	**2,419,395**	**246%**
Total Expenditure	**175,827**	**129%**	**510,605**	**137%**	**2,086,760**	**124%**	**3,403,381**	**346%**

Source: Programme Budget 2022 of each LA

(1) Peliyagoda UC

The financial statement of Peliyagoda UC in 2022 is shown in Table 7.2.3. The revenue in 2022 was Rs 176 million. Recurrent expenditure consists of Salaries and Wages (59%), Supplies (14%), Administrative Cost (12%), Repairs & Maintenance of Capital Assets (5%) and others. Sixty-six percent (66%) of the recurrent expenditure is generated from independent revenue sources such as Rates and Taxes, Rents, Licenses, Service Charges and so on.

Sixty-three percent (63%) of the recurrent expenditure is covered by grant revenue from the central and local government. This indicates that the high percentage of activities in Peliyagoda UC are financially supported by the central governments. Considering the tight budget structure of the government, it may not be easy to generate a budget for O&M activities after completion of the Project.

(2) Kelaniya PS

The financial statement of Kelaniya PS in 2022 is shown in Table 7.2.3. The revenue in 2022 was Rs. 511 million. Recurrent expenditure consists of Salaries and Wages (47%), Administrative Cost (16%), Supplies (12%), Repairs & Maintenance of Capital Assets (12%) and others. One hundred and five percent (105%) of the recurrent expenditure is generated from independent revenue sources such as Rates and Taxes, Rents, Licenses, Service Charges and so on.

Thirty-two percent (32%) of the recurrent expenditure is supplied by grant revenue from the central and local government. Considering the tight budget structure of the government, it may not be easy to generate a budget for O&M activities after completion of the Project.

(3) Dehiwala - Mount Lavinia MC

The financial statement of Dehiwala - Mount Lavinia MC in 2022 is shown in Table 7.2.3. The revenue in 2022 reached Rs. 2,087 million. The breakdown of recurrent expenditure consists of Salaries and Wages (62%), Administrative Cost (14%), Supplies (10%), Repairs & Maintenance of Capital Assets (9%) and others. Seventy percent (70%) of the recurrent expenditure is generated from independent revenue sources such as Rates and Taxes, Rents, Licenses, Service Charges and so on.

Fifty-four percent (54%) of the recurrent expenditure is covered by grant revenue from the central and local government. This indicates that the financial structure of Dehiwala - Mount Lavinia MC heavily depends on grant revenue from central and local governments. The major part of budget for O&M activities has to be covered by the grant from central and/or local governments after completion of the Project.

(4) Moratuwa MC

The financial statement of Moratuwa MC in 2022 is shown in Table 7.2.3. The revenue in 2022 was Rs 3,403 million. Recurrent expenditure is made up of Salaries and Wages (63%), Repairs & Maintenance of Capital Assets (18%), Supplies (7%), Administrative Cost (6%) and others. Forty-six percent (46%) of the recurrent expenditure is generated from independent revenue sources such as Rates and Taxes, Rents, Licenses, Service Charges and so on.

Sixty-one percent (61%) of the recurrent expenditure is covered by grant revenue from the government. This indicates that 61% of activities in Moratuwa MC are financially supported by central and local governments. Considering the tight budget structure of the government, it may not be easy to generate a budget for O&M activities after completion of the Project.

7.3 Operation and Maintenance Plan

7.3.1 Description of the Proposed Pre-F/S Project

The proposed Pre-F/S Project is composed of two drainage improvement schemes (“Mudun Ela sub-basin scheme” and “Moratuwa- Rathmalana Area scheme”). Drainage improvement measures proposed in each scheme is briefly described below.

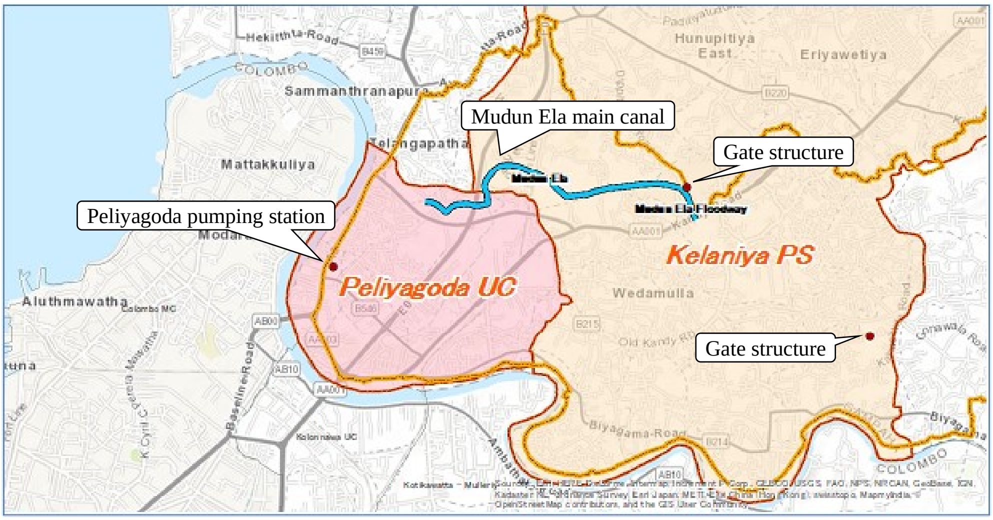
(1) Mudun Ela Sub-basin scheme

Improvement of storm water drainage system for Pre-F/S in the Mudun Ela sub-basin which is located at the right bank of the Kelani Ganga in Peliyagoda UC and Kelaniya PS is proposed. The outline of the storm water drainage facilities of the Mudun Ela sub-basin scheme is summarized in Table 7.3.1 and the locations of main facilities are indicated in Figure 7.3.1.

Table 7.3.1 Pre-F/S Project Outline on Mudun Ela Sub-basin Scheme

Improvement of Mudun Ela main canal	2.8 km
Gate structure (1)	To separate Natha canal basin and Mudun Ela basin
Gate structure (2)	To separate Naranmini Oya basin
Rehabilitation of Peliyagoda pumping station	Pumping capacity (From 0.5m3/s to 1.0m3/s)

Source: JICA Study Team



Source: JICA Study Team

Figure 7.3.1 Location of Main Facilities on Mudun Ela Sub-basin Scheme

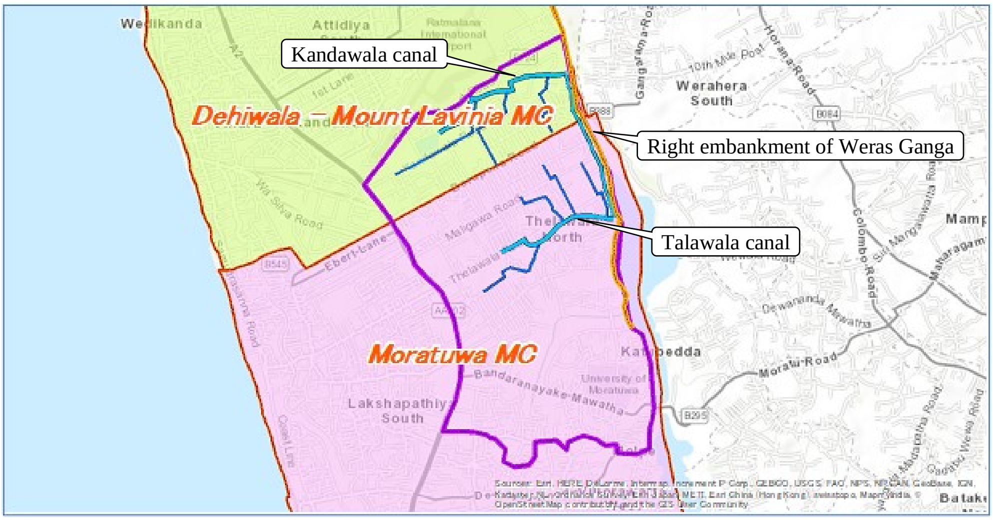
(2) Moratuwa- Rathmalana Area scheme

Improvement of storm water drainage system in Moratuwa-Rathmalana Area which is located at the right bank of the Weras Ganga in Dehiwala - Mount Lavinia MC and Moratuwa MC is proposed. The outline of the storm water drainage facilities of Moratuwa-Rathmalana Area scheme is summarized in Table 7.3.2 and the locations of main facilities are indicated in Figure 7.3.2.

Table 7.3.2 Pre-F/S Project Outline on Moratuwa- Rathmalana Area Scheme

Right embankment of Weras Ganga	3.0 km
Foot drain along the right embankment	3.0 km
Drainage flap gates along the right embankment	7 locations
Improvement of Kandawala canal	1,420m (Main canal), 2,530m (Secondary canal)
Improvement of Talawala canal	1,150m (Main canal), 2,610m (Secondary canal)

Source: JICA Study Team



Source: JICA Study Team

Figure 7.3.2 Location of Main Facilities on Moratuwa-Rathmalana Area Scheme

7.3.2 O&M Works Required and Work Demarcation

(1) O&M Works Required

The required O&M works for the Pre-F/S Project components given in the previous section are summarized below and the details are specified in Table 7.3.3.

1) Mudun Ela Sub-basin scheme

1. Periodical inspection of channels and the related structures (gate, pumping station)
2. Periodical cleaning and dredging of channels, and minor repair of channels and the related structures
3. Reactive maintenance to deal with incidents and emergencies

2) Moratuwa- Rathmalana Area scheme

1. Periodical inspection of channels, embankment and the related structures (flap gate)
2. Periodical cleaning and dredging of channels and embankment, and minor repair of channels, embankment and the related structures
3. Reactive maintenance to deal with incidents and emergencies

(2) Work Demarcation by Executing Organization

In order to execute the O&M works successfully, the work responsibility by each executing organization should be clearly demarcated. Considering the major project components and present condition of O&M work capacity of responsible organizations, it is proposed that SLLDC undertakes the substantial O&M works of the major project components and the related local authorities undertake the O&M works of the urban drainage system located in their local areas, respectively.

In addition, it is proposed that the local authorities assist SLLDC's O&M activity through undertaking of the periodical inspection of the project components extended in the respective local areas.

The detailed demarcation of the required O&M works for the Pre-F/S Project components are indicated in Table 7.3.3.

Table 7.3.3 Demarcation of responsibility for O&M Works

O&M Works	Organization				
	SLLDC	Peliyagoda UC	Kelaniya PS	Dehiwala - Mt. Lavinia MC	Moratuwa MC
1. Mudun Ela Sub-basin Scheme					
a. Periodical inspection of drainage channels and the related structures/facilities (quarterly)	O	O	O	-	-
b. Periodical Cleaning of drainage channels and the related facilities (once a year)	O	-	-	-	-
c. Periodical dredging (once in 3 years, based on channel cross sectional survey result)	O	-	-	-	-
d. Periodical grass cutting/clearing of the bank slope and removal of channel water surface weeds (twice a year)	O	-	-	-	-
e. Minor repair of the drainage channels and other related structures	O	-	-	-	-
f. Reactive maintenance to deal with incidents and emergencies such as dweller's encroachment, blockage of canal and O&M road, illegal dumping, accident to person, etc.	O	-	-	-	-
2. Moratuwa - Rathmalana Area Acheme					
a. Periodical inspection of drainage channels and the related structures/facilities (quarterly)	-	-	-	O	O
b. Periodical Cleaning of drainage channels and the related facilities (once a year)	-	-	-	O	O
c. Repair/reconstruction of bank protection as needed, according to the periodical inspection of drainage channel and flood protection dike	-	-	-	O	O
d. Periodical grass cutting/clearing of the flood protection dike and removal of channel water surface weeds (twice a year)	-	-	-	O	O
e. Minor repair of the drainage channels and other related structures	-	-	-	O	O
f. Reactive maintenance to deal with incidents and emergencies such as dweller's encroachment, blockage of canal, illegal dumping, accident to person, etc.	-	-	-	O	O

Source: JICA Study Team

7.3.3 Operation and Maintenance (O&M) Work Plan

The O&M works are undertaken by SLLDC and the four local authorities in the Pre-F/S Project area. The responsible section to handle the O&M works in each O&M organization is outlined below.

7.3.3.1 Implementation Section of O&M Organization

(1) SLLDC

The Drainage & Reclamation Division is the responsible section for the O&M works of the major drainage facilities including the drainage canals extending over the local authorities and the retention areas in Western Province. The existing regional offices are proposed to handle the actual activities under the management of the Drainage & Reclamation Division.

The present task of the regional office is the maintenance of the canals of which improvement is planned in the Pre-F/S Project and other minor canals. The establishment of a new section in the regional offices closest to the Pre-F/S Project area is proposed for the purpose of undertaking on-the-job training and lectures in the process of the transfer of urban drainage facilities to the related local authorities.

(2) Local Authorities

1) Peliyagoda UC and Kelaniya PS

These two local authorities are to undertake only the periodical inspection of the project components extended in the respective local areas in cooperation with SLLDC. It is presumed that these local authorities will be able to undertake the task for the Project within the existing organization structure.

However, it is recommended to consider the establishment of a section to handle the O&M works of storm water drainage with a view to future extension of the drainage system as the extension of built-up area continues. The new separate section for O&M of the storm water drainage will be headed by a chief engineer.

2) Dehiwala - Mount Lavinia MC and Moratuwa MC

These two local authorities are responsible for undertaking the O&M for the urban drainage system located in the respective local areas. The drainage facilities will be constructed through the Pre-F/S Project and transferred to these local authorities by means of the step-wise transfer. In parallel, on-the-job training and lectures for the purpose of improving O&M capacity of local authorities will be carried out through the transfer process under the leadership of SLLDC.

The two local authorities do not have substantial O&M implementation systems so it will be difficult to take over the drainage facilities and carry out the proper O&M. Therefore, an exclusive section for storm water drainage in each local authority will be established so that they can undertake the O&M related activities including participation in the training programs and the O&M by themselves after taking over the facilities. The new separate section for O&M of the storm water drainage will be headed by a chief engineer.

7.3.3.2 Staffing Plan of Related Local Authorities

(1) Peliyagoda UC and Kelaniya PS

For these local authorities, major O&M works for the project components are not planned and their tasks comprise only the periodical inspection of the drainage facilities in cooperation with SLLDC. It is presumed that the O&M works can be handled by the existing staff. An increase of staff is expected, however, to deal with the future increase in the tasks as the extension of urban area continues.

Since the substantial O&M works by these local authorities are not planned in the Pre-F/S Project and it is still too early to expect planning and implementation of a storm water project by these local authorities in a short period, the substantial increase in staff numbers is not proposed until near completion time of the Project.

Table 7.3.4 shows the proposed staffing plan for these two local authorities until the completion of the Pre-F/S Projects.

Table 7.3.4 Proposed Staffing Plan for Local Authorities Related to the Project (Peliyagoda UC, Kelaniya PS)

(Unit: No. of Person)

Staff	Existing	By start of the Project	By completion of the Project
Manager / Engineer	0	0	1
Other Engineer	0	0	0
Technical Officer	0	1	1
Work Supervisor	0	0	2
Machine Operator	0	0	1
Clerical Staff	0	0	1
Labor	0	0	5

Source: JICA Study Team

(2) Dehiwala -Mount Lavinia MC and Moratuwa MC

Considering necessity of the strengthening of the O&M system with a view of carrying out the proper O&M of storm water drainage system to be improved under the Pre-F/S Project, the following staff arrangement will be required.

In these local authorities, exclusive staff engaged in the storm water drainage works are not available, therefore the staffing plan and the timing shown in Table 7.3.5 is proposed so that the overall capacity of the staff for planning and implementation as well as O&M can be developed through engagement in the entire project stage.

Table 7.3.5 Proposed Staffing Plan for Local Authorities Related to the Project (Dehiwala -Mount Lavinia MC, Moratuwa MC)

(Unit: No. of Person)

Staff	Existing	By start of the Project	By completion of the Project
Manager / Engineer	0	1	1
Other Engineer	0	1	1
Technical Officer	0	1	2
Work Supervisor	0	2	3
Machine Operator	0	2	3
Clerical Staff	0	2	2
Labor	0	5	10

Source: JICA Study Team

7.3.3.3 Financial Arrangement for O&M

On the basis of the required O&M works and the staffing plan proposed in the above sections, the O&M cost to maintain the storm water drainage facilities to be constructed/improved under the Pre-F/S Project is estimated for each responsible organization.

(1) Estimate of Annual O&M Cost

1) Cost Items

The annual O&M cost for the Project components is estimated in terms of the following cost items taking the required O&M works into consideration. Procurement cost for the major O&M equipment is usually categorized into a capital expenditure and is not included in the annual cost estimated here.

(a) Cost for Routine Works

- Periodical inspection of canals and the related facilities
- Canal dredging and canal cleaning/minor repair including grass cutting of the bank and removal of water surface weeds
- Cleaning of drains and the related facilities

(b) Cost for Reactive Works

- Repair/reconstruction of canal and the related facilities based on the periodical inspection
- Works to deal with incidents and emergencies such as dweller’s encroachment, blockage of canal, illegal dumping, accident to person, etc.

2) Assumed Annual O&M Work

The annual O&M work is provided in Table 7.3.3 on the assumption of the following work frequency.

1. Inspection of canals, retention areas/ponds and O&M roads quarterly
2. Channel bank cleaning and removal of water surface weeds: twice a year
3. Cleaning of channels and the related facilities: once a year
4. Dredging of major channels: once in 3years

3) Cost Estimate

Based on the required O&M work items and the work schedule, major equipment and man power required for the works are assumed. Finally, applying various unit rates obtained from the SLLDC’s actual operation, the total annual O&M cost is worked out.

The preliminary annual O&M cost by SLLDC and each local authority in the Project area is summarized in Table 7.3.6 based on the work demarcation shown in Table 7.3.3 and the estimated cost.

Table 7.3.6 Preliminary Estimate of Annual O&M Cost for the Project

(Unit: Rs. 1,000)

Item	SLLDC	Peliyagoda UC	Kelaniya PS	Dehiwala - Mt. Lavinia MC	Moratuwa MC
(a) Routine Works					
Main canal	5,041	0	0	409	331
Secondary canal	720	0	0	354	365
Bank embankment	263	0	0	88	175
Inspection	98	12	42	22	22
(b) Reactive Works					
Repair	894	0	0	124	124
Emergencies	507	0	0	82	102
Total	7,523	12	42	1,079	1,119

Source: JICA Study Team

(2) Financial Arrangement for O&M

1) SLLDC

The financial source for all O&M activities of SLLDC is provided by the central Government. The budget for O&M work for the storm water drainage facilities proposed in the Pre-F/S Project is required as a new additional budge. It is proposed that SLLDC makes due arrangement to acquire the budget for the planned O&M works by the completion of the project implementation.

2) Local Authorities

At present, the annual budgets of the local authorities for the drainage O&M works are not sufficient to carry out substantial regular O&M works. In particular, the budget scales of Peliyagoda UC and Kelaniya PS are very limited. Furthermore, most of the budget is allocated for recurrent expenditure (employee salary and supplies) and the budget allocated for purchase or maintenance of the O&M equipment is too small to achieve the purpose.

The financial sources of the local authorities are their annual revenues and the subsidiaries from the Central Government and Western Provincial Government. It will be difficult for the local authorities, especially for Peliyagoda UC and Kelaniya PS to increase their revenue scale in a short term of 5 to 10 years. Considering the existing financial status and the O&M work demarcation for the Pre-F/S Project of each local authority, a budget arrangement is proposed.

In case of Peliyagoda UC and Kelaniya PS, the required O&M activity involves only inspection of the facilities in their respective areas and no substantial O&M works are planned for the Pre-F/S Project, therefore it will be possible to carry out the works within the present budget arrangement.

In case of Dehiwala - Mount Lavinia MC and Moratuwa MC, since a considerable increase in the annual budget will be required compared to the existing budget, the realistic budget plan should be prepared considering their substantial undertaking of the O&M works in the near future for the facilities to be constructed under the Pre-F/S Project.

7.3.4 Staff Training Program

(1) Purpose of the Staff Training Program

In considering the present management capacity of local authorities, a staff training program is described below for the purpose of achieving successful O&M works for the proposed drainage project in Pre-F/S. The staff training programs are organized during the project implementation period.

The training program is proposed in two categories, “O&M Management” and “Operation of O&M Equipment”. The Management Training is intended to develop management capability for managerial and engineering staff of each responsible organization. The main subjects are related to overview of management principles and planning and programming know-how of O&M works.

The Operation Training is proposed for the training of technical and work supervisory staff and machine operators of each responsible organization. The main subjects are to understand the mechanism of O&M equipment and to achieve the operation knowledge and experiences.

(2) Staff Training Program for Local Authorities

The outlines of "O&M Management Program" and "Operation of O&M Equipment Program" are summarized below.

1) O&M Management Program

(a) Introduction of O&M Activities

Course title:	Introduction of O&M Activities
Target LAs:	Peliyagoda UC, Kelaniya PS, Dehiwala - Mount Lavinia MC and Moratuwa MC
Target Groupe:	Engineering assistant, Technical staff, Work supervisor
Objective:	Understand necessity of O&M works and learn O&M method
Provider:	SLLDC Drainage & Reclamation Division with assistance of consultants hired by SLLDC
Contents:	• Introduction - purpose of O&M works • Routine activities • Reactive maintenance - incidents and emergencies • Reporting • Safety considerations

(b) Planning and Programming for O&M Works

Course title:	Planning and Programming for O&M Works
Target LAs:	Peliyagoda UC, Kelaniya PS, Dehiwala - Mount Lavinia MC and Moratuwa MC
Target Groupe:	Managerial staff, Engineer
Objective:	Understand purpose of O&M plan, overview of management principles and learn planning and programming know-how
Provider:	SLLDC Drainage & Reclamation Division with assistance of consultants hired by SLLDC
Contents:	• Introduction - purpose of O&M plan • Description of maintenance organization • How to plan and program work • Planned inspection for work monitoring • Performance standard • Safety considerations

2) Operation of O&M Equipment Program

Course title:	Operation of O&M equipment
Target LAs:	Peliyagoda UC, Kelaniya PS, Dehiwala - Mount Lavinia MC and Moratuwa MC
Target Groupe:	Machine operator

Objective:	Understand mechanism of O&M equipment, Learn how to operate equipment
Provider:	SLLDC Plant & Equipment Division with assistance of consultants hired by SLLDC
Contents:	• Brief explanation on mechanism of machines and equipment • Explanation on type of machine and equipment by work purposes • Basic operation in yard • Applied operation in field • Safety operation

CHAPTER 8 ENVIRONMENTAL AND SOCIAL CONSIDERATION

8.1 Confirmation of Environmental and Social Consideration related Aspects

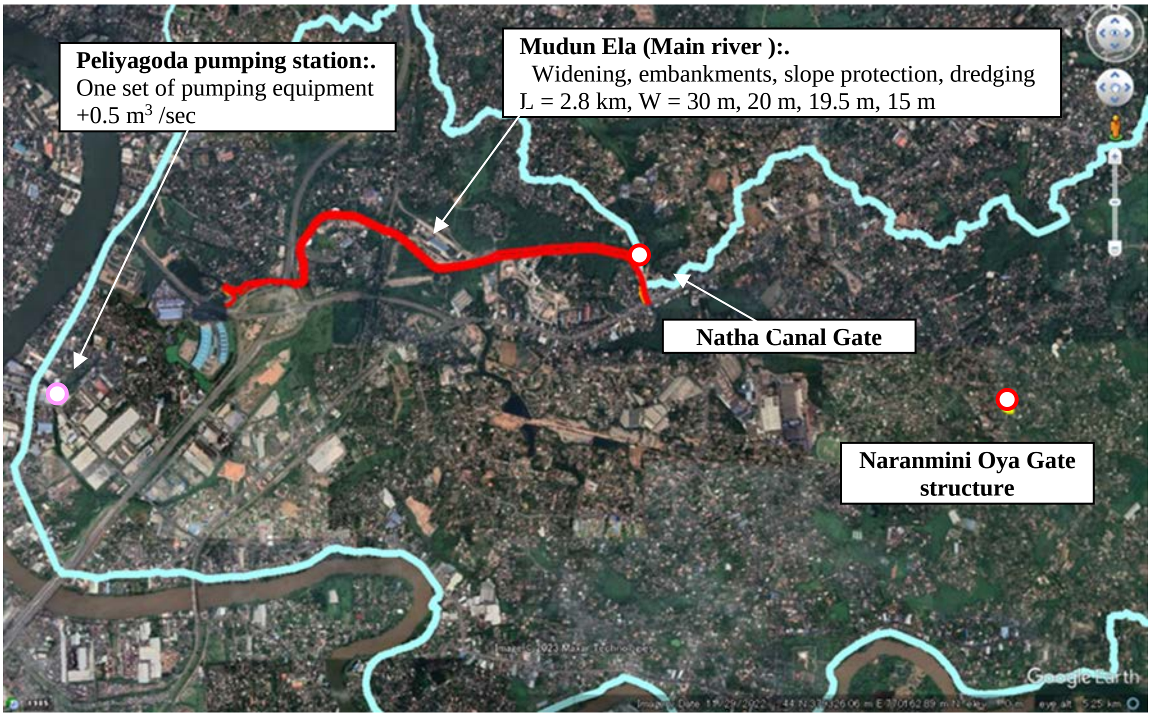
8.1.1 Proposed Project Components Subject to Environmental and Social Impacts

The outline of proposed components that may affect the surrounding environment is as follows. See also other chapters for details of proposed project components.

8.1.1.1 Mudun Ela Sub-basin

Mudun Ela sub-basin improvement will include drainage main channel rehabilitation, Peliyagoda pumping station rehabilitation, bridge replacement, and installation of the gate structure.

- Main canal improvement of Mudun Ela: 2,816 m
- Rehabilitation of Peliyagoda pumping station: Pumping capacity (Expansion by 0.5m^3/s)
- Bridges over the main canal: 3 bridges
- Gate structure: Naranmini Oya, Natha Canal



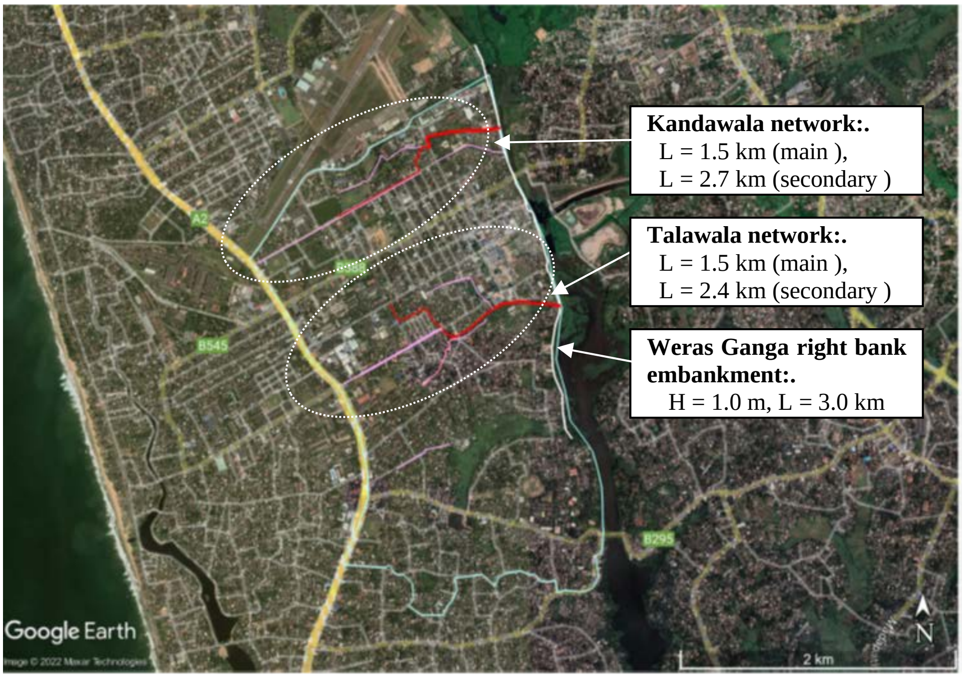
Source: JICA Study Team

Figure 8.1.1 Proposed Project Sites (Mudun Ela sub-basin)

8.1.1.2 Moratuwa-Rathmalana Area

Moratuwa-Rathmalana area improvement will cover right bank river embankment for flood protection and drainage improvements for reducing internal flooding in the area as follows.

- Right embankment of Weras Ganga: 3.0km
- Improvement of main and secondary canals:
  - Kandawala area: Catchment Area (CA)=141 ha, L=1,506 m (Main canal), 2,653 m (Secondary canal)
  - Talawala area: CA=217 ha, L=1,530 m (Main canal), 2,424 m (Secondary canal)



Source: JICA Study Team

Figure 8.1.2 Proposed Project Sites (Moratuwa-Rathmalana Area)

8.1.2 Baseline of Environmental and Social Condition

Baseline conditions will be attached as an appendix.

8.1.3 Legal and Institutional Framework for Environmental and Social Considerations

8.1.3.1 Laws and Regulations Related to Environmental Consideration

In Sri Lanka, a number of laws, regulations and reference values relating to the field of environmental and social considerations have been formally established, and these laws and regulations need to be thoroughly checked when conducting an IEE/EIA. The table below summarizes the representative laws, regulations and references.

Table 8.1.1 Relevant Laws and Regulations in Sri Lanka

Law and regulations	Contents	Responsible institution
Constitution of Sri Lanka (Constitution of Sri Lanka, 1978)	Environment (Nature & living) stipulates that protection is the responsibility of the people.	-
National Environmental Act (NEA) 1980, and amendments on 1988, 2000	Laws underlying environmental protection. Central Environment Agency (CEA), specifying powers, functions, responsibilities, etc.	Central Environment Agency (CEA)
National Environmental Action Plan 1992-1996	Defines environmental measures for the 21st century and the measures to be taken in each sector (divided into 9 sectors)	Ministry of Environment (MoMDE)
<Notification under the NEA> "A Simple Guide to Strategic Environmental Assessment, CEA, 2008" "Guidance for Implementing the Environmental Impact Assessment Process, CEA, 2006"	Provides for matters relating to EIA-approved bodies, scoping methods, etc.	Central Environment Agency (CEA)
<Regulations under the NEA> Regulations for setting environmental standards (National Environmental Act, 1990)	Defines environmental standards and measurement methods for air quality, noise and water quality.	Central Environment Agency (CEA)
Forest Act, 1966 (Forest Act, 1966)	Defines designation and management policies for forest development, forest harvesting, forest products use and forest protection.	Forestry Department (DOF)

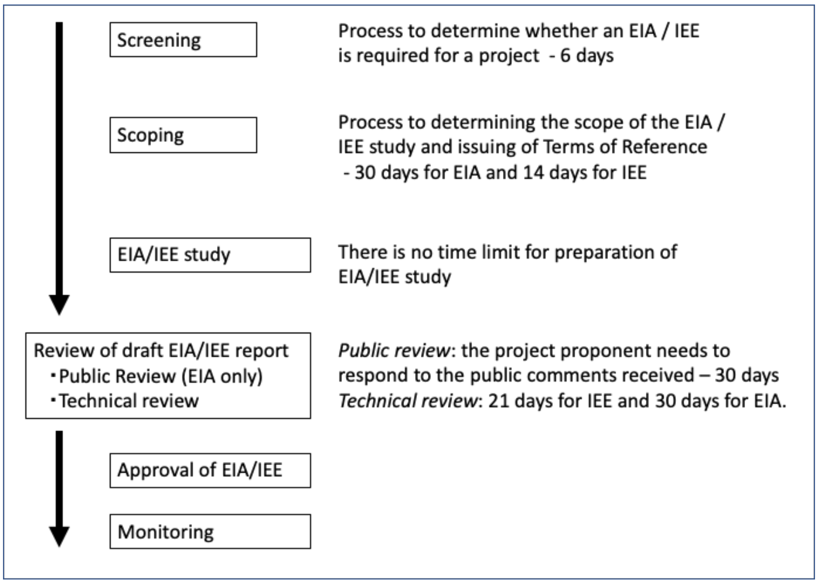
Law and regulations	Contents	Responsible institution
Fauna and Flora Protection Act, 1937	Provides for restrictions on commercial trade in plants and animals, and protection of the growth and habitat of plants and animals.	Central Environment Agency (CEA)
National Heritage and Wilderness Areas Act, 1988	Provides for the protection and management of unique ecosystems, genetic resources and rare flora and fauna in the context of nature conservation and wildlife protection.	Central Environment Agency (CEA) Ministry of Culture and the Arts (MoCA)
Fisheries and Aquatic Resources Act, 1996	Provides for the protection and management of fisheries resources in inland waters.	Ministry of Fisheries and Fisheries Management and Development
Monuments and Archaeological Sites and remains Act, 1958	Provides for the designation and management of historic cultural and natural heritage.	Central Environment Agency (CEA) Ministry of Culture and the Arts (MoCA)
Coastal Conservation Act No. 57/1981	Defines the administrative framework and licensing matters for the management and administration of coastal areas.	Ministry of Fisheries and Coastal Resources Development (MoFOR)
Land Acquisition Act, 1986	Defines designation and management policies for forest development, forest harvesting, forest products use and forest protection.	Ministry of Land and Land Development (MoLLD)
National Involuntary Resettlement Policy	Provides for restrictions on commercial trade in plants and animals and protection of the growth and habitat of plants and animals.	Ministry of Migration (MoR)

Source: JICA Study Team

8.1.3.2 Laws and Regulations Related to the Implementation of Proposed Improvements

(1) Legal Framework for Implementation of Pre-F/S Projects

In Sri Lanka, 'Prescribed Projects' under the provisions of the National Environment Act as described in the Official Gazette (Gazette No. 858/14 of 23 February 1995) are required to prepare and approve an Initial Environmental Evaluation (IEE) or Environmental Impact Assessment (EIA) are required to be prepared and approved. The Act states that “River basin development” constitutes a prescribed project, except for small irrigation projects.



Source: JICA Study Team

Figure 8.1.3 Flow of EIA/IEE in Sri Lanka

In addition, Projects (other than under emergency situation) involving involuntary resettlement of more than 100 households are also included in the 'prescribed projects' in the Official Gazette mentioned above. Furthermore, the National Involuntary Resettlement Policy (hereafter referred to as NIRP) introduced in 2001, requires the development of a resettlement action plan if there are 20 or more affected households.

It should be noted that projects to be implemented within Sanctuary are also included in the list of 'prescribed projects' and therefore either IEE or EIA will be required for Moratuwa-Rathmalana project. Determination on whether an IEE or EIA to be adopted will be made by screening procedure by the CEA presented in Figure 8.1.3; therefore, it is not possible to judge which will be applied before CEA’s judgement. Whereas, given that the Bellanwila Attidiya Sanctuary has been undergoing development since its designation as a sanctuary in 1990, and that some areas are being used as dumping sites and valuable ecosystems are no longer present. Therefore, it is unlikely that an EIA would be required for the project implementation within the area.

(2) Procedures to be followed in Implementing Pre-F/S Projects

The projects covered by Pre-F/S are priority projects in Mudun Ela sub-basin and Moratuwa-Rathmalana area. Specifically, the projects are (i) rehabilitation of main channel and secondary channels, rehabilitation of Peliyagoda pumping station and construction of gate in Mudun Ela sub-basin, (ii) construction of river embankments for flood protection, and (iii) drainage improvement for reducing internal flooding in Moratuwa-Rathmalana area. In order to ascertain whether these projects may be qualified as 'river development' and, if so, whether an EIA or IEE is required, a Basic Information Questionnaire, a screening procedure for IEE/EIA, was submitted to the CEA and an IEE/EIA The need for an IEE/EIA was screened. The results of the screening for each target basin/district are presented.

1) Mudun Ela Sub-basin improvement

A formal letter from the CEA notified that an IEE was not required for this project due to the size and nature of the project.

2) Moratuwa-Rathmalana area improvement

It was suggested that the environmental impact of the project is greater than Mudun Ela project due to the extent and scale of resettlement that would be induced by the project and the fact that the project is within Sanctuary. A letter from the CEA indicated that the project is currently in the Pre-F/S implementation stage, which does not provide the level of design required for an IEE/EIA review. Considering the response and other circumstances, IEE/EIA in accordance with Sri Lankan procedures was not conducted under this JICA funded project, and the SLLDC shall re-consult with CEA once the project implementation will be decided.

Therefore, in this Pre-F/S, IEE/EIA for both projects will not be processed in accordance with Sri Lankan procedures, but an IEE report will be prepared as reference for SLLDC, so it can be utilized when implementing the projects. Also, it should be noted that economic situation in the country made it difficult to conduct field survey for analyzing bio-physical environment, so secondary data was collected as much as possible. Whereas, field surveys were conducted focusing on social aspects, to formulate policy and plan for resettlement and land acquisition, including socio economic survey and discussion with local stakeholders.

8.1.3.3 Gap Analysis Between National Laws and JICA Guidelines

This section provides the gap between JICA guidelines for Environmental and Social considerations (2010) and relevant laws in Sri Lanka. Overall, there is no fundamental gap between them; nonetheless, some minor arose, such as 1) timing of conducting EIA study, 2) target of information disclosure and 3) criteria for public consultation. The result of gap analysis is presented.

JICA promulgated the new Guidelines for Environmental and Social Considerations as of 1 April 2010 (hereinafter referred to as “the JICA guidelines”), which came into effect on 1 July 2010. The Guidelines for Objection Procedures were also promulgated at the same time.

The Guidelines aim to encourage recipient countries to implement appropriate environmental and social considerations and to ensure appropriate implementation of JICA's environmental and social considerations support and confirmation by presenting JICA's responsibilities and procedures for environmental and social considerations and requirements. In this way, JICA strives to ensure the transparency, predictability and accountability of the environmental and social considerations assistance and confirmation provided by JICA. Therefore, all JICA funded project should be in compliance with JICA guidelines. The latest version of JICA guidelines were issued in January 2022, and they are applicable to projects requested after 1 April 2022. Therefore, JICA guidelines April 2010 version is applicable to this project.

Table 8.1.2 presents the results of the comparison between the JICA guidelines and Sri Lankan legislation, and recommendations for the project implementation to fill the gaps.

Table 8.1.2 Gap Analysis Between JICA Guidelines and National Legislation

JICA Guidelines	Relevant law in Sri Lanka	Gap and recommendations
Underlying principles		
Environmental impacts that may be caused by projects must be assessed and examined in the earliest possible planning stage. Alternatives or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	- According to the National Environment Act (NEA), Basic Information Questionnaire (BIQ) which is the preliminary information document that needs to be submitted to CEA or respective Project Approving Agency at an early stage of the project. Upon reviewing the BIQ (Scoping at site), the CEA or PAA determines the category of the project; Prescribed or Non-Prescribed and in case of a prescribed project, whether the project requires an Initial Environmental Examination (IEE), or an Environmental Impact Assessment (EIA) depending on the nature of the potential impacts. According to the NEA, no further environmental analysis is required for non-prescribed projects. In some cases limited environmental impact related is called for without going to the IEE or the EIA. - A chapter on Alternative Analysis is required in both IEE and EIA.	No major gap observed
Information Disclosure		
EIA reports must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining projects to residents, written materials must be provided in a language and form understandable to them; EIA reports are required to be made available to the residents of the country in which the project is to be implemented. The EIA reports are always required to be available for perusal by project stakeholders such as local residents and copying must be permitted	- In compliance with the NEA, Environment Impact Assessment (EIA) is opened to the public review for 30 working days. The final EIA report is made available in all three languages (Sinhala, Tamil and English) for the public in accessible places such as in relevant Divisional Secretariate Divisional offices and local authorities etc. - The comments and questions of stakeholders and the public should be addressed by the project proponent before the final conditional clearance is given. - In case of an IEE although it is not disclosed to public, translations are called for and ones published any interested part could obtain the IEE document from the CEA library. - Also, during the EIA or IEE process usually the information of the project is disclosed to public through Focus Group Discussions, formal or informal meetings.	No major gap observed
Social acceptability/Public consultation		
For projects with a potentially large environmental impact, enough consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The	- In NEA, this requirement is fulfilled through the public disclosure of the Environment Impact Assessment (EIA) for 30 working days which allows the public and stakeholders to review the final EIA report. After reviewing the public can submit their comments and questions to the PAA and these comments and questions should be addressed by the project proponent before the final conditional clearance is given.	No major gap observed. Although it is not specified in the NEA, public and stakeholder awareness and consultation is undertaken as a practice in Sri Lanka during the data collection and preparation of the EIA.

JICA Guidelines	Relevant law in Sri Lanka	Gap and recommendations
outcome of such consultations must be incorporated into the contents of project plans. In preparing EIA reports, consultations with stakeholders, such as residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared; Consultations with relevant stakeholders, such as residents, should take place, if necessary, throughout the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.	- The government agencies who act as stakeholders become the members of the Technical Evaluation Committee (TEC) appointed for the particular project by the PAA therefore they get involved in the EIA process throughout where stakeholders are allowed to review draft final and final EIA reports. - As affected persons of involuntary resettlement, etc., compensation target includes informal residents.	However, in the EIA reports usually there is no separate chapter as Public Consultation and Information disclosure. The required details will be included in Chapter 3 (The Existing Environment) under Social Environment.
Scope of impacts to be assessed-bio-physical environmental impacts-		
The impacts to be assessed about environmental and social considerations include impacts on human health and safety, as well as on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts.	- In compliance with the NEA, the PAA issues a TOR for the environmental assessment (IEE/EIA) with the help of the TEC appointed for the particular project. And the TOR requires to assess all possible impacts to the existing physical, biological and social environments due to the project by using appropriate impact assessment method. Each component is further subdivided to address specific environmental conditions of the project area.	No major gap observed.
Scope of impacts to be assessed-Socio-economic environment impacts		
These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety.	- In accordance with the NEA, the PAA, with the help of the TEC appointed for a particular project, issues a TOR for IEE/EIA. The TOR then requires that all possible impacts of the project on the existing physical, biological and social environment are assessed, using appropriate impact assessment methods. Each component is further subdivided to address the specific environmental conditions of the project area. - As per the NEA, projects which resettles more than 100 households are categorized as prescribed project to specifically assess the possible socio-economic impacts. - Further, in general, TOR issued by the PAA under the NEA specifies the requirement of assessing social impacts in the form of social impact assessment where impacts due to involuntary resettlement, livelihood impacts, impacts to vulnerable social groups, cultural heritage, indigenous people etc. are required to be assessed and feasible mitigation measures to be proposed in the EIA.	No major gap observed.
Monitoring		
Project proponents should make efforts to make the results of the monitoring process available to local project stakeholders.	- The project proponent is required to present a monitoring program in the EIA/IEE which is implemented in the project cycle. This program outlines the requirement of	Local regulation does not require to make results of the monitoring (e.g. - monitoring progress reports)

JICA Guidelines	Relevant law in Sri Lanka	Gap and recommendations
When third parties point out, in concrete terms, that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents etc. should make efforts to reach an agreement on procedures to be adopted with a view to resolving problems.	monitoring of changes in environmental parameters such as water quality, air quality etc. due to the project, monitoring of compliance with the EIA, institutional arrangement required and reporting of progress of monitoring. - In addition, PAA also forms a monitoring body generally consisting of stakeholders who take apart in the TEC to carry out periodical monitoring as an external monitoring body.	available for public and stakeholders. However ,this information could be provided to public if requested by CEA . If such a request is made under the Right to Information Act it is more likely that the CEA will provide it to the requested person. If such information is not provided the person who request the information could have recourse to the specified appellate procedure.
Ecosystem and biota		
Projects must not involve significant conversion or degradation of critical natural habitats and critical forests.	- TOR of the PAA requires to conduct ecological assessments to identify existing ecosystems and biota and possible impacts and necessary mitigation measures. Here, mitigation measures (specially by design) are recommended to minimize impacts to animal behavior, significant conversion, or degradation of natural habitats. - Such degradation is prohibited by various acts and statutes (e.g., Wildlife Act, Forest Ordinance etc.)	No major gap observed.

Source: JICA Study Team

8.1.3.4 Institutional Setting Relevant to Environmental and Social Considerations

In 1980, the Central Environmental Agency CEA was established under the Environmental Protection Act for the purpose of formulating policies related to environmental protection and management and coordinating between relevant ministries and agencies on environmental measures, and the 1988 amendments to the Act positioned the Ministry of Environment as the policy-making body for environmental protection and management and the Central Environmental Agency as the implementation body for measures formulated by the Ministry. The 1988 amendments to the Environmental Protection Act made an EIA/IEE mandatory for the whole country, and the amendments to the Act stipulate that the CEA is responsible for its jurisdiction.

The amendments to the Act also define the scope of the CEA's jurisdiction in relation to EIA/IEE, and the CEA is to prepare the necessary guidelines for the review of EIA/IEE, determine the EIA/IEE Approving Agencies (Project Approving Agencies, hereinafter PAA), and be responsible for guidance and supervision. The EIA/IEE is responsible for the guidance and oversight of the EIA/IEE.

The PAA guides and supervises the preparation of EIAs / IEEs by operators to ensure that they are prepared in accordance with procedures based on the EIA / IEE guidelines set out by the CEA, and finally examines the content prepared and submitted and issues approval or non-approval letters.

As the implementing agency of the project, SLLDC should conduct EIA/IEE as necessary. It is assumed that both personnel and experience in environmental and social considerations are adequate, as SLLDC has an environmental considerations section, and it has sufficient experience to conduct EIA/IEE and Resettlement Action Plan (hereinafter referred to as RAP).

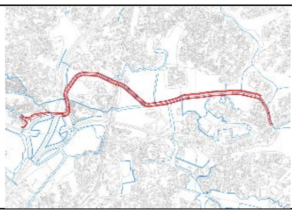
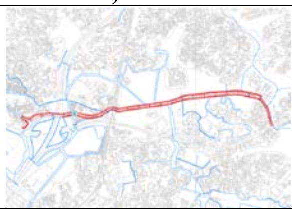
8.1.4 Comparison of Alternatives

8.1.4.1 Mudun Ela Sub-basin project

If the project will not be implemented (zero option), the drainage situation in the project area will not improve and will continue to be affected by flooding and other impacts during rainfall, so implementation of the project is essential.

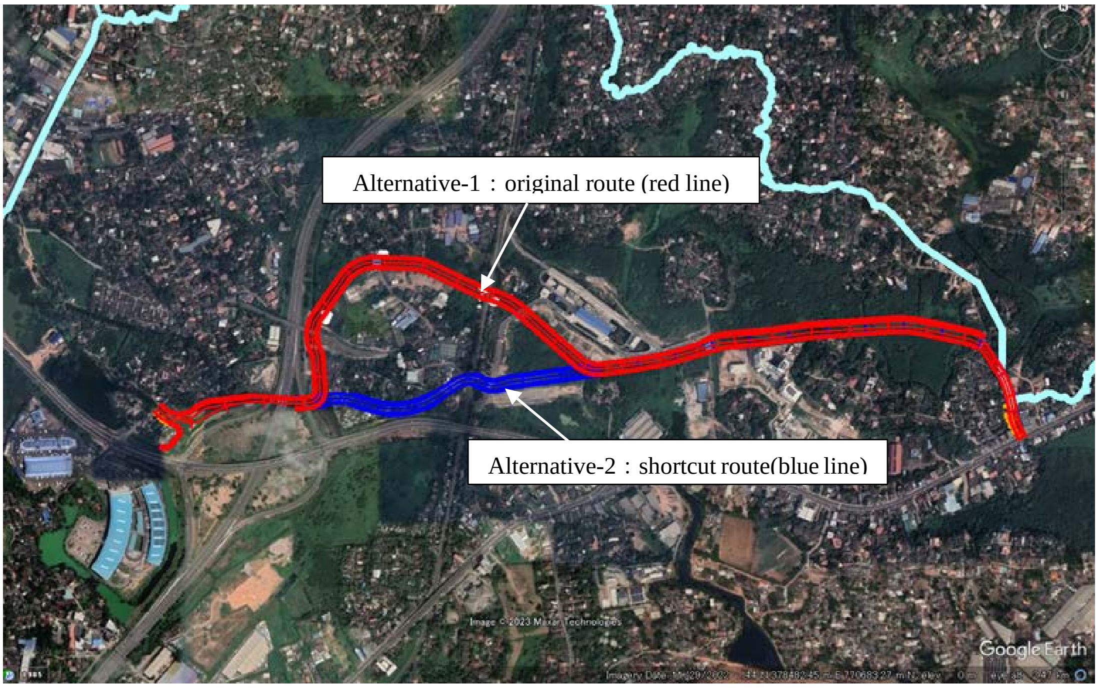
The alternative 1 (original route proposed in the M/P) and alternative 2 (shortcut) are also considered as presented in Figure 8.1.4. As the number involuntary resettlements and the impact to community facilities are expected to be larger for alternative 2, alternative 1 is judged to be appropriate.

Table 8.1.3 Results of the Comparative Study of Alternatives (Mudun Ela)

Items	Detailed items	Alternative-0	Alternative-1 (Selected in Pre-F/S)	Alternative-2
Outline of the work	Features.	Projects not implemented	Widening of existing channels, embankments and riverbed excavation	Widening of existing channels, embankments and riverbed excavation (Partial short-cut construction)
	Plan	-		
	Structural feature	Existing water channels (concrete, gabion, excavation without timbering))	Gabion revetments, U-shaped ditches, turf-lined slow-sloping revetments, (Steel sheet pile earth retaining at constricted areas, steel sheet pile revetments).	Same as the left
Land use	Land use	Dense dwellings, business premises, warehouses, wetlands	Same as on the left	Same as the left
	Consistency with urban development plans	Urbanized areas are partially present along river channels. Most of the other areas are wetlands, but there are development plans in almost all areas.	The river channel flows through urban areas and future development sites. This measure is desirable as it will improve the drainage situation in the development site	Same as the left
Effectiveness of mitigation works in reducing damage.		162 ha is inundated by the design rainfall (10 years).	Same as on the left	Same as the left
Mitigation work (only main river)	Main construction work and quantities	-	Excavation: 37,200 m^3 Gabion: 13,600 m^3 SSP revetment: 3,500 m^2	Excavation: 40,000 m^3 Gabion: 5,300 m^3 SSP revetment: 9,400 m^2
	Approximate construction costs	-	1.06 million LKR	1.08 million LKR
Effectiveness of mitigation works in reducing damage.			Inundated area becomes 95 ha from 162 ha.	Same as the left
Impact on surrounding area	Natural environment	-	Small	Same as the left
	Social Environment (Before construction phase)	-	Number of houses relocated：64 Number of residents to be relocated：16	Number of houses relocated：156 Number of residents to be relocated：44 Some large warehouse complexes (industrial facilities)

Items	Detailed items	Alternative-0	Alternative-1 (Selected in Pre-F/S)	Alternative-2
				or temples need to be relocated, which is very difficult
	Social Environnent (Construction phase)	-	Noise and vibration from heavy machinery operations and traffic safety needs to be ensured (more vibration and noise than Plan-2 as it involves sheet pile works, but, it is a common method of construction in urban areas).	Same as the left
Evaluation		Countermeasure works required	Construction costs are lower than Plan- 2 and the scale of relocation is smaller and more realistic to implement.	Construction costs are slightly higher than Plan 1 and the scale of the relocation makes it infeasible to implement.
		Not good	Good	Not good (very difficult)

Source: JICA Study Team



Source: JICA Study Team

Figure 8.1.4 Alternatives Study (Mudun Ela Sub-basin Projecct)

8.1.4.2 Moratuwa-Rathmalana Area

The project aims to construct river dike for flood protection and improve drainage to reduce inundation in the area. The study of alternatives for each of the dike construction and drainage improvement projects is presented below.

If the project will not be implemented (zero option), social impacts such as resettlement can be avoided, but the drainage situation in the project area will not improve and the project will continue to have negative impacts in the future on a wide area within the project area, such as large-scale damage caused by unexpected rainfall due to the effects of climate change in the future. Therefore, it is essential to implement the project.

(1) Dike Construction

It was anticipated that a large amount of resettlement was likely to occur on the right bank of the Weras Ganga by the construction of the dike. JICA Study Team considered several alternatives such as embankment height, extension, etc., and the result is shown in Table 8.1.4. The team finally adopted the dike proposal (Alternative-2) that would result in the least number of resettlements.

Table 8.1.4 Results of the Comparative Study of Alternatives (Moratuwa-Rathmalana: Right Bank Dike)

Items	Detailed item	Alternative-0	Alternative-1	Alternative-2 (Selected in Pre-F/S)
Outline of the work	Features.	Projects not implemented	Dike layout at elevation +1.0 m	Embankment layout at +1.0 m elevation and partially at +0.5 m
	Structural feature	-	Dike + 50 cm concrete parapet (for margin height)	Embankment + 50 cm concrete parapet (for margin height)
Land use	Land use	Natural riverbanks, wetlands, dense dwellings, business premises, and warehouses	Same as the left	Same as the left
	Consistency with urban development plans	largely urbanized, flood control in Weras Ganga is an urgent issue to be solved.	This countermeasure works is a desirable flood control measure in urban areas.	Same as the left
Overview of damage without mitigation measures		53 ha is inundated by the design rainfall (25 years).	Same as the left	Same as the left
Mitigation work	Main construction work and quantities	-	Embankment: 13,900 m^3 Concrete: 790 m^3	Embankment: 10,700 m^3 Concrete: 790 m^3
	Approximate construction costs	-	165 million LKR	156 million LKR
Effectiveness of mitigation works in reducing damage.		-	No area will be inundated.	Same as the left
Impact on surrounding area	Natural environment	-	Minimal impact on water bodies since the installation is on land. Construction will take place in the north, in Bellanwila Attidiya sanctuary, but the impact will be small as construction will take place along an already urbanised area..	The impact on water bodies is small, as the permanent water surface is around 0.5 m to 0.6 m above sea level and the installation is partly at the water's edge but mainly on land. Construction will take place in the north, in Bellanwila Attidiya sanctuary, but the impact will be small as construction will take place along an already urbanised area.
	Social Environment(Before construction phase)	-	Number of houses relocated：63 Number of residents to be relocated：252	Number of houses relocated：15 Number of residents to be relocated：60
	Social Environment(Construction phase)	-	Noise and vibration caused by the operation of heavy machinery during construction, and the need to ensure safety in traffic	Same as the left
Evaluation		Countermeasure works required	Construction costs are smaller than Plan-2, but the scale of relocation is large and relatively difficult to implement.	Construction costs are larger than Plan-1, but the scale of relocation is smaller and implementation is more realistic.
		Not good	Not good (very difficult)	Good

Source: JICA Study Team

(2) Drainage Improvement

For the drainage improvement proposal, the following alternatives were proposed: no implementation of the existing project, widening of the existing channel and riverbed excavation as Alternative 1, and similar channel widening as Alternative 2, but with an arrangement that avoids buildings as much as possible. As a result of the comparison, Alternative 2, which minimized the relocation of residents, was expected to have a positive effect on the project, so Alternative 2 was adopted as the best alternative.

Table 8.1.5 Results of the Comparative Study of Alternatives (Moratuwa-Rathmalana: Drainage Improvement)

Items		Alternative-0	Alternative-1	Alternative-2 (Selected in Pre-F/S)
Outline of the work	Features.	Projects not implemented	Widening of existing channel (both directions) and riverbed excavation	Widening of existing channel(Arrangement to avoid buildings where possible) and riverbed excavation
	Structural feature	Existing water channels (concrete, gabion, excavation without timbering))	Gabion revetments, U-shaped ditches, turfed slow-sloping revetments	Gabion revetments, U-shaped ditches, turfed slow-sloping revetments (steel sheet pile earth retaining and steel sheet pile revetment at the constriction site).
Land use	Land use	Dense dwellings, business premises, warehouses, wetlands	Same as the left	Same as the left
	Consistency with urban development plans	The area is already largely urbanized. Drainage improvements are an urgent issue.	This measure will improve the urban drainage situation and is desirable.	Same as the left
Overview of damage without mitigation measures		2.12 ha is inundated by the design rainfall (10 years - 5 years).		Same as the left
Mitigation work	Main construction work and quantities	-	Concrete channel：4,800 m^3 Gabion: 3,550 m^3	Concrete channel：4,800 m3 Gabion：3,440 m^3 Steel sagging revetment: 500 m^2
	Approximate construction costs	-	521 million LKR	728 million LKR
Effectiveness of mitigation works in reducing damage.		-	Inundated area becomes 0.80 ha from 2.12 ha.	Same as the left
Impact on surrounding area	Natural environment	-	Small	Small
	Social Environment(Before construction phase)	-	Number of houses relocated：56 Number of residents to be relocated：224	Number of houses relocated：18 Number of residents to be relocated：72
	Social Environnent (Construction phase)	-	Noise and vibration caused by the operation of heavy machinery during construction, and the need to ensure safety in traffic	Noise and vibration caused by the operation of heavy machinery during construction, and the need to ensure safety in traffic More vibration and noise than Alt 1 because of the sheet pile works involved, but it is a common method of construction in urban areas.
Evaluation		Countermeasure works required	Construction costs are smaller than Plan-2, but the scale of relocation is large and difficult to implement.	Construction costs are larger than Plan 1, but the scale of relocation is smaller, and implementation is more realistic.
		Not Good	Not good (very difficult)	Good

Source: JICA Study Team

8.1.5 Scoping and the TOR of the Environmental and Social Considerations Survey

8.1.5.1 Scoping results

(1) Mudun Ela Sub-basin project

Scoping of survey items for the projects recommended above, including the reasons for evaluation, envisaged in the implementation of the project is presented in Table 8.1.6. The project envisages the expansion of the existing watercourse and the rehabilitation of the pumping station, and no major works are planned, which indicates that the impact of this project will not be significant.

Table 8.1.6 Scoping Results (Mudun Ela Sub-basin)

	Item	Rating		Reasons
		CP*	OP*	** CP: Construction Phase, OP: Operation Phase*
Pollution Control				
1	Air Quality/Dust	✓		During construction: temporary deterioration of air quality is expected due to the operation of construction equipment, etc. Operation phase: no air quality impacts are of concern.
2	Water quality	✓	✓	During construction: Water quality is expected to be affected by the construction work due to excavation in the drainage canal. In addition, there is a possibility of water pollution due to wastewater from the construction site, heavy machinery, vehicles, and construction camps. Operation phase: Drainage functions will be improved, but there are concerns about the impact of rainfall on water quality in downstream rivers.
3	Waste/hazardous substances	✓		During construction: construction overburden and waste materials are expected to be generated. Operation phase: no waste is expected to be generated that would affect the surrounding environment.
4	Soil pollution	✓		During construction: possible soil contamination due to construction oil spills, etc. Operation phase: there is no concern about the impact of the project.
5	Noise and vibration	✓		During construction: noise due to operation of construction equipment and vehicles is expected. Operation phase: no impacts are foreseen from the project.
6	Subsidence			During construction/Operation phase: no concerns about impact on land subsidence.
7	Offensive Odors			During construction/Operation phase: no impact on odour is of concern.
8	Sediment	✓		During construction: construction work will be carried out in the river channel, which is expected to have an impact on the bottom sediment. Operation phase: no activities are envisaged that would alter the bottom sediment.
Natural (physical) environment				
9	Protected area			During construction/Operation phase: there are no national parks, protected areas, etc. in and around the project site.
10	Ecosystem/Flora and Fauna	✓	✓	During construction/Operation phase: the project site and its surroundings are in the vicinity of urban drainage channels, and no notable ecosystems are considered to exist in the targeted conduits, but general ecological impacts may occur.
11	Hydrography	✓	✓	During construction: widening of drainage channels may cause temporary changes in water flow and river beds of rivers and other watercourses. Operation phase: construction of new drainage channels may change the flow regime.
12	Topography/ geography			Under construction/Operation phase: the project is the rehabilitation of the existing drainage and pumping station, and no major cut and fill is planned, so no topographical or geological impacts are envisaged.
Social environment				
13	Land Acquisition/ resettlement	✓		Before construction: at the time of planning: small-scale resettlement is expected to occur due to land acquisition for river improvement. Operation phase: no additional land acquisition or resettlement is envisaged after the start of service.
14	Poor	✓		Before construction: the poor may be included among those to be relocated. Operation phase: no activities are envisaged that will have an impact on the additional poor after Operation phase.

	Item	Rating		Reasons
		CP*	OP*	* CP: Construction Phase, OP: Operation Phase
15	Ethnic minorities/indigenous peoples			Under construction/Operation phase: the project targets urban areas, and no ethnic minorities or indigenous peoples have been identified in or around the project site.
16	Local economy, including employment and means of livelihood	✓	✓	During construction: employment due to construction may increase the income of local workers and temporarily improve their livelihoods. Operation phase: The negative impacts of flooding and other inundation are reduced, resulting in stable economic benefits.
17	Land use and local resource use			Under construction/Operation phase: the project is a rehabilitation of existing drainage channels and facilities and is not expected to have any impact on land use or local resource use.
18	Water use	✓		During construction: if there is water use in the vicinity of the project site, e.g. in rivers, the impact of turbid water during construction is possible. Operation phase: drainage functions will be enhanced after project implementation, but no impact on water use is envisaged.
19	Existing social infrastructure and social services	✓	✓	During construction: traffic congestion is expected during construction. Operation phase: existing infrastructure and social services are expected to improve compared to pre-project levels due to improved drainage functions.
20	Social institutions such as social capital and local decision-making institutions			During construction/Operation phase: the project is a rehabilitation of the existing drainage system and is not expected to have any impact on social capital or local decision-making bodies.
21	Misdistribution of benefits and damages			During construction/Operation phase: the project does not envisage any major construction works, but the project aims to improve drainage conditions during rainfall in the surrounding area and is expected to have a positive impact on all residents of the catchment. The project is not expected to cause inequitable damage and benefits.
22	Local conflict of interests			During construction/Operation phase: the project is not expected to cause conflicts of interest within the area, as the project aims to improve the drainage situation during rainfall in the surrounding area and the drainage situation of the whole basin will be improved.
23	Cultural heritage			During construction/operation: no cultural heritage sites are located in the project site and its surroundings.
24	Landscape			During construction/Operation phase: the project is a renovation of an existing facility and is not expected to have an impact on the landscape.
25	Gender		✓	During construction/ Operation phase: no specific negative impacts on gender from the project are envisaged, but positive impacts due to flood protection are expected after the project is operation phase.
26	Children's rights	✓	✓	During construction: there are concerns about the impact of vehicle operations during construction on safety during commuting to and from school. Operation phase: no specific negative impacts on children's rights are expected from the project, but positive impacts from flood defenses are expected.
27	Risks of infectious diseases such as AIDS/HIV	✓		During construction: no major construction work is envisaged, but the influx of construction workers could spread infectious diseases. Operation phase: no specific impact on infectious diseases is envisaged as a result of the refurbishment of existing facilities.
28	Occupational health and safety (Working environment)	✓		During construction: the working environment of construction workers needs to be taken into account. Operation phase: no operations are planned that could have a negative impact on workers during the operation phase.
Other s				
29	Accident	✓		During construction: traffic accidents and other accidents are expected to occur due to the increase in construction machinery and construction vehicles during construction. Operation phase: no work is planned during the operation phase where accidents could be expected.

	Item	Rating		Reasons
		CP*	OP*	* CP: Construction Phase, OP: Operation Phase
30	Transboundary impacts, and climate change change			During construction/Operation phase: as the project is a renovation of an existing facility and is not large in scale, no transboundary impacts, climate change-related impacts, etc. are envisaged.

*Impact items for this scoping proposal were selected with reference to JICA guidelines and other sources.
Source: JICA Study Team

(2) Moratuwa-Rathmalana area project

Same as the Mudun Ela Sub-basin, scoping result of the Moratuwa-Rathmalana area project is presented in Table 8.1.7.

Table 8.1.7 Scoping Results (Moratuwa-Rathmalana Area)

	Item	Rating		Reasons
		CP*	OP*	* CP: Construction Phase, OP: Operation Phase
Pollution Control				
1	Air Quality/Dust	✓		During construction: temporary deterioration of air quality is expected due to the operation of construction equipment, etc. Operation phase: no air quality impacts are of concern.
2	Water quality	✓	✓	During construction: Water quality is expected to be affected by construction due to excavation in the drainage channel and along the Weras Ganga. In addition, there is a possibility of water pollution due to wastewater from the construction site, heavy machinery, vehicles, and construction camps. Operation phase: Drainage functions will be improved, but there are concerns about the impact of rainfall on water quality in downstream rivers.
3	Waste/hazardous substances	✓		During construction: construction overburden and waste materials are expected to be generated. In particular, construction overburden may be generated for the construction of embankments, and re-use, etc. should be considered.
4	Soil pollution	✓		Operation phase: no waste is expected to be generated that would affect the surrounding environment.
5	Noise and vibration	✓		During construction: possible soil contamination due to construction oil spills, etc.
6	Subsidence			Operation phase: there is no concern about the impact of the project.
7	Offensive Odors			During construction: noise due to operation of construction equipment and vehicles is expected.
8	Sediment	✓		Operation phase: no impacts are foreseen from the project.
Natural (physical) environment				
9	Protected area	✓	✓	During construction/Operation phase: the project site alters part of the Bolgoda Environmental Protection Area (CEA management), but the implementation of the project within this Protection Area is not regulated and no special permits or approvals are required to implement the project.
10	Ecosystem/Flora and Fauna	✓	✓	Under construction/Operation phase: the project site and its surroundings are designated as Bolgoda Environmental Protection Area and have special ecosystems such as wetland ecosystems, which may be affected by the construction of embankments along the Weras Ganga and other projects.
11	Hydrography	✓	✓	During construction: construction work in the area adjacent to Weras Ganga may cause temporary changes in water flow and river beds and other watercourses.
12	Topography/ geography	✓	✓	Operation Phase: flow regime may change due to embankment structures.
Social environment				
13	Land Acquisition/ resettlement	✓		Before construction: at the time of planning: it is assumed that the relocation of residents and land acquisition for river improvement will result in a relatively large relocation of residents. The exact number of people to be relocated is currently assumed to be around 200 or less.
14	Poor	✓		Operation phase: no additional land acquisition or resettlement is envisaged after the start of service.

	Item	Rating		Reasons
		CP*	OP*	* CP: Construction Phase, OP: Operation Phase
15	Ethnic minorities/indigenous peoples			Before construction: the poor may be included among those to be relocated.
16	Local economy, including employment and means of livelihood	✓	✓	During construction: employment due to construction may increase the income of local workers and temporarily improve their livelihoods. Operation phase: once Operation phase, the negative impacts of flooding and other inundation are reduced, resulting in stable economic benefits.
17	Land use and local resource use	✓	✓	Under construction/Operation phase: the project will construct an embankment along the Weras Ganga, and there are concerns about the impact on land use and local resource use.
18	Water use	✓		During construction: if there is water use in the vicinity of the project site, e.g. in rivers, the impact of turbid water during construction is possible. Operation phase: the drainage function will be enhanced after the project is implemented, but it is the drainage channels that are targeted and water use is not expected to be affected.
19	Existing social infrastructure and social services	✓	✓	During construction: traffic congestion is expected during construction. Operation phase: existing infrastructure and social services are expected to improve compared to pre-project levels due to improved drainage functions.
20	Social institutions such as social capital and local decision-making institutions			During construction/Operation phase: the project is a rehabilitation of the existing drainage system and is not expected to have any impact on social capital or local decision-making bodies.
21	Misdistribution of benefits and damages			During construction/Operation phase: the project does not envisage any major construction works, but the project aims to improve drainage conditions during rainfall in the surrounding area and is expected to have a positive impact on all residents of the catchment. The project is not expected to cause inequitable damage and benefits.
22	Local conflict of interests			Under construction/Operation phase: the project aims to improve the drainage situation during rainfall in the surrounding area and is expected to have a positive impact on all basin residents, as it will improve the drainage situation of the entire basin. On the other hand, less than 200 people will be resettled, including those who do not own land rights, and there are concerns that conflicts of interest between resettled and non-settled residents may arise during the resettlement and land acquisition stages.
23	Cultural heritage			During construction/operation: no cultural heritage sites are located in the project site and its surroundings.
24	Landscape			During construction/Operation phase: the project is expected to have an impact on the landscape along the Weras Ganga due to the construction of an embankment.
25	Gender		✓	During construction/ Operation phase: no specific negative impacts on gender from the project are envisaged, but positive impacts due to flood protection are expected after the project is Operation phase.
26	Children's rights	✓	✓	During construction: there are concerns about the impact of vehicle operations during construction on safety during commuting to and from school. Operation phase: no specific negative impacts on children's rights are expected from the project, but positive impacts from flood defenses are expected.
27	Risks of infectious diseases such as AIDS/HIV	✓		During construction: no major construction work is envisaged, but the influx of construction workers could spread infectious diseases. Operation phase: no specific impact on infectious diseases is envisaged as a result of the refurbishment of existing facilities.
28	Occupational health and safety (Working environment)	✓		During construction: the working environment of construction workers needs to be taken into account. Operation phase: no operations are planned that could have a negative impact on workers during the operation phase.
Others				
29	Accident	✓		During construction: traffic accidents and other accidents are expected to occur due to the increase in construction machinery and construction vehicles during construction. Operation phase: no work is planned during the operation phase where accidents could be expected.

	Item	Rating		Reasons * CP: Construction Phase, OP: Operation Phase
		CP*	OP*	
30	Transboundary impacts, and climate change change			During construction/Operation phase: as the project is a renovation of an existing facility and is not large in scale, no transboundary impacts, climate change-related impacts, etc. are envisaged.

*Impact items for this scoping proposal were selected with reference to JICA guidelines and other sources.

Source: JICA Study Team

8.1.6 Results of Environmental and Social Considerations Survey

In this study, due to the impact of COVID-19 pandemic and the economic situation in Sri Lanka, it was difficult to conduct measurements and analysis etc. through environmental surveys, and being an IEE, it was difficult to conduct field surveys on the environment, so secondary data was collected. For water quality, initially a field survey and laboratory analysis were planned, but due to the economic situation in Sri Lanka, it was deemed difficult to conduct a correct water quality survey due to the maintenance of water quality analysis equipment and shortage of reagents in the country at the time of the survey, so only a visual survey was conducted in the field. In addition, surveys related to resettlement and land acquisition were covered by field surveys and interviews, while flora and fauna surveys were covered by field trudging and collection of secondary data.

8.1.7 Assessment of Environmental and Social Impact of the Projects

8.1.7.1 Mudun Ela Sub-basin project

For the project, based on the secondary documents collected and the results of the field visits. The environmental impact assessment was conducted as follows.

Table 8.1.8 Environmental Impact Assessment (Mudun Ela Sub-basin)

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
Pollution Control						
1	Air Quality/Dust	✓		B-	N/A	During construction: although temporary deterioration of air quality is expected due to the operation of construction equipment, etc., the project is small-scale and is expected to meet the national reference value and international reference values. Operation phase: as the project is a rehabilitation of the drainage and pumping station, no significant increase in traffic is expected after the project is Operation phase and no impact is envisaged.
2	Water quality	✓	✓	B-	B-	During construction: Water quality is expected to be affected by construction due to excavation in the drainage channel. In addition, there is a possibility of water pollution due to wastewater from the construction site, heavy machinery, vehicles, and construction camps. Since this is not a large-scale project, the impact is expected to be limited, but adequate environmental protection measures. Operation phase: The drainage function will be improved and the amount of wastewater discharged downstream will increase, but since this is not a large-scale project, the impact is expected to be limited. Monitoring and adequate environmental protection measures will be required.
3	Waste/hazardous substances	✓		B-	N/A	During construction: construction waste is generated during construction and needs to be properly disposed of. Operation phase: this project is not envisaged as it is a rehabilitation of the existing drainage and pumping station and is not a waste-generating project.
4	Soil pollution	✓		B-	N/A	During construction: possible soil contamination due to spills of construction oil, etc. Thorough maintenance of construction equipment and vehicles, management of oil, etc. is recommended. Operation phase: the project is a rehabilitation of the existing drainage and pumping station, and there is no concern about the impact of these operations on the soil.
5	Noise and vibration	✓		B-	N/A	During construction: as the project implementation area is adjacent to residential areas, noise and vibration due to the operation of construction equipment and vehicles during construction is expected to occur, so mitigation

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
						measures such as setting construction implementation times and decentralizing work are desirable.
6	Subsidence			N/A	N/A	No impact is envisaged.
7	Offensive Odors			N/A	N/A	No impact is envisaged.
8	Sediment	✓		B-	N/A	During construction: there is concern that the modification of drainage channels will have an impact on sediment quality. Operation phase: no significant impact on sediment is envisaged.
Natural environment						
9	Protected area			N/A	N/A	No protected areas are located in the vicinity and therefore no impacts are envisaged.
10	Ecosystem/Flora and Fauna	✓	✓	B-	B-	During construction & Operation phase: the existing survey sites have already been urbanized and no notable ecosystems etc. have been identified. In the future, if necessary, when the IEE survey confirms the presence of important species, etc., it is desirable to monitor the effectiveness of conservation measures for the respective species and take action from the perspective of ecosystem protection, such as adding mitigation measures if necessary.
11	Hydrography	✓	✓	B-	B+	During construction: excavation in the watercourse for drainage channel rehabilitation will take place, which will have an impact on water elephants. When Operation phase: as the area has suffered from flood damage for a long period of time, the project will improve the operational status of the drainage system, which will be properly managed to control flood damage.
12	Topography/ geology			N/A	N/A	During construction: widening of the drainage channel may cause topographical changes at the excavation and downstream of it due to instability of the channel banks and bed material, but the area altered is limited and no significant impact is envisaged.
Social environment						
13	Land Acquisition/ resettlement	✓		A-	N/A	During construction: land needs to be secured for the rehabilitation of the waterway, which will result in resettlement and land acquisition. At present, a resettlement plan has not been drawn up because the implementation of the project has not been finalized, but it is urgent to draw up a resettlement plan to inform the relevant parties when the implementation of the project is clear and to avoid illegal resettlement measures. Operation phase: no additional site collection is expected to occur and no impact will occur.
14	Poor	✓		B-	A+	Pre-construction: small-scale resettlement will occur and there is concern about the impact on the poor if the resettled population includes illegal residents who do not own land rights. Operation phase: no additional land acquisition etc. is envisaged, so no impact is of concern.
15	Ethnic minorities/indigenous peoples			D	N/A	Construction & Operation phase: no impact is envisaged as no indigenous minority settlements requiring special protection have been identified in the project area.
16	Local economy, including employment and means of livelihood	✓	✓	B+	A+/ B-	Before and during construction: no impacts are expected at this stage as no projects are planned to occur that will have a negative impact on the local economy, such as resettlement. Temporary positive impacts on the local economy are expected due to increased commercial/employment opportunities generated by construction activities during construction. Operation phase: the project is expected to have an indirect positive impact on the local economy of the project area as a result of enhanced drainage measures. In the long term, the project is expected to increase commercial/employment opportunities due to the growth of the local economy in the project implementation area. On the other hand, negative impacts may occur after the completion of construction works due to the termination of temporary employment opportunities for local workers.
17	Land use and local resource use					Construction & Operation phase: the project is a rehabilitation of existing drainage channels and facilities and is not expected to have any impact on land use or local resource use.

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
18	Water use	✓		B-	N/A	During construction: if there is water use in rivers, etc. in the vicinity of the project site, the impact of turbid water during construction is possible. Although water use was not confirmed in the field survey, it is assumed that houses, etc. along rivers and drainage channels where water supply is not available may use these water sources. It is desirable that water abstraction and water rights during construction are properly managed, and it is necessary to hold briefing sessions with relevant stakeholders on the impacts during construction and share information in advance. Operation phase: the drainage function will be enhanced after the project is implemented, but it is the drainage channels that are targeted and water use is not expected to be affected.
19	Existing social infrastructure and social services	✓	✓	B-	A+	Before construction :Land acquisition will occur, but is limited and no significant impact is expected. During construction :Temporary impact on social infrastructure and services may occur due to traffic congestion caused by construction yards, worker accommodation setup and increased number of construction vehicles. Operation phase: no negative impacts of the project on the surrounding area are foreseen, but the project is expected to make a significant contribution to improved social services through the sustainable use of water resources and flood protection.
20	Social institutions such as social capital and local decision-making institutions			N/A	N/A	No impact is assumed.
21	Misdistribution of benefits and damages			B-	A+	During construction: there is a risk of uneven distribution of harm and benefits in construction activities, e.g. commercial opportunities with construction stakeholders. Operation phase: the effects of the project on sustainable use of water resources and flood protection will be equally enjoyed.
22	Local conflict of interests			B-	B-	Before construction & Operation phase: there will be relocation of about 20 houses, etc., but conflicts of interest can be avoided if relocation procedures are properly implemented. During construction: conflicts of interest between beneficiaries and affected residents may arise within the area, e.g. due to uneven distribution of damage and benefits before and during construction and during service, but the impact is small as the construction works are small.
23	Cultural heritage			N/A	N/A	No impact is assumed.
24	Landscape			N/A	N/A	No impact is assumed.
25	Gender		✓	N/A	A+	During construction: no impact from the project is expected. Operation phase: the project is expected to contribute to improving the livelihoods of socially vulnerable women. On the other hand, with regard to the employment of construction workers, it is desirable to have as good a gender balance as possible, such as active employment of women workers for light duty workers. (installation of women-only outdoor toilets, management of safety systems) is desirable to create a system that allows women workers to engage in the project safely.
26	Children's rights	✓	✓	B-	A+	During construction: no significant impact is foreseen from the project. The construction work may affect school routes in neighboring villages, depending on the construction route and other factors. The impact can be minimized by ensuring safety education and training for drivers of construction vehicles and strict adherence to speed. Operation phase: the improved capacity of the drainage channels due to the project will contribute to improving the lives of vulnerable children in society.
27	Risks of infectious diseases such	✓		B-	N/A	During construction: due to the expected impact on public health due to the large influx of construction workers, mitigation measures are required, such as the provision of a sufficient number of toilets exclusively for construction workers and the implementation of hygiene training programs for workers.

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
	as AIDS/HIV					In addition, an increased risk of sexually transmitted infections (STD/STI) and HIV/AIDS between workers and the local population is expected.
28	Occupational health and safety (Working environment)	✓		B-	N/A	During construction: attention needs to be paid with regard to the occupational health and safety of construction workers. Operation phase: attention should be paid to the occupational health and safety of workers involved in the maintenance and upkeep of existing facilities. In particular, as composting and sand removal work is carried out around the dam lake, sufficient attention should be given to safety, for example by requiring workers to wear safety belts, life jackets and other safety equipment during the work.
Others						
29	Accident	✓		B-	N/A	During construction: increased risk of accidents due to the operation of construction equipment and the driving of construction vehicles is expected. Minimize the occurrence of accidents through proper safety management during construction in accordance with Sri Lanka's labor laws. As the risk of accidents with the general public is also increased around the construction route, the impact will be minimized by ensuring safe driving through safety training programs for construction workers and by taking appropriate environmental mitigation measures, such as installing sign boards indicating the construction site. Operation phase: no impact
30	Transboundary impacts, and climate change			B-	N/A	During construction: although the impact during construction is expected to be temporary and small, the operation of construction equipment and the driving of construction vehicles will emit greenhouse gases (GHGs).

Note: A+/-: significant positive/negative impact expected.
B+/-: some positive/negative impact expected.
D: No impact considered.
N/A: No impact assessment was carried out as no impact was determined in the scoping phase.

Source: JICA Study Team

8.1.7.2 Moratuwa-Rathmalana area project

Based on the secondary documents collected and the results of the field visits, the results of environmental impact assessment conducted are as follows.

Table 8.1.9 Environmental Impact Assessment (Moratuwa-Rathmalana Area)

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
Pollution control						
1	Air Quality/ Dust	✓		B-	N/A	During construction: although temporary deterioration of air quality is expected due to the operation of construction equipment, etc., the project is small-scale and is expected to meet the national reference value and international reference values. Operation phase: as the project is a drainage channel project, no significant increase in traffic is expected after the project is Operation phase and no impact is envisaged.
2	Water quality	✓	✓	B-	B-	During construction: excavation and filling work will be carried out in the drainage canal and along the Weras Ganga for construction of embankments, and water quality is expected to be affected by the construction works. There is also potential for water pollution from the construction site, heavy machinery, vehicles and effluents from construction accommodation. As this is not a large-scale construction project, the impact is assumed to be limited, but adequate environmental protection measures are required. Operation phase: the drainage function will be improved, but there are concerns about the impact on the downstream river water quality and overseas areas to which the water is discharged during rainfall, but as this is not a large-scale project, the impact is assumed to be limited, but monitoring and adequate environmental protection measures are required..
3	Waste/ hazardous substances	✓		B-	N/A	During construction: possible soil contamination due to construction oil spills, etc. Operation phase: the project is a rehabilitation of the existing drainage and pumping station, and there is no concern about the impact of these operations on the soil.
4	Soil pollution	✓		B-	N/A	During construction: as the project area is adjacent to residential areas, noise and vibration is expected to be generated by the operation of construction equipment and vehicles during construction, so mitigation measures such as setting construction implementation times and decentralizing work are desirable.
5	Noise and vibration	✓		B-	N/A	During construction: as the project area is adjacent to residential areas, noise and vibration is expected to occur due to the operation of construction equipment and vehicles during construction, so it is desirable to take mitigation measures such as setting construction implementation times and decentralizing work.
6	Subsidence			N/A	N/A	No impact is assumed.
7	Offensive Odors			N/A	N/A	No impact is assumed.
8	Sediment	✓		B-	N/A	During construction: there is concern that the modification of drainage channels will have an impact on sediment. On the other hand, if the drainage channels are only excavated, the impact on sediment will be limited.
Natural environment						
9	Protected area	✓	✓	N/A	N/A	No impact is assumed.
10	Ecosystem/Flora and Fauna	✓	✓	A-	A-	During construction & Operation phase: the construction of the embankment along the Weras Ganga is foreseen to have a significant impact on the ecosystems within the Protection area; if the EIA survey confirms the presence of important species etc., monitoring of the effectiveness of conservation measures for each species should be carried out and if necessary It is desirable to take action from the perspective of ecosystem protection, for example by adding mitigation measures.
11	Hydrography	✓	✓	B-	B-/B+	During construction: the project will involve excavation in drainage channels, which will have an impact on water elephants. Operation phase: flood damage will be controlled and properly managed as the project will improve the operation of drainage channels.
12	Topography/geology	✓	✓	B-	B-	During construction: the widening of the drainage channel may cause instability at the excavation site and thus cause topographical changes downstream of it, but the area altered is limited and no significant impact is envisaged.
Social environment						
13	Land Acquisition/ resettlement	✓		A-	N/A	The number of people to be resettled is less than 200, but as large-scale land acquisition will take place, it will be necessary to prepare a resettlement plan and work on compensation based on this plan.
14	Poor	✓		A+	A+	Special consideration is required if the resettlement target group includes the poor.

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
15	Ethnic minorities/ indigenous peoples			D	D	Construction & Operation phase: no impact is envisaged as no indigenous minority settlements requiring special protection have been identified in the project area.
16	Local economy, including employment and means of livelihood	✓	✓	B+	A+ /B-	Before construction :No impact is envisaged at this time, as the project is planned to have no negative impact on the local economy, such as resettlement. Under construction :Temporary positive impacts on the local economy are expected due to increased commercial/employment opportunities generated by construction activities. Operation phase :The project is expected to have an indirect positive impact on the local economy of the project area by providing a more stable supply of water resources. In the long term, the project is expected to increase commercial/employment opportunities due to the growth of the local economy in the project area. On the other hand, negative impacts may occur after the completion of construction works due to the termination of temporary employment opportunities for local workers.
17	Land use and local resource use			B-	B-	Before construction: Some land acquisition will occur in the downstream area within the shortcut area of the river channel, but the subject land is grazing land and no land use impacts are envisaged. During construction: Land use changes are expected to occur on a small scale in the river improvement area. In addition, land use changes for construction yards and workers' accommodation setup will only be temporary. Operation phase: For proper sediment management, there is a possibility of continuous excavation in the upstream area, in the dam lake and in parts of the downstream area. Revegetation measures are also planned on some existing slopes to prevent sediment run-off.
18	Water use	✓		B-	A+	During construction: if there is water use in rivers, etc. around the project site, the impact of turbid water during construction is possible. Although water use was not confirmed during the field survey, it is assumed that water from the Weras Ganga is used by houses, etc. along the Weras Ganga where water supply is not available. It is desirable that water abstraction and water rights during construction are properly managed, and information should be shared in advance by holding briefing sessions with relevant stakeholders on the impacts during construction. Operation phase: the drainage function will be enhanced after the project is implemented, but it is the drainage channels that are targeted and water use is not expected to be affected.
19	Existing social infrastructure and social services	✓	✓	B-	A+	Before construction: a certain number of land acquisitions will occur, so a relatively large impact is expected. During construction: social infrastructure and services may be temporarily affected due to traffic congestion caused by construction yards, worker accommodation setup and increased number of construction vehicles. Operation phase: no negative impacts of the project on the surrounding area are foreseen, but it is expected to make a significant contribution to improved social services through the sustainable use of water resources and flood protection.
20	Social institutions, social capital and local decision-making institutions			B-	A+	Before construction: Land acquisition will be necessary, but is limited and no significant impact is expected. During construction: Temporary impact on social infrastructure and services may occur due to traffic congestion caused by construction yards, worker accommodation setup and increased number of construction vehicles. Operation phase: Negative impacts of the project on the surrounding area are not foreseen, but the project is expected to make a significant contribution to improved social services through the sustainable use of water resources and flood protection.
21	Misdistribution of benefits and damages	N/A	N/A	B-	A+	Operation phase: the sustainable use of water resources and flood protection benefits of the project will be equally enjoyed.
22	Local conflict of interests	✓	✓	B-	B-	Before construction & Operation phase: there will be some resettlement of about 20 houses, but no significant impact is assumed. During construction: conflicts of interest between beneficiaries and affected residents may arise within the area, e.g. due to uneven distribution of damage and

	Item	Scoping		Evaluation		Reasons *CP: Construction Phase including before construction* *OP: Operation Phase*
		CP	OP	CP	OP	
						benefits before and during construction and during service, but the impact is small as the construction works are small.
23	Cultural heritage			N/A	N/A	No impact is assumed.
24	Landscape	✓	✓	B-	B-	The construction of the embankment along the Weras Ganga will have an impact on the general landscape, whereas the landscape as a tourism resource is not applicable and cannot be confirmed.
25	Gender		✓	N/A	A+	During construction: no impact from the project is expected. Operation phase: the project is expected to contribute to improving the livelihoods of socially vulnerable women. On the other hand, with regard to the employment of construction workers, it is desirable to have as good a gender balance as possible, such as active employment of women workers for light duty workers. (installation of women-only outdoor toilets and management of safety systems) is desirable to create a system that allows women workers to engage in the project safely.
26	Children's rights	✓	✓	B-	A+	During construction: no significant impact is foreseen from the project. The construction work may affect school routes in neighboring villages, depending on the construction route and other factors. The impact can be minimized by ensuring safety education and training for drivers of construction vehicles and strict adherence to speed. Operation phase: the improved capacity of the drainage channels due to the project will contribute to improving the lives of vulnerable children in society.
27	Risks of infectious diseases such as AIDS/HIV	✓		B-	N/A	During construction: due to the expected impact on public health due to the large influx of construction workers, mitigation measures are required, such as the provision of a sufficient number of toilets exclusively for construction workers and the implementation of hygiene training programs for workers. In addition, an increased risk of sexually transmitted infections (STD/STI) and HIV/AIDS between workers and the local population is expected.
28	Occupational health and safety (Working environment)	✓		B-	N/A	During construction: attention needs to be paid with regard to the occupational health and safety of construction workers. Operation phase: attention should be paid to the occupational health and safety of workers involved in the maintenance and upkeep of dam facilities (including sand removal work). In particular, as composting and sand removal work is carried out around the dam lake, sufficient attention should be given to safety, for example by requiring workers to wear safety belts, life jackets and other safety equipment during the work.
Others						
29	Accident	✓		B-	N/A	During construction: increased risk of accidents due to the operation of construction equipment and the running of construction vehicles is expected. Minimize the occurrence of accidents through proper safety management during construction in accordance with Sri Lanka's labor laws. As the risk of accidents with the general public is also increased around the construction route, the impact will be minimized by ensuring safe driving through safety training programs for construction workers and by taking appropriate environmental mitigation measures, such as installing sign boards to indicate the construction site. Operation phase: no impact
30	Transboundary impacts, and climate change			B-	N/A	During construction: although the impact during construction is expected to be temporary and small, the operation of construction equipment and the driving of construction vehicles will emit greenhouse gases (GHGs). On the other hand, it is envisaged that bare ground within existing catchments will be revegetated as an erosion control measure, and these are expected to reduce CO_2 emissions as a climate change adaptation measure.

Note: A+/-: significant positive/negative impact expected.
B+/-: some positive/negative impact expected.
D: No impact considered.
N/A: No impact assessment was carried out as no impact was determined in the scoping phase.

Source: JICA Study Team

8.1.8 Environmental Management Plan, Mitigation Measures and Costs of Implementation

Environmental Management Plans (EMP) and mitigation measures proposed based on the environmental impact assessment. Note that the items of the environmental management items are described according to Sri Lanka's IEE/EIA format, considering that they will be referred to in the future by SLLDC in the Sri Lanka's IEE procedure.

Table 8.1.10 Environmental Management Plans and Mitigation Measures

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
1.	Design Phase						
1-1	Preparation of project plan	Social conflicts, public protest	Information disclosure: Inform the project to stakeholders and the PAPs	PMU- Senior Social Officer	SLLDC	0.5	Existing infrastructure and services/Children's right/Misdistribution of benefits and damages/Local conflict of interests
1-2	Managing social conflicts & grievances	Grievances of PAPs	Establishment of grievance redress mechanism	PMU-Senior Social Officer	SLLDC	0.5	Land acquisition/Involuntary resettlement
1-3	Preparation of traffic management plan	Congestion, obstructions, accidents, Nuisance for pedestrians and commuters	Preparation of traffic management plan: The traffic management plan should be prepared after consultation with relevant stakeholder agencies and should be informed with required levels of details to relevant agencies and the public. Adequately trained staff at site and in the office along with required resources（sign boards, computers etc.） should be made available before implementation of the construction works	PMU- Traffic expert/ Senior EHS officer	SLLDC	4.0	Existing infrastructure and services
1-4	Training plan for project staff	Pollution emissions, Environmental quality degradation, health and safety nonconformance, accidents, social conflicts, nuisance to public	Preparation of site-specific training plans for each staff category: Every site worker must be given a suitable site induction. The induction should be site specific and highlight any risks （and control measures that those working on the project need to know about.	PMU-Senior EHS officer/ Senior social officer	SLLDC	2.0	Air Quality/Water quality/Noise and Vibration/Waste Management /Local conflict of interests/Accident
2.	**Pre-Construction Phase**						
2-1	Providing alternative access to PAPs	Hindrance to movement, access obstruction by construction works	Before commencing the construction works alternative access should be provided for all the personnel who's access is obstructed by the project works	PMU	Contractor	Engineering Cost	Existing infrastructure and services
2-2	Establishment of erosion control measures and silt traps, dewatering pits and disposal drains	Pollution of waterways, wetlands with turbid waters, silt deposition and impacting aquatic life	Erosion control measures, silt traps at strategic locations, dewatered water collection pits and drain paths should be established before the excavation's works are commenced	PMU	Contractor	6.0	Soil contamination
2-3	On-site health safety/sanitation	Project staff and public are exposed	"Adequate resources such as PEPs, Sanitary facilities, toilet facilities, cleaning	PMU/ Contractor	Contractor	3.0	Occupational health and safety (Working

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
	measures	to project induced direct and indirect accidents and safety issues	and washing facilities, first aid, safety barriers, fencing, warning signs, should be provided for all staff.				environment)/Accident
2-4	Emergency, injuries operation during disaster situation	Accidents, injuries, and death to project staff and public	- The emergency management system, first aid, contact information, responsible officer etc. should be arranged before construction work begin. - Special attention should be made on the drowning risk of site crews during heavy rain and flood situations at locations close to deep, fast flowing canal sections, at the bund construction site	PMU/ Contractor	Contractor	1.0	Accident/
2-5	Preliminary crack survey	Vibration induced structural damage to buildings	Preliminary crack surveys should be done from a competent agency for sensitive buildings and structures before work starts and reports should be made available for required parties.	PMU	Contractor	10	Misdistribution of benefits and damages/Local conflict of interests
2-6	Dike construction	Loss of breeding and nesting and foraging habitats of species	- Construction of earthen bunds - Culverts and other channels to facilitate water regulation	PMU/ Contractor	Contractor	Engineering cost	Ecosystem/Flora and fauna
2-7	Land acquisition and demolition of housing and business structures	Loss of land	Preparation of a Resettlement Plan	PMU/ Contractor	Contractor	Engineering cost	Land acquisition/Involuntary resettlement/Lifestyle and livelihood
		Loss of housing/ business structures	Compensation for the loss of land and housing/businesses based on the Land Acquisition Act （LAA） including 2008 regulations and National Involuntary Resettlement Policy （NIRP）.				
		Displacement of people	Implementing a livelihood restoration program				
		Loss of income	Monitor the implementation of Resettlement Plan				
2-8	Demolition of community properties	Loss of community properties	Reconstruction of community properties for the satisfaction of care takers/devotees/users	PMU/ Contractor	Contractor	Engineering cost	Existing infrastructure and services/Misdistribution of benefits and damages/Local conflict of interests
2-9	Shifting of utility supply lines	Loss of access to services	Reestablishment of utilities with the services providers	PMU/ Contractor	Contractor	Engineering cost	Existing infrastructure and services/Children's right/Misdistribution of benefits and damages
3.Construction Phase							
3-1	Demolition of structures: Concrete	Sediment laden runoff, silting,	- No storage near roadside or waterways. - Recover the useful material letting only	PMU/ Contractor	Contractor	Engineering cost	Waste management

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
	waste, demolished building parts	blockage of water ways, increased turbidity, cut down of light penetration, respiratory visibility impairment to aquatic life, damage substrate ecology, dumping on lands loss of arability	unrecoverable material be disposed-off in the landfills. - All domestic waste should be disposed via relevant local authority - Disposal of unrecovered material at the approved disposal sites by the Local Authority - Construction waste, unusable materials and debris generated during demolition works should be disposed of at approved sites. Such materials should be removed frequently without storing them in and around the construction site for a long period				
3-2	Canal surface clearing: Waste vegetative mass and trees	Blockage of waterways, nuisance to public, decay may cause pollution of water and soil, unhealthy conditions, aesthetic pollution	No storage near roadside or waterways.	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-3	Disposal on roadside, water ways	Ditto	Use as compost fertilizer and a soil manure	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-4	Removal of trees: Waste trees	Blockage of water ways, nuisance to public, decay may cause water and soil unhealthy conditions, aesthetic pollution	Obtain approval from the Dept. of forest for trees regulated by the felling of trees act	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-5	Disposal on roadside, water ways	Ditto	- No storage near roadside or waterways. - No open burning of wood cut offs or plant litter - Recover timber from trees with timber value and firewood value - Disposal of unrecovered material at the approved disposal sites by the Local Authority	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-6	Construction work: Plastic, polythene, papers, glass, cardboard cartons, materials generated during the	Washing away with runoff, block drainage paths, fumes from open burning causing air pollution and	- No storage near roadside or waterways	PMU/ Contractor	Contractor	Engineering cost	Waste management

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
	construction works	breathing difficulty to residents					
3-7	Open disposal, dumping near roadsides, open burning	Ditto	- No open burning - Recover the useful material only. unrecoverable material should be disposed of in landfills. - Disposal of unrecovered material at the approved disposal sites by the Local Authority	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-8	Demolition of asbestos roofs and ceilings.	Careless demolition, open storage, land disposal: fiber become airborne and sensitive receptors on-site and off-site are exposed; May have respiratory ailments with possible risk of asbestos exposure related health issues	- Should be handled extremely carefully during demolition works to minimize asbestos fiber becoming airborne.	PMU/ Contractor	Contractor	Engineering cost	Waste management
3-9	Clearing of canal passage and canal construction works: Damage service facilities and infrastructure	Interruption to related service（water, electricity, telecom）,	- Identification of service facilities and structures that need essential shifting and disconnection and those at the risk of being affected by the project works	PMU/ Contractor	Contractor		Water Quality
3-10	Waterlines, wastewater lines outfalls, septic tanks, telecom lines, electricity lines	Pollution from released wastewater interrupts the works, damage to wastewater lines may cause leaks and release of polluted water	- Shifting structures that need essential shifting - Disconnect structures requiring disconnection with alternative options - Disposal through temporary canal（e.g., Stormwater and greywater of households） - Good care and precautions taken in the demolition and construction works to minimize the damages service facilities - Compensate any damage either by payment, replacement, or repair	Other Agencies: CEB, NWS&DB	Contractor	Engineering cost	Water Quality
3-11	Dewatering excavated pits: Disposal of dewatered water	Disposal into a nearby canal may result in increased sediment content and impairment to water quality	- Sediment laden water should not be pumped into sensitive aquatic environments, but should be sent through a sediment filters-silt traps/detention pool before being released to the environment	PMU/ Contractor	Dewatering excavated pits: Disposal of dewatered water	Engineering cost	Water Quality

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
3-12	Demolition works	Dust and particles from demolition works causing localized visibility issues for the commuters and pedestrians, health implications related to breathing and respiratory tract	- Surface wetting with watering near sensitive locations. - Dust control measures (dust screens) are mandatory in work sites near public places, community centres, roads and residences. - A mobile water tanker with pump and sprays should be available at site ready to use for dust suppression on dry days. - Stockpiles of soil material, soils, waste concrete should be avoided near sensitive receptors and piles should be covered with tarpaulin or suitable High density cover material to prevent particles to become air borne - Transportation of material should be done covered always using tarpaulin - Precautions should be made to prevent spill of any material with air borne potential on the ground during transportation and handling, if a spill occurs. Precautions should be made to prevent spill of any material with air borne potential on the ground during transportation and handling, if a spill occurs.	PMU/ Contractor	Contractor	Engineering cost	Air Quality/Water quality/Noise and Vibration/Waste Management
3-13	Operation of construction machinery	Generate pollutants, such as nitrogen oxides （NOx）, hydrocarbon（HC）, carbon monoxide （CO）, particulate matter （PM）, and carbon dioxide （CO2）. health implications related to breathing and respiratory tract	- All vehicles used in the project activities shall have emission testing certificates before being put in to work. - The machinery and vehicles services and maintenance shall be done on a timely manner to ensure that emissions are controlled to a practical minimum. - Machinery or vehicles if found to be emitting smoky polluted gaseous emissions they should be removed from the operation and sent for servicing.	PMU/ Contractor	Contractor	Engineering cost	Air Quality/Noise and Vibration/

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
3-14	Cutting of trees, Demolition, excavation and construction works	Noise pollution & perceptible vibration impact on sensitive human receptors annoyance, stress, discomfort	- Shall abide by the Central Environmental Authority （CEA） regulations and other applicable laws related to noise and vibration level control. - Shouting by laborers, sirens and whistles should be restricted especially in areas of residents, religious places, and at times of religious activities. - Operation of noise and vibration generation machinery and equipment shall be restricted from 6.p.m. to 6.a.m. - Installation temporary noise barriers under special circumstances - Heavy noise and vibration construction works and operations should be restricted on days of public events near the construction site.	PMU/ Contractor	Contractor	Engineering cost	Noise and Vibration
3-15	Demolition, excavation and construction works	Vibration induced building cracks and structural damages	- As much as practicable, construction methods that produce minimal vibration should be adopted, especially in sites adjacent to residential. - In case of building cracks due to project induced vibration, inform the client immediately and repair the damage by their own cost or may agree to compensate the damage - Pre-crack surveys should be done for sensitive buildings and structures before works starts and after the work is completed.	PMU/ Contractor	Contractor	Engineering cost	Air Quality/Noise and Vibration/

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
3-16	All construction activities	Hap hazard waste disposal water and soil pollution, Aesthetic pollution, public nuisance, risk of injuries, obstruction of walkways and traffic movement	- Management of construction waste storage/disposal including waste concrete, concrete ready-mix batching, washing and waste disposal - All hazardous waste should be disposed in a safe manner via approved agencies by the CEA. - All aggregate materials should be obtained from the approved suppliers holding the license of the GSMB. - Manage unhardened waste, pre-hardened waste, and wash wastewater treatment to remove solids, before discharge to the environment. - Locate temporary waste storage sufficiently away from any drainage paths, inundation areas, canal banks, or areas with groundwater extraction wells, and keep covered. - Install erosion and sediment control measures such as sediment filters and silt traps at appropriate locations, such as stockpiles of earth material and excavation areas. - Divert run-off from outside the excavation area to prevent mixing with that of the work site to prevent overloading of sediment control structures.	PMU/ Contractor	Contractor	Engineering cost	Air Quality/Water quality/Noise and Vibration/Waste Management
3-17	Construction machinery operation and maintenance	Oil spills-water and soil pollution	- Servicing of all machinery should be done at external service stations, no servicing facilities should be located within the project site - Any accidental oil spills/leaks from machinery if occur should be attended immediately complying to accepted oil spill management practices in construction sites - Oils waste if generated should be removed through a licensed waste collectors approved by the local authority	PMU/ Contractor	Contractor	Engineering cost	Water quality/ Accident/Climate change
3-18	Construction works & operation of machinery	Loss and disturbance to Access	- Works that affects the use of existing accesses shall not be undertaken without providing adequate Work that affects the use of existing accesses shall not be	PMU/ Contractor	Contractor	Engineering cost	Existing infrastructure and services/Children's right//Accident/Climate change

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
			undertaken without providing adequate provisions for access. Provide safe and convenient access/ passage for vehicles, commuters, residents pedestrians. If access to places to be obstructed permanently, alternative access should be provided prior to the commencement of work.				
3-19	Deep excavation works	Deep excavation with the risk of falling	- Management of deep excavation with the risk of falling - Deep excavations with risk of falling should be fenced and covered with meshes to prevent falling risk with appropriate with warning sign boards - Pits should be inspected daily to check any life, and if found should be rescued immediately - Once the work is completed the excavations should be filled immediately without leaving open	PMU/ Contractor	Contractor	Engineering cost	Occupational health and safety (Working environment) /Accident/
3-20	Construction machinery operation, loading unloading trucks, transport of material and waste	Traffic congestion, block of passage, inconvenience to commuters, public nuisance	- Assess and plan when, where and for how long full road closures are necessary, and one side of the road closure necessary - Movement of construction machinery, and trucks on the roads: travel routes for construction vehicles/trucks should be investigated to avoid areas of congestion. - Contractors should be informed of using the approved routes and times, - Speed limits and operating times for construction vehicles should be imposed. - Construction machinery and trucks movement on the road should be done during off-peaks at low traffic congestion times. - Consider nighttime work in off peak hours to avoid day time traffic while complying noise limit and visibility of construction works. - Place signboards and traffic controllers. - To give an early indication of the location of possible traffic congestion along with alternative routes.	PMU/ Contractor	Contractor	Engineering cost	Air Quality/Water quality/Noise and Vibration/Existing infrastructure and services/Children's right/Misdistribution of benefits and damages/Local conflict of interests/Risks of infectious diseases such as AIDS/HIV /Occupational health and safety (Working environment) /Accident/Climate change

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
3-21	Excavation of earth and soil and sediment matter	Generation of solid waste （disposed plastic, glass, tins etc.） disposed to environment may cause block runoff paths, unhygienic and aesthetically unpleasant condition. Generation watery sludge.	- Any excavated material generated should be disposed completely adhering to the sediment management plan approved by the CEA - The PMU should prepare the sediment management plan complying to regulations of NEA, other legislations and terms and conditions.	PMU/ Contractor Other Agencies: CEB, NWS & DB/	Contractor	Engineering cost/may vary depending on the approval disposal	Waste management/Soil contamination
		Generation of soils, thick sediment matter with fines clay and silt	- The plan should be prepared in consultation with relevant technical agencies such as the Central Environmental Authority, SLLR&DC, Marine Pollution Prevention Authority, Western Province Waste Management Authority, the Local Authorities.	PMU/ Contractor	Contractor		Air quality/ Soil contamination/Sediment
		Generate drain water and suspended solid that increase water turbidity, and worsen aquatic environment toxic to aquatic life	- Necessary approvals should be obtained from the relevant agencies - Approval of CEA should be obtained. - The plan may require revisions, if needed approval to revised plan should be obtained from the CEA	PMU/ Contractor	Contractor	Engineering cost	Water quality/ Ecosystem/Flora and Fauna
3-22	Removal of invasive plants	Facilitate spread	- Dispose in a systematic manner / incineration	PP/ Contractor	Contractor	Project cost	Ecosystem/Flora and Fauna
3-23	Removal of large trees	Loss of breeding sites/reduction in carbon sequestration	- Replanting with native species	PP/Contractor/ Forest Department	Contractor	Project cost	Ecosystem/Flora and Fauna
3-24	Influx of migratory workers	Cultural degradation due to influx of migratory workers （Drug/Sexually transmitted diseases, child/women abuse etc.） Possession of firearms Risk to PAPs	- Consider off-site labor camps with transport facilities for labor force - Should be vigilant on possible malicious acts such as using drugs, alcohol, adultery, sex abuses of women and children, robberies, disputes and indecent behaviors - Proper awareness should be made by the contractor ES officer on behavioral issues and discipline requirement of labor force - A scheme of punishments, legal actions or even expel from the job should be in place to control unavoidable cases	PMU/Contractor	Contractor	Engineering cost	Poor/Misdistribution of benefits and damages/Local conflict of interests /Risks of infectious diseases such as AIDS/HIV/Occupational health and safety (Working environment)

No.	Project activity	Anticipated impacts	Proposed management measure	Responsible agency	Implementation agency	Approximate Cost (Rs. Million)	Items by JICA guidelines
			- Possession of firearms, or life-threatening tools should be prohibited.				
3-25		Transmission risks of waterborne/communicable diseases/infections from Open defecation and littering	- Installation of adequate on-site sanitary facilities to prevent open defecation. - Create awareness on restrictions and punishment should be made for those who violate the terms and conditions workers code of conduct. - Disseminate instructions issued by the government health authorities on control of air borne infections and COVID-19, and other diseases etc. - Conduct awareness campaigns for construction staff to control the possible spread of sexually transmitted diseases such as HIV/AIDS.	PMU/Contractor	Contractor	Engineering cost	Poor/Misdistribution of benefits and damages/Local conflict of interests /Risks of infectious diseases such as AIDS/HIV/Occupational health and safety (Working environment)
4.Operation Phase							
4-1	Maintenance of acquired land area	Encroachment of canal/river reservation for future developments	- Continuous monitoring and strict regulations should be there to avoid encroachments - Awareness to public not to encroach canal/river reservations	SLLDC	SLLDC	Maintenance budget of SLLDC	Lifestyle and livelihood/Local conflict of interests/ Ecosystem/Flora and Fauna
4-2	Maintenance of canals	Blocking of canals	- Awareness to public not to dispose waste to canals/river - Regular clearance and maintenance of canals	SLLDC	SLLDC	Maintenance budget of SLLDC	Lifestyle and livelihood/Local conflict of interests/ Ecosystem/Water quality

Source: JICA Study Team

8.1.9 Environmental Monitoring Plan

Proposed Environmental Monitoring Plan (EMoP) is as presented in Table 8.1.11. The content shall be similar for the two projects, but the number of sites etc. shall be addressed at the time of implementation of the IEE in Sri Lanka as appropriate. Monitoring related to resettlement and land acquisition shall be proposed in the RAP and is omitted from the following table.

Table 8.1.11 Draft Environmental Monitoring Plan

Impact factor	Parameters to be Monitored	Frequency / Applicable regulations /guidelines	Locations	Responsibility	Approximate cost m LKR
Design/Pre-Construction Phase					
Inform disclosure	- Status of implementation of information disclosure	1 time before construction	Surrounding area of Project site	SLLDC	-
Plan to be prepared	- Training plan - Traffic management plan - Safety management plan	1 time before construction		SLLDC	-
Construction Phase					
Mitigation measures related to Construction works	Implementation of mitigation measures in Construction area	Weekly Construction records	Construction area	PMU	Engineering cost
Noise	Noise （15 min and 1 hour in Morning, Afternoon, Evening and Night in a day） Leq, L90, L50 & L10	Baseline noise levels Frequency: Once before commencement of works-Extraordinary Gazette, No. 924/1- May 23, 1996 - Central Environmental Authority of Sri Lanka.	At locations with sensitive receptors （houses, schools, temples) with the risk of exposure for construction-based noise pollution	PMU	0.125.0
		Construction noise Frequency: Monitor daily on the incidents of perceptible high noise operations and record in the site log book	At locations with sensitive receptors （houses, schools, temples） with the risk of exposure for construction-based noise pollution	PMU/EHS officer/ Contractor EHS officer	Included as the salary of the contractor's EHS officer
Vibration	Vibration （Ground and Structural） PPV, Hz	Frequency: Once before commencement of works-The interim standards on Vibration for the Machinery, Construction activities and Vehicular Movements - Central Environmental Authority of Sri Lanka	At locations with sensitive receptors （houses, schools, temples） with the risk of exposure for construction-based vibration impact	PMU	0.25
		Construction induced vibration Monitor daily on the operations that would generate high perceptible vibration and record in the site log book	At locations with sensitive receptors （houses, schools, temples） with the risk of exposure for construction-based vibration impact	Contractor EHS officer	Included as the salary of the contractor's EHS officer

Water Quality	Water quality parameters Surface fresh water pH, Conductivity, Dissolved Oxygen, Total Suspended Solids, Oil & Grease, Bio-chemical Oxygen Demand, Faecal coliforms	Baseline ambient water quality Frequency: Twice before commencement of works to cover wet and dry seasons Ambient water quality standards – CEA Where such standards are not available the comparisons should be made against the baseline's quality and with spatial and temporal trends	To cover surface water retentions-streams, covering project influence areas and locations outside the project influence areas Suggested maximum number of samples/ events around 10	PMU	0.5
	High turbid water, silt and sediment depositions in sensitive habitats	Water quality during construction phase Frequency: Monitor daily on the discharge water quality Visual observations on high turbid water, silt and sediment depositions in sensitive habitats	Adjacent natural streams, water pools, wetlands	Contractor EHS officer	Included as the salary of the contractor's EHS officer
Traffic survey	Traffic density pattern	Baseline traffic survey Frequency: as decided by a competent agency Service of a competent agency should be used to decide the frequency, duration and times	In roads with canal sections near roads, the interacting roads sections by the project as decided by a competent officer	PMU-should engage a Competent agency	5.0
		Construction phase Frequency: as decided by a competent agency Service of a competent agency should be used to decide the frequency, duration and times	In roads with canal sections near roads, the interacting roads sections by the project as decided by a competent officer	Contractor EHS officer	Included as the salary of the contractor's EHS officer
Waste Managem ent	Applicable waste management status	Weekly	Construction area	Contractor EHS officer	Engineering cost
Sediment quality	Physical and chemical properties of sediments As decided by the Project's Technical Evaluation Committee appointed by the CEA （TEC-CEA）, the committee may consider following sediment quality monitoring to decide on most appropriate disposal option	Single set of measurements for each section before excavation and from excavated batches As decided by the Project's Technical Evaluation Committee appointed by the CEA （TEC-CEA）, the committee may consider following sediment quality monitoring to decide on most appropriate disposal option	In canal sections where substantial quantity of sediment/earth material are generated and requiring disposal	PMU/EHS officer-by a competent monitoring agency	The costs may vary greatly depending on the sections requiring excavation, disposal strategy, number of samples to be collected, and the type of parameters to be tested as decided by the CEA-TEC. At the preparation of this report information pertinent to above aspects were not available.
	General: Water-sediment ratio, Grain size distribution, Organic matter content	Single set of measurements for each section before excavation and from excavated batches			

	Potential acidity	Single set of measurements for each section before excavation and from excavated batches Estimates on the required acid neutralization			
	For disposal at a sanitary landfill: USEPA: Toxicity Characteristic Leaching Procedure （TCLP）: consider option of disposal at a sanitary landfill site: 40 parameters listed under maximum concentration of contaminants for toxicity characteristic	Single set of measurements for each section before excavation and from excavated batches USEPA-TCLP: maximum concentration of contaminants for toxicity characteristic			
	Dumping at sea: Parameters listed under schedule II of Marine Pollution Prevention Act. No 1816/37-2013	Single set of measurements for each section before excavation and from excavated batches levels recommended under schedule II of Marine Pollution Prevention Act. No 1816/37-2013			
	Deposition in the environment: land reclamation Appropriate parameters listed under Canadian Sediment quality Guidelines for protection of aquatic life	Single set of measurements for each section before excavation and from excavated batches Canadian Sediment Quality Guidelines ISQG: Interim sediment Quality Guideline Value. protection of aquatic life PEL: Probable effect level – Above the PEL; the probable effect range within which adverse effects frequently occur			
Operation Phase					
Lifestyle and livelihood /Local conflict of interests/ Ecosystem/Water quality	Continuous monitoring and strict regulations should be there to avoid encroachments	Quarterly/Two years after completion of construction works	Project site	SLLCD	SLLDC Cost
	Awareness to public not to encroach canal/river reservations	1time/Two years after completion of construction works	Project site	SLLDC	SLLDC Cost
	Regular clearance and maintenance of canals	1time/Two years after completion of construction works	Project site	SLLDC	SLLDC Cost

Source: JICA Study Team

8.1.10 Implementation Structure of Environmental Impact Monitoring

The main implementing agency for the project is SLLDC, under which the Project Management Unit (PMU) will be established at the time of project implementation. Within the PMU, environmental/social experts from SLLDC's Environmental and Social Considerations Section will be assigned to conduct project tasks such as EMP/EMOP. Monitoring will be carried out by employing external environmental experts and consultants as required.

Source: JICA Study Team

Figure 8.1.5 Implementing Structure for Environmental Monitoring

8.1.11 Consultation with Stakeholders

The project conducted several focus group discussions (FGDs) with the surrounding community while taking into account COVID-19 and other safety status. The implementation of FGDs in each Pre-F/S project is summarized as below.

8.1.11.1 Mudun Ela Sub-basin project

(1) Results of Focus Group Discussions

Seven FGDs were conducted with the surrounding population in the Mudun-Ela project area. As a whole, a total of 92 participants, 36 men and 56 women participated to the FDGs.

Table 8.1.12 Overview of FGDs for Mudun Ela Sub-basin Project

Item No.	Date.	Location.	Target Group	Number of participants		
				Males.	Females.	Total
1	01.10.2022	Meegahawatta GND.	Residents.	5	1	6
2	29.10.2022	Wanawasala East GND	Residents.	6	5	11
3	29.10.2022	Wanawasala East GND	Residents.	6	5	11
4	29.10.2022	Peliyagoda Gangabada East GND	Residents.	3	4	7
5	29.10.2022	Peliyagoda Gangabada East GND	Resident Women.	-	8	8
6	05.11.2022	Pattiya North GND	Residents.	13	25	38
7	05.11.2022	Pattiya North GND	Residents.	3	8	11
Total				36	56	92

FGD in Peliyagoda Gangabada East

FGD in Pattiya North.

Source: JICA Study Team

(2) Summary of Discussions and Feedbacks

Summary of points discussed and input received from stakeholders is as follows.

Table 8.1.13 Summary of Points Discussed for Mudun Ela Sub-basin Project

No	Location.	Key points discussed
1	Meegahawatta GND.	- The area gets flooded frequently for every 2-3 consecutive days rain. most recent occurrence was in May, 2022. Impacts: - People in the area are mostly daily paid workers, especially three-wheel drivers, unskilled labors who are involved in coconut plucking. All of these income sources are affected by floods. - Also, people are unable to meet the basic needs such as accessing food and drinking water during the floods. - Children cannot attend schools during floods. - Women and children are vulnerable to waterborne diseases such as fever and other bacterial infections in post flood duration. - Previous Experience on similar projects: - Residents are not aware of this drainage improvement project but they are already aware of the Oliyamulla pumping station construction project implemented by SLLDC - Suggestions/ Proposals - Expect fast resolving issues related to relocation due to the proposed pumping station project that has already taken place. - Solution to overcome open waste dumping problem in the area.
2	Wanawasala East GND	- The area gets flooded frequently every year in the month of May. Impacts: - Most of the people in the area receive daily wages, and some of them are self-employed. - Also, people are unable to fulfil their daily requirements. - Children cannot attend schools during floods. - Women and children get affected with fever and other bacterial infections in post flood period. - Previous Experience on similar projects: - People are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage system in the area

No	Location.	Key points discussed
		- Solution to overcome waste dumping into canals in the area.
3	Wanawasala East GND	- The area gets flooded frequently after every continuous rainfall. frequency after constructing the Colombo Solid Waste Processing Site Project. Water pathways are blocked due to the abandonment of pre-construction structures. Impacts: - People in the area are mostly daily paid workers, and some of them are self-employed All of these income sources are affected during floods. - Also, people are unable to fulfil their daily requirements. - Children cannot attend schools during floods. - Women and children get affected with fever and other bacterial infections in post flood period. - Previous Experience on similar projects: - People are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage system in the area - Solution to overcome waste dumping into canals in the area.
4	Peliyagoda Gangabada East GND	- Floods rarely occur as a result of Kelani River overflow, mostly due to the blockage of drainage canals. Impacts: - People in the area are mostly daily paid workers, and some of them are self-employed All of these income sources are affected during floods. - Also, people are unable to fulfil their daily requirements. - Children cannot attend schools during floods. - Women and children get affected with fever and other bacterial infections in post flood duration. - Previous Experience on similar projects: - Residents are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage system in the area - Solution to overcome waste dumping into canals in the area. - Better management of floods
5	Peliyagoda Gangabada East GND	- Floods rarely occur as a result of Kelani River overflow, mostly due to the blockage of drainage canals. Impacts: - Ladies in the area are involved in daily paid activities such as housekeeping (close proximity) and "Nanny Duties" (looking after small kids in day time). - Also, some of the ladies are involved in home based small scale business activities, such as sewing bags (low quality), selling lunch packets. livelihood activities are affected during floods. - Women are unable to meet the basic needs during a particular time period (feeding children, health and safety). - Previous Experience on similar projects: - They are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage and canal system in the area - Solution for the dumping of waste into canals and drains in the area. - Better management of floods
6	Pattiya North GND	- The area gets flooded frequently every year in the month of May. Impacts: - People in the area are mostly daily paid workers, and some of them are self-employed All of these income sources are affected by floods. - Also, people are unable to fulfil their daily requirements. - Children cannot attend schools during floods. - Women and children get affected with fever and other waterborne diseases during the post-flood period. - Previous Experience on similar projects: - Residents are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage system in the area - Solution for dumping of garbage into canals in the area.
7	Pattiya North GND	- The area gets flooded frequently every year in the month of May. Impacts: - People in the area are mostly daily paid workers, and some of them are self-employed All of these income sources are affected by floods. - Also, people are unable to fulfil their daily requirements. - Children cannot attend schools during floods. - Women and children get affected with fever and other waterborne diseases during the post-flood duration. - Previous Experience on similar projects:

No	Location.	Key points discussed
		- People are not aware of this drainage improvement project. - Suggestions/ Proposals - Improve drainage system in the area - Solution for dumping of garbage into canals in the area.

Source: JICA Study Team

8.1.11.2 Moratuwa- Rathmalana area project

(1) Results of Focus Group Discussions

For Moratuwa- Rathmalana area project, 8 FGDs were conducted with project affected people in the area. A total of 58 participants consists of 15 men and 43 women participated to the FDGs.

Table 8.1.14 Overview of FGDs for Moratuwa- Rathmalana Area Project

Item No.	Date.	Location.	Target Group	Number of participants		
				Males.	Females.	Total
1	10.10.2022	Katubedda GND.	Residents.	1	4	5
2	10.10.2022	Thelawala North GND	Residents.	2	4	6
3	10.10.2022	Thelawala North GND	Residents.	-	8	8
4	20.10.2022	Thelawala South GND	Residents.	1	7	8
5	20.10.2022	Thelawala South GND	Residents.	-	4	4
6	20.10.2022	Borupana GND	Residents.	6	3	9
7	27.10.2022	Kandawala GND	Residents.	4	7	11
8	27.10.2022	Kandawala GND	Residents.	1	6	7
Total				15	43	58

FGD in Katubedda Telawala.

FGD in Telawala.

Source: JICA Study Team

(2) Summary of Discussions and Feedbacks

Summary of points discussed and input received from stakeholders is as follows.

Table 8.1.15 Summary of Points Discussed for Mudun Ela Sub-basin Project

No.	Location.	Key points discussed and the Feedback Received
1	Katubedda GND.	- The people in the area experienced flood events in every rainy season mainly due to the South-West Monsoon.Latest occurrence of a considerable flood level was in 2017 - Impacts: - The livelihoods of the people in the area are affected by floods, since most of the people in the community are daily paid workers and they are unable to work. during floods. - During flood events children cannot attend schools and private tuition - Children and women were affected with dengue fever and other waterborne diseases in the post-flood duration. - Previous Experience on similar projects: - Community of the area do not have experiences of similar projects - Suggestions/ Proposals - People in the area agree to the proposal of constructing a dike along Weras ganga with minimal impact to their existing properties.

No.	Location.	Key points discussed and the Feedback Received
		- People in the area also expect that their income sources will not be affected by this proposed project. - If the houses of people are affected by the proposed project, people are concerned about constructing new houses under prevailing circumstances. Also, people have objections to moving into high-rise apartments since they will lose their home gardens and gathering areas. home gardens and gathering areas.
2	Thelawala North GND (Yogashrama Mawatha)	- People in the area experienced flood events in every rainy season mainly due to South- West Monsoon. Latest occurrence of a considerable flood level was in 2021 - Impacts: - The livelihood of residents is affected during floods, since most of them are daily paid workers and skilled labourers. - Most of them have no safer locations to go and sometimes they stay in the same location keeping their household items safe from floods. At some instances, men stay at the houses after sending women and children to their relations' houses. - During flood events children cannot attend schools and private tuition classes. - Children and women are affected with dengue fever and other waterborne diseases in the post flood duration. the past due to dengue fever. - Previous Experience on similar projects: - However, government officials have surveyed the area and marked the reservation of the Weras ganga. Some residents have these survey maps and some have cards provided by SLLDC to identify the residents. - Suggestions/ Proposals - People in the area agree to the proposal of constructing a dike along the Weras ganga with minimal impact to their existing properties. - People in the area also expect that their income sources will not be affected by this proposed project. - If the houses of people are affected by the proposed project, people are concerned about constructing new houses under prevailing circumstances. Also, people have objections to moving into high-rise apartments since they will lose their home gardens and gathering areas. home gardens and gathering areas.
3	Thelawala North GND	- People in the area experience flood events in every rainy season when the rainfall intensity is considerably higher mainly due to the South-West Monsoon. Latest occurrence of a critical flood with the most damage level was in 2017 - Impacts: - The livelihood of the people in the area is affected during floods, since most of them are daily paid workers and skilled labourers. - People cannot fulfil their daily needs during flood events and most of them stay in their houses with flood water to protect their household items. - During flood events children cannot attend schools and private tuition classes. - Children and women are affected with bacterial infections and dengue fever in the post flood context. - Previous Experience on similar projects: - People in the area are not aware of this project. However, government officials have surveyed the area. Some of the residents have been advised not to construct new structures beyond the marked boundaries. - Suggestions/ Proposals - People in the area agree to the proposal of constructing a dike along the Weras ganga with minimal impact to their existing properties. - People in the area also expect that their income sources will not be affected by this proposed project. - If the houses of people are affected by the proposed project, people are concerned about constructing new houses under prevailing circumstances. People also requested not to provide houses in high rise apartments since they will lose their home gardens and gathering areas. People also requested not to provide houses in high rise apartments since they will lose their home gardens and gathering areas.
4	Thelawala South GND (GND Office)	- People in the area experience floods in every rainfall that retains 2-3 consecutive days. - Impacts: - Most of the people are daily paid workers and their livelihood are affected during floods. 's protection and basic needs. - Some of the people are involved in self-employment those activities cannot be functioned during floods. - People cannot fulfil their daily needs during floods. - During flood events children cannot attend schools and private tuition classes. - Children and women are affected with bacterial infections and dengue fever in the post flood context. Also, there is an increase in house flies and bad odour as a result of diverting the sewer lines into drains and canals.

No.	Location.	Key points discussed and the Feedback Received
		Previous Experience on similar projects: - People in the area are not aware of this project. However, government officials have surveyed the area. Some of the residents have been advised not to construct new structures beyond the marked boundaries. - Suggestions/ Proposals - The people in the area expect better management of flood events in the area as a result of this project. - People expect if separate sewer lines are provided to the area, it will minimise the discharge of sewer into drains. - There should be a proper system to monitor the cleanliness of canals and drains at least monthly. - The people in the area also expect that their income sources will not be affected by this project but further assisted by the government. - If the project is implemented immediately, they are more than happy to support the government but, they requested fair & reasonable compensation.
5	Thelawala South GND (Pottery Houses)	- People in the area experience floods in every rainfall that retains 2-3 consecutive days. - Impacts: - People in this group are involved in self-employed activities including pottery industry. the women make pots and males do the selling and transportation. During floods these livelihood activities are highly affected. - People cannot fulfil their daily needs during floods. - During flood events children cannot attend schools and private tuition classes. - Children and women are affected with bacterial infections and dengue fever in the post flood context. Also, there is an increase in house flies and bad odour as a result of diverting the sewer lines into drains and canals. - Previous Experience on similar projects: - People in the area are not aware of this project. However, government officials have surveyed the area. Some of the residents have been advised not to construct new structures beyond the marked boundaries. - Suggestions/ Proposals - The people expect better management of flood events in the area because of this project. - People expect if separate sewer lines are provided to the area, it will minimise the discharge of sewer into drains. - There should be a proper system to monitor the cleanliness of canals and drains at least monthly. - The people in the area also expect that their income sources will not be affected by this project but further assisted by the government. - If the project is implemented immediately, they are more than happy to assist the government but, they requested fair & reasonable compensation.
6	Borupana GND	- The houses situated in close proximity to the canal get flooded during the heavy rainy season. most recent occurrence was in 2017 - Impacts: - The livelihood of the people in the area affected during the floods, since most of them are daily paid workers and skilled labourers such as three-wheel drivers and masons. Some of the people are involved in self-employed activities such as selling food items, sewing clothes, preparing homemade spice blends. These activities are affected during floods. - People cannot fulfil their daily needs during floods. - During flood events children cannot attend schools and private tuition classes. - Children and women are affected with waterborne infections and dengue fever in the post flood duration. past due to dengue fever. - Previous Experience on similar projects: - People do not possess experiences exactly on this project, but there were few previous land estimations by government officials. - Suggestions/ Proposals - The people in the area expect better management of flood events in the area as a result of this project. - If separate sewer lines are provided to the area, it will minimise the discharge of sewer into drains. - There should be a proper system to monitor the cleanliness of canals and drains at least monthly. - The people in the area also expect that their income sources will not be affected by this project and further assisted by the government. - If the project is implemented immediately, they are more than happy to assist the government with a fair compensation.
7	Kandawala GND (Kandawalawatta)	- The people in the area experience floods very rarely. last occurrence was in 2017 Impacts:

No.	Location.	Key points discussed and the Feedback Received
		- The livelihood of the people in the area is affected during floods, since most of them are daily paid workers and skilled labourers. - People cannot fulfil their daily needs during floods. - During flood events children cannot attend schools and private tuition classes. - Children and women affected with waterborne infections and dengue fever in the post flood duration. There were several child deaths recorded in the past. - Previous Experience on similar projects: - People are not aware of this drainage improvement project. - Suggestions/ Proposals - Proper flood mitigation as a result of this project - Since the crocodiles lurk inside the drains, constructing a dike will improve children's safety. - Fair compensation is expected from the government.
8	Kandawala GND (Sentry road)	- The people in the area experienced floods whenever the rainfall intensity is higher. latest occurrence of a considerable flood level was observed in 2017 where many areas affected island wide. - Impacts: - The livelihood of the people in the area are affected during floods, since most of them are daily paid workers and skilled labors. employed and these livelihood activities are affected during flood events. - People cannot fulfil their daily needs during floods. - During flood events children cannot attend schools and private tuition classes. - Children and women affected with waterborne infections and dengue fever in the post flood duration. There were several child deaths recorded in the past. - Previous Experience on similar projects: - People are not aware of this drainage improvement project. - Suggestions/ Proposals - Proper flood control. - Execute the project with proper management, in land acquisition and construction periods specially. - If they are given house for house as per the compensation method, most of the people in the area expect a house with enough space for their day to day and livelihood activities and peaceful background other than a house in a flat

Source: JICA Study Team

8.2 Policy Framework for Land Acquisition and Resettlement

This section provides the scale and nature of land acquisition and involuntary resettlement required to implement Pre-F/S Projects.

8.2.1 Basic Policy and Required Procedures for Land Acquisition and Involuntary Resettlement

8.2.1.1 Basic Policy of Land Acquisition and Preparation of Resettlement Action Plan in Sri Lanka

The laws and regulations governing land acquisition associated with involuntary resettlement in Sri Lanka are set out in the Land Acquisition Act (enacted in 1950, hereinafter referred as LAA) and its amendments, the National Environmental Act (enacted in 1980, hereinafter referred as NEA) and its amendments, the Land Acquisition Regulations (entered into force in 2008, hereinafter referred as LAR) and the National Involuntary Resettlement Policy (enacted in 2001, hereinafter referred as NIRP). Based on the provisions of the NEA as contained in Official Gazette1995, projects involving involuntary resettlement of more than 100 households are required to conduct EIA or IEE. In addition, the NIRP provides for the preparation of a resettlement plan if the number of affected households exceeds 20 households.

The standard land acquisition procedure in Sri Lanka, based on above-mentioned legislation is as follows. Where the implementation of public works projects that involve land acquisition and/or involuntary resettlement, the avoidance or minimization of land acquisition should be considered and discussed in Public Consultation. Following the results of the consultations, the implementing agency (SLLDC) applies to the Ministry of Land and Land Development (MLLD) for approval and MLLD instructs to conduct a study for land acquisition. Followed by MLLD's instructions, the implementing agency conducts a census survey Project Affected People (PAP) according to type and extent of impact and formulates a draft Resettlement Action Plan (hereinafter referred to as RAP) including compensation policy (entitlement matrix). The contents of the draft plan are discussed through public consultation and finalized by incorporating the opinions and requests of PAPs.

8.2.1.2 JICA's Basic Policy in developing Resettlement Action Plan

According to JICA's Guidelines for Environmental and Social Considerations (2010) (hereinafter referred to as JICA Guidelines), a project entailing land acquisition and involuntary resettlement is required to prepare a RAP. In case the scale of impact is minimal, an Abbreviated RAP (A-RAP) should be prepared in accordance with JICA Guidelines and World Bank OP 4.12 (the operation policy related to Involuntary Resettlement). For the proposed Pre-F/S projects, different level of study would be required. Table 8.2.1 presents basic policy of RAP.

Table 8.2.1 Standard Structure and the Contents of A-RAP for JICA Financed Projects

Structure	Content
Project Description	Explain the latest project description
Necessity of Land Acquisition and Resettlement and Objectives of RAP	Show the area to be acquired by the Project and explain the scale of land acquisition and resettlement
Legal Framework	Confirm the latest relevant regulations in the country and the gaps with the JICA Guidelines
Scope of Land Acquisition and Resettlement Impact	Confirm the required area (private and public use, respectively) to be acquired by the project and the number of households to be relocated due to land acquisition
Census, Asset Inventory, Socio-Economic Study	Confirm all households living or doing economic activities and assets in the project area by conducting interview survey
Compensation Policy	Examine the compensation policy based on the identified gap and policies examined in the previous projects in similar settings in the country funded by JICA
Grievance Procedure	Examine the easily access procedure based on the regulations in the country, practice in the project area and the method applied by the previous projects in similar settings in the country funded by JICA
Institutional Framework	Examine practical framework considering structure of implementing agency, SABESP, the regional government and concerned municipalities.
Implementing Schedule	Examine the schedule of implementing land acquisition and resettlement considering the entire project schedule
Budget	Examine the budget to be secured to implement the A-RAP
Monitoring and Evaluation	Examine the monitoring items, methods, frequency, and monitoring structure
Public Consultation	Show the results of consultation meetings to be held for the possible project affected households

Source: JICA Guidelines (2010) and JICA's guidelines for preparation of ESIA report(2019)

8.2.2 Socio Economic Survey

Socio-economic surveys of the affected households were conducted by selecting about 20% of the affected households and interviewing them. For Moratuwa- Rathmalana Project, 27 households in Moratuwa and 5 households in Rathmalana were selected. For Mudun Ela project, 14 households in Kelaniya were interviewed. The results of the survey, including household status, income, and type of house ownership, which are relevant to the planning of land acquisition, are extracted and summarized as follows. (Detailed survey results will be included in the land acquisition and resettlement policy to be attached to Final Report).

Table 8.2.2 shows the distribution and average number of household members per area. The average number of household members is around four people per household in all areas.

Table 8.2.2 Distribution and Average household size in Project Affected Area

Project	DSD*	Household size （No. of family members)						Average No. of Member
		1-2	%	3-4	%	5 +	%	
Mudun Ela	Kelaniya (N=14)	4	28.6%	8	57.1%	2	14.3%	3.21
Moratuwa-Rathmalana	Moratuwa (N=27)	3	11.1%	14	51.9%	10	37.0%	3.93
	Rathmalana (N=5)	0	0.0%	4	80.0%	1	20.0%	4.20

Note) DSD: Divisional Secretariat Divisions
Source: JICA Study Team

The economic situations of PAPs are summarized in this part. The employment status for the entire survey population is presented in Table 8.2.3. Among the employed, "Daily Paid Labour" was most popular among male respondents while "Private Sector" was the most popular among female. Among dependent population, students were the most common for male and housewives for female.

Table 8.2.3 Employment Status of Paps By Sex (Covering All Area)

Type of Employment	Male		Female	
	No.	%	No.	%
Government Worker	4	4.8	3	3.5
Private Sector	8	9.6	9	10.6
Skilled Labour	10	12.0	0	0.0
Daily Paid Labour	16	19.3	6	7.1
Business	2	2.4	1	1.2
Self-employed	2	2.4	3	3.5
Unemployed	5	6.0	0	0.0
Dependent Population (Retired, Old, Disabled, housewife, student etc.)				
Retired/old/disabled	9	10.8	2	2.4
Housewife	0	0.0	35	40.7
Student	28	33.7	27	31.8
Total	84	100.0	86	100.0

Source: JICA Study Team

Table 8.2.4 presents income status of affected households. The household income bands with the highest number of responses were between 30,001 – 40,000 LKR for Moratuwa and Rathmalana, 10,001 – 20,000 LKR and 40,001 – 50,000 LKR for Kelaniya. Several households in the survey indicated that they had more than one source of income and that they had additional income from livestock or other sources.

Table 8.2.4 Household Monthly Income

Range of Income (SLR)	Kelaniya (N=14)		Moratuwa (N=27)		Rathmalana (N=5)	
	No of Household	(%)	No of Household	(%)	No of Household	(%)
=<5,000	1	7%	0	0%	0	0%
5,001 – 10,000	0	0%	0	0%	0	0%
10,001 – 20,000	***2***	***14%***	0	0%	0	0%
20,001 – 30,000	0	0%	3	11%	0	0%
30,001 – 40,000	***2***	***14%***	***8***	***30%***	***2***	***40%***
40,001 – 50,000	***2***	***14%***	4	15%	0	0%
50,001 – 60,000	1	7%	3	11%	0	0%
60,001 - 70,000	1	7%	3	11%	2	40%
70-001 - 80,000	1	7%	4	15%	1	20%
80,001 - 90,000	0	0%	0	0%	0	0%
90,001 - 100,000	0	0%	0	0%	0	0%
100,001 – 200,000	1	7%	1	4%	0	0%
200,001 – 300,000	0	0%	0	0%	0	0%
300,001=<	1	7%	0	0%	0	0%
Not declared	2	14%	1	4%	0	0%

Source: JICA Study Team

Following part describes property status of PAPs. House structure types and sanitation facilities per district is presented in Table 8.2.5. The majority of house structure types in all districts are permanent structures, with only three temporary structures in Moratuwa area. In addition, although the type of sanitation facility was generally flush or water sealed, a small number of houses (two in Moratuwa and one in Kelaniya) were found to have no sanitation facilities.

Table 8.2.5 Type of Houses and Sanitation Facilities in Each House

Project	DSD	Type of housing structure			Type of sanitary system		
		Permanent	Semi-permanent	Temporary	Flush	Water sealed	None
Mudun Ela	Kelaniya (N=14)	10	4	0	9	4	1
Moratuwa-Rathmalana	Moratuwa (N=27)	20	4	3	8	17	2
	Rathmalana (N=5)	3	2	0	1	4	0

Source: JICA Study Team

Table 8.2.6 presents household ownership patterns of each district. In all three districts, the majority was squatter on governmental land that means to live on unused land without formal ownership. In Kelaniya, the number of households holding ownership rights was 43%, which is higher than in the other districts.

Table 8.2.6 House Ownership Types

Type of Land Tenure	Kelaniya (N=14)		Moratuwa (N=27)		Rathmalana (N=5)	
	No of HHs	%	No of HHs	%	No of HHs	%
Sole deed/Titleholder	6	43%	1	4%	0	0%
Government Owned land for rental	0	0%	1	4%	0	0%
Private owned land for rental	0	0%	0	0%	0	0%
Share Ownership	0	0%	0	0%	0	0%
Squatter* on government land	7	50%	25	93%	5	100%
Squatter on private land	0	0%	0	0%	0	0%
Uncertain Ownership	1	7%	0	0%	0	0%

Note * : Squatter: a person residing on unused public or private land without formal land ownership.
Source: JICA Study Team.

8.2.3 Legal Framework Relevant to Land Acquisition

8.2.3.1 Legal Framework of Sri Lanka

Legal framework for land acquisition in Sri Lanka is described in Section 8.2.1.1. Key legislation and policies are as described in Table 8.2.7.

Table 8.2.7 Land Acquisition Legislation and Policies in Sri Lanka

Law, Policy and Year	Outline
Land Acquisition Act (1950)	Explains the procedure for acquisition of lands for public purpose. The act requires compensation based on market value, calculation methods for structures and crops, procedures of land acquisition.
National Environmental Act (1980)	Central Environment Authority was established under this Act. And the act mentions the environmental approval procedure for a project. The act also mentions about involuntary resettlement under prescribed projects.
Land Acquisition Regulations (2008)	Mention the factors to be considered when compensating for injurious affection caused by the acquisition of lands.
National Involuntary Resettlement Policy (2001)	Mention the policy principles regarding involuntary resettlement of development projects. It defines the necessity of alternative studies, securing gender equality and components eligible for compensation.

Source: JICA Study Team

8.2.3.2 JICA's Policy on Involuntary Resettlement and Land Acquisition

JICA Guideline stipulates its policy on involuntary resettlements and land acquisition including the required information, procedure to be followed and so on. Moreover, it is required to refer World Bank Operation Policy regarding resettlement (WB OP 4.12) as international standards. Table 8.2.8 presents the summary of JICA's policy with reference to WB OP4.12 where required. The involuntary resettlement and land acquisition for the proposed project should be planned and implemented in accordance with the policy.

Table 8.2.8 JICA's Policy Related to Resettlement and Land Acquisition

item	Principle
I.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.
II.	When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected.
III.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.
IV.	Compensation must be based on the full replacement cost as much as possible.

item	Principle
V.	Compensation and other kinds of assistance must be provided prior to displacement.
VI.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.
VII.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.
VIII.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.
IX.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.
Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.	
X.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.
XI.	Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.
XII.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
XIII.	Provide support for the transition period (between displacement and livelihood restoration.
XIV.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.
XV.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.
In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.	

Source: JICA Guidelines (2010), JICA's guidelines for preparation of ESIA report(2019), and World Bank OP4.12

8.2.3.3 Gap Analysis Between Sri Lankan System and JICA Guidelines

Sri Lankan regal framework related to involuntary resettlement and land acquisition were compared with JICA Guidelines and World Bank OP4.12, and gaps and basic policies to be adopted to the proposed project to fill the gaps are summarized in Table 8.2.9.

Table 8.2.9 Gap Analysis between JICA's policy and Sri Lankan Regulations

No.	JICA GL and WB safeguard OP4.12	Sri Lankan Laws and Regulations	Gap and Measures to fill the gap
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	NIRP (2001) states that involuntary resettlement should be avoided or reduced as much as possible by reviewing alternatives to the project as well as alternatives within the project.	No major gap observed. The project proponent should explore alternative project designs to avoid/minimize involuntary resettlement following NIRP JICA GL and WB OP 4.12.
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	LAA and 2008 regulations provide guidance for payment of compensation. NIRP provides conceptual framework for payment of compensation for people affected by development induced land acquisition.	No major gap observed. The project proponent should follow LAA and 2008 regulations to pay compensation for affected people within the conceptual framework of NIRP.

No.	JICA GL and WB safeguard OP4.12	Sri Lankan Laws and Regulations	Gap and Measures to fill the gap
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	LAA and 2008 regulations have provisions for payment of loss of income and other payments for disturbances NIRP (2001) provides for recovery or improvement of income and livelihood after the resettlement.	No major gap observed. In implementing the proposed measures, the type and extent of impacts on the affected population should be taken into account, and compensation and assistance should be provided to enable improvement or restoration in terms of living standards, income opportunities and productivity.
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	The NIRP and LAR provide for the payment of compensation based on full replacement cost.	No major differences. Compensation shall be calculated based on full replacement cost.
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	LAA provide guidance to compensate prior to land is vested for the government.	No major gap observed. Compensation should be provided prior to displacement.
6.	For projects that entail large-scale involuntary resettlement, Resettlement Action Plans must be prepared and made available to the public. (JICA GL)	NIRP requires that a comprehensive RAP for projects exceeding displacement of more than 20 families. A project affecting 100 families is considered as a prescribed project under the NEA.	There are no major gaps in the preparation of RAP, but there is no clear provision for public disclosure. Public disclosure of resettlement plans when implementing projects is encouraged.
7.	In preparing a Resettlement Action Plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	NIRP stipulates the participation of affected populations in selecting relocation sites and determining the content of livelihood restoration assistance.	Opportunities for public participation provided by national legislation are limited. When implementing the project, facilitate public participation of RAP in accordance with JICA Guidelines and WB OP 4.12.
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	There are no clear provisions on the language and format for conducting community consultations.	Not clearly defined in national legislation. When consulting on resettlement plans, use a language and format that the affected population can understand.
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of Resettlement Action Plans. (JICA GL)	There is no clear provision for promoting public participation.	As there is no clear stipulation, it is suggested to project sponsors to promote the participation of affected communities in the implementation of land acquisition and in the planning, implementation and monitoring of livelihood restoration support.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	The NIRP provides for the development of a grievance mechanism. LAA also provides for legal measures that can be taken by affected populations.	No major differences. When implementing projects, consider grievance mechanisms that are accessible to affected populations, making use of existing administrative procedures and local customs.
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey	Although cut-off dates for legal landowners are defined in the LAA, cut-off dates are not defined for the affected population as a whole.	Implementation of baseline survey and the setting of a cut-off date are not specified. Once the project design is decided, an

No.	JICA GL and WB safeguard OP4.12	Sri Lankan Laws and Regulations	Gap and Measures to fill the gap
	(including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)		initial baseline should be implemented and a cut-off date should be set to avoid undue influx of people.
12.	Eligibility of benefits includes, the PAPs who have formal legal rights to the land (including customary and traditional land rights recognized under the law), the PAPs who do not have formal legal right to the land they occupying. (WB OP 4.12 Para.11)	NIRP provides for compensation to affected populations who do not have legal rights to land but who effectively occupy it or whose livelihoods depend on it.	No significant differences. National legislation provides for compensation for informal populations, and plans should be made to ensure that this is properly implemented accordingly.
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	No applicable legislation.	There is no clear provision on prioritizing land-based resettlement strategies. If the affected population falls under such case, it is recommended for the implementing agency to prioritize land-based resettlement strategy.
14.	Provide support for the transition period (between displacement and livelihood restoration). (WB OP 4.12 Para.6)	Transitional period support is defined by LAR and NIRP.	No major gap observed. Ensure that support is also provided during the transition period in line with national legislation.
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc. (WB OP 4.12 Para. 8)	The LAR defines the need for consideration of socially vulnerable groups and others.	No major gaps observed. If socially vulnerable people are affected in any negative way by the implementation of the project, appropriate support will be considered and proposed.
16.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	Relocation plans are specified by the NIRP as being prepared for projects involving the resettlement or land acquisition of 10 or more households.	No major gaps observed. In implementing the project, a summary version of the relocation plan shall be developed if there are less than 10 relocated households and less than 200 affected residents.

Source: JICA Guidelines (2010), World Bank OP4.12 and Sri Lankan Laws, specially LAA, 2008 regulations and NIRP

8.2.4 Basic Policy for Land acquisition and Resettlement for the Pre F/S Projects

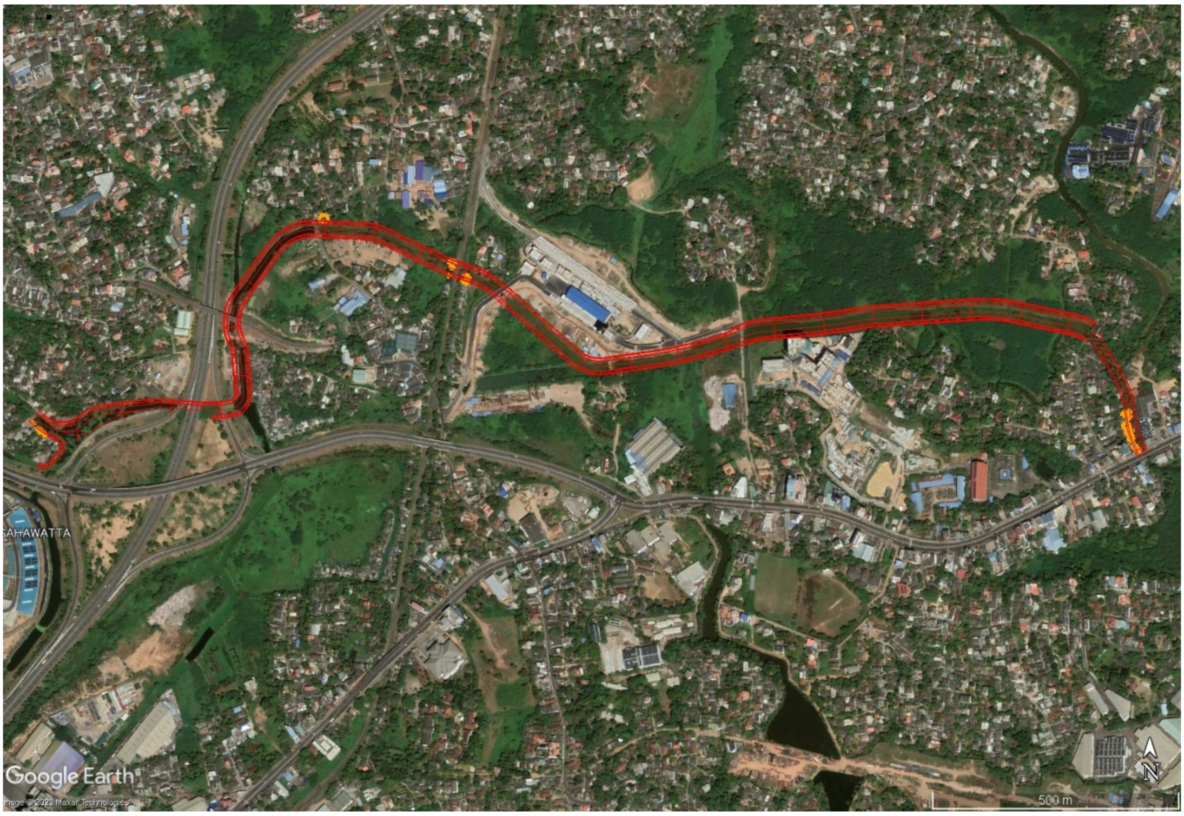
8.2.4.1 Scope of Land Acquisition and Resettlement

Estimated number of households subject to involuntary resettlement as the result of the Pre-F/S projects are summarized in Table 8.2.10 and overall affected areas are presented in Figure 8.2.1 and Figure 8.2.2 and detailed maps are presented as attachment of this report. For Mudun Ela project, the number of households to be resettled is estimated at 20 and the number of affected residents is estimated at 65. For the Moratuwa-Rathmalana project, it was estimated that 33 households and 134 people will be resettled as a result of the implementation of the projects. The numbers of households and residents to be affected by Weras Ganga right bank embankment are indicated in brackets.

Table 8.2.10 Number of Affected households and Residents to Be Resettled

Project	District	Nos of households (of which located at right bank embankment)	Number of residents relocated due to projects* (of which located at right bank embankment)	Average Nos of people per household
Mudun Ela	Kelaniya.	20	65	3.21
Moratuwa-Rathmalana. (canal + right bank)	Moratuwa	20 (13)	79 (52)	3.93
	Rathmalana.	13 (3)	55 (13)	4.20

Note *) Number of households multiplied by the average number of people per households by district(socio-economic survey)
Source: JICA Study Team



Source: JICA survey team

Figure 8.2.1 Map of Affected Households (Orange Colored) - Mudun Ela Project

Source: JICA survey team

Figure 8.2.2 Map of Affected Households (Orange Colored) - Moratuwa-Rathmalana Project

8.2.4.2 Conditions of Compensation for Land Acquisition and Resettlement

The targets of compensation are mainly residential land, residents, and commercial and commercial premises. In accordance with national legislation, JICA guidelines and WB OP 4.12, the scope and content of compensations are summarized in Table 8.2.11.

Table 8.2.11 Entitlement Matrix (Extract)

Type of Loss	Entitled Persons	Entitlements	Remarks and Responsibility
A Residential Land and Structures			
Loss of land (residential land) and/or residents (including auxiliary facilities)	A1) Owner with title deed or registration certificate	- Full replacement cost of the land and the dwelling (or any ancillary buildings etc.) - In case the residential plot is partially acquired, and it is not possible to construct a house or other structure of the same spec, an alternative site should be provided by the project proponent. - The costs of transporting and relocating construction materials should be covered as compensation.	Accommodation and compensation for loss of accommodation and compensation for relocation <Responsible organization>. Chief Valuer （CV), Division Secretariate （DS), SLLDC
	A2) Tenant, user with lease	- Loss of rented accommodation to be compensated: maximum three months' rent based on the category of residential area (Rs 5,000-10,000/month)	Compensation for loss of housing, assistance in determining alternative housing <Responsible organization>.

Type of Loss	Entitled Persons	Entitlements	Remarks and Responsibility
			SLLDC, CV, DS
	A3) Non-titled user, non- permitted user or squatter	- No compensation for land will be provided - Replacement cost of resident (or ancillary structures) installed by the inhabitants should be covered - If relocation sites are made available by the project proponent, resettlement to the site is recommended - The costs of transporting and relocating construction materials should be covered as compensation.	- Compensation for loss of shelter; construction of replacement shelter on another site <Responsible organization>. - SLLDC, CV, DS - In case relocation site will be provided: National Housing Development Authority (NHDA)
B Compensation for commercial land and commercial premises			
Loss of commercial land and structure	B1) Owner/s and/ or Operator/s of registered business	- Reacquisition cost of commercial land and commercial premises (or ancillary buildings) - Cost of transporting and relocating materials to be covered by the compensation. - Compensation for losses to businesses is calculated on the basis of the most recent three years' tax paid - For the business who does not own account book, the higher one between 1) business income for the last six months or 2) subsistence shall be paid	Compensation for commercial losses and continuation, compensation necessary for recovering profits should be covered. In addition, the project proponent should ensure that the affected commercial operator has sufficient time to construct alternative facilities and relocate. <Responsible organization>. - SLLDC, CV, DS
Loss or damage of commercial land and structure	B2) Tenant / operator of registered business	- Provide compensation for the loss of a leased commercial property based on rents for 3 months	- Compensation for loss of commercial premises, search for alternative premises and assistance in making decisions <Responsible organization>. SLLDC, CV, DS
	B3) Owners of commercial premises and non-registered businesses	- Compensation for partial or total loss of facilities: compensate the price of reacquisition of equivalent facilities - The costs of transporting and relocating materials are covered by the compensation.	- Compensation for loss of commercial premises, and assistance during transition periods <Responsible organization>. SLLDC, CV, DS
	B4) tenant	- Compensation for expected loss of business profits and assistance with temporary relocation	

Source: JICA Study Team.

8.2.5 Grievance Redress Mechanism

8.2.5.1 Outline of Grievance Redress Mechanism

The purpose of the Grievance Redress Mechanism (hereafter referred to as GRM) is to provide a mechanism for stakeholders, including PAPs, to express their concerns about the project to the implementing agency and to take action when improvements are required. It also aims to mitigate the negative impacts of project implementation by classifying concerns, complaints and opinions according to type and scope of impact, taking appropriate action and monitoring the progress of improvements in matters where concerns have been expressed. Therefore, the GRM needs to be a mechanism that is recognized and accessible to all PAPs and other stakeholders.

8.2.5.2 Framework of GRM proposed for implementation of the Pre F/S projects

There are three levels of GRM recommended in the implementation of the proposed projects, which are summarized as follows.

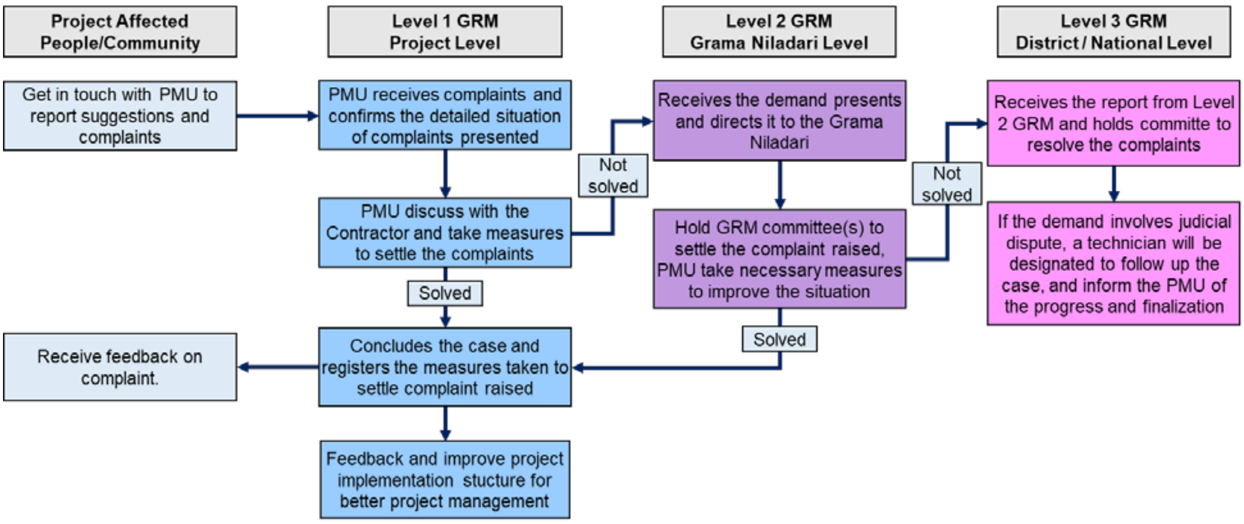
1. Field level: complaints at the project level are made directly to the field staff implementing the proposed projects. The person in charge of social considerations of PMU, the person in charge of the contractor employed for the project implementation are the contact person to receive the complain and deal with the measures to be taken

2. District level: For complaints that couldn't be resolved at the field level as described above, the district administration (Grama Nilarari: village officers) and the grievance redressal committee consisting of district representatives will discuss remedial measures and resolve the grievance in the presence of PMU and the contractor.

3. Regional/central government level: When it is difficult to resolve a grievance at the district level, it need to be resolved at the regional level (district and provincial level) or by a grievance redress committee chaired by the secretary of line ministry. However, situations where grievances reach to this level should be avoided as much as possible.

8.2.5.3 Procedures of GRM

Figure 8.2.3 presents level wise flows of GRM, which is proposed for the Pre F/S projects.



Source: JICA Study Team.

Figure 8.2.3 Flow of Grievance Redress

8.2.6 Policy Framework for Land Acquisition

8.2.6.1 Implementing agencies for Land Acquisition

Preparation for land acquisition need to be initiated as soon as the decision to implement the proposed project is made. For that purpose, SLLDC, as the project proponent, should establish a PMU to be responsible for procurement, budget preparation and supervision of contractors to handle land acquisition procedures as part of the overall project implementation.

As for land acquisition, as soon as the detailed design for the implementation of the project is decided, RAP or A-RAP should be formulated, and land acquisition and livelihood restoration programs for the involuntary resettled people should be implemented as in approved RAP or A-RAP. Table 8.2.12 presents institutions that should take part in land acquisition, such as SLLDC, especially PMU, Ministry of Land and Land Development, Local Government, survey department and valuator.

Table 8.2.12 Institutions and Organizations Responsible of Implementing Land Acquisition

Responsible agencies	Responsibilities
SLLDC (Sri Lanka Land Development Cooperation)	SLLDC as implementing agency, needs to handle land acquisition and resettlement activities for the project. It is important for SLLDC to establish a Project Management Unit (PMU) to handle project activities. The establishment of PMU will help to expedite project activities avoiding bureaucratic constraints.
PMU (Project Management Unit)	The PMU operates as a time-bound project office headed by a project director and its members in engineering, resettlement, land acquisition, environment and other required functions.
MLLD (Ministry of Land and Land Development)	The responsibilities of MLLD are to formulate and implement state land policies, conserve state lands, and implement activities related to land settlement and land acquisition for public purpose. In commencing land acquisition process, SLLDC should send a land acquisition application to MLLD and the ministry appoints respective divisional secretary. MLLD coordinates and acts as the main organization regarding acquisition of land until required land will be taken over.
DS (Divisional Secretariat)	DS headed by a Divisional Secretary is the administrative institution responsible for each division under the government system. Under LAA, the Divisional Secretary is nominated as the “Acquiring Officer” for lands under his/her jurisdiction. The project area comes under the jurisdiction of three DS divisions namely, Moratuwa, Rathmalana and Kelaniya. The DS and the officers attached to DS division play important roles regarding (A-)RAP preparation and land acquisition.
Sri Lanka Survey Department	Survey Department is the national surveying and mapping organization. In the land acquisition process, Survey Department has a statutory role as per the (A-)RAP to survey land and prepare survey plans. On the formal request issued to Surveyor General by the acquisition officer, Survey Department employs its licensed surveyors to survey lands. In the final survey plans (preliminary plans) prepared by the Department of Surveys, survey plans of all land plots to be acquired under the project are given with tenement list (list of persons claiming ownership for land/structures) to the acquisition officer following standard survey techniques and procedures.
Department of Valuation	The Department is the responsible for valuation and management of real estate. The highest official position of the Department is titled as “Chief Valuer’. As per the (A-)RAP, Chief Valuer or any other officer authorized by him/her only can attend to valuation of properties expected to be acquired. As per LAA, valuation of properties is based on market price.

Source: JICA Study Team.

8.2.6.2 Land Acquisition Procedures

As mentioned above, land acquisition involves various institution and can be time consuming; therefore, an concrete plan is necessary to ensure timely implementation. When PMU and its person in charge initiates land acquisition with the assistance of relevant agencies, prior notifications to PAPs should be made in advance. Then compensation and livelihood restoration programs should be provided as planed in approved A-RAP/RAP. Also, it should be noted that all compensation and resettlement must be completed by the time the civil works contract will be awarded, and the livelihood restoration assistance program must be implemented at the appropriate timing. The procedures for land acquisition and resettlement, the responsible institutions and the time required for each procedure are as shown in Table 8.2.13.

Table 8.2.13 Procedures for Land Acquisition and Required Timeframe

Procedure	Responsible agencies	Required time(estimated)
Conducting Census and socio-economic survey and preparation of A-RAP/RAP	PMU SLLDC, Consultants	4 months
Starting of the land acquisition process by sending land acquisition proposal to MLLD	PMU SLLDC	1 month
Issuance of Section 2 notice and preparation of the Advance Tracing	Ministry of Land and Land Development, Divisional Secretary, Survey Department	1 month
Updating (A-)RAP, establishing GRMs	PMU SLLDC	2 months
Issuance of section 4 notice and objection inquiries	Divisional Secretary	2 months
Preparation of Preliminary Plans	Survey Department	4 months
Inquiries (Section 9) and Decision (Section 10-1)	Divisional Secretary	4 months
Property Valuation	Government Valuation Department	3 months
Award of Section 17 and payment of compensation	Divisional Secretary	1 month
Relocation of houses and companies	PMU SLLDC	5 months
Implementing income restoration program	PMU SLLDC	7 months
Order Section 38 (a) and taking over vacant possession	Ministry of Land and Land Development, Divisional Secretary	1 month
Registration of land	Divisional Secretary, PMU SLLDC	1 month

Source: JICA Study Team.

8.2.6.3 Estimated budget required for Land Acquisition

Table 8.2.14 and Table 8.2.15 present estimated costs required for land acquisition associated with resettlement of households and business entities. It should be noted that these are estimative based on the costs as of Nov. 2022, and subject to updated resettlement plans at the project implementation. Also, the value of calculated budget is not linked with cost estimation of the project as the base time is different for both calculations.

Table 8.2.14 Estimated Budget Required for Resettlement (Mudun Ela Project)

Item	No.	Unit	Rs/unit	Total Rs
1. Compensation for Land				
Residential Land	2,815.8	m^2	79,073	222,654,489
Commercial Land	56.8	m^2	83,027	4,714,084
2. Compensation for structure				
Residential	1,407.9	m^2	83,582	117,675,098
Commercial	51.1	m^2	91,493	4,675,292
3. Other costs (for relocation and associated expenses)				
Expenses applicable to households	20	HHs	100,000	2,000,000
Expenses for business	1	Business	80,000	80,000
			Total	**351,798,964**

Source: JICA survey team.

Table 8.2.15 Estimated Budget Required for Resettlement (Moratuwa-Rathmalana Project)

Item	No.	Unit	Rs/unit	Total Rs
1. Compensation for Land				
Residential Land	4,730.20	m^2	48,235	228,159,728

Item	No.	Unit	Rs/unit	Total Rs
Commercial Land	280.0	m^2	50,646	14,180,999
2. Compensation for structure				
Residential	2,365.1	m^2	77,307	182,838,786
Commercial a	64.2	m^2	59,202	3,800,500
Commercial b	187.8	m^2	64,583	12,132,000
3. Other costs (for relocation and associated expenses)				
Expenses applicable to households	33	HHs	100,000	3,300,000
Expenses for business	2	Business	80,000	160,000
			Total	**444,572,012**

Source: JICA survey team.

8.2.7 Monitoring

Considering the scale and content of the project's site acquisition, it is proposed to carry out internal monitoring and external monitoring for land acquisition of Pre F/S projects.

8.2.7.1 Internal Monitoring

The items of internal monitoring are usually expected to include the following.

- Overall progress: the progress of the land acquisition should be summarized with comparing the implementing schedule approved in (A-)RAP, and the actual progress of land acquisition.
- Satisfaction of PAPs (livelihood recovery program): survey level of satisfaction of PAPs, especially those who participated and supported by livelihood recovery program.
- Satisfaction of PAPs (other than livelihood recovery program): survey level of satisfaction of PAPs, who have been provided with relocation housing, compensation for business to cover loss of profits, and compensation or repairs for damage to residents or other auxiliary facilities.
- Consistency with the compensation policy: confirm whether compensation have been appropriately provided based on the ownership of the properties (land and/or house) in accordance with the compensation policy/entitlement matrix presented in Section 8.2.4.2.
- Appropriateness of grievance redress: confirm the nature of complaints and how they were handled during monitoring period. In addition, analyze the time required to settle a complaints and feedback from residents who raised complaints, and propose improvements for GRM if there are any.

8.2.7.2 External Monitoring

External monitoring will be carried out by external monitoring agency (such as local consultant specialized for land acquisition) contracted by PMU. Outline of external monitoring will as follows.

- Review baseline data (before resettlement/relocation) of PAPs, project affected households and business entities.
- Confirm the status of A-RAP/RAP implementation based on the record provided by PMU or each PAP/project affected household.
- Propose improvements of implementing policy if significant issues against the project's safeguards policy are identified in the implementation of resettlement and land acquisition. Those issues should be discussed with the PMU to propose realistic countermeasures.
- Consider appropriate indicators for collecting information and analyzing the impact of land acquisition and resettlement on PAPs and surrounding communities (see Table 8.2.16).
- Collect official data or primary data to analyze impact of land acquisition and resettlement.
- Assess the efficiency, effectiveness, impact and sustainability of resettlement procedures.

- Make recommendations for future resettlement implementation based on the results of above-mentioned survey and analysis.

Table 8.2.16 presents examples of indicators to be applied for evaluating and analyzing impact of land acquisition and involuntary resettlement. Proposed monitoring forms for internal and external monitoring are presented as an appendix

Table 8.2.16 External Monitoring Evaluation Indicators and Survey Items

type	Indicator	Survey item
Process	Staffing	No. of SLLDC staff employed functional wise No. of resettlement and land acquisition staff employed
	Consultation	No. of awareness meetings held with the stake holders
	Participation	No. of training programmes held for the officers No. of informative leaflets distributed
Output	Structures	No. type and area of private structures acquired No. type and area of state structures acquired No. type and area of community structures acquired
	Compensation & Rehabilitation	No. of households Displaced according to type of losses Type, number and total of allowances paid No. of resettlement sites developed
Impact indicators	Household Earning Capacity	No. of APs who loss employment No. of APs suffered from loss of income from a) Business b) No obtained loans from bank and other sources c) No. assisted by IRP d) No. employed by the project
	Changes to Status of Women	Participation in Community Based activities Loss of employment Aggravation /facilitation of gender issues Participation in project activities
	Changes to status of Children	Changes in school attendance, gender wise No attending new schools, gender wise
	Settlement & Population	Generation of new businesses, Influx of population Increase in encroachers /squatters in state lands

Source: JICA Study Team.

CHAPTER 9 COST-BENEFIT ANALYSIS AND FINANCIAL FEASIBILITY

9.1 Methodology of Cost-Benefit Analysis

9.1.1 General

The main objective of the cost-benefit analysis is to examine the investment efficiency of the Pre-F/S Target Project from the viewpoint of the national economy. Market prices have been converted to economic prices where the influence of market distortion is removed (so-called shadow prices). Opportunity costs are used for the costs of goods and services whose markets do not exist. Economic Internal Rate of Return (EIRR) is used here as the indicator of the efficiency of a project investment.

9.1.2 Preconditions

The following preconditions are assumed in the economic evaluation. Additional preconditions will be clarified as necessary.

(1) With-project and Without-project

Without-project is the case where the flood is managed by the currently existing works. With-project is the case where new projects are implemented into the currently existing works.

(2) Evaluation Period

Evaluation period covers the whole project life from the preparation of construction. It is decided in principal as 50 years after starting the construction works of the project.

(3) Standard Conversion Factor (SCF)

SCF is used for bringing such goods that are valued in domestic price level to the common base with those are valued in border price level. In addition, SCF is simply the inverse of the Shadow Exchange Rate Factor (SERF), which is the ratio of the shadow exchange rate to the official exchange rate by definition. It is updated using the latest data based on the SCF calculated in the recent JICA Study "Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo, Sri Lanka, 2018." 0.91 is employed here for SCF based on the calculation result shown below:

Table 9.1.1 Calculation of SCF

(Unit: million Rs.)

	2014	2015	2016	2017	2018
(1) Import Tax	**348,315**	**359,210**	**493,923**	**554,550**	**536,853**
Import Duties	77,726	108,115	156,487	136,501	96,991
VAT (Imports)	102,280	83,726	115,336	168,393	179,163
Ports & Airports Development Levy	68,646	56,733	88,822	102,360	113,950
Import Cess Levy	35,622	42,467	59,058	56,574	50,777
Special Commodity Levy	47,952	52,275	55,825	71,402	75,807
Nation Building Tax (Imports)	16,089	15,894	18,395	19,320	20,165
(2) Export Tax	**27,164**	**2,746**	**2,703**	**3,010**	**2,631**
Export Duties	24,080	33	31	30	40
Export Cess Levy	3,084	2,713	2,672	2,980	2,592
(3) Total Imports	**2,535,163**	**2,572,467**	**2,794,393**	**3,198,572**	**3,606,644**
(4) Total Exports	**1,453,176**	**1,431,431**	**1,500,766**	**1,732,440**	**1,933,533**
SCF ={(3)+(4)}/[{(3)+(1)}+{(4)-(2)}]	**0.93**	**0.92**	**0.90**	**0.90**	**0.91**
Average of SCF			**0.91**		

Source: Ministry of Finance, Central Bank of Sri Lanka, JICA Study Team

(4) Shadow Discount Rate (SDR)

12% is employed here for SDR based on the recent JICA Studies "Preparatory Survey on Landslide Disaster Protection Project of the National Road Network Phase 2 in Sri Lanka, 2019" and "Preparatory Survey on the Project for Establishment of New Light Rail Transit System in Colombo, Sri Lanka, 2018". SDR is used as the criteria for the economic evaluation.

(5) Taxes

Taxes are deducted from the market price since they are just transfer items from the viewpoint of the national economy.

(6) Price Level

Price level is set at 2022. However, since price fluctuations due to the recent economic crisis are considered to be temporary, recent price fluctuations are not included in accordance with the cost estimation. Price data which is not at 2022 level is adjusted to 2022 level with applying inflation rate.

9.1.3 Economic Project Benefits

Incremental benefits are included in the evaluation by comparing with-project and without-project. The benefits are calculated in the form of cashflow of each year during the evaluation period. Benefits of a flood mitigation project are reduction or mitigation of damages caused by floods.

As for the direct damage caused by the flood, it can generally be calculated with the following formula:

[Direct Damage in the Area (Rs.)] =

[Area Size (ha)] × [Damageable Value (Rs./ha)] × [Damage Rate by Inundation Depth]

The damageable value is the maximum amount of asset value that will be damaged by the inundation. It is assumed that damage rate is a function of inundation depth (m) and the function should be estimated. Since the flood causing inundation is a probability event, the damage value to be calculated is the annual expected value based on the probability of flood occurrence (sum of damages multiplied by each flood probability).

Estimation of indirect damages will be discussed later.

9.1.4 Economic Project Costs

Incremental costs are included in the evaluation by comparing with-project and without-project. The costs are calculated in the form of cash flow of each year during the evaluation period. The following cost items are considered.

(1) Initial Cost

Initial cost includes costs of construction of the facility and equipment, engineering services, etc. Economic evaluation includes physical contingencies but excludes price escalation.

(2) Operation and Maintenance Cost

Operation and maintenance cost for each year is included. Price escalation is not included.

(3) Depreciation

Although a certain amount of money is allocated as depreciation on the books, it is not actually spent at that time. So, it is not included in the cost items in the economic evaluation.

9.1.5 Estimation of Economic Benefits

Benefits of the project are captured in the form of expected direct/indirect damage reduction. Damages are examined and estimated for each sector including households, manufacturing, and other industries and infrastructure/utilities as below:

9.1.5.1 Manufacturing and Other Industrial Sectors

(1) Direct Damages

The fixed assets (building, machinery, vehicle, office appliances, equipment, etc.) and inventory assets (materials and components) of factories are considered as the damageable property of the manufacturing and other industrial sectors.

Available Data

Department of Census and Statistics published "Annual Survey of Industries 2017," which includes the fixed asset data and inventory asset data in book value in addition to the number of companies, employees, and value added by industrial division at the national level.

Estimation of Damages

Damageable value on fixed assets and inventory assets per ha of settlement area is calculated with applying the census data and GIS data for large establishments (persons engaged are 25 or more) and for small establishments (persons engaged are less than 25)[*]. This data is applied to the results of flood simulation.

(2) Indirect Damages

Indirect damages due to business suspension is calculated with applying the value added per day of "Annual Survey of Industries 2017".

9.1.5.2 Household Sector

(1) Direct Damages

Floods cause damages directly on houses and household assets. Number of houses for a district is estimated with "Census of Population 2012" published by Department of Census and Statistics[**]. The price of standard house construction is Rs. 5.7 – 5.0 million according to the interview survey to Urban Development Authorities. Average price of household assets (TV, PC, refrigerator, rice cooker, bicycle, motor cycle, automobile, etc.) per household is estimated with percentage data of "household possessions" in "Demographic and Health Survey - 2016".

Damageable value on houses and household assets per ha of settlement area is calculated with applying the census data and GIS data. This data is applied to the results of flood simulation.

(2) Indirect Damages

Indirect damages due to business suspension is calculated with applying the family income per day using the data in "Household Income and Expenditure Survey 2016" published by Department of Census and Statistics.

9.1.5.3 Infrastructure and Utilities

Damageable values of infrastructure and utilities are calculated at 74.1% of the direct damage on buildings and assets of industry sector and household sector with referring to "Manual for Economic Analysis for Flood Control Projects in Japan", Ministry of Infrastructure, Land and Transport, Japan.

9.1.5.4 Damage Rates / Business Suspension Days

Damage rates / business suspension days designated in "Manual for Economic Analysis for Flood Control Projects in Japan" are applied as presented in the following tables.

[*] Only the data for large establishments (persons engaged are 25 or more) are applied to industrial parks.

[**] As it is assumed that the average number of families for a house with 1 - 2 stories is 1.0, the average number of families for other types of houses is 1.7 or less, it can be assumed that the other types of houses are also houses with 1 - 2 stories for simplification of calculation.

Table 9.1.2 Damage Rates/Days

Inundation (m)			House	Business Building	Household Assets	Business Fixed Assets	Business Inventories	Days off for Families (days)	Business Suspension (days)
0.00	–	0.15	0.032	0.032	0.021	0.099	0.056	4.0	3.0
0.15	–	0.65	0.092	0.092	0.145	0.232	0.128	7.5	4.4
0.65	–	1.15	0.119	0.119	0.326	0.453	0.267	13.3	6.3
1.15	–	2.15	0.266	0.266	0.508	0.789	0.586	26.1	10.3
2.15	–	3.15	0.580	0.580	0.928	0.966	0.897	42.4	16.8
3.15	–		0.834	0.834	0.991	0.995	0.982	50.1	22.6

Note: Floor elevation is assumed at 0.15 m from the ground.
Source: "Manual for Economic Analysis for Flood Control Projects in Japan", Ministry of Infrastructure, Land and Transport, Japan. 2005.

9.1.6 Estimation of Economic Costs

Transfer items such as taxes are excluded. Following items are included in the cost calculation: (1) Construction, (2) Engineering, (3) Physical contingencies, (4) Land acquisition, (5) Administration, and (6) O&M, (7) Replacement. Costs of (1) to (5) will accrue as initial costs before and/or in the construction period. O&M cost will accrue every year after the construction is completed and the facilities start to be used. It is assumed that the replacement cost accrues every seven years on the replacement of gabions for the revetment work.

9.2 Economic Evaluation

Economic Internal Rate of Return (EIRR), B/C and Net Present Value (NPV) of the projects are calculated as shown in Table 9.2.1.

Table 9.2.1 EIRR and Other Indicators of the Projects

River Basin/Area and Pre-F/S Target Project		EIRR	B/C	NPV (million Rs.)
Mudun Ela Project		96.8%	12.06	20,008
Muratuwa-Rathmalana	Drainage Improvement	8.32%	0.70	-341
	Weras Ganga Right Bank Dike	15.46%	1.34	337
	Both projects	11.44%	0.95	-105

Source: JICA Study Team

Mudun Ela Project and Weras Ganga Right Bank are evaluated as feasible from the perspective of economic analysis, since 12% is adopted as the shadow discount rate. However, although the EIRR of the drainage improvement did not reach the shadow discount rate of 12%, it was still 8.32%, which is not a low value for such an infrastructure project. The same thing can be said for the Alt-2 for drainage improvement at Moratuwa Rathmalana area (5-year + 2-year return period). This rough estimation of EIRR for this alternative shows 10.41%, which is better than the proposing drainage improvement (described as Alt-3 in the above study) but less than the shadow discount rate. The EIRR of the Mudun Ela Project is high at the 90% level, but this is due to the effect of the construction of the pumping station with the Sri Lankan's own funds. Considering the construction cost of this pumping station, the EIRR will be in the 50% range, depending on the assumptions in the construction plan.

Cashflow tables of projects for river basins are shown from page 9-6.

9.3 Examination of Financial Feasibility

The financial costs for the Pre-F/S target projects in each basin are shown in the table below.

Table 9.3.1 Financial Cost

Unit: Million Rs.

River Basin/Area and Pre-F/S Target Project		Construction cost	Renweal cost	Deprecciation per year	O&M cost per year	Total cost per year
Mudun Ela Project		1,637.8	82.3	44.5	5.4	49.9
Muratuwa-Rathmalana	Drainage Improvement	1,066.4	19.8	24.2	3.6	27.8
	Weras Ganga Right Bank	336.0	0.0	6.7	0.8	7.5
	All project	1,402.3	19.8	30.9	4.4	35.3

Note: Construction cost does not include land acquisition cost. In addition, the service life of the structure is assumed to be 50 years.
Source: JICA Study Team

The annual budget in FY2019 for the D&R Division, which is responsible for the operation and maintenance of rainwater drainage facilities at SLLDC, which is assumed to be the project's implementing body, is 561 million rupees. In contrast, the total annual cost of the project is at most 8.9%. Although the EIRR of Drainage Improvement did not reach the shadow discount rate of 12% in the economic analysis, the annual cost is less than 5.0% against the annual budget of SLLDC, so it is evaluated as being financially sustainable.

Table 9.3.2 Cashflow Table of Projects for Mudun Ela Sub-basin

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	31.0	84.7	781.6	18.6	915.9			915.9	0.0	-915.9
3	2024	516.2	15.5	55.2	0.0	11.5	598.4			598.4	0.0	-598.4
4	2025	516.2	15.5	56.3	0.0	11.8	599.7			599.7	1,737.9	1,138.1
5	2026	0.0	0.0	0.0	0.0	0.0	0.0	4.9		4.9	3,475.8	3,470.9
6	2027	0.0	0.0	0.0	0.0	0.0	0.0	4.9		4.9	3,475.8	3,470.9
7	2028	0.0	0.0	0.0	0.0	0.0	0.0	4.9		4.9	3,475.8	3,470.9
8	2029	0.0	0.0	0.0	0.0	0.0	0.0	4.9		4.9	3,475.8	3,470.9
9	2030	0.0	31.0	3.6	0.0	0.8	35.4	4.9		40.3	3,475.8	3,435.5
10	2031						0.0	4.9		4.9	3,475.8	3,470.9
11	2032						0.0	4.9	74.9	79.8	3,475.8	3,395.9
12	2033						0.0	4.9		4.9	3,475.8	3,470.9
13	2034						0.0	4.9		4.9	3,475.8	3,470.9
14	2035						0.0	4.9		4.9	3,475.8	3,470.9
15	2036						0.0	4.9		4.9	3,475.8	3,470.9
16	2037						0.0	4.9		4.9	3,475.8	3,470.9
17	2038						0.0	4.9		4.9	3,475.8	3,470.9
18	2039						0.0	4.9	74.9	79.8	3,475.8	3,395.9
19	2040						0.0	4.9		4.9	3,475.8	3,470.9
20	2041						0.0	4.9		4.9	3,475.8	3,470.9
21	2042						0.0	4.9		4.9	3,475.8	3,470.9
22	2043						0.0	4.9		4.9	3,475.8	3,470.9
23	2044						0.0	4.9		4.9	3,475.8	3,470.9
24	2045						0.0	4.9		4.9	3,475.8	3,470.9
25	2046						0.0	4.9	74.9	79.8	3,475.8	3,395.9
26	2047						0.0	4.9		4.9	3,475.8	3,470.9
27	2048						0.0	4.9		4.9	3,475.8	3,470.9
28	2049						0.0	4.9		4.9	3,475.8	3,470.9
29	2050						0.0	4.9		4.9	3,475.8	3,470.9
30	2051						0.0	4.9		4.9	3,475.8	3,470.9
31	2052						0.0	4.9		4.9	3,475.8	3,470.9
32	2053						0.0	4.9	74.9	79.8	3,475.8	3,395.9
33	2054						0.0	4.9		4.9	3,475.8	3,470.9
34	2055						0.0	4.9		4.9	3,475.8	3,470.9
35	2056						0.0	4.9		4.9	3,475.8	3,470.9
36	2057						0.0	4.9		4.9	3,475.8	3,470.9
37	2058						0.0	4.9		4.9	3,475.8	3,470.9
38	2059						0.0	4.9		4.9	3,475.8	3,470.9
39	2060						0.0	4.9	74.9	79.8	3,475.8	3,395.9
40	2061						0.0	4.9		4.9	3,475.8	3,470.9
41	2062						0.0	4.9		4.9	3,475.8	3,470.9
42	2063						0.0	4.9		4.9	3,475.8	3,470.9
43	2064						0.0	4.9		4.9	3,475.8	3,470.9
44	2065						0.0	4.9		4.9	3,475.8	3,470.9
45	2066						0.0	4.9		4.9	3,475.8	3,470.9
46	2067						0.0	4.9	74.9	79.8	3,475.8	3,395.9
47	2068						0.0	4.9		4.9	3,475.8	3,470.9
48	2069						0.0	4.9		4.9	3,475.8	3,470.9
49	2070						0.0	4.9		4.9	3,475.8	3,470.9
50	2071						0.0	4.9		4.9	3,475.8	3,470.9
51	2072						0.0	4.9		4.9	3,475.8	3,470.9
52	2073						0.0	4.9		4.9	3,475.8	3,470.9
53	2074						0.0	4.9	74.9	79.8	3,475.8	3,395.9
54	2075						0.0	4.9		4.9	3,475.8	3,470.9
55	2076						0.0	4.9		4.9	3,475.8	3,470.9
56	2077						0.0	4.9		4.9	3,475.8	3,470.9
57	2078						0.0	4.9		4.9	3,475.8	3,470.9
58	2079						0.0	4.9		4.9	3,475.8	3,470.9
59	2080						0.0	4.9		4.9	3,475.8	3,470.9
60	2081						0.0	4.9	74.9	79.8	3,475.8	3,395.9
Total		1,032.4	92.9	199.8	781.6	42.7	2,149.4				EIRR:	96.76%

Discount Rate: 12%

	Cost	Benefit
PV	1,808.97	21,817.37

NPV:	20,008.40
B/C:	12.06

Table 9.3.3 Cashflow Table of Drainage Improvement in the Moratuwa-Rathmalana Area

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	20.8	49.9	457.9	11.0	539.5			539.5	0.0	-539.5
3	2024	346.6	10.4	37.2	0.0	7.8	402.0			402.0	0.0	-402.0
4	2025	346.6	10.4	38.0	0.0	8.0	402.9			402.9	62.0	-341.0
5	2026	0.0	0.0	0.0	0.0	0.0	0.0	3.3		3.3	124.0	120.6
6	2027	0.0	0.0	0.0	0.0	0.0	0.0	3.3		3.3	124.0	120.6
7	2028	0.0	0.0	0.0	0.0	0.0	0.0	3.3		3.3	124.0	120.6
8	2029	0.0	0.0	0.0	0.0	0.0	0.0	3.3		3.3	124.0	120.6
9	2030	0.0	0.0	0.0	0.0	0.0	0.0	3.3		3.3	124.0	120.6
10	2031						0.0	3.3		3.3	124.0	120.6
11	2032						0.0	3.3	18.0	21.3	124.0	102.7
12	2033						0.0	3.3		3.3	124.0	120.6
13	2034						0.0	3.3		3.3	124.0	120.6
14	2035						0.0	3.3		3.3	124.0	120.6
15	2036						0.0	3.3		3.3	124.0	120.6
16	2037						0.0	3.3		3.3	124.0	120.6
17	2038						0.0	3.3		3.3	124.0	120.6
18	2039						0.0	3.3	18.0	21.3	124.0	102.7
19	2040						0.0	3.3		3.3	124.0	120.6
20	2041						0.0	3.3		3.3	124.0	120.6
21	2042						0.0	3.3		3.3	124.0	120.6
22	2043						0.0	3.3		3.3	124.0	120.6
23	2044						0.0	3.3		3.3	124.0	120.6
24	2045						0.0	3.3		3.3	124.0	120.6
25	2046						0.0	3.3	18.0	21.3	124.0	102.7
26	2047						0.0	3.3		3.3	124.0	120.6
27	2048						0.0	3.3		3.3	124.0	120.6
28	2049						0.0	3.3		3.3	124.0	120.6
29	2050						0.0	3.3		3.3	124.0	120.6
30	2051						0.0	3.3		3.3	124.0	120.6
31	2052						0.0	3.3		3.3	124.0	120.6
32	2053						0.0	3.3	18.0	21.3	124.0	102.7
33	2054						0.0	3.3		3.3	124.0	120.6
34	2055						0.0	3.3		3.3	124.0	120.6
35	2056						0.0	3.3		3.3	124.0	120.6
36	2057						0.0	3.3		3.3	124.0	120.6
37	2058						0.0	3.3		3.3	124.0	120.6
38	2059						0.0	3.3		3.3	124.0	120.6
39	2060						0.0	3.3	18.0	21.3	124.0	102.7
40	2061						0.0	3.3		3.3	124.0	120.6
41	2062						0.0	3.3		3.3	124.0	120.6
42	2063						0.0	3.3		3.3	124.0	120.6
43	2064						0.0	3.3		3.3	124.0	120.6
44	2065						0.0	3.3		3.3	124.0	120.6
45	2066						0.0	3.3		3.3	124.0	120.6
46	2067						0.0	3.3	18.0	21.3	124.0	102.7
47	2068						0.0	3.3		3.3	124.0	120.6
48	2069						0.0	3.3		3.3	124.0	120.6
49	2070						0.0	3.3		3.3	124.0	120.6
50	2071						0.0	3.3		3.3	124.0	120.6
51	2072						0.0	3.3		3.3	124.0	120.6
52	2073						0.0	3.3		3.3	124.0	120.6
53	2074						0.0	3.3	18.0	21.3	124.0	102.7
54	2075						0.0	3.3		3.3	124.0	120.6
55	2076						0.0	3.3		3.3	124.0	120.6
56	2077						0.0	3.3		3.3	124.0	120.6
57	2078						0.0	3.3		3.3	124.0	120.6
58	2079						0.0	3.3		3.3	124.0	120.6
59	2080						0.0	3.3		3.3	124.0	120.6
60	2081						0.0	3.3	18.0	21.3	124.0	102.7
Total		693.1	41.6	125.1	457.9	26.8	1,344.4				EIRR:	8.32%

Discount Rate	12%

	Cost	Benefit
PV	1,119.07	778.04

NPV:	-341.04
B/C:	0.70

Table 9.3.4 Cashflow Table of Projects for Weras Ganga Right Bank Dike in the Moratuwa-Rathmalana Area

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	4.5	89.9	858.0	19.8	972.2			972.2	0.0	-972.2
3	2024	74.3	2.2	8.0	0.0	1.7	86.2			86.2	0.0	-86.2
4	2025	74.3	2.2	8.2	0.0	1.7	86.4			86.4	106.7	20.3
5	2026	0.0	0.0	0.0	0.0	0.0	0.0	0.7		0.7	213.3	212.6
6	2027	0.0	0.0	0.0	0.0	0.0	0.0	0.7		0.7	213.3	212.6
7	2028	0.0	0.0	0.0	0.0	0.0	0.0	0.7		0.7	213.3	212.6
8	2029	0.0	0.0	0.0	0.0	0.0	0.0	0.7		0.7	213.3	212.6
9	2030	0.0	0.0	0.0	0.0	0.0	0.0	0.7		0.7	213.3	212.6
10	2031						0.0	0.7		0.7	213.3	212.6
11	2032						0.0	0.7		0.7	213.3	212.6
12	2033						0.0	0.7		0.7	213.3	212.6
13	2034						0.0	0.7		0.7	213.3	212.6
14	2035						0.0	0.7		0.7	213.3	212.6
15	2036						0.0	0.7		0.7	213.3	212.6
16	2037						0.0	0.7		0.7	213.3	212.6
17	2038						0.0	0.7		0.7	213.3	212.6
18	2039						0.0	0.7		0.7	213.3	212.6
19	2040						0.0	0.7		0.7	213.3	212.6
20	2041						0.0	0.7		0.7	213.3	212.6
21	2042						0.0	0.7		0.7	213.3	212.6
22	2043						0.0	0.7		0.7	213.3	212.6
23	2044						0.0	0.7		0.7	213.3	212.6
24	2045						0.0	0.7		0.7	213.3	212.6
25	2046						0.0	0.7		0.7	213.3	212.6
26	2047						0.0	0.7		0.7	213.3	212.6
27	2048						0.0	0.7		0.7	213.3	212.6
28	2049						0.0	0.7		0.7	213.3	212.6
29	2050						0.0	0.7		0.7	213.3	212.6
30	2051						0.0	0.7		0.7	213.3	212.6
31	2052						0.0	0.7		0.7	213.3	212.6
32	2053						0.0	0.7		0.7	213.3	212.6
33	2054						0.0	0.7		0.7	213.3	212.6
34	2055						0.0	0.7		0.7	213.3	212.6
35	2056						0.0	0.7		0.7	213.3	212.6
36	2057						0.0	0.7		0.7	213.3	212.6
37	2058						0.0	0.7		0.7	213.3	212.6
38	2059						0.0	0.7		0.7	213.3	212.6
39	2060						0.0	0.7		0.7	213.3	212.6
40	2061						0.0	0.7		0.7	213.3	212.6
41	2062						0.0	0.7		0.7	213.3	212.6
42	2063						0.0	0.7		0.7	213.3	212.6
43	2064						0.0	0.7		0.7	213.3	212.6
44	2065						0.0	0.7		0.7	213.3	212.6
45	2066						0.0	0.7		0.7	213.3	212.6
46	2067						0.0	0.7		0.7	213.3	212.6
47	2068						0.0	0.7		0.7	213.3	212.6
48	2069						0.0	0.7		0.7	213.3	212.6
49	2070						0.0	0.7		0.7	213.3	212.6
50	2071						0.0	0.7		0.7	213.3	212.6
51	2072						0.0	0.7		0.7	213.3	212.6
52	2073						0.0	0.7		0.7	213.3	212.6
53	2074						0.0	0.7		0.7	213.3	212.6
54	2075						0.0	0.7		0.7	213.3	212.6
55	2076						0.0	0.7		0.7	213.3	212.6
56	2077						0.0	0.7		0.7	213.3	212.6
57	2078						0.0	0.7		0.7	213.3	212.6
58	2079						0.0	0.7		0.7	213.3	212.6
59	2080						0.0	0.7		0.7	213.3	212.6
60	2081						0.0	0.7		0.7	213.3	212.6
Total		148.5	8.9	106.1	858.0	23.2	1,144.8				EIRR:	15.46%

Discount Rate 12%

	Cost	Benefit
PV	1,002.42	1,339.01

NPV:	336.59
B/C:	1.34

Table 9.3.5 Cashflow Table of Projects for All Projects in the Moratuwa-Rathmalana Area

Unit: Million Rs.

Year		Cost									Benefit	Net Benefit
		Initial						O&M	Replace	Cost Total		
		Construction	Engineering	Physical	Land	Admin.	Total					
1	2022	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
2	2023	0.0	25.2	139.8	1,315.9	30.7	1,511.7			1,511.7	0.0	-1,511.7
3	2024	420.8	12.6	45.2	0.0	9.5	488.1			488.1	0.0	-488.1
4	2025	420.8	12.6	46.2	0.0	9.7	489.3			489.3	160.6	-328.7
5	2026	0.0	0.0	0.0	0.0	0.0	0.0	4.0		4.0	321.2	317.2
6	2027	0.0	0.0	0.0	0.0	0.0	0.0	4.0		4.0	321.2	317.2
7	2028	0.0	0.0	0.0	0.0	0.0	0.0	4.0		4.0	321.2	317.2
8	2029	0.0	0.0	0.0	0.0	0.0	0.0	4.0		4.0	321.2	317.2
9	2030	0.0	0.0	0.0	0.0	0.0	0.0	4.0		4.0	321.2	317.2
10	2031						0.0	4.0		4.0	321.2	317.2
11	2032						0.0	4.0	18.0	22.0	321.2	299.2
12	2033						0.0	4.0		4.0	321.2	317.2
13	2034						0.0	4.0		4.0	321.2	317.2
14	2035						0.0	4.0		4.0	321.2	317.2
15	2036						0.0	4.0		4.0	321.2	317.2
16	2037						0.0	4.0		4.0	321.2	317.2
17	2038						0.0	4.0		4.0	321.2	317.2
18	2039						0.0	4.0	18.0	22.0	321.2	299.2
19	2040						0.0	4.0		4.0	321.2	317.2
20	2041						0.0	4.0		4.0	321.2	317.2
21	2042						0.0	4.0		4.0	321.2	317.2
22	2043						0.0	4.0		4.0	321.2	317.2
23	2044						0.0	4.0		4.0	321.2	317.2
24	2045						0.0	4.0		4.0	321.2	317.2
25	2046						0.0	4.0	18.0	22.0	321.2	299.2
26	2047						0.0	4.0		4.0	321.2	317.2
27	2048						0.0	4.0		4.0	321.2	317.2
28	2049						0.0	4.0		4.0	321.2	317.2
29	2050						0.0	4.0		4.0	321.2	317.2
30	2051						0.0	4.0		4.0	321.2	317.2
31	2052						0.0	4.0		4.0	321.2	317.2
32	2053						0.0	4.0	18.0	22.0	321.2	299.2
33	2054						0.0	4.0		4.0	321.2	317.2
34	2055						0.0	4.0		4.0	321.2	317.2
35	2056						0.0	4.0		4.0	321.2	317.2
36	2057						0.0	4.0		4.0	321.2	317.2
37	2058						0.0	4.0		4.0	321.2	317.2
38	2059						0.0	4.0		4.0	321.2	317.2
39	2060						0.0	4.0	18.0	22.0	321.2	299.2
40	2061						0.0	4.0		4.0	321.2	317.2
41	2062						0.0	4.0		4.0	321.2	317.2
42	2063						0.0	4.0		4.0	321.2	317.2
43	2064						0.0	4.0		4.0	321.2	317.2
44	2065						0.0	4.0		4.0	321.2	317.2
45	2066						0.0	4.0		4.0	321.2	317.2
46	2067						0.0	4.0	18.0	22.0	321.2	299.2
47	2068						0.0	4.0		4.0	321.2	317.2
48	2069						0.0	4.0		4.0	321.2	317.2
49	2070						0.0	4.0		4.0	321.2	317.2
50	2071						0.0	4.0		4.0	321.2	317.2
51	2072						0.0	4.0		4.0	321.2	317.2
52	2073						0.0	4.0		4.0	321.2	317.2
53	2074						0.0	4.0	18.0	22.0	321.2	299.2
54	2075						0.0	4.0		4.0	321.2	317.2
55	2076						0.0	4.0		4.0	321.2	317.2
56	2077						0.0	4.0		4.0	321.2	317.2
57	2078						0.0	4.0		4.0	321.2	317.2
58	2079						0.0	4.0		4.0	321.2	317.2
59	2080						0.0	4.0		4.0	321.2	317.2
60	2081						0.0	4.0	18.0	22.0	321.2	299.2
Total		841.6	50.5	231.2	1,315.9	50.0	2,489.2				EIRR:	11.44%

Discount Rate 12%

	Cost	Benefit
PV	2,121.49	2,016.30

NPV:	-105.19
B/C:	0.95

ANNEX TABLE

（Part 1）

Annex-T 6.7.1 Disbursement Schedule for Kalu Oya Basin Improvement (M/P)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	0	38	38	0	4	4	0	2	2	0	0	0	0	1	1	0	7	7	0	51	51
2024	0	0	0	84	38	122	8	4	13	0	3	3	0	0	0	0	3	3	0	21	21	92	69	161
2025	0	0	0	84	15	99	8	132	141	0	157	157	0	1,151	1,151	0	8	8	0	60	60	92	1,523	1,615
2026	1,158	505	1,663	33	15	49	119	198	317	0	307	307	0	1,151	1,151	0	47	47	0	350	350	1,311	2,572	3,883
2027	1,158	505	1,663	33	15	49	119	206	325	0	392	392	0	1,151	1,151	0	49	49	0	364	364	1,311	2,682	3,992
2028	1,859	851	2,710	33	15	49	189	112	301	0	249	249	0	0	0	0	66	66	0	496	496	2,081	1,790	3,871
2029	701	346	1,047	33	15	49	73	49	122	0	124	124	0	0	0	0	27	27	0	201	201	808	762	1,570
2030	701	346	1,047	33	0	33	73	49	122	0	139	139	0	0	0	0	27	27	0	201	201	808	762	1,569
合計	5,576	2,554	8,130	335	153	488	591	753	1,344	0	1,372	1,372	0	3,453	3,453	0	227	227	0	1,700	1,700	**6,502**	**10,212**	**16,714**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	0	38	38	0	4	4	0	2	2	0	0	0	0	1	1	0	7	7	0	51	51
2024	0	0	0	84	38	122	8	4	12	0	3	3	0	0	0	0	3	3	0	21	21	92	69	161
2025	0	0	0	84	15	99	8	2	10	0	151	151	0	1,104	1,104	0	8	8	0	60	60	92	1,339	1,431
2026	1,158	505	1,663	33	15	49	119	52	171	0	298	298	0	1,104	1,104	0	47	47	0	350	350	1,311	2,371	3,682
2027	1,158	505	1,663	33	15	49	119	52	171	0	381	381	0	1,104	1,104	0	49	49	0	364	364	1,311	2,470	3,780
2028	1,859	851	2,710	33	15	49	189	87	276	0	249	249	0	0	0	0	66	66	0	496	496	2,081	1,765	3,846
2029	701	346	1,047	33	15	49	73	36	110	0	124	124	0	0	0	0	27	27	0	201	201	808	750	1,558
2030	701	346	1,047	33	0	33	73	35	108	0	139	139	0	0	0	0	27	27	0	201	201	808	748	1,555
合計	5,576	2,554	8,130	335	153	488	591	271	862	0	1,346	1,346	0	3,313	3,313	0	227	227	0	1,700	1,700	**6,502**	**9,564**	**16,065**

Source: JICA Study Team

Annex-T 6.7.2 Detailed Disbursement Schedule for Kalu Oya Basin Improvement (M/P)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022	FC,Total:	million JPY
Exchange Rate:	USD = JPY	109.12 LC	: million LKR
	USD = LKR	181.06	
	LKR = JPY	0.603	
Price Escalation:	FC: 0.00%	LC: 4.30%	
Physical Contingency:	10.0%		
Physical Contingency for Consultant:	10.0%		

	Item	Total			2023			2024			2025			2026			2027			2028			2029			2030		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	3,699	3,593	5,865	0	0	0	0	0	0	0	0	0	768	657	1,164	768	685	1,181	1,233	1,205	1,960	465	512	773	465	534	787
	Kalu Oya	2,067	1,383	2,901	0	0	0	0	0	0	0	0	0	689	461	967	689	461	967	689	461	967	0	0	0	0	0	0
	Natha canal	28	131	107	0	0	0	0	0	0	0	0	0	9	44	36	9	44	36	9	44	36	0	0	0	0	0	0
	Old Dutch canal and Diversion	1,268	1,039	1,894	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	423	346	631	423	346	631	423	346	631
	Base Cost	3,362	2,554	4,902	0	0	0	0	0	0	0	0	0	698	505	1,003	698	505	1,003	1,121	851	1,634	423	346	631	423	346	631
	Price Escalation	0	713	430	0	0	0	0	0	0	0	0	0	0	93	56	0	118	71	0	245	148	0	119	72	0	139	84
	Physical Contingency	336	327	533	0	0	0	0	0	0	0	0	0	70	60	106	70	62	107	112	110	178	42	47	70	42	49	72
II)	Consulting Services	222	202	344	0	0	0	55	46	83	55	48	84	22	20	34	22	21	35	22	22	35	22	23	36	22	24	36
	Base Cost	202	153	294	0	0	0	50	38	74	50	38	74	20	15	29	20	15	29	20	15	29	20	15	29	20	15	29
	FS+DD for Kalu Oya, Natha Canal, Old Dutch and OD Divers	101	77	147	0	0	0	50	38	74	50	38	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CS for Kalu Oya, Natha Canal, Old Dutch and OD Diversion	101	77	147	0	0	0	0	0	0	0	0	0	20	15	29	20	15	29	20	15	29	20	15	29	20	15	29
	Price Escalation	0	31	19	0	0	0	0	3	2	0	5	3	0	3	2	0	4	2	0	4	3	0	5	3	0	6	4
	Physical Contingency	20	18	31	0	0	0	5	4	8	5	4	8	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3
Total (I+II)		3,920	3,796	6,209	0	0	0	55	46	83	55	48	84	790	677	1,199	790	706	1,216	1,255	1,227	1,995	487	534	809	487	557	823
b	Land Acquisition / Compensation Cost and Site Development	0	4,498	2,712	0	0	0	0	0	0	0	1,437	866	0	1,498	904	0	1,563	942	0	0	0	0	0	0	0	0	0
	Kalu Oya, Natha Canal, Old Dutch and Old Dutch Diversion	0	3,453	2,082	0	0	0	0	0	0	0	1,151	694	0	1,151	694	0	1,151	694	0	0	0	0	0	0	0	0	0
	Base Cost	0	3,453	2,082	0	0	0	0	0	0	0	1,151	694	0	1,151	694	0	1,151	694	0	0	0	0	0	0	0	0	0
	Price Escalation	0	636	383	0	0	0	0	0	0	0	155	93	0	211	127	0	270	163	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	409	247	0	0	0	0	0	0	0	131	79	0	136	82	0	142	86	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	296	178	0	0	0	0	3	2	0	32	19	0	70	42	0	72	43	0	66	40	0	27	16	0	27	16
d	Tax	0	1,545	931	0	0	0	0	21	12	0	21	13	0	298	180	0	303	182	0	496	299	0	201	121	0	205	123
	VAT	0	1,545	931	0	0	0	0	21	12	0	21	13	0	298	180	0	303	182	0	496	299	0	201	121	0	205	123
Total (a+b+c+d)		0	6,338	3,822	0	0	0	0	23	14	0	1,489	898	0	1,866	1,125	0	1,937	1,168	0	562	339	0	228	138	0	232	140
TOTAL (A+B)		3,920	10,134	10,031	0	0	0	55	69	97	55	1,537	982	790	2,543	2,324	790	2,643	2,384	1,255	1,790	2,334	487	762	947	487	789	963

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 6.7.3 Disbursement Schedule for Mudun Ela Sub-basin Improvement (M/P)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	21	15	36	2	69	71	0	28	28	0	644	644	0	3	3	0	20	20	23	779	802
2024	348	302	650	17	15	31	36	105	141	0	84	84	0	644	644	0	18	18	0	136	136	401	1,304	1,706
2025	348	302	650	17	2	19	36	51	88	0	61	61	0	149	149	0	16	16	0	123	123	401	705	1,106
2026	84	75	159	3	2	5	9	27	35	0	42	42	0	149	149	0	5	5	0	36	36	95	336	431
2027	84	75	159	3	2	5	9	10	18	0	18	18	0	0	0	0	4	4	0	30	30	95	139	234
2028	84	75	159	3	2	5	9	10	19	0	22	22	0	0	0	0	4	4	0	31	31	95	144	240
2029	84	75	159	3	2	5	9	10	19	0	27	27	0	0	0	0	4	4	0	31	31	95	150	245
2030	84	75	159	3	0	3	9	11	19	0	30	30	0	0	0	0	4	4	0	32	32	95	152	247
Total	1,116	980	2,096	67	41	108	118	292	410	0	312	312	0	1,587	1,587	0	59	59	0	439	439	**1,302**	**3,709**	**5,011**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	21	15	36	2	66	68	0	28	28	0	641	641	0	3	3	0	20	20	23	772	795
2024	348	302	650	17	15	31	36	96	132	0	84	84	0	641	641	0	18	18	0	136	136	401	1,291	1,693
2025	348	302	650	17	2	19	36	45	82	0	61	61	0	149	149	0	16	16	0	123	123	401	699	1,100
2026	84	75	159	3	2	5	9	23	31	0	42	42	0	149	149	0	5	5	0	36	36	95	331	427
2027	84	75	159	3	2	5	9	8	16	0	18	18	0	0	0	0	4	4	0	30	30	95	137	233
2028	84	75	159	3	2	5	9	8	16	0	22	22	0	0	0	0	4	4	0	31	31	95	142	237
2029	84	75	159	3	2	5	9	8	16	0	27	27	0	0	0	0	4	4	0	31	31	95	147	242
2030	84	75	159	3	0	3	9	8	16	0	30	30	0	0	0	0	4	4	0	32	32	95	149	244
Total	1,116	980	2,096	67	41	108	118	260	378	0	312	312	0	1,579	1,579	0	59	59	0	439	439	**1,302**	**3,669**	**4,970**

Source: JICA Study Team

Annex-T 6.7.4 Detailed Disbursement Schedule for Mudun Ela Sub-basin Improvement (M/P)

Annual Fund Requirement

Base Year/Month for Cost Estimation: Dec, 2022 FC,Total: million JPY
Exchange Rate: USD = JPY 109.12 LC : million LKR
USD = LKR 181.06
LKR = JPY 0.603
Price Escalation: FC: 0.00% LC: 4.30%
Physical Contingency: 10.0%
Physical Contingency for Consultant: 10.0%

Item	Total			2023			2024			2025			2026			2027			2028			2029			2030		
	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I) Procurement / Construction	740	1,271	1,507	0	0	0	231	361	449	231	377	458	56	98	115	56	102	117	56	106	120	56	111	123	56	116	126
Mudun Ela (10 yrs)	420	604	784	0	0	0	210	302	392	210	302	392	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mudun Ela (25 yrs)	254	375	480	0	0	0	0	0	0	0	0	0	51	75	96	51	75	96	51	75	96	51	75	96	51	75	96
Base Cost	673	980	1,264	0	0	0	210	302	392	210	302	392	51	75	96	51	75	96	51	75	96	51	75	96	51	75	96
Price Escalation	0	176	106	0	0	0	0	27	16	0	41	25	0	14	8	0	18	11	0	22	13	0	26	16	0	30	18
Physical Contingency	67	116	137	0	0	0	21	33	41	21	34	42	5	9	10	5	9	11	5	10	11	5	10	11	5	11	11
II) Consulting Services	44	73	88	14	21	26	11	18	22	11	18	22	2	3	3	2	3	4	2	3	4	2	3	4	2	3	4
Base Cost	40	59	76	13	18	24	10	15	19	10	15	19	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3
FS+DD for Mudun Ela (10 yrs)	13	18	24	13	18	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS for Mudun Ela (10 yrs)	13	18	24	0	0	0	6	9	12	6	9	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS+DD for Mudun Ela (25 yrs)	8	11	14	0	0	0	4	6	7	4	6	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CS for Mudun Ela (25 yrs)	8	11	14	0	0	0	0	0	0	0	0	0	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3
Price Escalation	0	7	4	0	1	0	0	1	1	0	2	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	1
Physical Contingency	4	7	8	1	2	2	1	2	2	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total (I+II)	785	1,344	1,595	14	21	26	242	379	470	242	395	480	57	101	118	57	105	121	57	110	123	57	114	126	57	119	129
b Land Acquisition / Compensation Cost and Site Development	0	1,890	1,140	0	739	446	0	771	465	0	186	112	0	194	117	0	0	0	0	0	0	0	0	0	0	0	0
Mudun Ela (10 yrs)	0	1,289	777	0	644	389	0	644	389	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mudun Ela (25 yrs)	0	298	180	0	0	0	0	0	0	0	149	90	0	149	90	0	0	0	0	0	0	0	0	0	0	0	0
Base Cost	0	1,587	957	0	644	389	0	644	389	0	149	90	0	149	90	0	0	0	0	0	0	0	0	0	0	0	0
Price Escalation	0	132	79	0	28	17	0	57	34	0	20	12	0	27	16	0	0	0	0	0	0	0	0	0	0	0	0
Physical Contingency	0	172	104	0	67	41	0	70	42	0	17	10	0	18	11	0	0	0	0	0	0	0	0	0	0	0	0
c Administration Cost	0	91	55	0	16	9	0	31	19	0	20	12	0	8	5	0	4	2	0	4	2	0	4	3	0	4	3
d Tax	0	397	239	0	7	4	0	117	71	0	119	72	0	29	18	0	30	18	0	31	19	0	31	19	0	32	19
VAT	0	397	239	0	7	4	0	117	71	0	119	72	0	29	18	0	30	18	0	31	19	0	31	19	0	32	19
Total (a+b+c+d)	0	2,378	1,434	0	762	459	0	919	554	0	325	196	0	231	139	0	34	21	0	35	21	0	36	21	0	36	22
TOTAL (A+B)	785	3,722	3,029	14	782	486	242	1,298	1,025	242	720	676	57	332	258	57	139	141	57	144	144	57	150	148	57	156	151

Administration Cost = 2.0%
VAT = 15.0%
Import Tax = 0.0%
Other Taxes = 0.0%

Source: JICA Study Team

Annex-T 6.7.5 Disbursement Schedule for Bolgoda Basin Improvement (M/P)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	1	4	5	0	2	2	0	15	15	0	340	340	0	8	8	0	1	1	1	369	370
2024	18	61	79	30	63	93	5	50	55	0	41	41	0	340	340	0	12	12	0	30	30	53	597	650
2025	18	61	79	30	63	93	5	124	129	0	148	148	0	974	974	0	28	28	0	31	31	53	1,429	1,482
2026	395	813	1,207	12	24	36	41	214	255	0	332	332	0	974	974	0	56	56	0	231	231	447	2,644	3,091
2027	395	813	1,207	12	24	36	41	103	144	0	196	196	0	0	0	0	32	32	0	238	238	447	1,406	1,853
2028	395	813	1,207	12	24	36	41	108	148	0	241	241	0	0	0	0	33	33	0	245	245	447	1,463	1,910
2029	395	813	1,207	12	24	36	41	112	153	0	287	287	0	0	0	0	34	34	0	253	253	447	1,523	1,970
2030	395	813	1,207	12	24	36	41	117	158	0	335	335	0	0	0	0	35	35	0	261	261	447	1,585	2,032
Total	2,010	4,185	6,195	121	251	372	213	832	1,045	0	1,594	1,594	0	2,628	2,628	0	237	237	0	1,288	1,288	**2,344**	**11,015**	**13,359**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	1	4	5	0	33	33	0	14	14	0	323	323	0	8	8	0	1	1	1	382	383
2024	18	61	79	30	63	93	5	45	49	0	39	39	0	323	323	0	12	12	0	30	30	53	572	625
2025	18	61	79	30	63	93	5	110	115	0	148	148	0	974	974	0	28	28	0	31	31	53	1,414	1,468
2026	395	813	1,207	12	24	36	41	181	222	0	332	332	0	974	974	0	56	56	0	231	231	447	2,611	3,058
2027	395	813	1,207	12	24	36	41	84	124	0	196	196	0	0	0	0	32	32	0	238	238	447	1,386	1,833
2028	395	813	1,207	12	24	36	41	84	124	0	241	241	0	0	0	0	33	33	0	245	245	447	1,439	1,886
2029	395	813	1,207	12	24	36	41	84	124	0	287	287	0	0	0	0	34	34	0	253	253	447	1,494	1,941
2030	395	813	1,207	12	24	36	41	84	124	0	335	335	0	0	0	0	35	35	0	261	261	447	1,551	1,998
Total	2,010	4,185	6,195	121	251	372	213	703	916	0	1,592	1,592	0	2,593	2,593	0	237	237	0	1,288	1,288	**2,344**	**10,849**	**13,193**

Source: JICA Study Team

Annex-T 6.7.6 Detailed Disbursement Schedule for Bolgoda Basin Improvement (M/P)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022	FC,Total:	million JPY
Exchange Rate:	USD = JPY	109.12 LC	: million LKR
	USD = LKR	181.06	
	LKR = JPY	0.603	
Price Escalation:	FC: 0.00%	LC: 4.30%	
Physical Contingency:	10.0%		
Physical Contingency for Consultant:	10.0%		

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	1,333	5,913	4,899	0	0	0	12	73	56	12	76	58
	Weras Ganga Right Bank Dike	22	121	95	0	0	0	11	61	48	11	61	48
	Bolgoda Basin except for Weras Ganga Right Bank	1,190	4,063	3,640	0	0	0	0	0	0	0	0	0
	Base Cost	1,212	4,185	3,736	0	0	0	11	61	48	11	61	48
	Price Escalation	0	1,191	718	0	0	0	0	5	3	0	8	5
	Physical Contingency	121	538	445	0	0	0	1	7	5	1	7	5
II)	Consulting Services	80	331	279	1	4	3	20	75	65	20	78	67
	Base Cost	73	251	224	1	4	3	18	63	56	18	63	56
	FS+DD for Weras Ganga Right Bank Dike	0.66	3.64	3	1	4	3						
	CS for Weras Ganga Right Bank Dike	0.66	3.64	3	0	0	0	0	2	1	0	2	1
	FS+DD for Others	35.7	121.9	109	0	0	0	18	61	55	18	61	55
	CS for Others	35.7	121.9	109	0	0	0	0	0	0	0	0	0
	Price Escalation	0	49	30	0	0	0	0	6	3	0	8	5
	Physical Contingency	7	30	25	0	0	0	2	7	6	2	7	6
Total (I+II)		1,413	6,243	5,178	1	4	3	32	148	121	32	154	125
b	Land Acquisition / Compensation Cost and Site Development	0	3,280	1,978	0	390	235	0	407	245	0	1,215	733
	Weras Ganga Right Bank Dike	0	680	410	0	340	205	0	340	205	0	0	0
	Bolgoda Basin except for Weras Ganga Right Bank	0	1,947	1,174	0	0	0	0	0	0	0	974	587
	Base Cost	0	2,628	1,585	0	340	205	0	340	205	0	974	587
	Price Escalation	0	354	214	0	15	9	0	30	18	0	131	79
	Physical Contingency	0	298	180	0	35	21	0	37	22	0	110	67
c	Administration Cost	0	237	143	0	8	5	0	12	7	0	28	17
d	Tax	0	1,288	777	0	1	0	0	30	18	0	31	19
	VAT	0	1,288	777	0	1	0	0	30	18	0	31	19
Total (a+b+c+d)		0	4,806	2,898	0	399	241	0	449	271	0	1,275	769
TOTAL (A+B)		1,413	11,049	8,076	1	403	244	32	597	392	32	1,429	894

	Item	2026			2027			2028			2029			2030		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	262	1,058	900	262	1,103	927	262	1,151	956	262	1,200	986	262	1,252	1,017
	Weras Ganga Right Bank Dike	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bolgoda Basin except for Weras Ganga Right Bank	238	813	728	238	813	728	238	813	728	238	813	728	238	813	728
	Base Cost	238	813	728	238	813	728	238	813	728	238	813	728	238	813	728
	Price Escalation	0	149	90	0	190	115	0	234	141	0	279	168	0	325	196
	Physical Contingency	24	96	82	24	100	84	24	105	87	24	109	90	24	114	92
II)	Consulting Services	8	32	27	8	33	28	8	35	29	8	36	30	8	38	31
	Base Cost	7	24	22	7	24	22	7	24	22	7	24	22	7	24	22
	FS+DD for Weras Ganga Right Bank Dike															
	CS for Weras Ganga Right Bank Dike															
	FS+DD for Others	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	CS for Others	7	24	22	7	24	22	7	24	22	7	24	22	7	24	22
	Price Escalation	0	4	3	0	6	3	0	7	4	0	8	5	0	10	6
	Physical Contingency	1	3	2	1	3	3	1	3	3	1	3	3	1	3	3
Total (I+II)		270	1,090	927	270	1,137	955	270	1,185	984	270	1,236	1,015	270	1,290	1,047
b	Land Acquisition / Compensation Cost and Site Development	0	1,268	764	0	0	0	0	0	0	0	0	0	0	0	0
	Weras Ganga Right Bank Dike	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Bolgoda Basin except for Weras Ganga Right Bank	0	974	587	0	0	0	0	0	0	0	0	0	0	0	0
	Base Cost	0	974	587	0	0	0	0	0	0	0	0	0	0	0	0
	Price Escalation	0	179	108	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	115	69	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	56	34	0	32	19	0	33	20	0	34	20	0	35	21
d	Tax	0	231	139	0	238	143	0	245	148	0	253	152	0	261	157
	VAT	0	231	139	0	238	143	0	245	148	0	253	152	0	261	157
Total (a+b+c+d)		0	1,554	937	0	269	162	0	278	167	0	286	173	0	295	178
TOTAL (A+B)		270	2,644	1,864	270	1,406	1,117	270	1,463	1,152	270	1,523	1,188	270	1,585	1,225

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

ANNEX TABLE

（Part 2）

Annex-T 5.2.1 Disbursement Schedule for Mudun Ela Sub-basin Improvement (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	18	15	33	2	92	94	0	38	38	0	870	870	0	21	21	0	6	6	20	1,042	1,061
2024	298	248	545	9	7	16	31	28	58	0	22	22	0	0	0	0	13	13	0	96	96	337	414	752
2025	298	248	545	9	7	16	31	29	60	0	34	34	0	0	0	0	13	13	0	98	98	337	430	767
Total	595	495	1,091	36	30	65	63	149	212	0	95	95	0	870	870	0	47	47	0	200	200	**694**	**1,886**	**2,580**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	18	15	33	2	87	89	0	38	38	0	859	859	0	21	21	0	6	6	20	1,025	1,045
2024	298	248	545	9	7	16	31	26	56	0	22	22	0	0	0	0	13	13	0	96	96	337	412	749
2025	298	248	545	9	7	16	31	26	56	0	34	34	0	0	0	0	13	13	0	98	98	337	426	764
Total	595	495	1,091	36	30	65	63	138	201	0	94	94	0	859	859	0	47	47	0	200	200	**694**	**1,864**	**2,558**

Source: JICA Study Team

Annex-T 5.2.2 Detailed Disbursement Schedule for Mudun Ela Sub-basin Improvement (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	109.12	LC	: million LKR
	USD = LKR	181.06		
	LKR = JPY	0.603		
Price Escalation:	FC: 0.00%	LC: 4.30%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	395	605	760	0	0	0	197	296	376	197	309	384
	Mudun Ela (All Packages)	359	495	658	0	0	0	179	248	329	179	248	329
	Base Cost	359	495	658	0	0	0	179	248	329	179	248	329
	Price Escalation	0	55	33	0	0	0	0	22	13	0	33	20
	Physical Contingency	36	55	69	0	0	0	18	27	34	18	28	35
II)	Consulting Services	24	35	45	12	17	22	6	9	11	6	9	12
	Base Cost	22	30	39	11	15	20	5	7	10	5	7	10
	FS+DD for Mudun Ela	11	15	20	11	15	20	0	0	0	0	0	0
	CS for Mudun Ela	11	15	20	0	0	0	5	7	10	5	7	10
	Price Escalation	0	2	1	0	1	0	0	1	0	0	1	1
	Physical Contingency	2	3	4	1	2	2	1	1	1	1	1	1
Total (I+II)		419	641	805	12	17	22	203	305	387	203	318	395
b	Land Acquisition / Compensation Cost and Site Development	0	1,001	604	0	985	594	0	0	0	0	0	0
	Mudun Ela	0	870	525	0	859	518	0	0	0	0	0	0
	Base Cost	0	859	518	0	859	518	0	0	0	0	0	0
	Price Escalation	0	40	24	0	37	22	0	0	0	0	0	0
	Physical Contingency	0	91	55	0	90	54	0	0	0	0	0	0
c	Administration Cost	0	47	28	0	20	12	0	13	8	0	13	8
d	Tax	0	200	121	0	6	3	0	96	58	0	98	59
	VAT	0	200	121	0	6	3	0	96	58	0	98	59
Total (a+b+c+d)		0	1,248	752	0	1,011	610	0	109	66	0	111	67
TOTAL (A+B)		419	1,888	1,557	12	1,028	632	203	414	453	203	430	463

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.3 Disbursement Schedule for Mudun Ela Sub-basin (Package-1) Improvement (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	11	13	24	1	92	93	0	38	38	0	870	870	0	21	21	0	4	4	12	1,038	1,050
2024	181	217	398	5	7	12	19	24	43	0	20	20	0	0	0	0	9	9	0	71	71	205	348	553
2025	181	217	398	5	7	12	19	25	44	0	30	30	0	0	0	0	10	10	0	73	73	205	361	566
Total	362	434	796	22	26	48	38	142	180	0	88	88	0	870	870	0	40	40	0	148	148	**422**	**1,747**	**2,169**

Source: JICA Study Team

Annex-T 5.2.4 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-1) Improvement (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	109.12	LC	: million LKR
	USD = LKR	181.06		
	LKR = JPY	0.603		
Price Escalation:	FC: 0.00%	LC: 4.30%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

Item		Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	240	531	560	0	0	0	120	260	277	120	271	283
	Mudun Ela (Package 1)	218	434	480	0	0	0	109	217	240	109	217	240
	Base Cost	218	434	480	0	0	0	109	217	240	109	217	240
	Price Escalation	0	48	29	0	0	0	0	19	12	0	29	18
	Physical Contingency	22	48	51	0	0	0	11	24	25	11	25	26
II)	Consulting Services	14	31	33	7	15	16	4	8	8	4	8	9
	Base Cost	13	26	29	7	13	14	3	7	7	3	7	7
	FS+DD for Mudun Ela	7	13	14	7	13	14	0	0	0	0	0	0
	CS for Mudun Ela	7	13	14	0	0	0	3	7	7	3	7	7
	Price Escalation	0	2	1	0	1	0	0	1	0	0	1	1
	Physical Contingency	1	3	3	1	1	1	0	1	1	0	1	1
Total (I+II)		254	562	593	7	15	16	124	268	285	124	279	292
b	Land Acquisition / Compensation Cost and Site Development	0	998	602	0	998	602	0	0	0	0	0	0
	Mudun Ela	0	870	525	0	870	525	0	0	0	0	0	0
	Base Cost	0	870	525	0	870	525	0	0	0	0	0	0
	Price Escalation	0	37	23	0	37	23	0	0	0	0	0	0
	Physical Contingency	0	91	55	0	91	55	0	0	0	0	0	0
c	Administration Cost	0	40	24	0	21	12	0	9	6	0	10	6
d	Tax	0	148	89	0	4	2	0	71	43	0	73	44
	VAT	0	148	89	0	4	2	0	71	43	0	73	44
Total (a+b+c+d)		0	1,186	715	0	1,023	617	0	80	48	0	82	50
TOTAL (A+B)		254	1,747	1,308	7	1,038	633	124	348	333	124	361	341

Administration Cost = 2.0%
VAT = 15.0%
Import Tax = 0.0%
Other Taxes = 0.0%

Source: JICA Study Team

Annex-T 5.2.5 Disbursement Schedule for Mudun Ela Sub-basin (Package-2) Improvement (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3
2024	27	8	35	1	0	1	3	1	4	0	1	1	0	0	0	0	1	1	0	6	6	30	17	47
2025	27	8	35	1	0	1	3	1	4	0	1	1	0	0	0	0	1	1	0	6	6	30	17	47
Total	53	16	69	3	1	4	6	2	8	0	2	2	0	0	0	0	2	2	0	12	12	**62**	**35**	**97**

Source: JICA Study Team

Annex-T 5.2.6 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-2) Improvement (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	109.12	LC	: million LKR
	USD = LKR	181.06		
	LKR = JPY	0.603		
Price Escalation:	FC: 0.00%	LC: 4.30%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

Item		Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	35	20	47	0	0	0	18	10	23	18	10	24
	Mudun Ela (Package 2)	32	16	42	0	0	0	16	8	21	16	8	21
	Base Cost	32	16	42	0	0	0	16	8	21	16	8	21
	Price Escalation	0	2	1	0	0	0	0	1	0	0	1	1
	Physical Contingency	3	2	4	0	0	0	2	1	2	2	1	2
II)	Consulting Services	2	1	3	1	1	1	1	0	1	1	0	1
	Base Cost	2	1	3	1	0	1	0	0	1	0	0	1
	FS+DD for Mudun Ela	1	0	1	1	0	1	0	0	0	0	0	0
	CS for Mudun Ela	1	0	1	0	0	0	0	0	1	0	0	1
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
Total (I+II)		38	21	50	1	1	1	18	10	24	18	10	24
b	Land Acquisition / Compensation Cost and Site Development	0	0	0	0	0	0	0	0	0	0	0	0
	Mudun Ela	0	0	0	0	0	0	0	0	0	0	0	0
	Base Cost	0	0	0	0	0	0	0	0	0	0	0	0
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	2	1	0	0	0	0	1	0	0	1	0
d	Tax	0	12	7	0	0	0	0	6	4	0	6	4
	VAT	0	12	7	0	0	0	0	6	4	0	6	4
Total (a+b+c+d)		0	14	8	0	0	0	0	7	4	0	7	4
TOTAL (A+B)		38	35	58	1	1	2	18	17	28	18	17	29

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.7 Disbursement Schedule for Mudun Ela Sub-basin (Package-3) Improvement (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	5	1	7	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	6	3	9
2024	90	23	113	3	1	3	9	3	12	0	2	2	0	0	0	0	3	3	0	19	19	102	50	152
2025	90	23	113	3	1	3	9	3	12	0	3	3	0	0	0	0	3	3	0	20	20	102	51	153
Total	180	45	225	11	3	14	19	5	24	0	5	5	0	0	0	0	5	5	0	40	40	**210**	**104**	**314**

Source: JICA Study Team

Annex-T 5.2.8 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-3) Improvement (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total: million JPY
Exchange Rate:	USD = JPY	109.12	LC : million LKR
	USD = LKR	181.06	
	LKR = JPY	0.603	
Price Escalation:	FC: 0.00%	LC: 4.30%	
Physical Contingency:	10.0%		
Physical Contingency for Consultant:	10.0%		

Item		Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	120	55	153	0	0	0	60	27	76	60	28	77
	Mudun Ela (Package 3)	109	45	136	0	0	0	54	23	68	54	23	68
	Base Cost	109	45	136	0	0	0	54	23	68	54	23	68
	Price Escalation	0	5	3	0	0	0	0	2	1	0	3	2
	Physical Contingency	11	5	14	0	0	0	5	2	7	5	3	7
II)	Consulting Services	7	3	9	4	2	5	2	1	2	2	1	2
	Base Cost	7	3	8	3	1	4	2	1	2	2	1	2
	FS+DD for Mudun Ela	3	1	4	3	1	4	0	0	0	0	0	0
	CS for Mudun Ela	3	1	4	0	0	0	2	1	2	2	1	2
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	1	0	1	0	0	0	0	0	0	0	0	0
Total (I+II)		127	58	162	4	2	5	62	28	78	62	29	79
b	Land Acquisition / Compensation Cost and Site Development	0	0	0	0	0	0	0	0	0	0	0	0
	Mudun Ela	0	0	0	0	0	0	0	0	0	0	0	0
	Base Cost	0	0	0	0	0	0	0	0	0	0	0	0
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	5	3	0	0	0	0	3	2	0	3	2
d	Tax	0	40	24	0	1	1	0	19	12	0	20	12
	VAT	0	40	24	0	1	1	0	19	12	0	20	12
Total (a+b+c+d)		0	46	28	0	1	1	0	22	13	0	22	13
TOTAL (A+B)		127	104	189	4	3	5	62	50	92	62	51	93

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.9 Disbursement Schedule for Weras Ganga Right Bank Dike (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	2	3	5	0	102	102	0	42	42	0	978	978	0	23	23	0	1	1	2	1,148	1,151
2024	35	43	78	1	1	2	4	5	8	0	4	4	0	0	0	0	2	2	0	14	14	40	69	109
2025	35	43	78	1	1	2	4	5	9	0	6	6	0	0	0	0	2	2	0	14	14	40	71	111
Total	70	86	156	4	5	9	7	112	120	0	52	52	0	978	978	0	26	26	0	29	29	**82**	**1,288**	**1,371**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	2	3	5	0	95	95	0	41	41	0	943	943	0	23	23	0	1	1	2	1,104	1,106
2024	35	43	78	1	1	2	4	4	8	0	4	4	0	0	0	0	2	2	0	14	14	40	68	108
2025	35	43	78	1	1	2	4	4	8	0	6	6	0	0	0	0	2	2	0	14	14	40	71	111
Total	70	86	156	4	5	9	7	103	111	0	50	50	0	943	943	0	26	26	0	29	29	**82**	**1,243**	**1,325**

Source: JICA Study Team

Annex-T 5.2.10 Detailed Disbursement Schedule for Weras Ganga Right Bank Dike (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022	
Exchange Rate:	USD = JPY	109.12
	USD = LKR	181.06
	LKR = JPY	0.603
Price Escalation:	FC: 0.00%	LC: 4.30%
Physical Contingency:	10.0%	
Physical Contingency for Consultant:	10.0%	

Item		Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	47	105	110	0	0	0	23	51	54	23	54	56
	Weras Ganga Right Bank Dike	42	86	94	0	0	0	21	43	47	21	43	47
	Base Cost	42	86	94	0	0	0	21	43	47	21	43	47
	Price Escalation	0.0	9.5	6	0	0	0	0	4	2	0	6	3
	Physical Contingency	4.2	9.5	10	0	0	0	2	5	5	2	5	5
II)	Consulting Services	2.8	6.1	6	1	3	3	1	2	2	1	2	2
	Base Cost	2.5	5.1	6	1	3	3	1	1	1	1	1	1
	FS+DD	1.3	2.6	3	1	3	3	0	0	0	0	0	0
	CS	1.3	2.6	3	0	0	0	0.6	1.3	1.4	0.6	1.3	1.4
	Price Escalation	0.0	0.4	0	0	0	0	0.0	0.1	0.1	0.0	0.2	0.1
	Physical Contingency	0.3	0.6	1	0	0	0	0.1	0.1	0.1	0.1	0.1	0.2
Total (I+II)		50	111	116	1	3	3	24	53	56	24	55	57
b	Land Acquisition / Compensation Cost and Site Development	0	1,122	677	0	1,122	677	0	0	0	0	0	0
	Weras Ganga Right Bank Dike	0	1,122	677	0	1,122	677	0	0	0	0	0	0
	Base Cost	0	978	590	0	978	677	0	0	0	0	0	0
	Price Escalation	0	42	25	0	42	25	0	0	0	0	0	0
	Physical Contingency	0	102	62	0	102	62	0	0	0	0	0	0
c	Administration Cost	0	26	16	0	23	14	0	2	1	0	2	1
d	Tax	0	29	17	0	1	0	0	14	8	0	14	9
	VAT	0	29	17	0	1	0	0	14	8	0	14	9
Total (a+b+c+d)		0	1,177	710	0	1,146	691	0	16	10	0	16	10
TOTAL (A+B)		50	1,288	826	1	1,148	694	24	69	65	24	71	67

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.11 Disbursement Schedule for Moratuwa-Rathmalana Area Drainage Improvement (Pre-F/S)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	11	11	22	1	58	60	0	24	24	0	549	549	0	13	13	0	4	4	12	659	671
2024	181	182	363	5	5	11	19	20	39	0	16	16	0	0	0	0	9	9	0	64	64	205	297	502
2025	181	182	363	5	5	11	19	21	40	0	25	25	0	0	0	0	9	9	0	66	66	205	309	514
Total	362	364	726	22	22	44	38	100	138	0	66	66	0	549	549	0	30	30	0	134	134	**422**	**1,265**	**1,687**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	11	11	22	1	51	52	0	22	22	0	503	503	0	13	13	0	4	4	12	604	616
2024	181	182	363	5	5	11	19	19	37	0	16	16	0	0	0	0	9	9	0	64	64	205	296	501
2025	181	182	363	5	5	11	19	19	37	0	25	25	0	0	0	0	9	9	0	66	66	205	306	511
Total	362	364	726	22	22	44	38	89	127	0	64	64	0	503	503	0	30	30	0	134	134	**422**	**1,206**	**1,628**

Source: JICA Study Team

Annex-T 5.2.12 Detailed Disbursement Schedule for Moratuwa-Rathmalana Area Drainage Improvement (Pre-F/S)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		
Exchange Rate:	USD = JPY	109.12	
	USD = LKR	181.06	
	LKR = JPY	0.603	
Price Escalation:	FC: 0.00%		LC: 4.30%
Physical Contingency:	10.0%		
Physical Contingency for Consultant:	10.0%		

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	240	445	508	0	0	0	120	218	251	120	227	257
	Moratuwa-Rathmalana area drainage improvement	218	364	438	0	0	0	109	182	219	109	182	219
	Base Cost	218	364	438	0	0	0	109	182	219	109	182	219
	Price Escalation	0.0	40.5	24	0	0	0	0	16	10	0	24	15
	Physical Contingency	21.8	40.4	46	0	0	0	11	20	23	11	21	23
II)	Consulting Services	14.4	25.9	30	7	13	15	4	7	8	4	7	8
	Base Cost	13.1	21.8	26	7	11	13	3	5	7	3	5	7
	FS+DD	6.5	10.9	13	7	11	13	0	0	0	0	0	0
	CS	6.5	10.9	13	0	0	0	3.3	5.5	6.6	3.3	5.5	6.6
	Price Escalation	0.0	1.7	1	0	0	0	0.0	0.5	0.3	0.0	0.7	0.4
	Physical Contingency	1.3	2.4	3	1	1	1	0.3	0.6	0.7	0.3	0.6	0.7
Total (I+II)		254	471	538	7	13	15	124	224	259	124	234	265
b	Land Acquisition / Compensation Cost and Site Development	0	630	380	0	630	380	0	0	0	0	0	0
	Moratuwa-Rathmalana area drainage improvement	0	630	380	0	630	380	0	0	0	0	0	0
	Base Cost	0	549	331	0	549	380	0	0	0	0	0	0
	Price Escalation	0	24	14	0	24	14	0	0	0	0	0	0
	Physical Contingency	0	57	35	0	57	35	0	0	0	0	0	0
c	Administration Cost	0	30	18	0	13	8	0	9	5	0	9	5
d	Tax	0	134	81	0	4	2	0	64	39	0	66	40
	VAT	0	134	81	0	4	2	0	64	39	0	66	40
Total (a+b+c+d)		0	794	479	0	647	390	0	73	44	0	75	45
TOTAL (A+B)		254	1,265	1,017	7	659	405	124	297	303	124	309	310

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.13 Disbursement Schedule for Mudun Ela Sub-basin Improvement (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	48	27	75	5	157	162	0	118	118	0	1,427	1,427	0	36	36	0	13	13	53	1,777	1,830
2024	806	448	1,254	24	13	38	83	54	137	0	78	78	0	0	0	0	30	30	0	226	226	913	849	1,762
2025	806	448	1,254	24	13	38	83	58	141	0	121	121	0	0	0	0	31	31	0	233	233	913	905	1,818
Total	1,612	896	2,508	97	54	150	171	269	440	0	317	317	0	1,427	1,427	0	97	97	0	472	472	**1,880**	**3,531**	**5,411**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	48	27	75	5	157	162	0	118	118	0	1,408	1,408	0	36	36	0	13	13	53	1,758	1,812
2024	806	448	1,254	24	13	38	83	54	137	0	78	78	0	0	0	0	30	30	0	226	226	913	849	1,762
2025	806	448	1,254	24	13	38	83	58	141	0	121	121	0	0	0	0	31	31	0	233	233	913	905	1,818
Total	1,612	896	2,508	97	54	150	171	269	440	0	317	317	0	1,408	1,408	0	97	97	0	472	472	**1,880**	**3,513**	**5,392**

Source: JICA Study Team

Annex-T 5.2.14 Detailed Disbursement Schedule for Mudun Ela Sub-basin Improvement (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	142.06	LC	: million LKR
	USD = LKR	363.25		
	LKR = JPY	0.391		
Price Escalation:	FC: 0.00%	LC: 8.10%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

Item		Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	693	1,198	1,162	0	0	0	347	576	572	347	622	590
	Mudun Ela (All Packages)	630	896	981	0	0	0	315	448	490	315	448	490
	Base Cost	630	896	981	0	0	0	315	448	490	315	448	490
	Price Escalation	0	193	76	0	0	0	0	75	30	0	118	46
	Physical Contingency	63	109	106	0	0	0	32	52	52	32	57	54
II)	Consulting Services	42	68	68	21	32	33	10	17	17	10	19	18
	Base Cost	38	54	59	19	27	29	9	13	15	9	13	15
	FS+DD for Mudun Ela	19	27	29	19	27	29	0	0	0	0	0	0
	CS for Mudun Ela	19	27	29	0	0	0	9	13	15	9	13	15
	Price Escalation	0	8	3	0	2	1	0	2	1	0	4	1
	Physical Contingency	4	6	6	2	3	3	1	2	2	1	2	2
Total (I+II)		735	1,266	1,230	21	32	33	357	593	589	357	641	608
b	Land Acquisition / Compensation Cost and Site Development	0	1,697	663	0	1,697	663	0	0	0	0	0	0
	Mudun Ela (All Packages)	0	1,427	558	0	1,427	558	0	0	0	0	0	0
	Base Cost	0	1,427	558	0	1,427	558	0	0	0	0	0	0
	Price Escalation	0	116	45	0	116	45	0	0	0	0	0	0
	Physical Contingency	0	154	60	0	154	60	0	0	0	0	0	0
c	Administration Cost	0	97	38	0	36	14	0	30	12	0	31	12
d	Tax	0	472	184	0	13	5	0	226	88	0	233	91
	VAT	0	472	184	0	13	5	0	226	88	0	233	91
Total (a+b+c+d)		0	2,265	886	0	1,745	682	0	256	100	0	264	103
TOTAL (A+B)		735	3,531	2,116	21	1,777	716	357	849	689	357	905	711

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.15 Disbursement Schedule for Mudun Ela Sub-basin (Package-1) Improvement (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	37	24	61	4	157	161	0	118	118	0	1,427	1,427	0	35	35	0	10	10	41	1,771	1,812
2024	622	400	1,022	19	12	31	64	48	112	0	70	70	0	0	0	0	25	25	0	185	185	705	740	1,445
2025	622	400	1,022	19	12	31	64	52	116	0	109	109	0	0	0	0	26	26	0	192	192	705	790	1,495
Total	1,244	801	2,045	75	48	123	132	257	389	0	296	296	0	1,427	1,427	0	86	86	0	387	387	**1,450**	**3,301**	**4,752**

Source: JICA Study Team

Annex-T 5.2.16 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-1) Improvement (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	142.06	LC	: million LKR
	USD = LKR	363.25		
	LKR = JPY	0.391		
Price Escalation:	FC: 0.00%	LC: 8.10%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	535	1,071	954	0	0	0	267	515	469	267	556	485
	Mudun Ela (Package 1)	486	801	799	0	0	0	243	400	400	243	400	400
	Base Cost	486	801	799	0	0	0	243	400	400	243	400	400
	Price Escalation	0	173	68	0	0	0	0	67	26	0	105	41
	Physical Contingency	49	97	87	0	0	0	24	47	43	24	51	44
II)	Consulting Services	32	61	56	16	29	27	8	15	14	8	17	15
	Base Cost	29	48	48	15	24	24	7	12	12	7	12	12
	FS+DD for Mudun Ela	15	24	24	15	24	24	0	0	0	0	0	0
	CS for Mudun Ela	15	24	24	0	0	0	7	12	12	7	12	12
	Price Escalation	0	7	3	0	2	1	0	2	1	0	3	1
	Physical Contingency	3	6	5	1	3	2	1	1	1	1	2	1
Total (I+II)		567	1,132	1,010	16	29	27	276	530	483	276	573	500
b	Land Acquisition / Compensation Cost and Site Development	0	1,697	663	0	1,697	663	0	0	0	0	0	0
	Mudun Ela (Package 1)	0	1,427	558	0	1,427	558	0	0	0	0	0	0
	Base Cost	0	1,427	558	0	1,427	558	0	0	0	0	0	0
	Price Escalation	0	116	45	0	116	45	0	0	0	0	0	0
	Physical Contingency	0	154	60	0	154	60	0	0	0	0	0	0
c	Administration Cost	0	86	33	0	35	14	0	25	10	0	26	10
d	Tax	0	387	151	0	10	4	0	185	72	0	192	75
	VAT	0	387	151	0	10	4	0	185	72	0	192	75
Total (a+b+c+d)		0	2,170	848	0	1,742	681	0	210	82	0	217	85
TOTAL (A+B)		567	3,301	1,858	16	1,771	709	276	740	565	276	790	585

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.17 Disbursement Schedule for Mudun Ela Sub-basin (Package-2) Improvement (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	4
2024	36	10	47	1	0	1	4	1	5	0	2	2	0	0	0	0	1	1	0	8	8	41	23	64
2025	36	10	47	1	0	1	4	1	5	0	3	3	0	0	0	0	1	1	0	8	8	41	24	66
Total	73	21	94	4	1	6	8	3	10	0	5	5	0	0	0	0	2	2	0	17	17	**85**	**49**	**134**

Source: JICA Study Team

Annex-T 5.2.18 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-2) Improvement (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	142.06	LC	: million LKR
	USD = LKR	363.25		
	LKR = JPY	0.391		
Price Escalation:	FC: 0.00%	LC: 8.10%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	31	28	42	0	0	0	16	13	21	16	14	21
	Mudun Ela (Package 2)	28	21	37	0	0	0	14	10	18	14	10	18
	Base Cost	28	21	37	0	0	0	14	10	18	14	10	18
	Price Escalation	0	4	2	0	0	0	0	2	1	0	3	1
	Physical Contingency	3	3	4	0	0	0	1	1	2	1	1	2
II)	Consulting Services	2	2	2	1	1	1	0	0	1	0	0	1
	Base Cost	2	1	2	1	1	1	0	0	1	0	0	1
	FS+DD for Mudun Ela	1	1	1	1	1	1	0	0	0	0	0	0
	CS for Mudun Ela	1	1	1	0	0	0	0	0	1	0	0	1
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
Total (I+II)		33	29	45	1	1	1	16	14	22	16	15	22
b	Land Acquisition / Compensation Cost and Site Development	0	0	0	0	0	0	0	0	0	0	0	0
	Mudun Ela (Package 2)	0	0	0	0	0	0	0	0	0	0	0	0
	Base Cost	0	0	0	0	0	0	0	0	0	0	0	0
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	2	1	0	0	0	0	1	0	0	1	0
d	Tax	0	17	7	0	0	0	0	8	3	0	8	3
	VAT	0	17	7	0	0	0	0	8	3	0	8	3
Total (a+b+c+d)		0	19	8	0	1	0	0	9	4	0	10	4
TOTAL (A+B)		33	49	52	1	1	1	16	23	25	16	24	26

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.19 Disbursement Schedule for Mudun Ela Sub-basin (Package-3) Improvement (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	9	2	11	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2	10	5	15
2024	148	37	185	4	1	6	15	4	20	0	6	6	0	0	0	0	4	4	0	32	32	168	86	253
2025	148	37	185	4	1	6	15	5	20	0	10	10	0	0	0	0	4	4	0	33	33	168	90	258
Total	296	74	370	18	4	22	31	9	41	0	17	17	0	0	0	0	9	9	0	67	67	**345**	**181**	**526**

Source: JICA Study Team

Annex-T 5.2.20 Detailed Disbursement Schedule for Mudun Ela Sub-basin (Package-3) Improvement (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022		FC,Total:	million JPY
Exchange Rate:	USD = JPY	142.06	LC	: million LKR
	USD = LKR	363.25		
	LKR = JPY	0.391		
Price Escalation:	FC: 0.00%	LC: 8.10%		
Physical Contingency:	10.0%			
Physical Contingency for Consultant:	10.0%			

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	127	99	166	0	0	0	64	48	82	64	51	84
	Mudun Ela (Package 3)	116	74	145	0	0	0	58	37	72	58	37	72
	Base Cost	116	74	145	0	0	0	58	37	72	58	37	72
	Price Escalation	0	16	6	0	0	0	0	6	2	0	10	4
	Physical Contingency	12	9	15	0	0	0	6	4	7	6	5	8
II)	Consulting Services	8	6	10	4	3	5	2	1	2	2	2	3
	Base Cost	7	4	9	3	2	4	2	1	2	2	1	2
	FS+DD for Mudun Ela	3	2	4	3	2	4	0	0	0	0	0	0
	CS for Mudun Ela	3	2	4	0	0	0	2	1	2	2	1	2
	Price Escalation	0	1	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	1	1	1	0	0	0	0	0	0	0	0	0
Total (I+II)		135	104	176	4	3	5	65	49	85	65	53	86
b	Land Acquisition / Compensation Cost and Site Development	0	0	0	0	0	0	0	0	0	0	0	0
	Mudun Ela (Package 3)	0	0	0	0	0	0	0	0	0	0	0	0
	Base Cost	0	0	0	0	0	0	0	0	0	0	0	0
	Price Escalation	0	0	0	0	0	0	0	0	0	0	0	0
	Physical Contingency	0	0	0	0	0	0	0	0	0	0	0	0
c	Administration Cost	0	9	4	0	0	0	0	4	2	0	4	2
d	Tax	0	67	26	0	2	1	0	32	13	0	33	13
	VAT	0	67	26	0	2	1	0	32	13	0	33	13
Total (a+b+c+d)		0	76	30	0	2	1	0	37	14	0	37	15
TOTAL (A+B)		135	181	206	4	5	6	65	86	99	65	90	101

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.21 Disbursement Schedule for Weras Ganga Right Bank Dike (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	5	4	9	1	174	174	0	130	130	0	1,604	1,604	0	38	38	0	2	2	6	1,953	1,958
2024	86	72	158	3	2	5	9	9	17	0	12	12	0	0	0	0	4	4	0	29	29	97	128	225
2025	86	72	158	3	2	5	9	9	18	0	19	19	0	0	0	0	4	4	0	30	30	97	137	234
Total	171	144	315	10	9	19	18	192	210	0	162	162	0	1,604	1,604	0	46	46	0	60	60	**200**	**2,217**	**2,417**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	5	4	9	1	155	156	0	126	126	0	1,546	1,546	0	38	38	0	2	2	6	1,871	1,877
2024	86	72	158	3	2	5	9	7	16	0	12	12	0	0	0	0	4	4	0	29	29	97	127	224
2025	86	72	158	3	2	5	9	7	16	0	19	19	0	0	0	0	4	4	0	30	30	97	135	232
Total	171	144	315	10	9	19	18	170	188	0	158	158	0	1,546	1,546	0	46	46	0	60	60	**200**	**2,133**	**2,333**

Source: JICA Study Team

Annex-T 5.2.22 Detailed Disbursement Schedule for Weras Ganga Right Bank Dike (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

Base Year/Month for Cost Estimation:	Dec, 2022	
Exchange Rate:	USD = JPY	142.06
	USD = LKR	363.25
	LKR = JPY	0.391
Price Escalation:	FC: 0.00%	LC: 8.10%
Physical Contingency:	10.0%	
Physical Contingency for Consultant:	10.0%	

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	74	192	149	0	0	0	37	92	73	37	100	76
	Weras Ganga Right Bank Dike	67	144	123	0	0	0	33	72	62	33	72	62
	Base Cost	67	144	123	0	0	0	33	72	62	33	72	62
	Price Escalation	0.0	31.1	12	0	0	0	0	12	5	0	19	7
	Physical Contingency	6.7	17.5	14	0	0	0	3	8	7	3	9	7
II)	Consulting Services	4.4	10.9	9	2	5	4	1	3	2	1	3	2
	Base Cost	4.0	8.6	7	2	4	4	1	2	2	1	2	2
	FS+DD	2.0	4.3	4	2	4	4	0	0	0	0	0	0
	CS	2.0	4.3	4	0	0	0	1.0	2.2	1.8	1.0	2.2	1.8
	Price Escalation	0.0	1.3	1	0	0	0	0.0	0.4	0.1	0.0	0.6	0.2
	Physical Contingency	0.4	1.0	1	0	0	0	0.1	0.3	0.2	0.1	0.3	0.2
Total (I+II)		78	203	158	2	5	4	38	95	75	38	103	78
b	Land Acquisition / Compensation Cost and Site Development	0	1,839	719	0	1,839	719	0	0	0	0	0	0
	=B14	0	1,839	719	0	1,839	719	0	0	0	0	0	0
	Base Cost	0	1,546	605	0	1,546	719	0	0	0	0	0	0
	Price Escalation	0	125	49	0	125	49	0	0	0	0	0	0
	Physical Contingency	0	167	65	0	167	65	0	0	0	0	0	0
c	Administration Cost	0	45	18	0	37	14	0	4	2	0	4	2
d	Tax	0	60	24	0	2	1	0	29	11	0	30	12
	VAT	0	60	24	0	2	1	0	29	11	0	30	12
Total (a+b+c+d)		0	1,944	760	0	1,877	734	0	33	13	0	34	13
TOTAL (A+B)		78	2,147	918	2	1,882	738	38	128	88	38	137	91

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

Source: JICA Study Team

Annex-T 5.2.23 Disbursement Schedule for Moratuwa-Rathmalana Area Drainage Improvement (Pre-F/S, w/ Present Unit Cost)

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency			Price Contingency			Land Acquisition and Compensation			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	24	18	42	2	126	128	0	94	94	0	1,145	1,145	0	28	28	0	7	7	27	1,418	1,445
2024	408	295	703	12	9	21	42	36	78	0	51	51	0	0	0	0	17	17	0	128	128	462	536	998
2025	408	295	703	12	9	21	42	38	80	0	80	80	0	0	0	0	18	18	0	133	133	462	573	1,035
Total	816	591	1,406	49	35	84	86	200	286	0	226	226	0	1,145	1,145	0	63	63	0	268	268	**951**	**2,527**	**3,479**

(Unit: Million LKR)

Year	Construction			Engineering Services			Physical Contingency (w/o Price Contingency)			Price Contingency			Land Acquisition			Administration			Tax			Total		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
2023	0	0	0	24	18	42	2	109	111	0	88	88	0	1,070	1,070	0	28	28	0	7	7	27	1,320	1,347
2024	408	295	703	12	9	21	42	30	72	0	51	51	0	0	0	0	17	17	0	128	128	462	531	993
2025	408	295	703	12	9	21	42	30	72	0	80	80	0	0	0	0	18	18	0	133	133	462	565	1,027
Total	816	591	1,406	49	35	84	86	170	256	0	219	219	0	1,070	1,070	0	63	63	0	268	268	**951**	**2,416**	**3,367**

Source: JICA Study Team

Annex-T 5.2.24 Detailed Disbursement Schedule for Moratuwa-Rathmalana Area Drainage Improvement (Pre-F/S, w/ Present Unit Cost)

Annual Fund Requirement

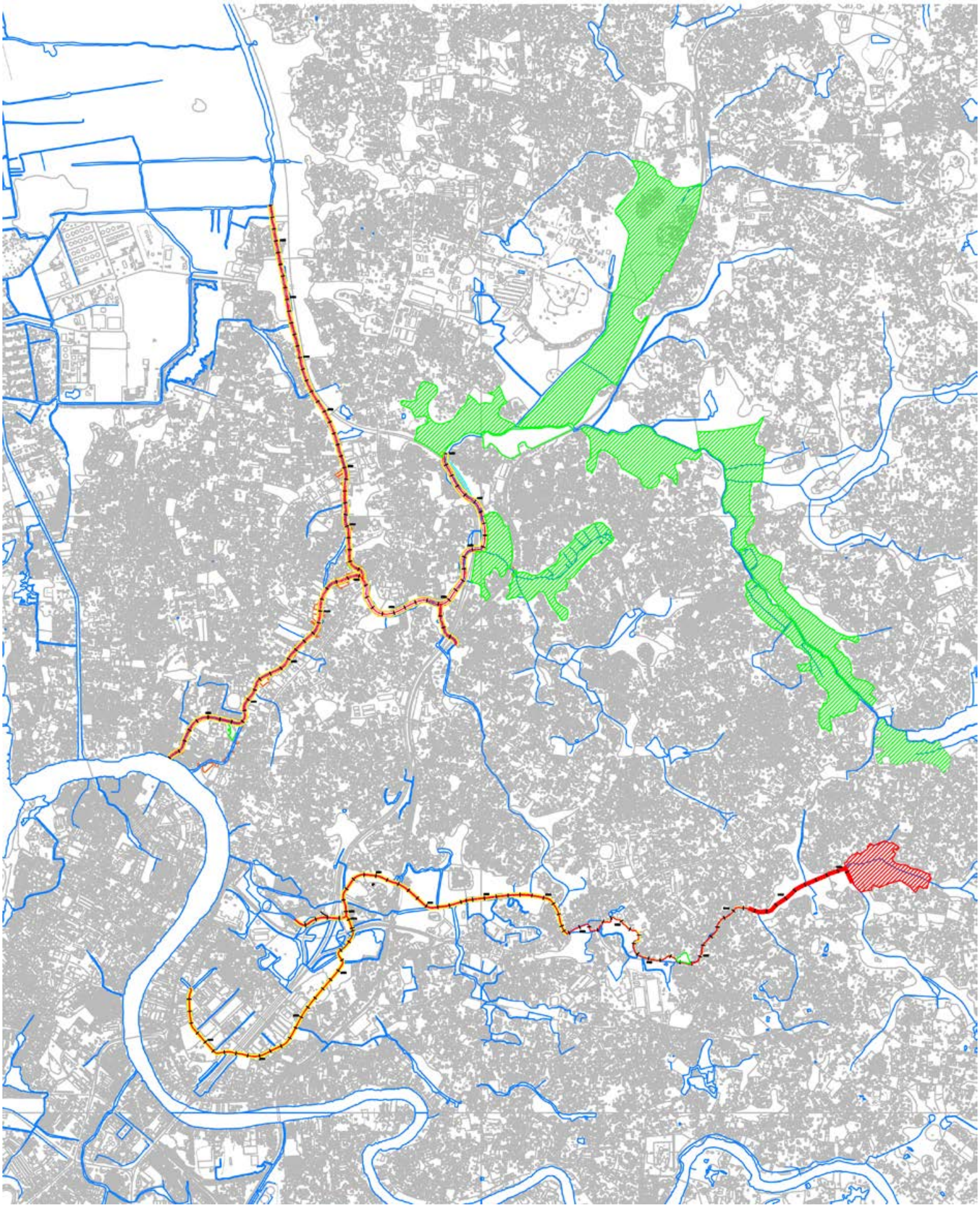
Base Year/Month for Cost Estimation:	Dec, 2022	
Exchange Rate:	USD = JPY	142.06
	USD = LKR	363.25
	LKR = JPY	0.391
Price Escalation:	FC: 0.00%	LC: 8.10%
Physical Contingency:	10.0%	
Physical Contingency for Consultant:	10.0%	

	Item	Total			2023			2024			2025		
		FC	LC	Total	FC	LC	Total	FC	LC	Total	FC	LC	Total
I)	Procurement / Construction	351	790	660	0	0	0	175	380	324	175	410	336
	Moratuwa-Rathmalana area drainage improvement	319	591	550	0	0	0	159	295	275	159	295	275
	Base Cost	319	591	550	0	0	0	159	295	275	159	295	275
	Price Escalation	0.0	127.5	50	0	0	0	0	50	19	0	78	30
	Physical Contingency	31.9	71.8	60	0	0	0	16	35	29	16	37	31
II)	Consulting Services	21.1	44.8	39	11	21	19	5	11	10	5	12	10
	Base Cost	19.1	35.4	33	10	18	16	5	9	8	5	9	8
	FS+DD	9.6	17.7	16	10	18	16	0	0	0	0	0	0
	CS	9.6	17.7	16	0	0	0	4.8	8.9	8.2	4.8	8.9	8.2
	Price Escalation	0.0	5.3	2	0	1	1	0.0	1.5	0.6	0.0	2.3	0.9
	Physical Contingency	1.9	4.1	4	1	2	2	0.5	1.0	0.9	0.5	1.1	0.9
Total (I+II)		372	835	698	11	21	19	181	391	334	181	423	346
b	Land Acquisition / Compensation Cost and Site Development	0	1,362	532	0	1,362	532	0	0	0	0	0	0
	Moratuwa-Rathmalana area drainage improvement	0	1,362	532	0	1,362	532	0	0	0	0	0	0
	Base Cost	0	1,145	448	0	1,145	532	0	0	0	0	0	0
	Price Escalation	0	93	36	0	93	36	0	0	0	0	0	0
	Physical Contingency	0	124	48	0	124	48	0	0	0	0	0	0
c	Administration Cost	0	63	25	0	28	11	0	17	7	0	18	7
d	Tax	0	268	105	0	7	3	0	128	50	0	133	52
	VAT	0	268	105	0	7	3	0	128	50	0	133	52
Total (a+b+c+d)		0	1,693	662	0	1,397	546	0	145	57	0	150	59
TOTAL (A+B)		372	2,527	1,360	11	1,418	565	181	536	390	181	573	405

Administration Cost =	2.0%
VAT =	15.0%
Import Tax =	0.0%
Other Taxes =	0.0%

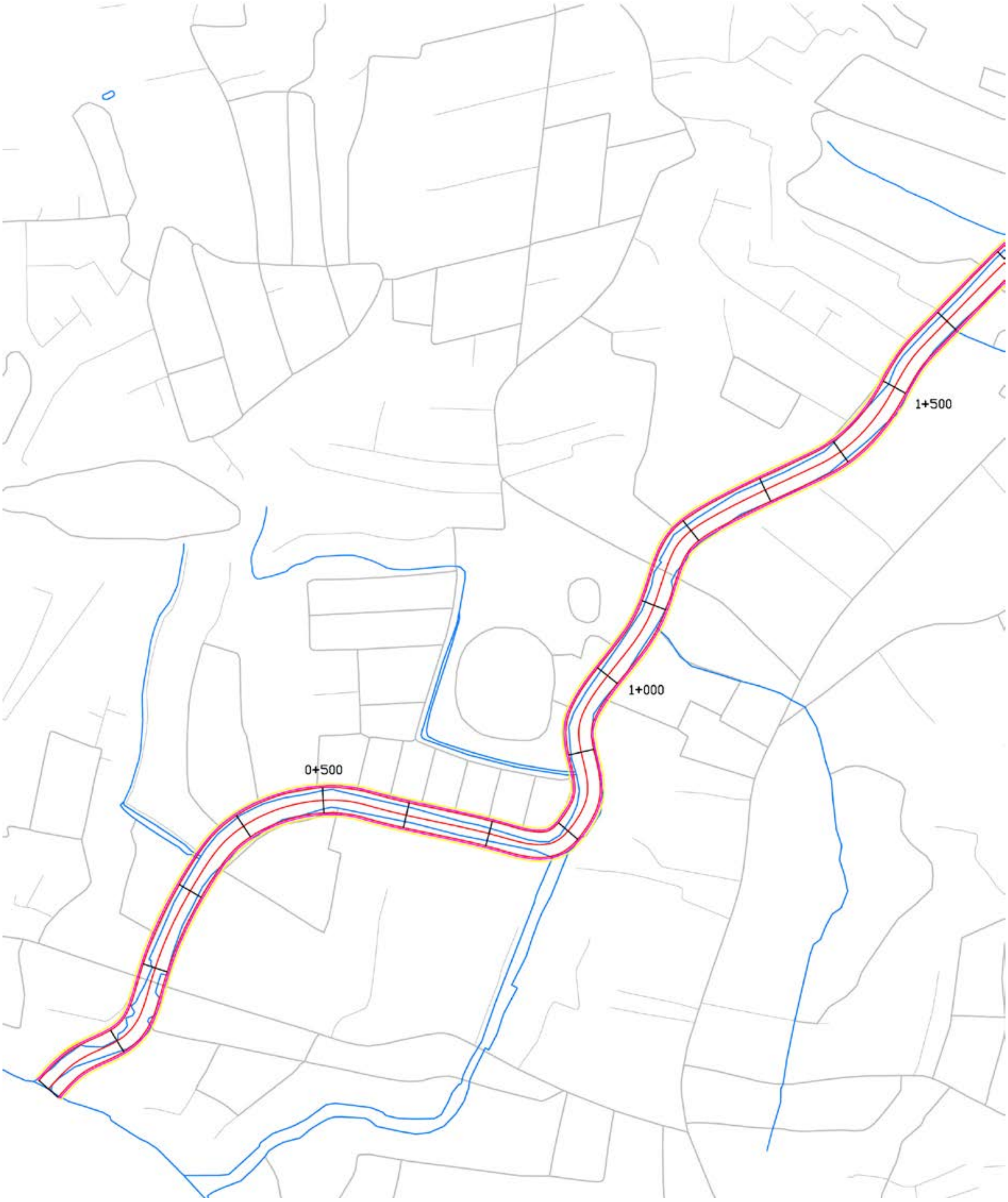
Source: JICA Study Team

ANNEX FIGURE
(Part 1)



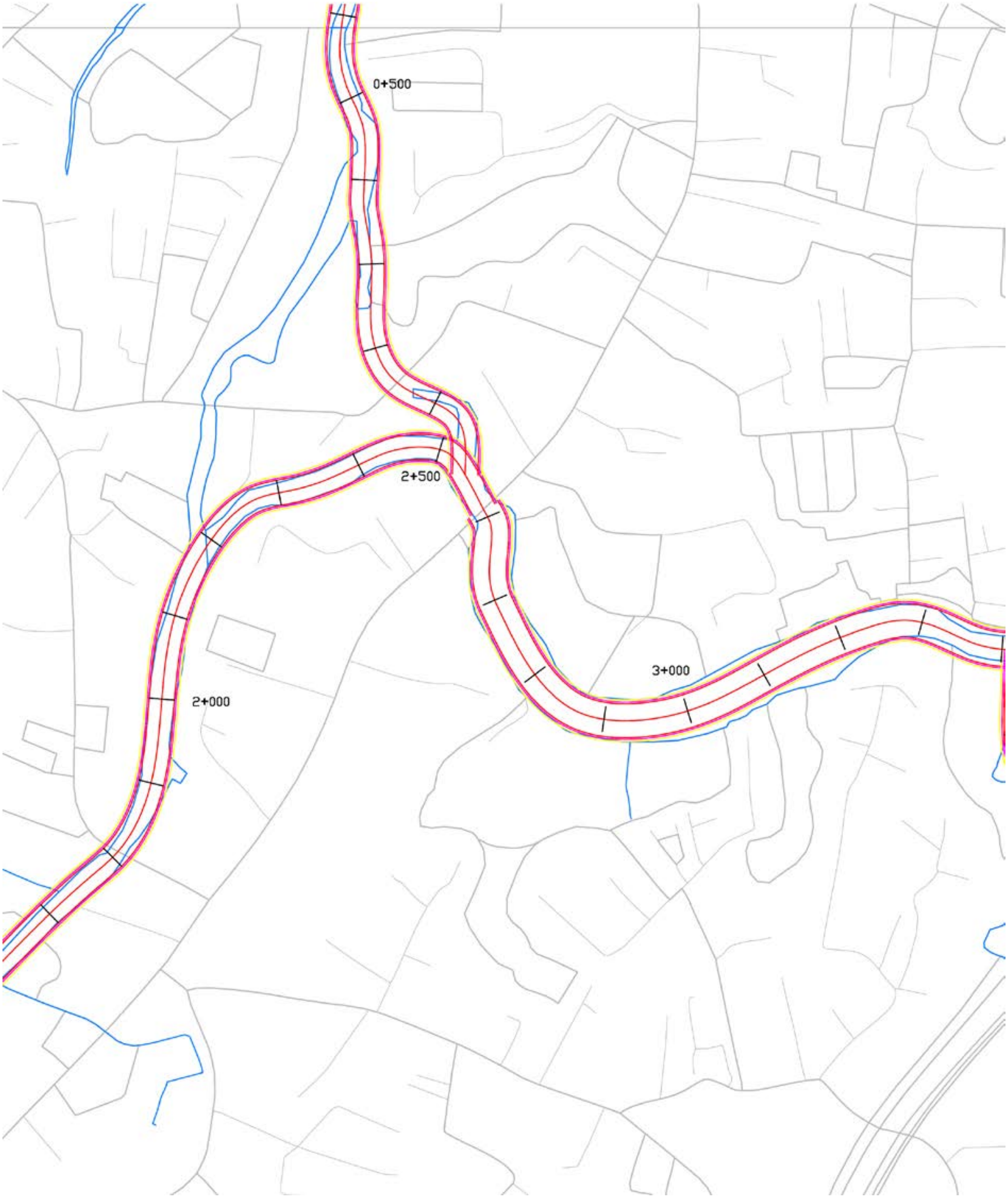
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.1 Plan Map for the M/P at Kalu Oya Basin and Mudun Ela Sub-basin
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



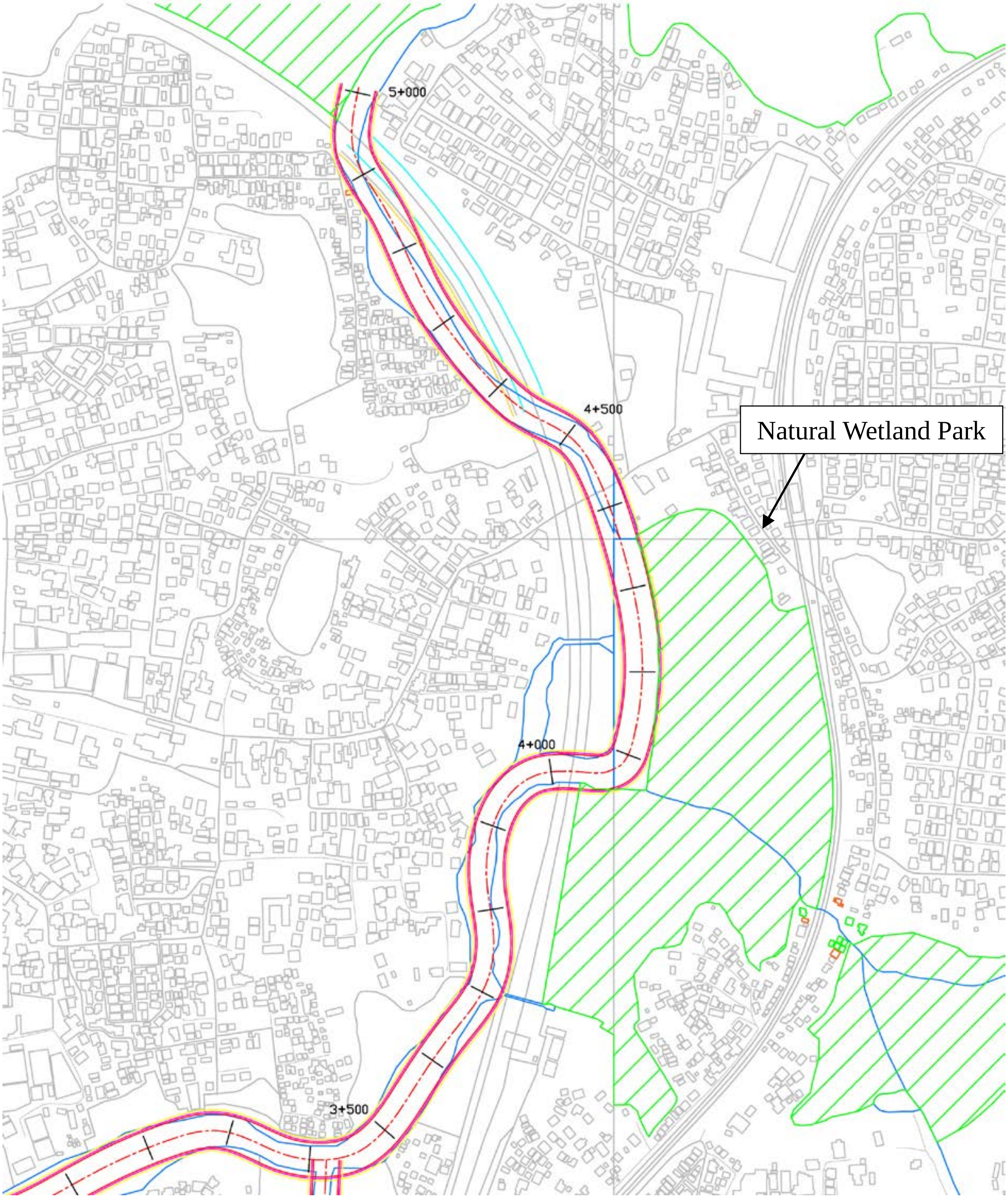
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.2 Plan Map for the M/P at Kalu Oya Basin (1/4)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



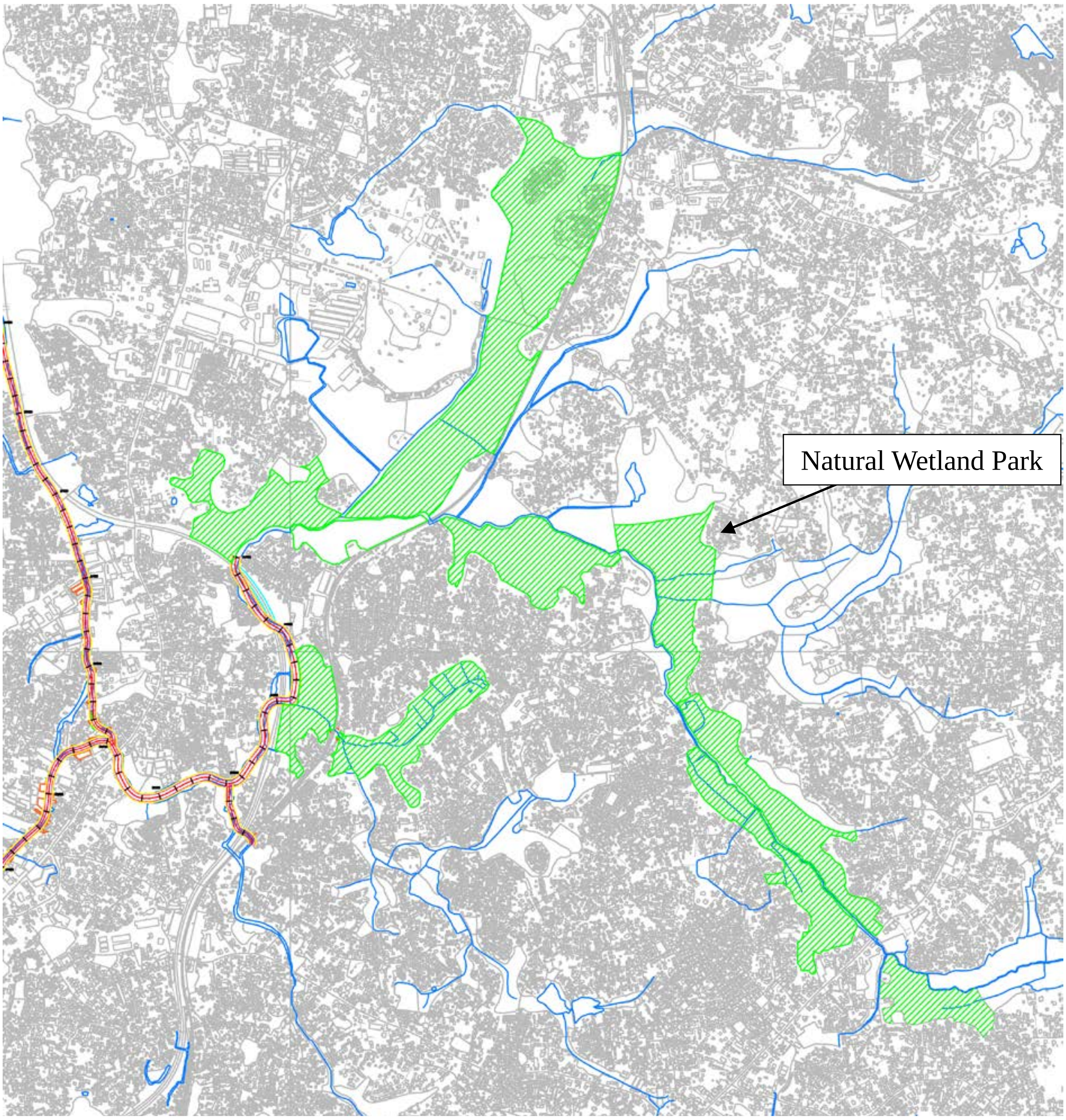
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.3 Plan Map for the M/P at Kalu Oya Basin (2/4)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



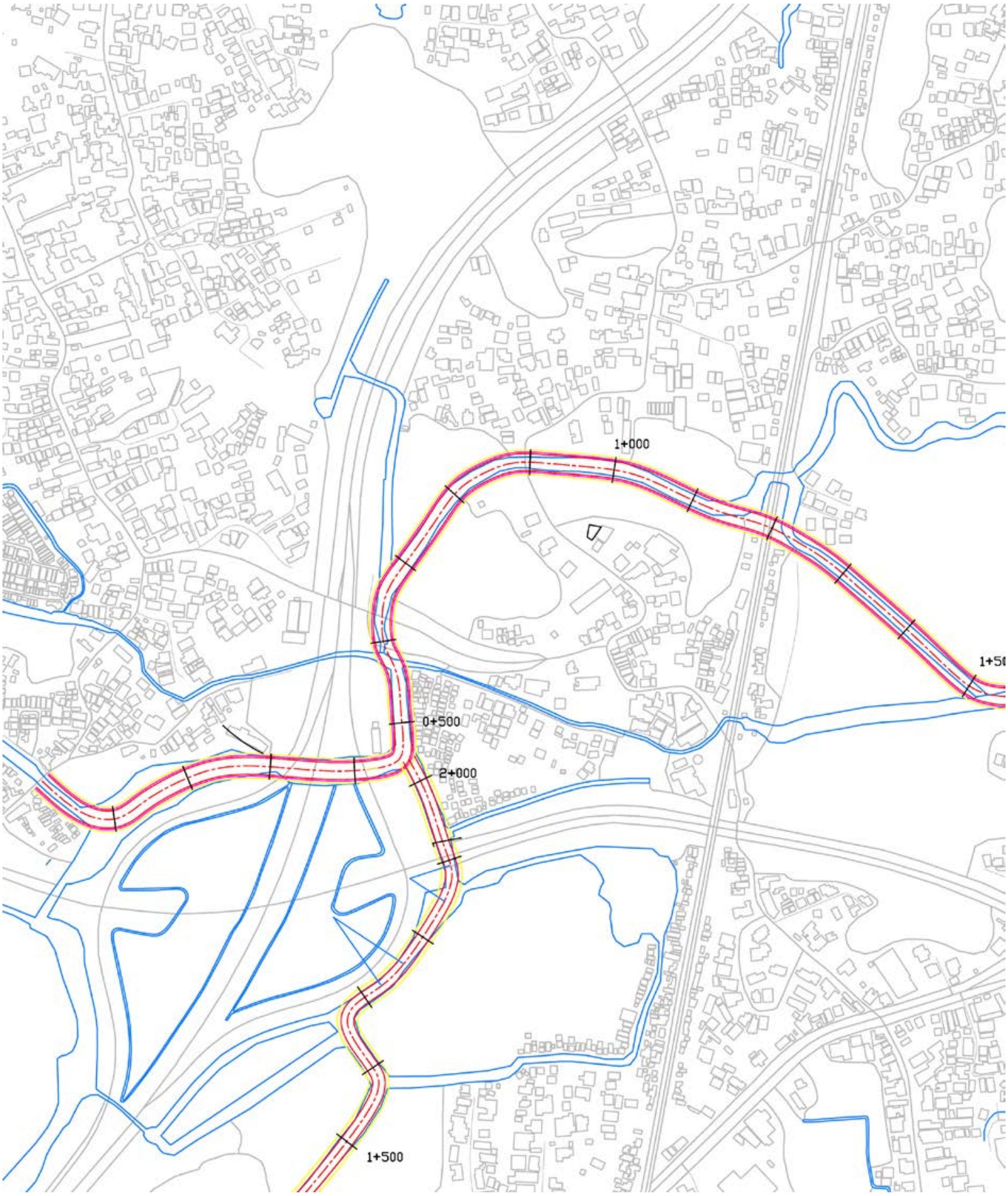
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.4 Plan Map for the M/P at Kalu Oya Basin (3/4)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



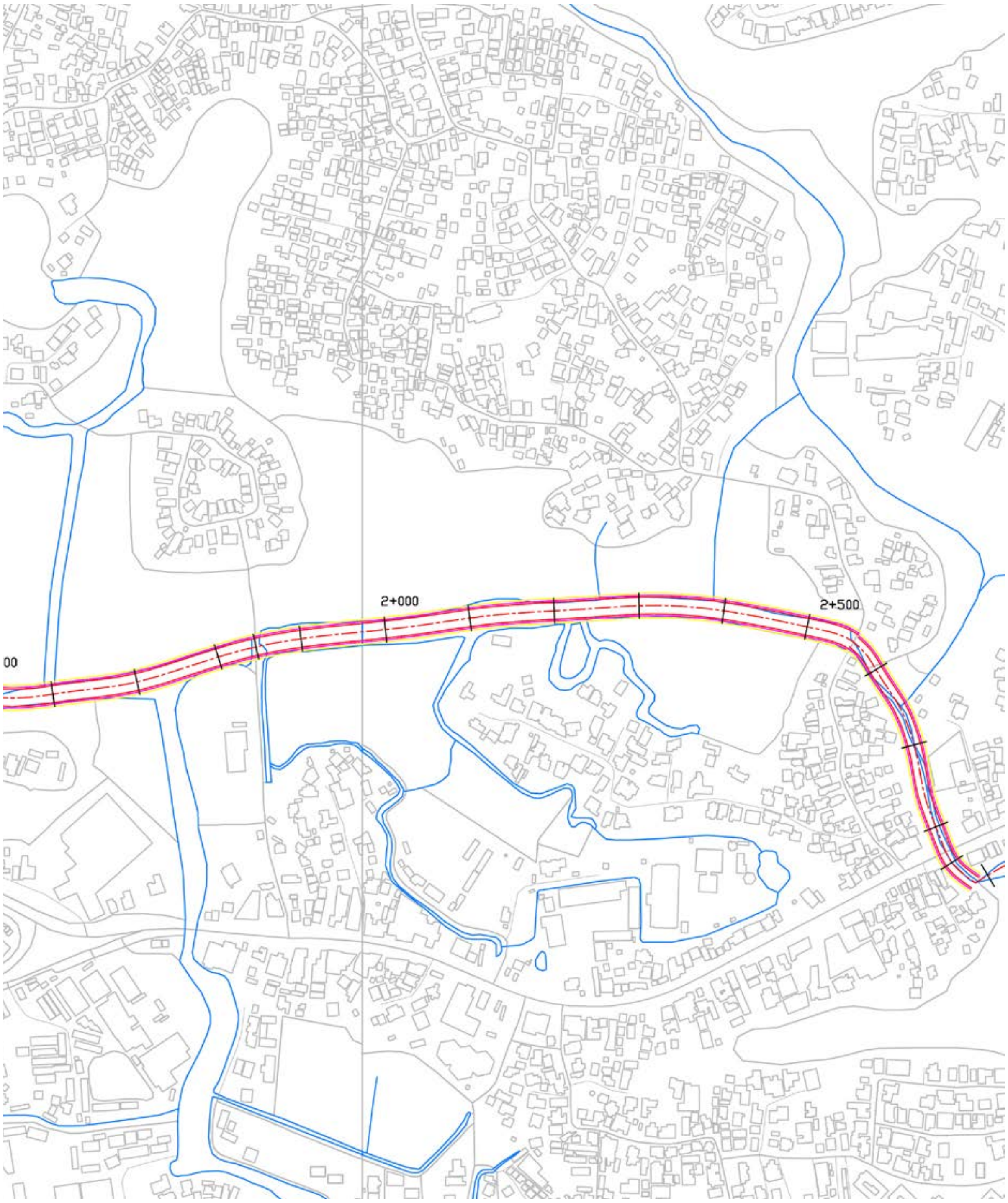
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.5 Plan Map for the M/P at Kalu Oya Basin (4/4)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



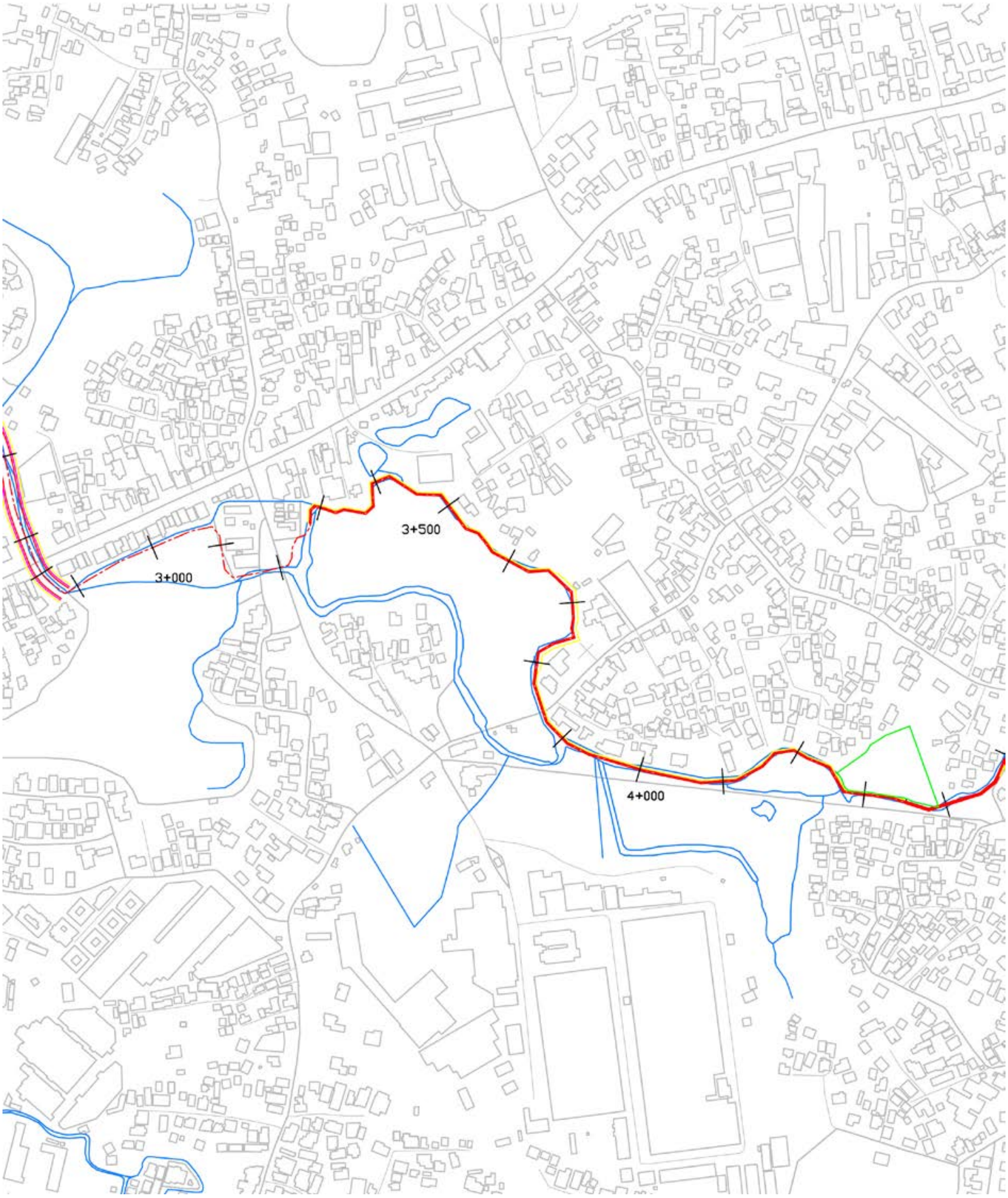
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.6 Plan Map for the M/P at Mudun Ela Sub-basin (1/5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



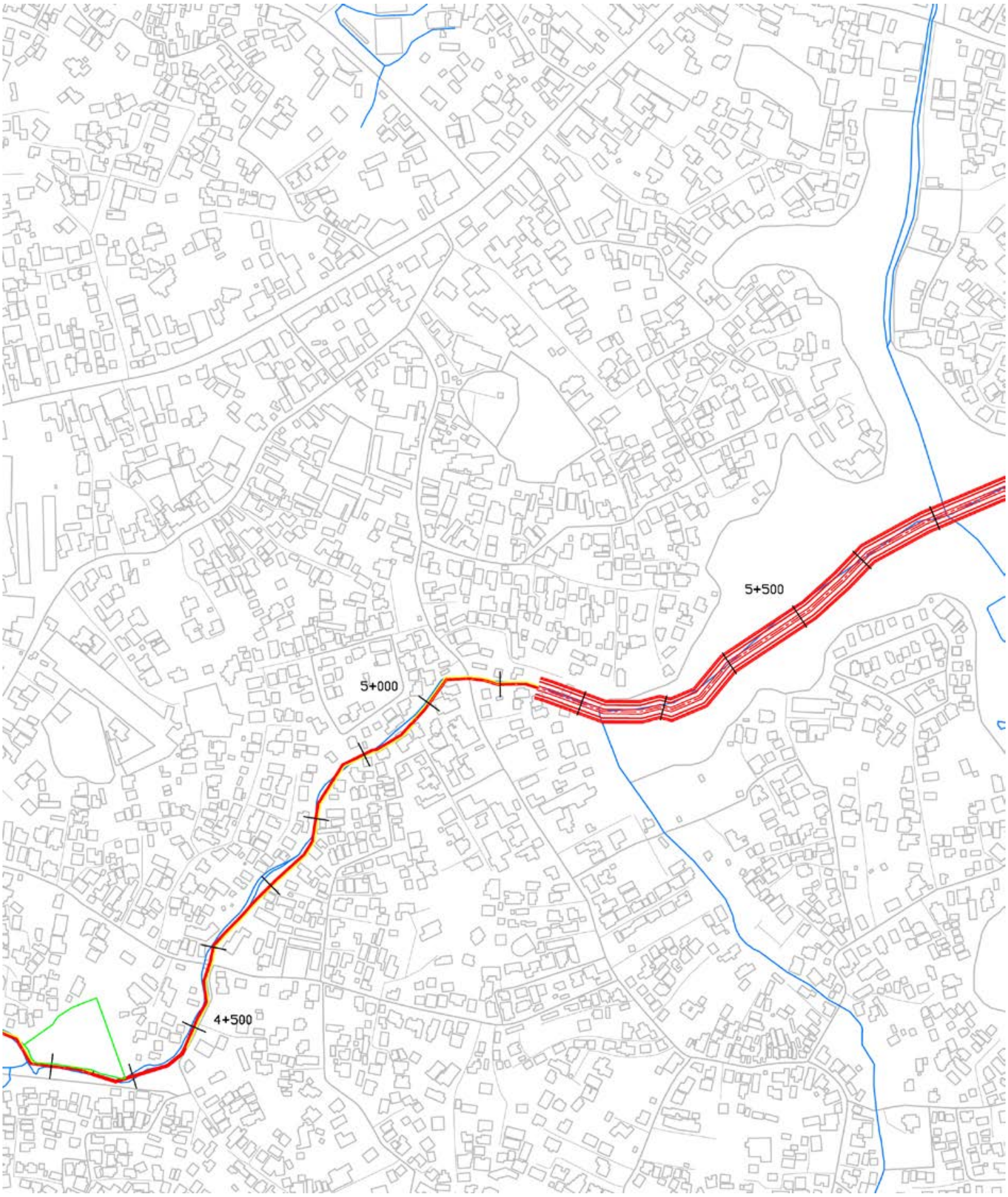
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.7 Plan Map for the M/P at Mudun Ela Sub-basin (2/5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



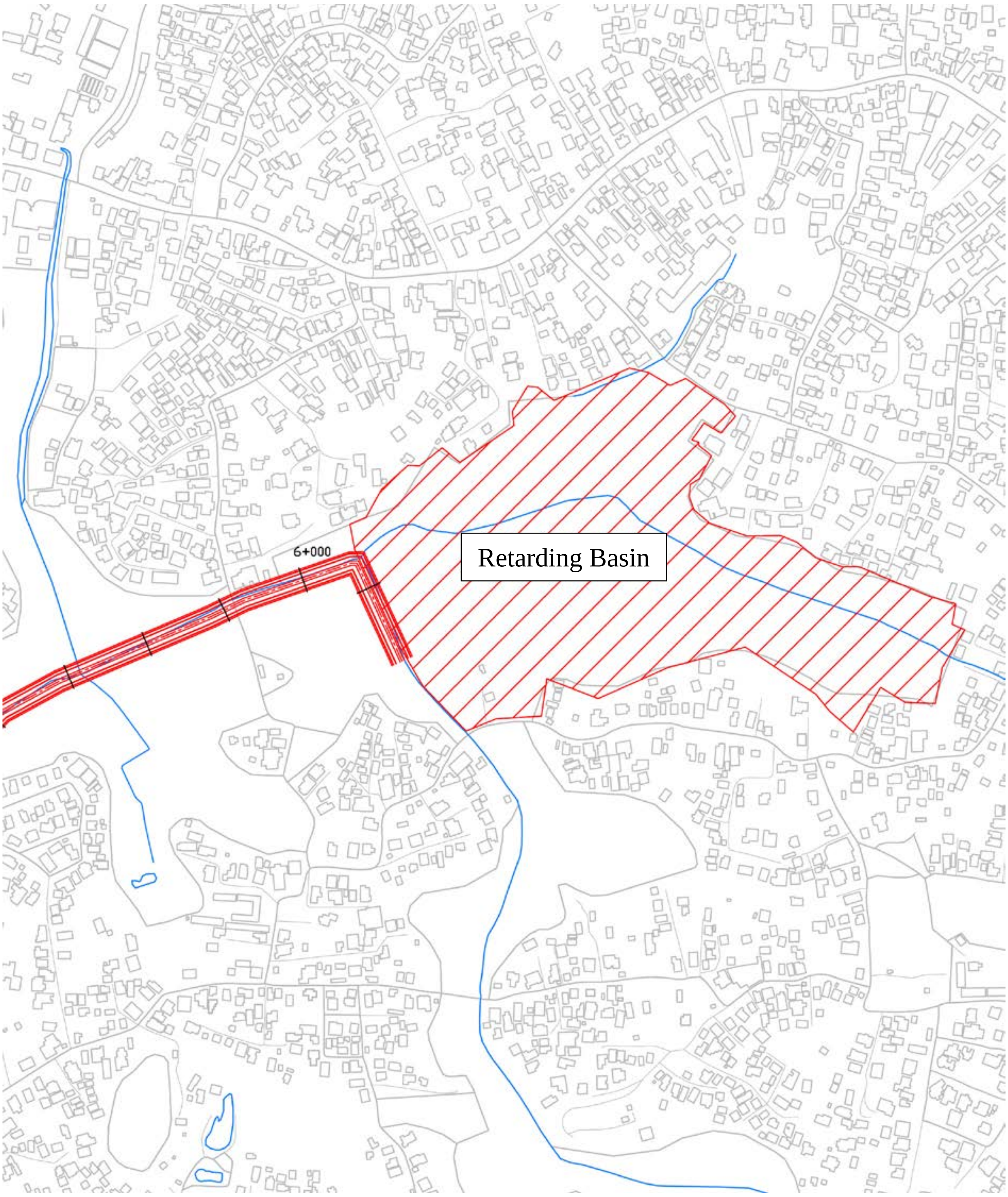
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.8 Plan Map for the M/P at Mudun Ela Sub-basin (3/5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



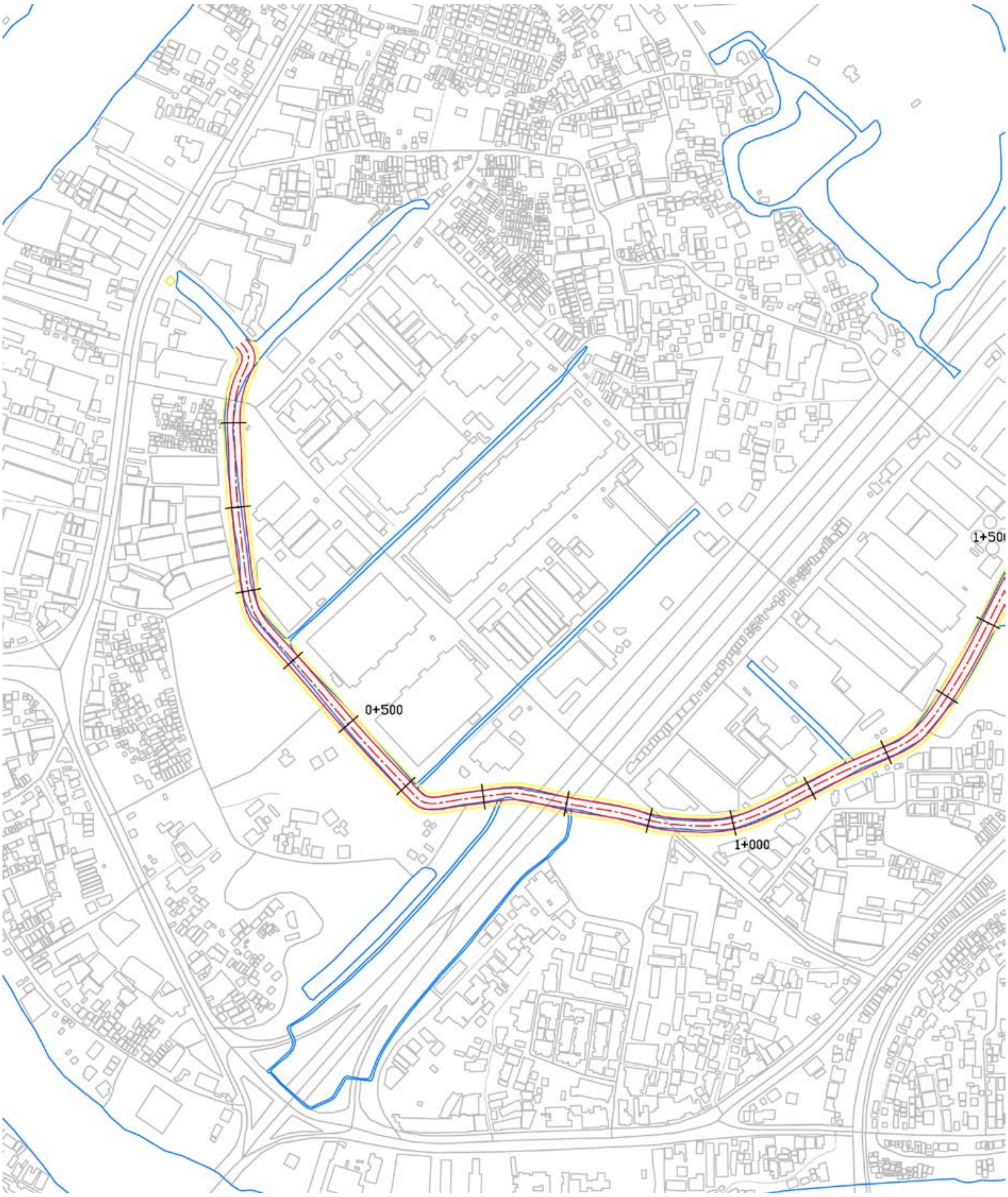
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.9 Plan Map for the M/P at Mudun Ela Sub-basin (4/5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



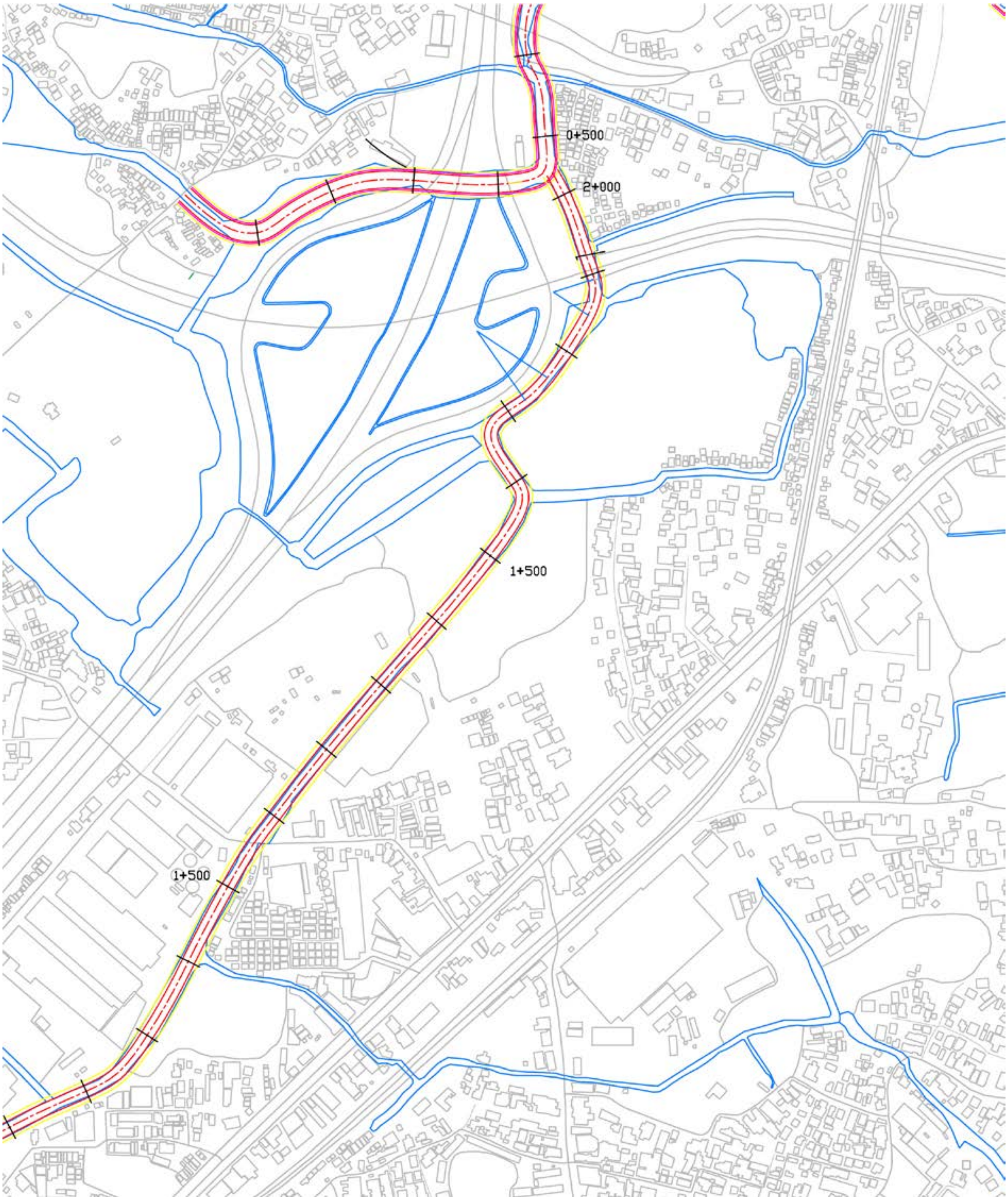
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.10 Plan Map for the M/P at Mudun Ela Sub-basin (5/5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



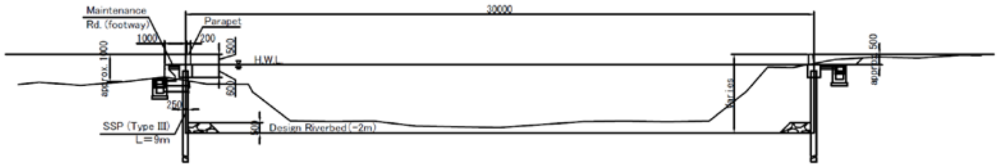
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.11 Plan Map for the M/P at Peliyagoda Canal (1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

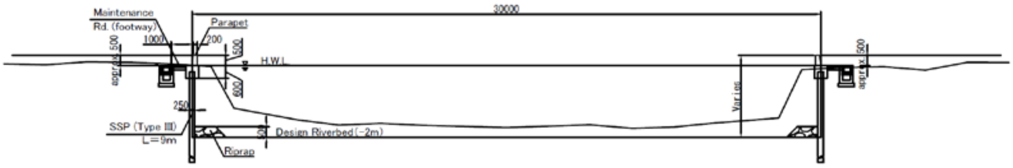


Source: JICA Study Team

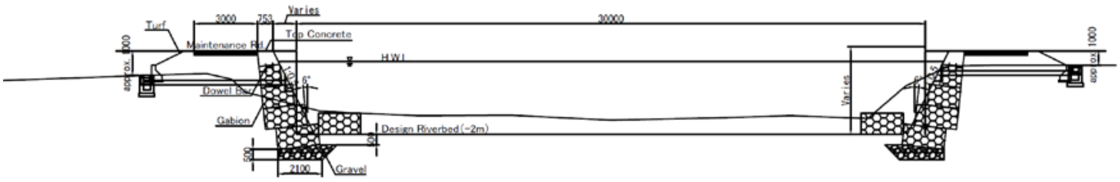
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.12 Plan Map for the M/P at Peliyagoda Canal (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



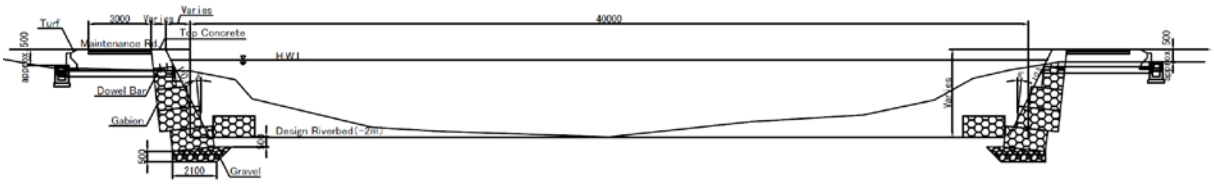
Standard Cross Section between 0+000 to 1+720



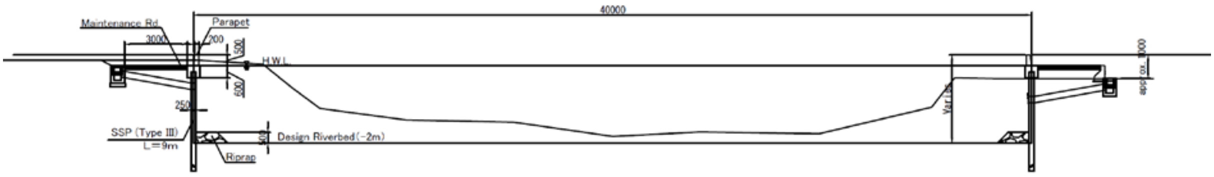
Standard Cross Section between 1+720 to 2+070, 2+170 to 2+600



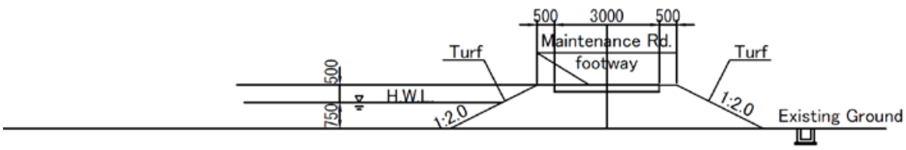
Standard Cross Section between 2+070 to 2+170



Standard Cross Section between 2+600 to 3+700 and 3+800 to 4+000



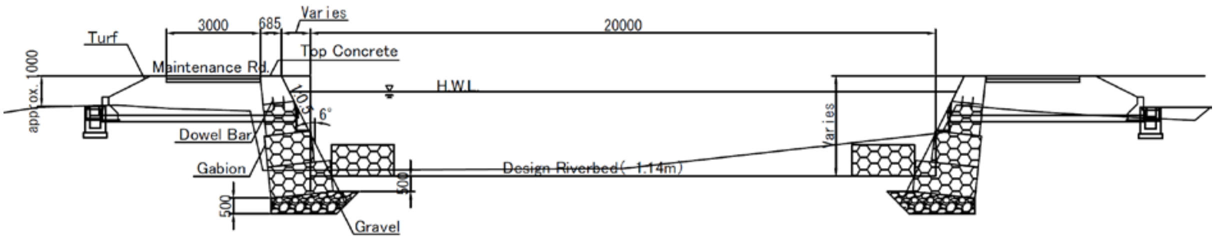
Standard Cross Section between 3+700 to 3+800



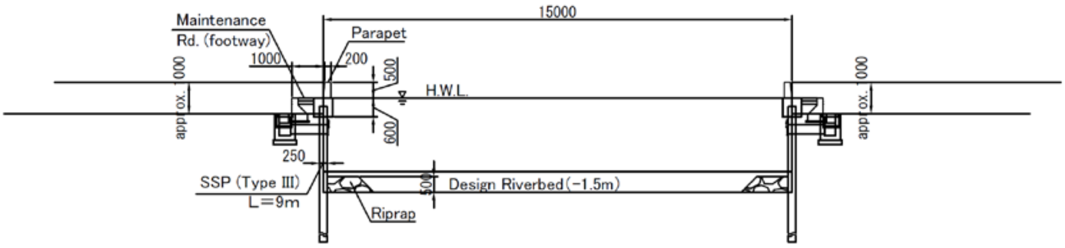
Standard Cross Section between 4+000 to 4+500

Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.13 Standard Cross Section for the M/P at Kalu Oya
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



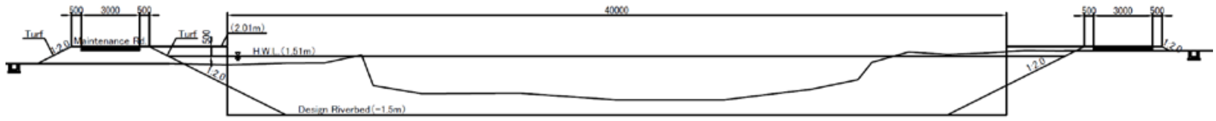
Standard Cross Section between 0+000 to 0+430 (Natha Canal)



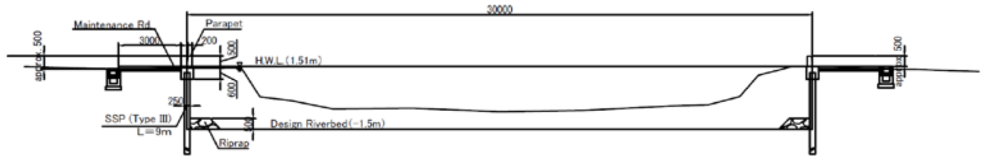
Standard Cross Section between 0+000 to 0+330 (Old Dutch Diversion)

Source: JICA Study Team

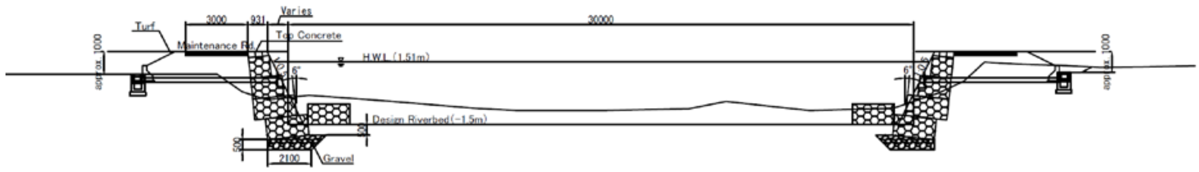
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.14 Standard Cross Section for the M/P at Natha Canal and Old Dutch Diversion
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



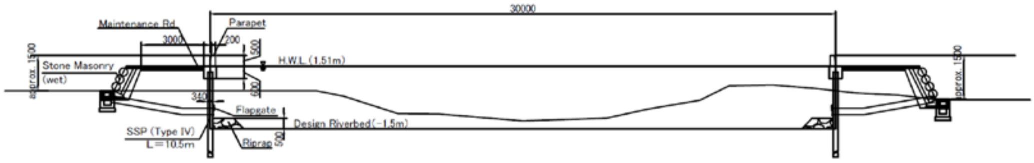
Standard Cross Section between 3+200 to 5+270



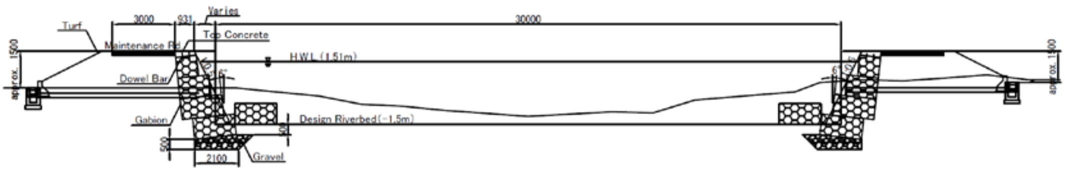
Standard Cross Section between 5+270 to 5+530



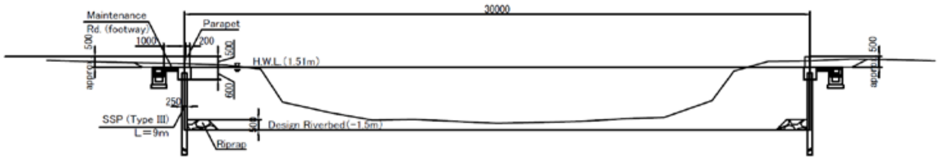
Standard Cross Section between 5+530 to 6+300



Standard Cross Section between 6+300 to 6+900



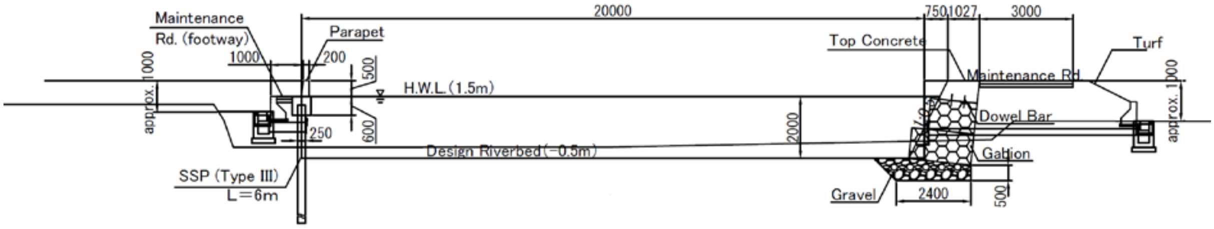
Standard Cross Section between 6+900 to 7+200



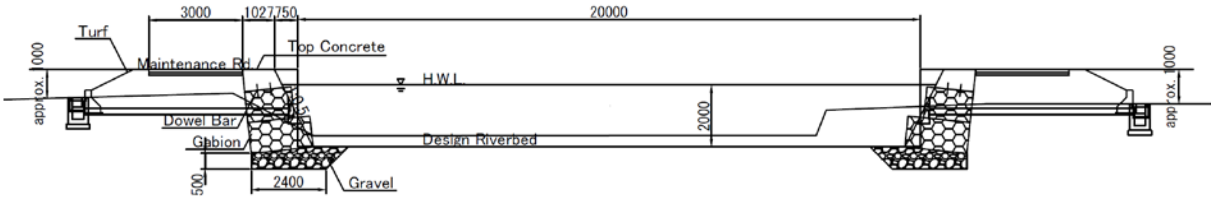
Standard Cross Section between 7+200 to 8+080

Source: JICA Study Team

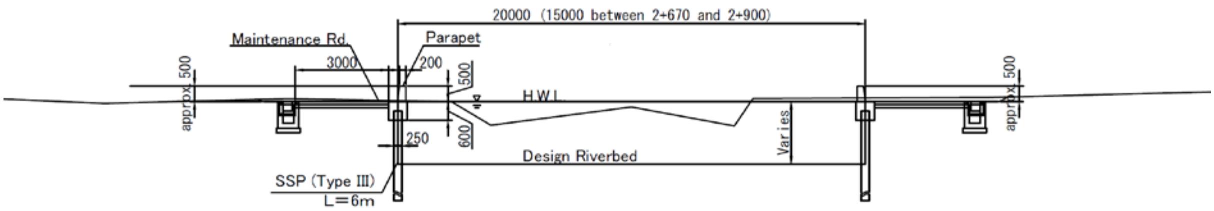
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.15 Standard Cross Section for the M/P at Old Dutch Canal
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



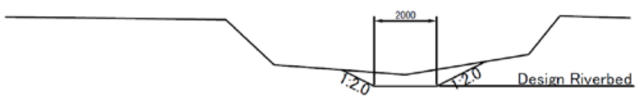
Standard Cross Section between 0+000 to 0+100



Standard Cross Section between 0+100 to 2+560



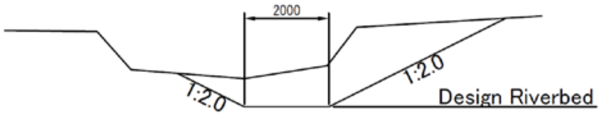
Standard Cross Section between 2+560 to 2+900



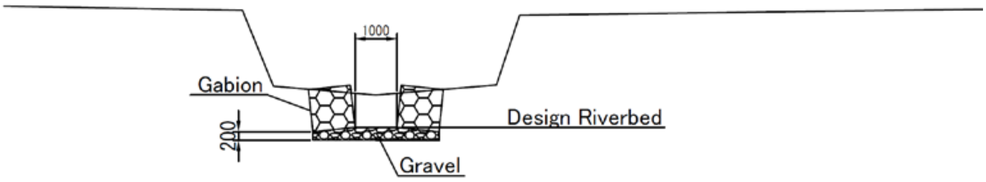
Standard Cross Section between 3+270 to 3+660, 3+810 to 4+350 and 4+969 to 5+145

Source: JICA Study Team

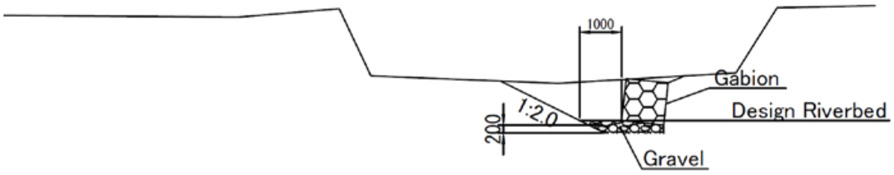
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.16 Standard Cross Section for the M/P at Mudun Ela
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



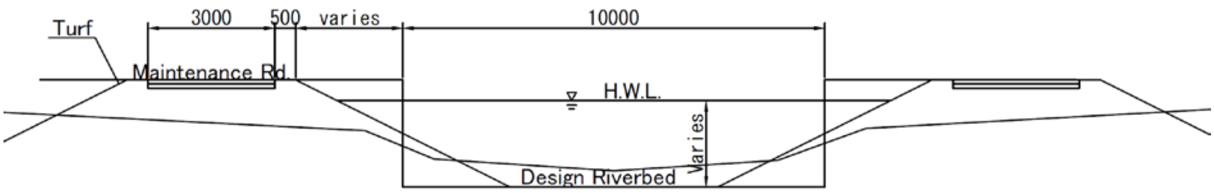
Standard Cross Section between 3+660 to 3+810 (Mudun Ela)



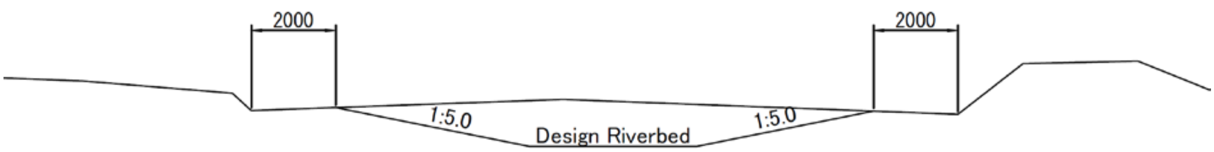
Standard Cross Section between 4+350 to 4+473 (Mudun Ela)



Standard Cross Section between 4+473 to 4+969 (Mudun Ela)



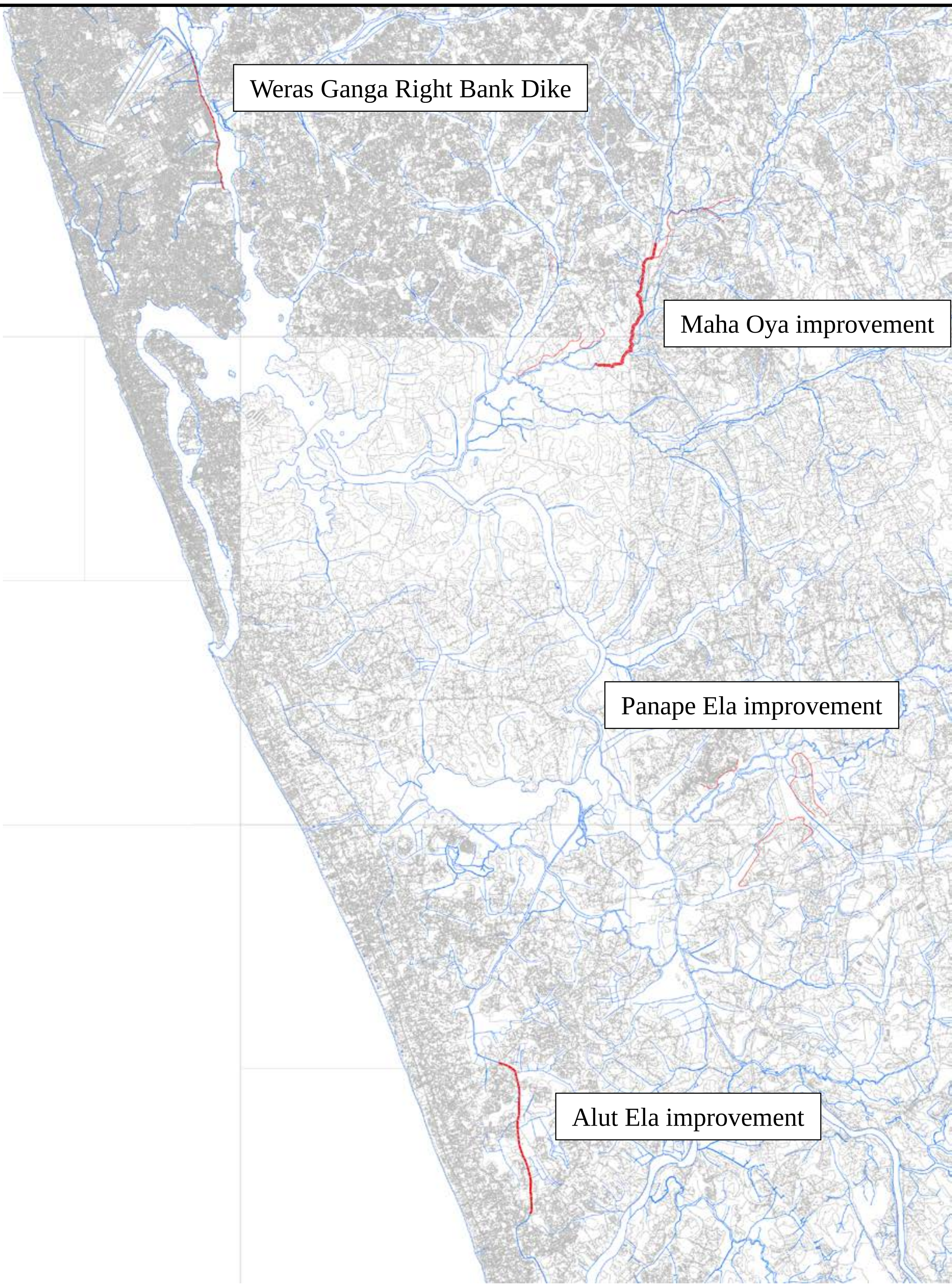
Standard Cross Section between 5+145 to 6+195 (Mudun Ela)



Standard Cross Section between (Peliyagoda)

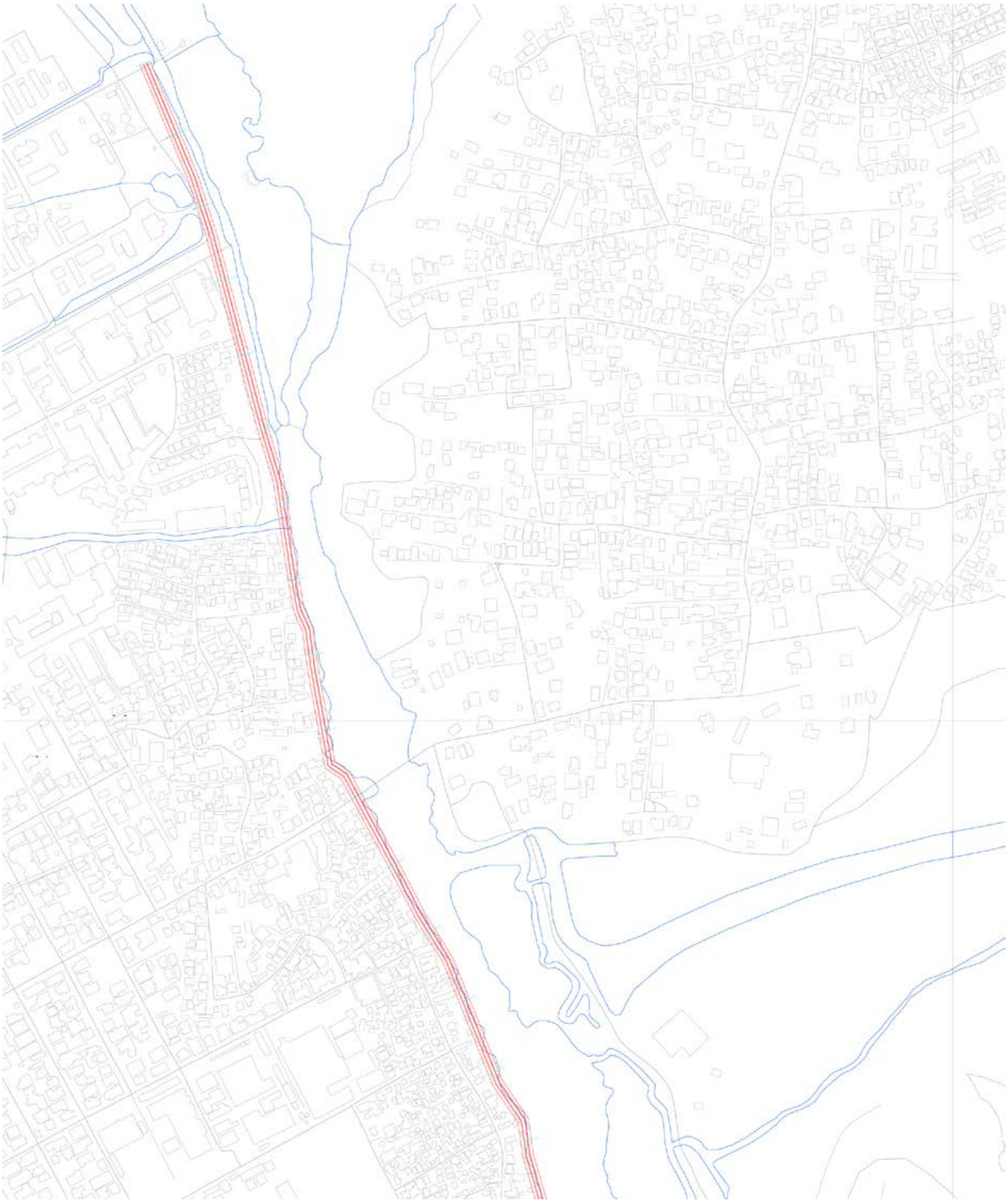
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.17 Standard Cross Section for the M/P at Mudun Ela and Peliyagoda canal
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



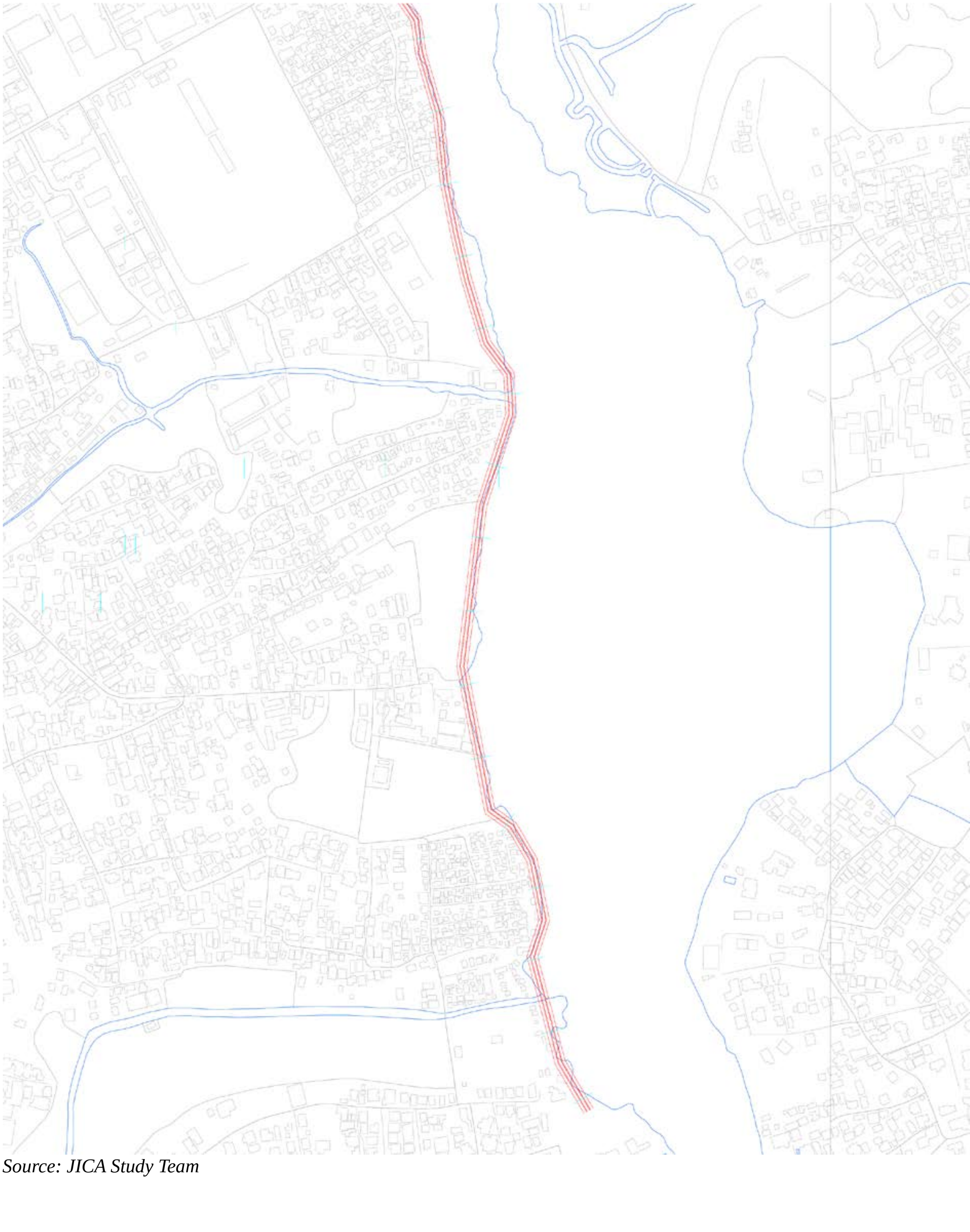
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.18 Plan Map for the M/P at Bolgoda Basin
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



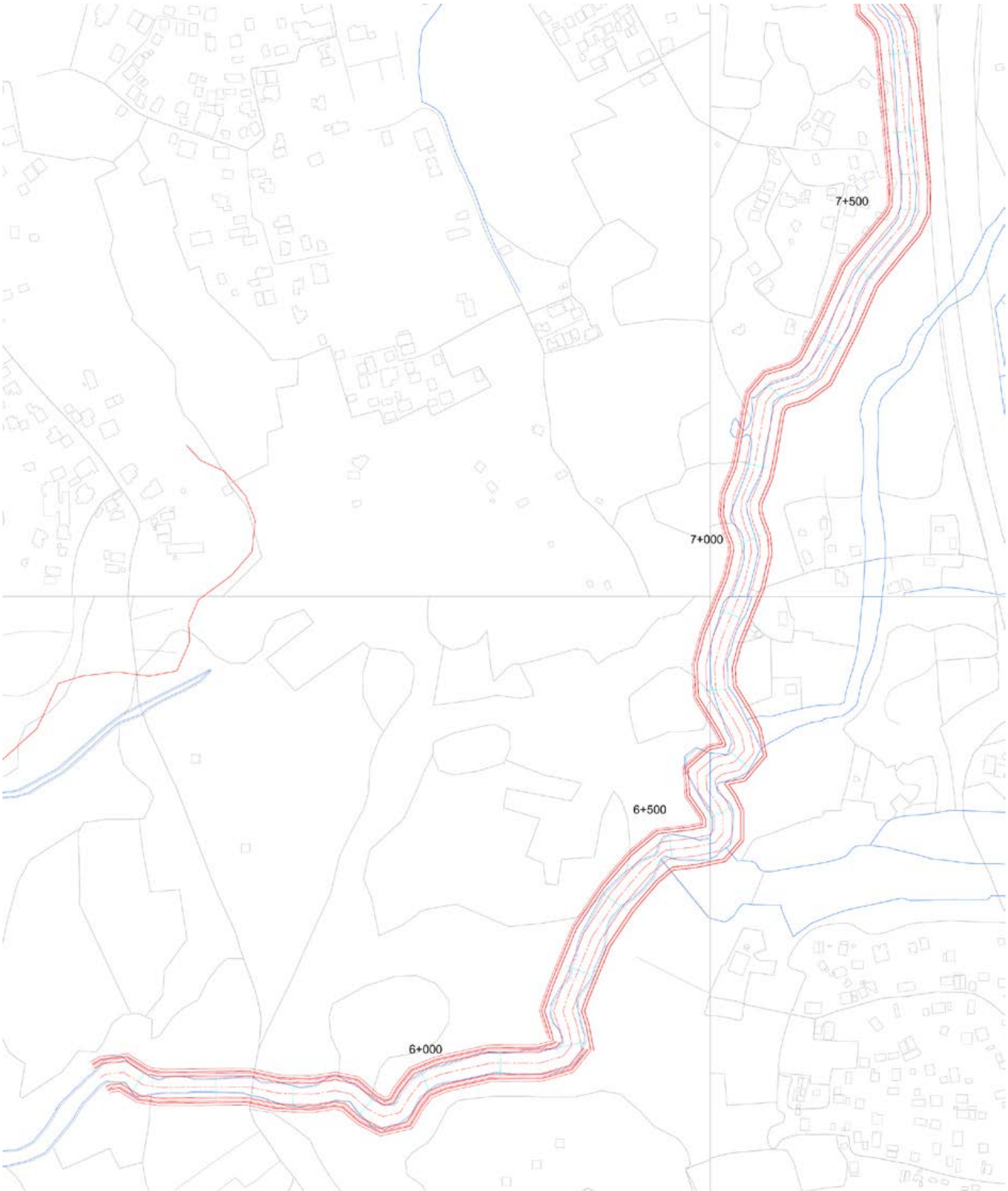
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.19 Plan Map for the M/P at Weras Ganga Right Bank Dike (1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



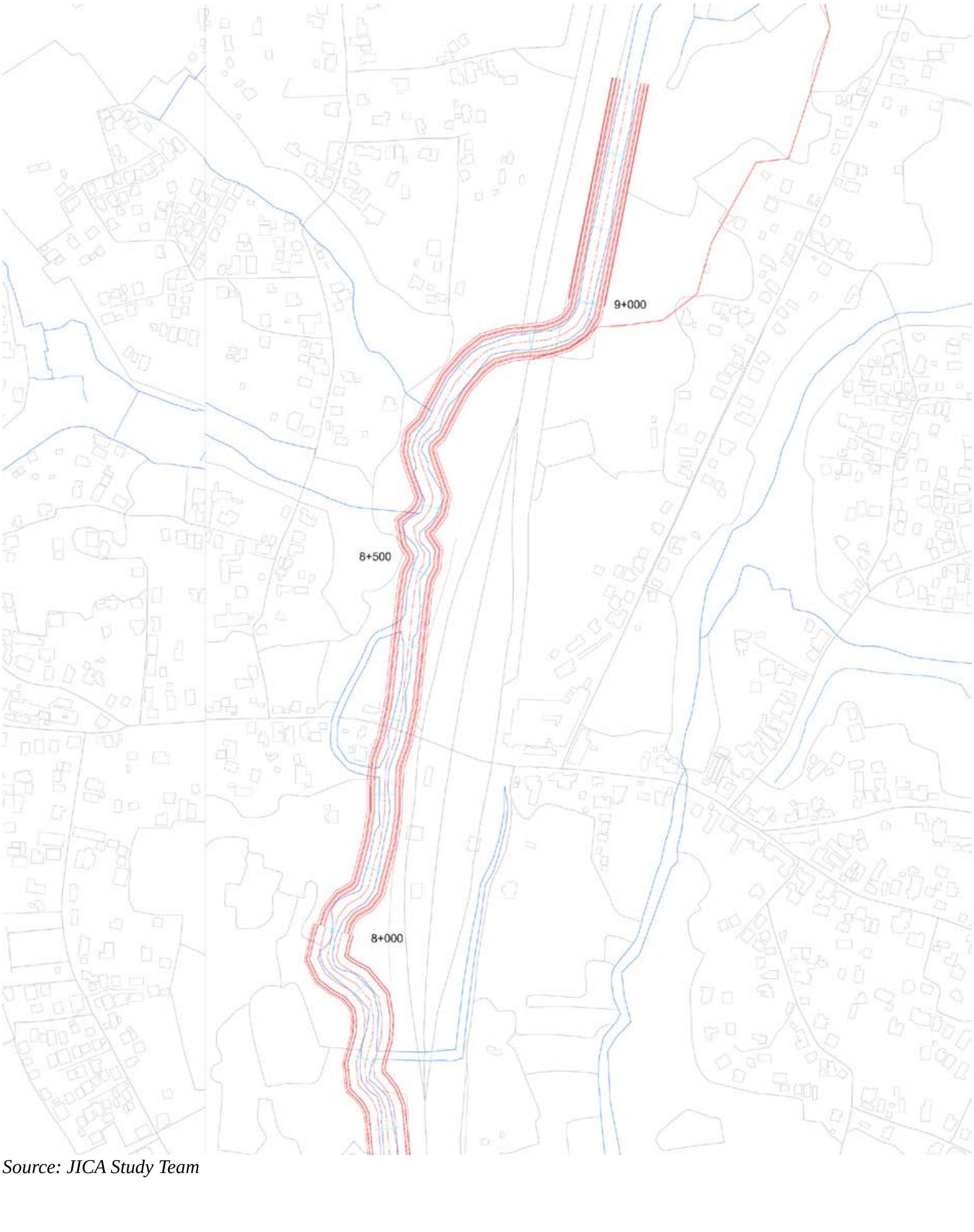
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.20 Plan Map for the M/P at Weras Ganga Right Bank Dike (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



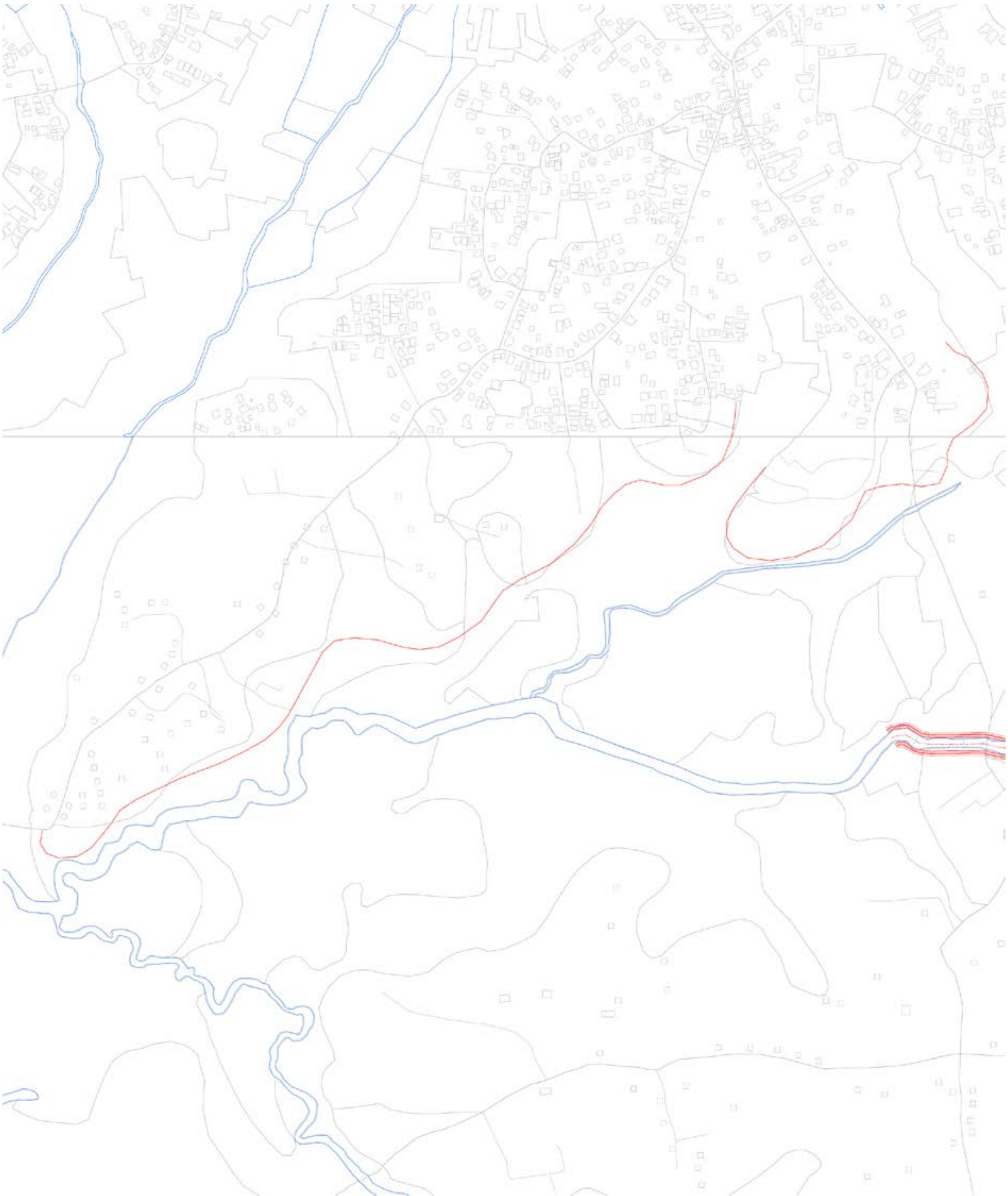
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.21 Plan Map for the M/P at Maha Oya (1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



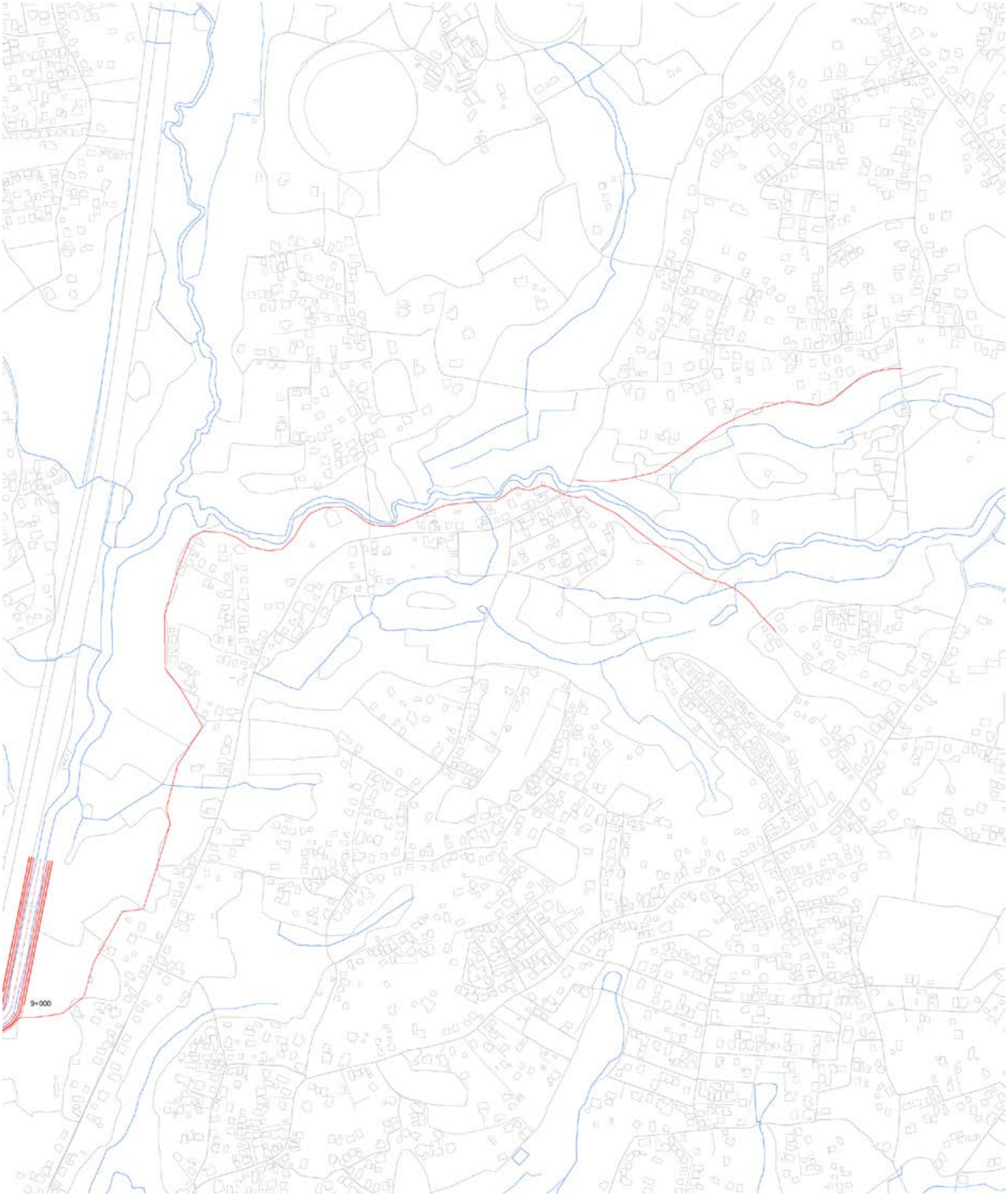
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.22 Plan Map for the M/P at Maha Oya (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



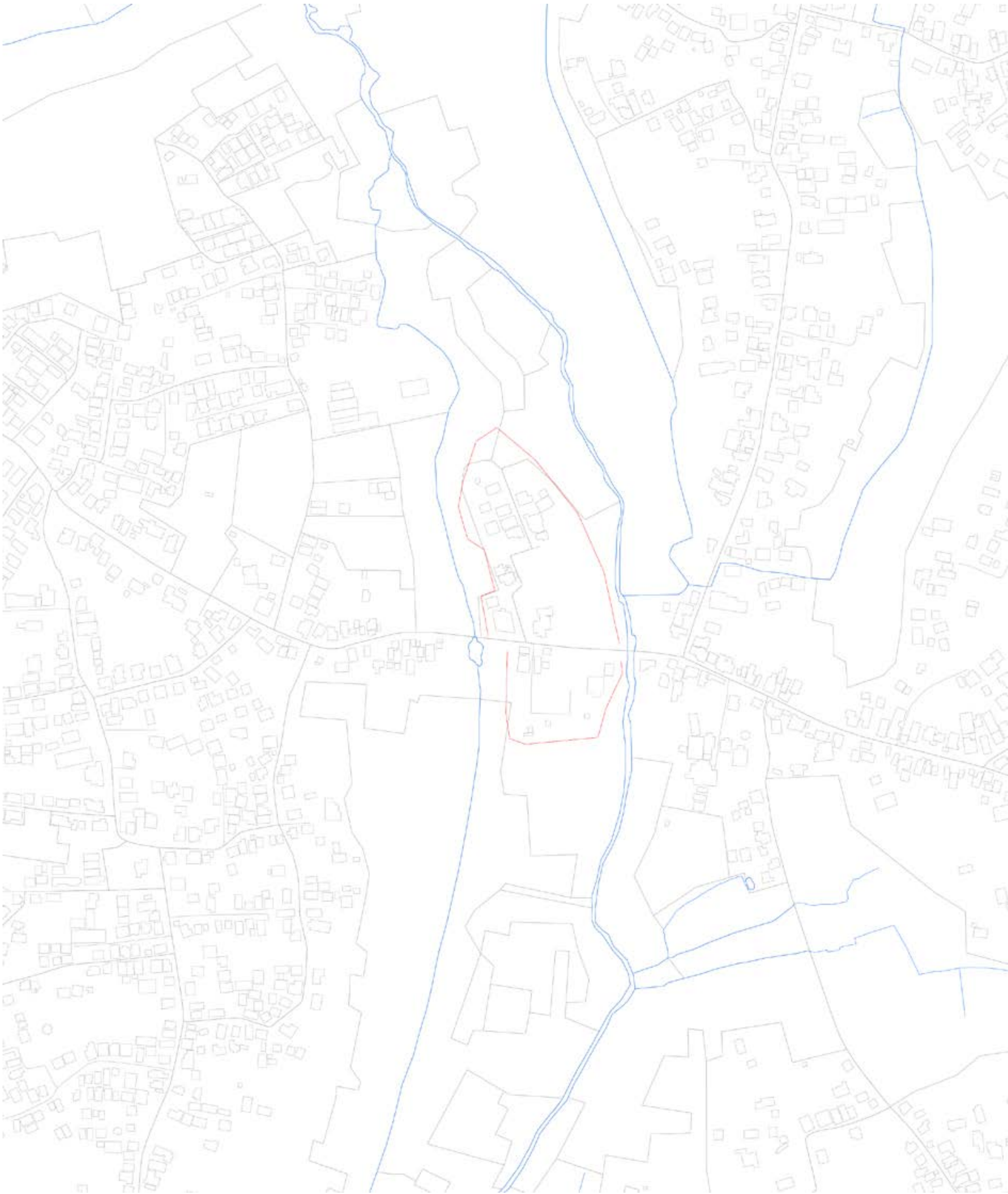
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.23 Layout Plan Map for the M/P at Maha Oya Surrounding Dike (1/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



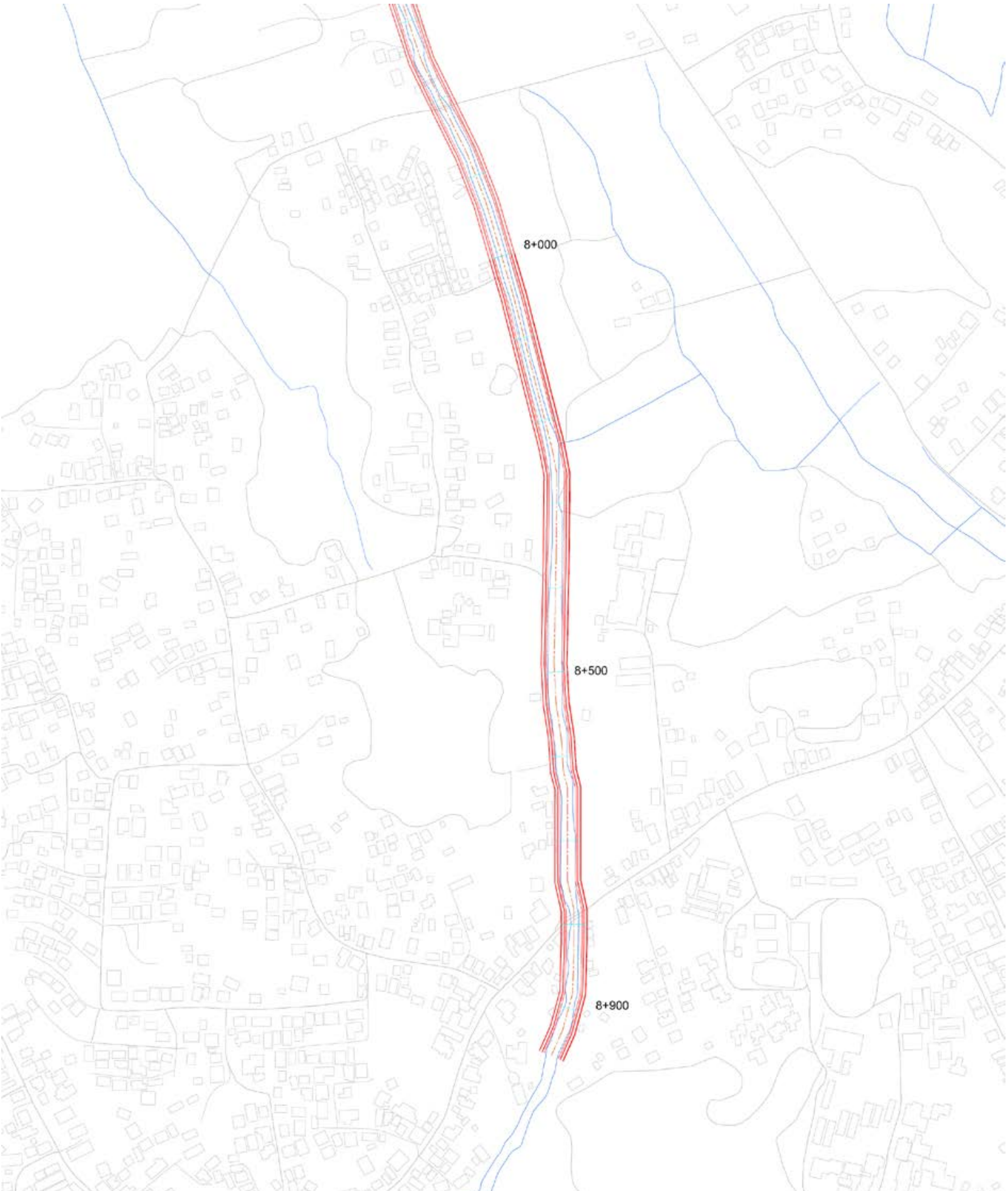
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.24 Layout Plan Map for the M/P at Maha Oya Surrounding Dike (2/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



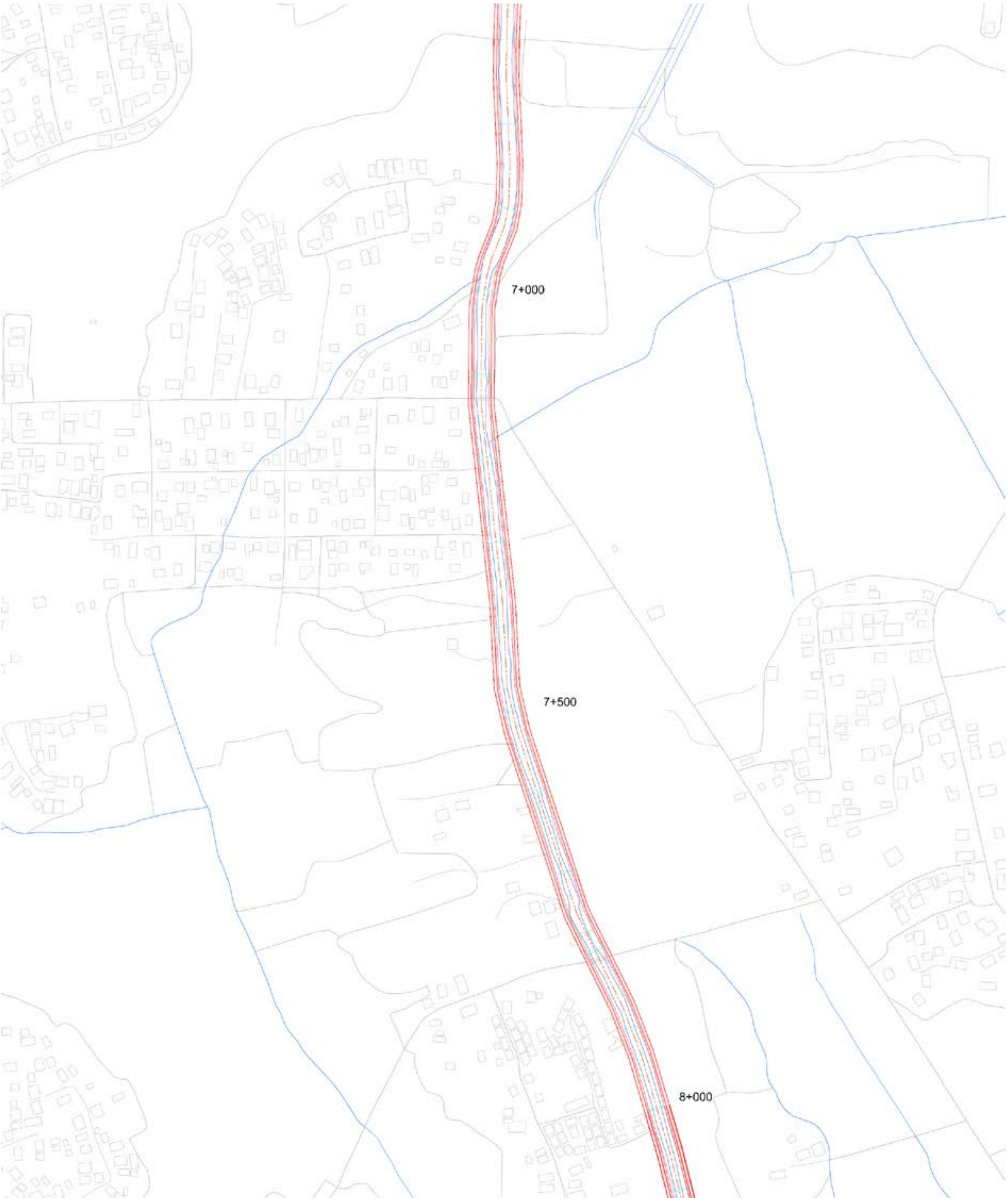
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.25 Layout Plan Map for the M/P at Maha Oya Surrounding Dike (3/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



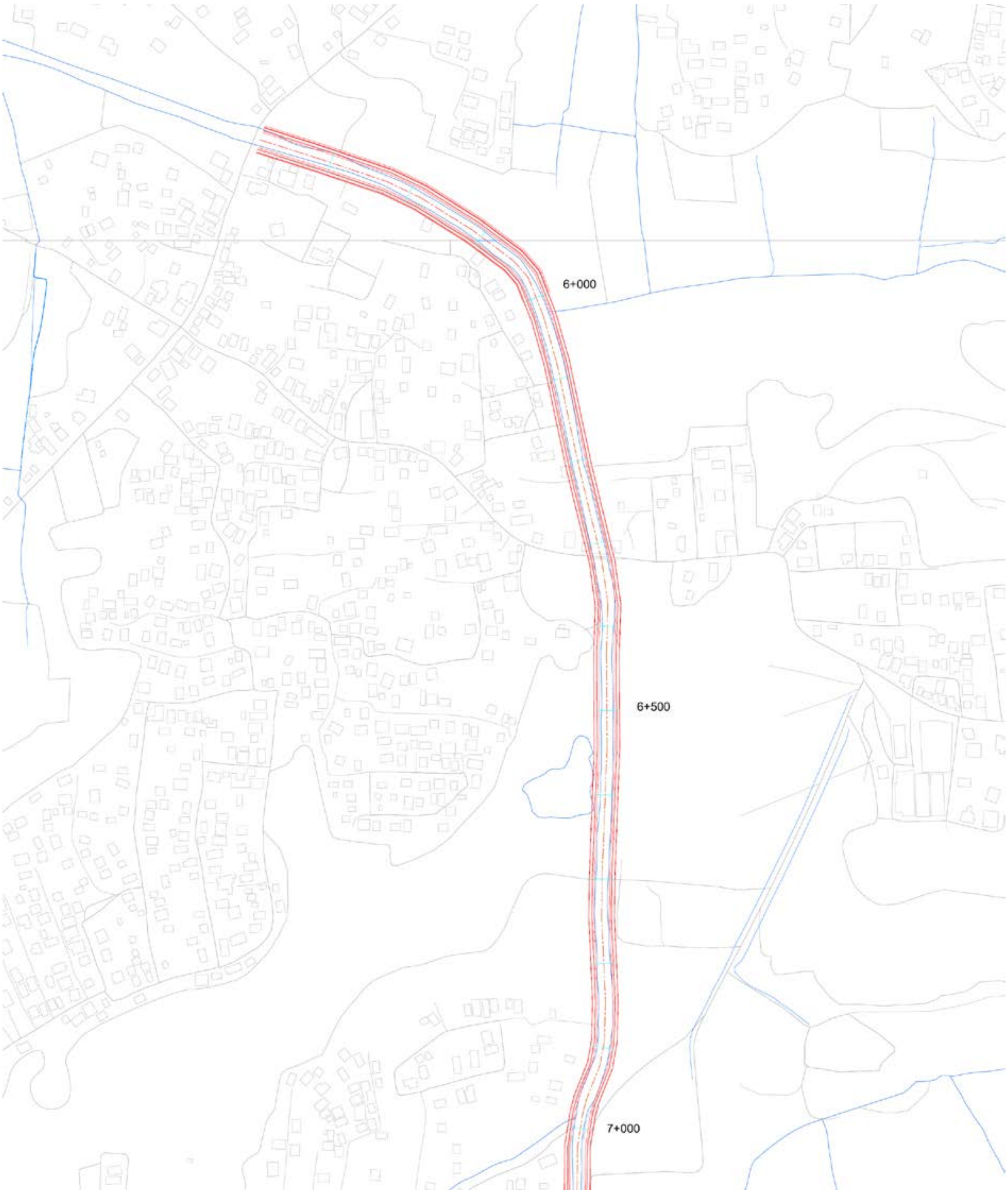
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.26 Plan Map for the M/P at Alut Ela (1/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



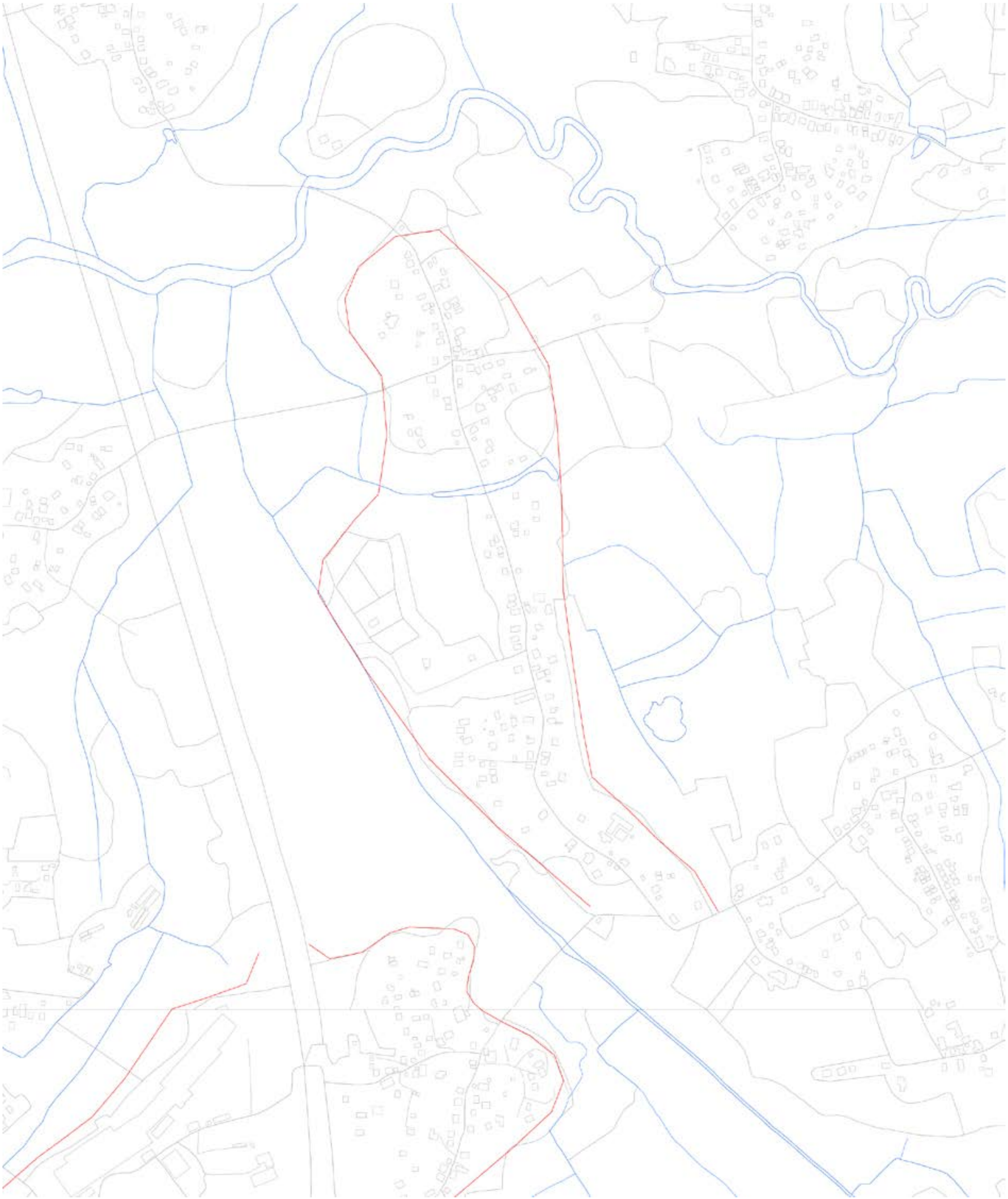
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.27 Plan Map for the M/P at Alut Ela (2/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.28 Plan Map for the M/P at Alut Ela (3/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Source: JICA Study Team

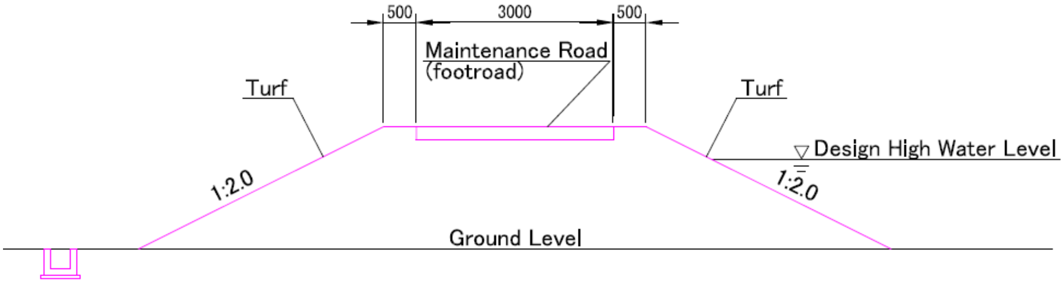
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.29 Layout Plan Map for the M/P at Panape Ela Surrounding Dike (1/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

Source: JICA Study Team

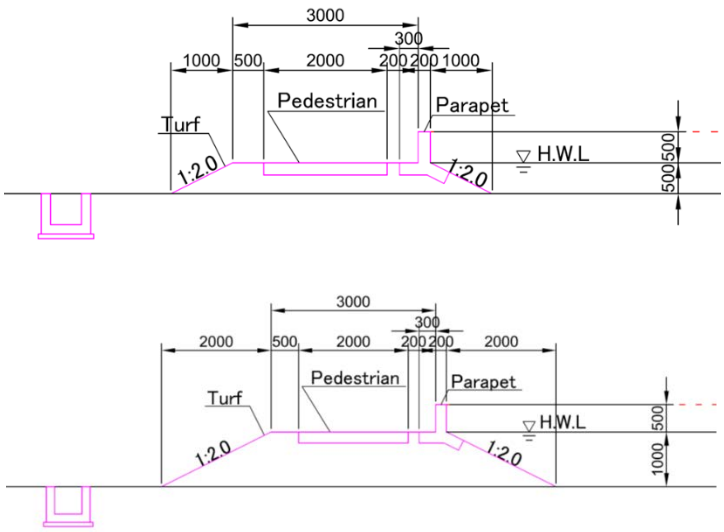
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.30 Layout Plan Map for the M/P at Panape Ela Surrounding Dike (2/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.31 Layout Plan Map for the M/P at Panape Ela Surrounding Dike (3/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Standard Cross Section of the Surrounding Dike

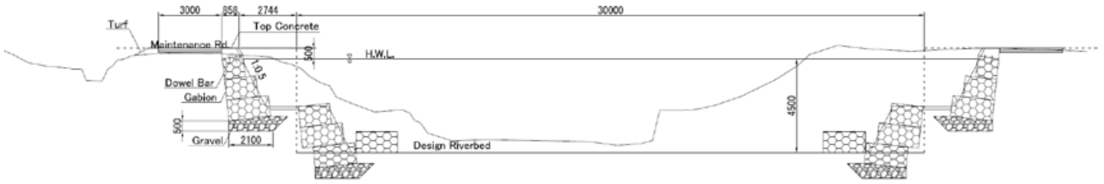


Weras Ganga Right Bank Dike

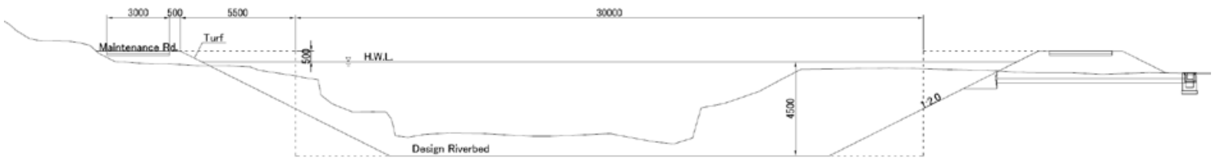
Note: The same sections are applied in the Pre-F/S.

Source: JICA Study Team

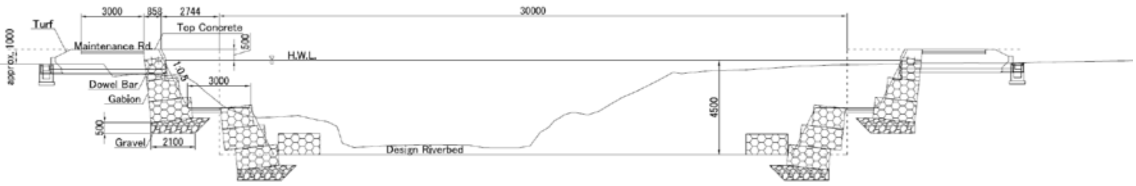
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.32 Standard Cross Section for the M/P for the Surrounding Dike and Weras Gnga Right Bnk Dike
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



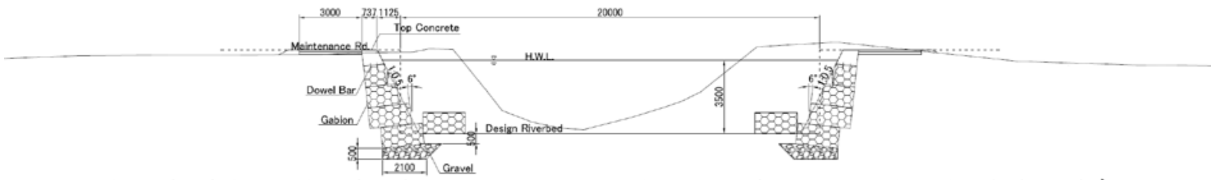
Standard Cross Section between 5+550 to 6+200, 8+000 to 9+000 (Maha Oya)



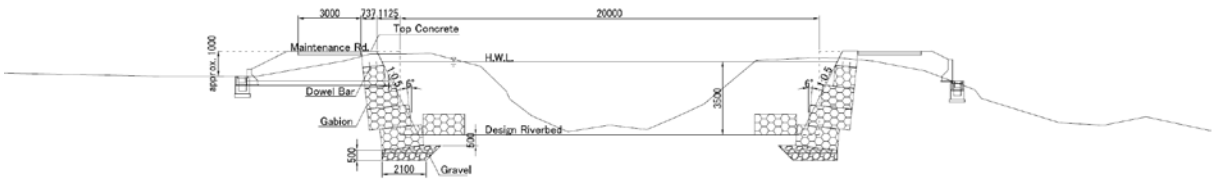
Standard Cross Section between 6+200 to 8+000 (Maha Oya)



Standard Cross Section between 9+000 to 9+550 (Maha Oya)



Standard Cross Section between 5+590 to 6+000 and 8+000 to 8+960 (Alut Ela)

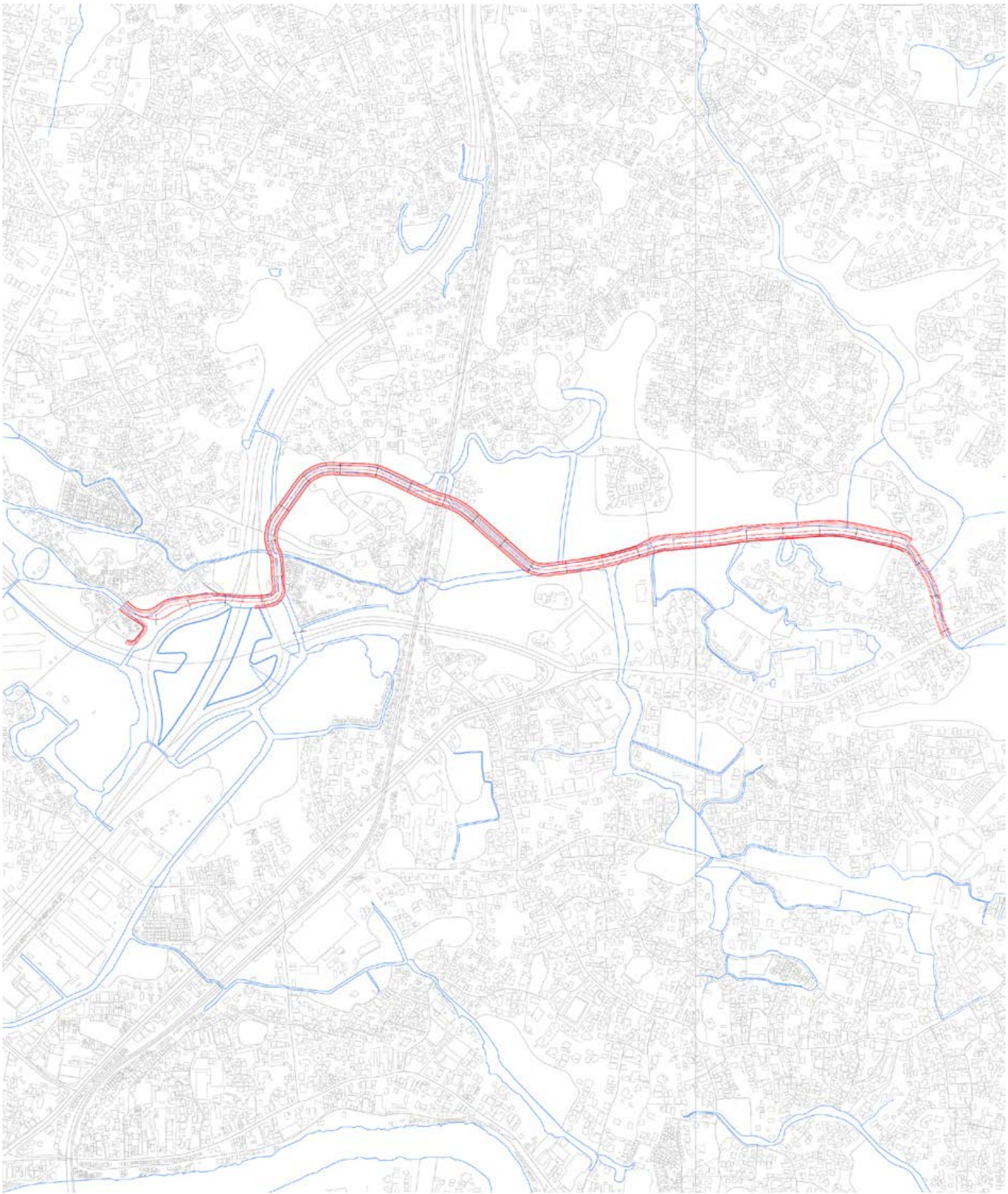


Standard Cross Section between 6+000 to 8+000 (Alut Ela)

Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 6.7.33 Standard Cross Section for the M/P at Maha Oya and Alut Ela
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

ANNEX FIGURE
(Part 2)



Source: JICA Study Team

<table>
<tr><td>The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region</td><td rowspan="2">Annex-F 3.2.1 Plan Map for the Pre-F/S at Mudun Ela Sub-basin</td></tr>
<tr><td>CTI Engineering International Co., Ltd.
Nippon Koei Co., Ltd.
Earth System Science Co., Ltd.</td></tr>
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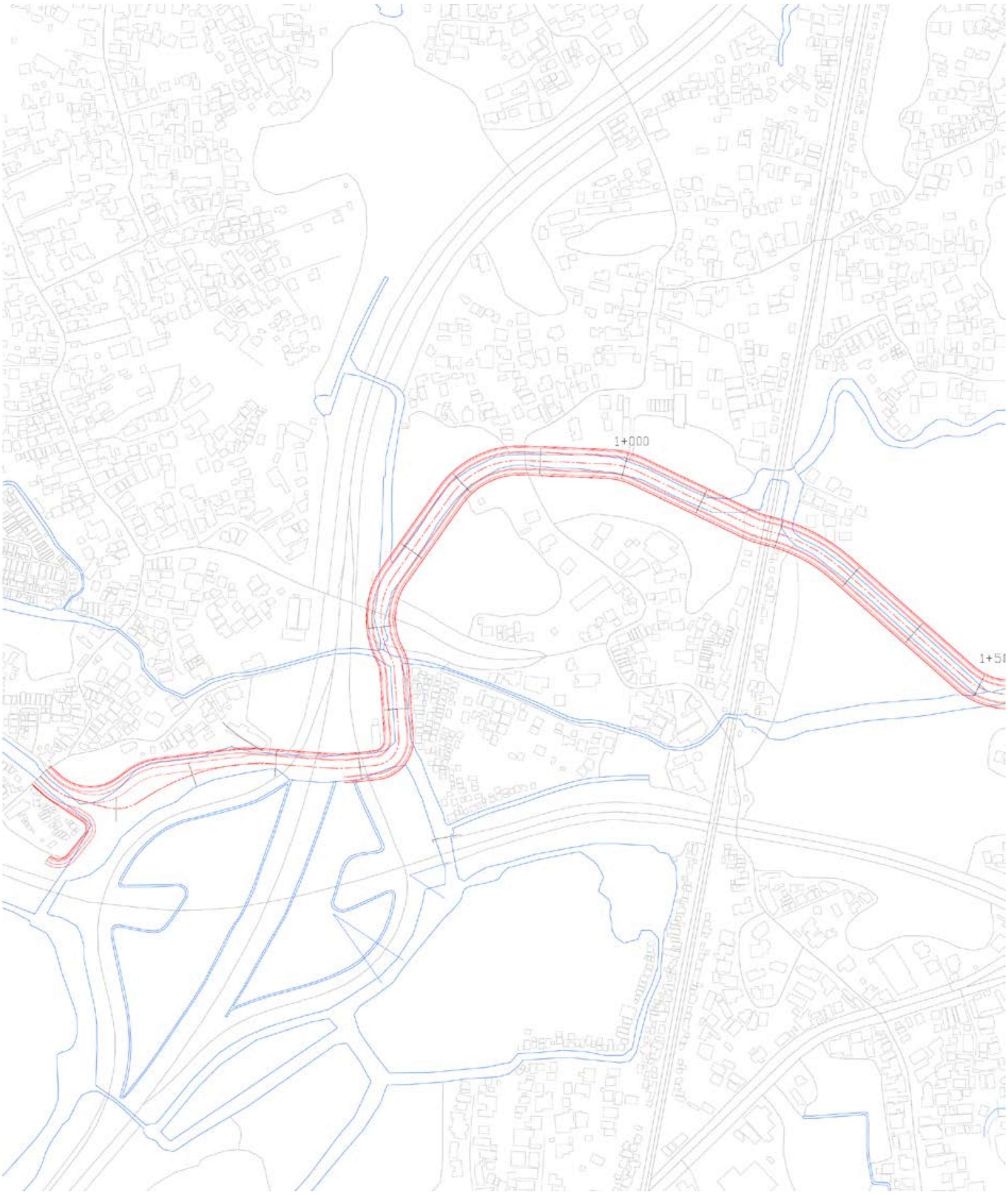
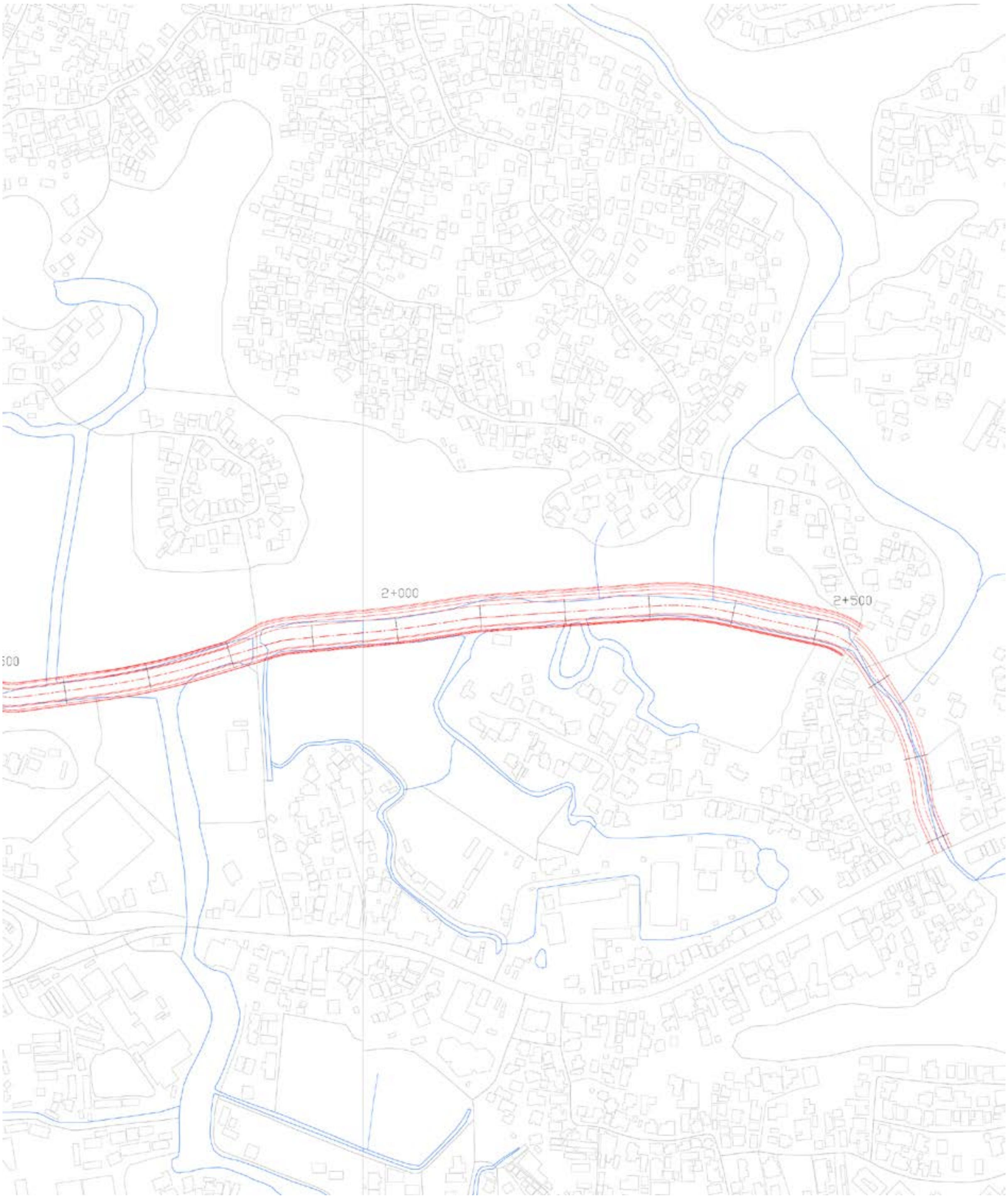


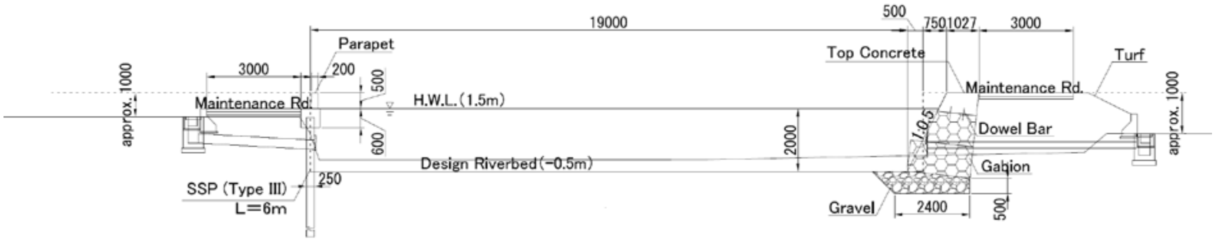
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.2 Plan Map for the Pre-F/S at Mudun Ela Sub-basin (1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

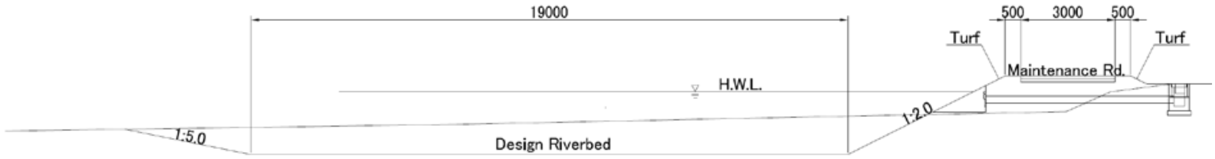


Source: JICA Study Team

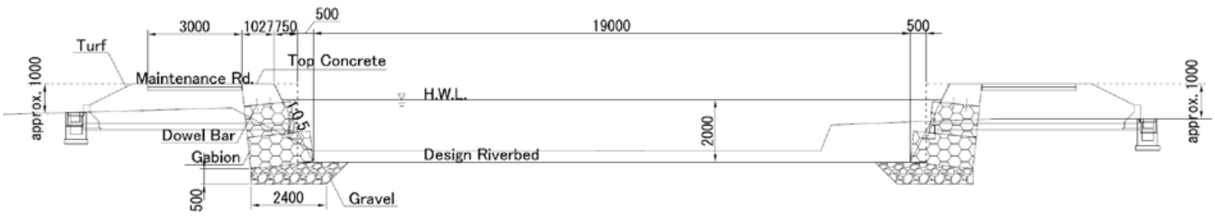
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.3 Plan Map for the Pre-F/S at Mudun Ela Sub-basin (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



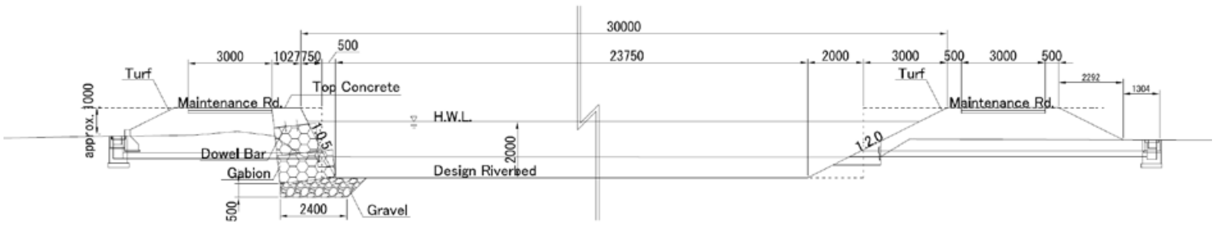
Standard Cross Section between 0+000 to 0+045



Standard Cross Section between 0+045 to 0+270



Standard Cross Section between 0+270 to 1+833 (Left bank starts at 0+380)



Standard Cross Section between 1+833 to 2+544

Source: JICA Study Team

<table>
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<tr><td>CTI Engineering International Co., Ltd.
Nippon Koei Co., Ltd.
Earth System Science Co., Ltd.</td></tr>
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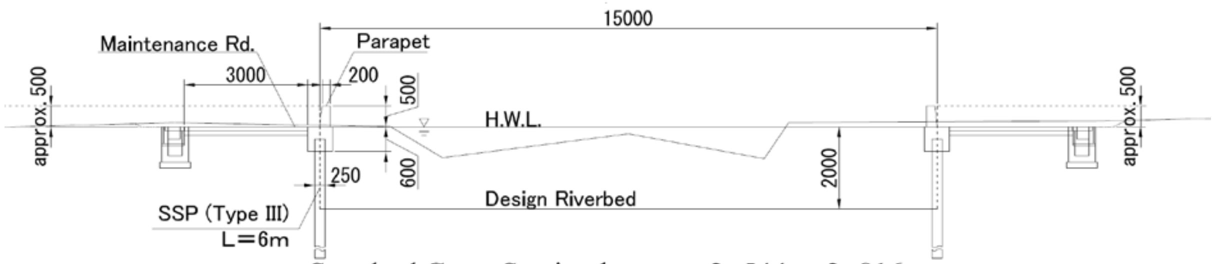
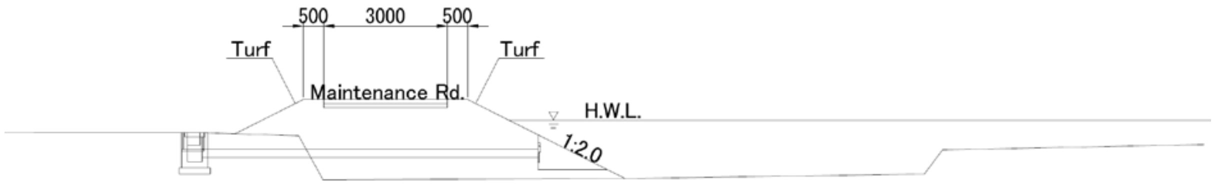


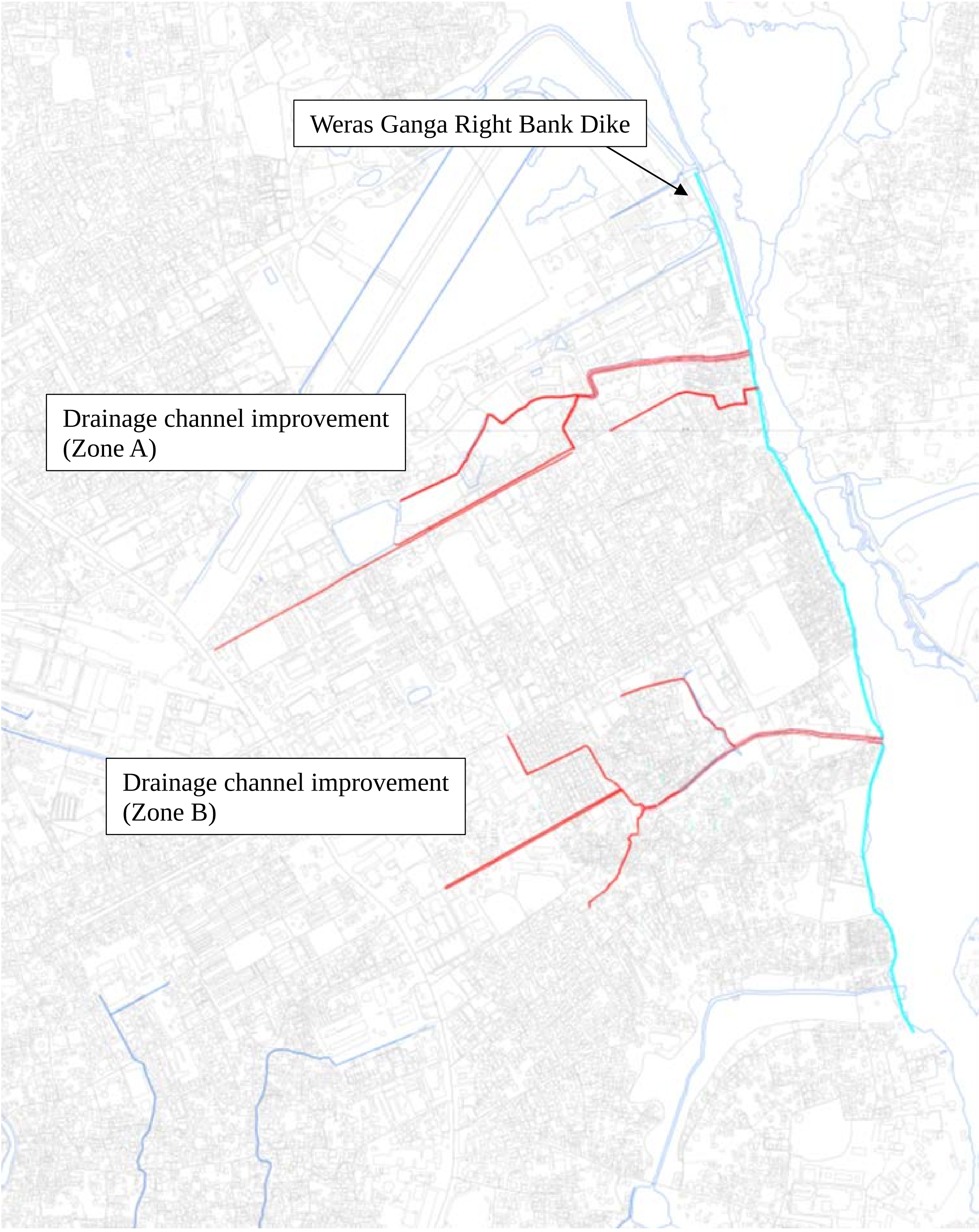
Standard Cross Section between 2+544 to 2+816



Standard Cross Section between at Left Bank, for 120m

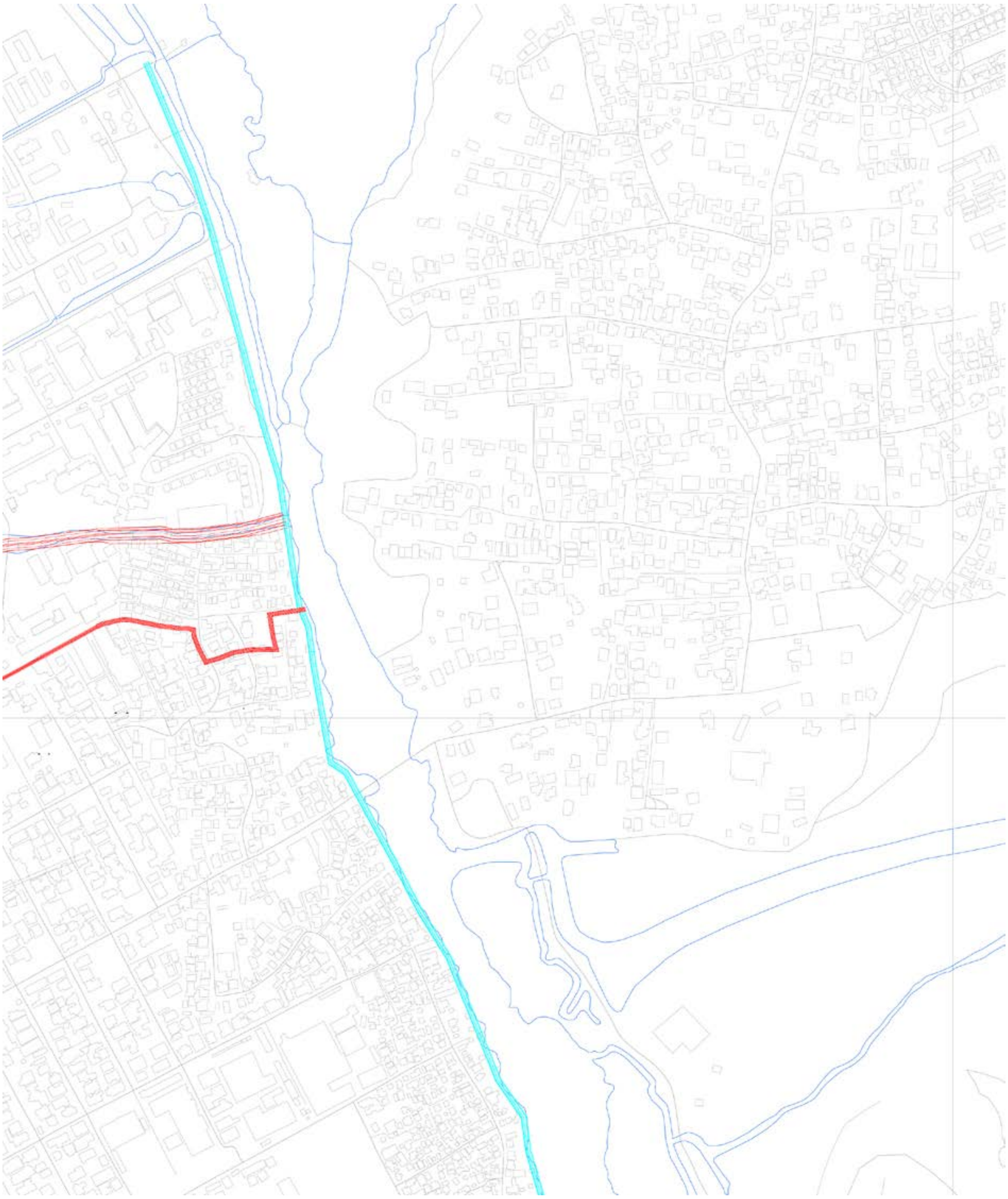
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.5 Standard Cross Section for the Pre-F/S at Mudun Ela (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



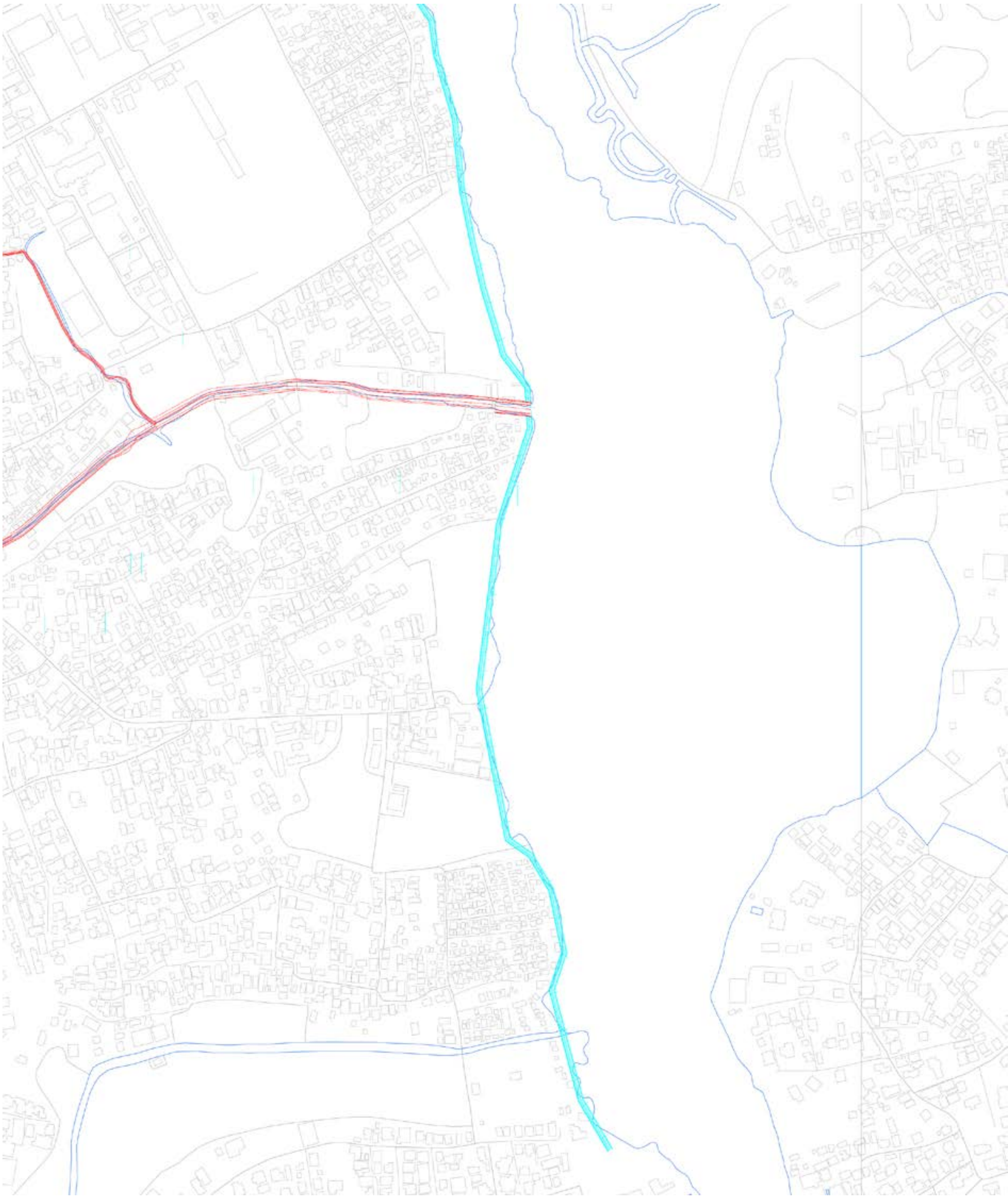
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.6 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



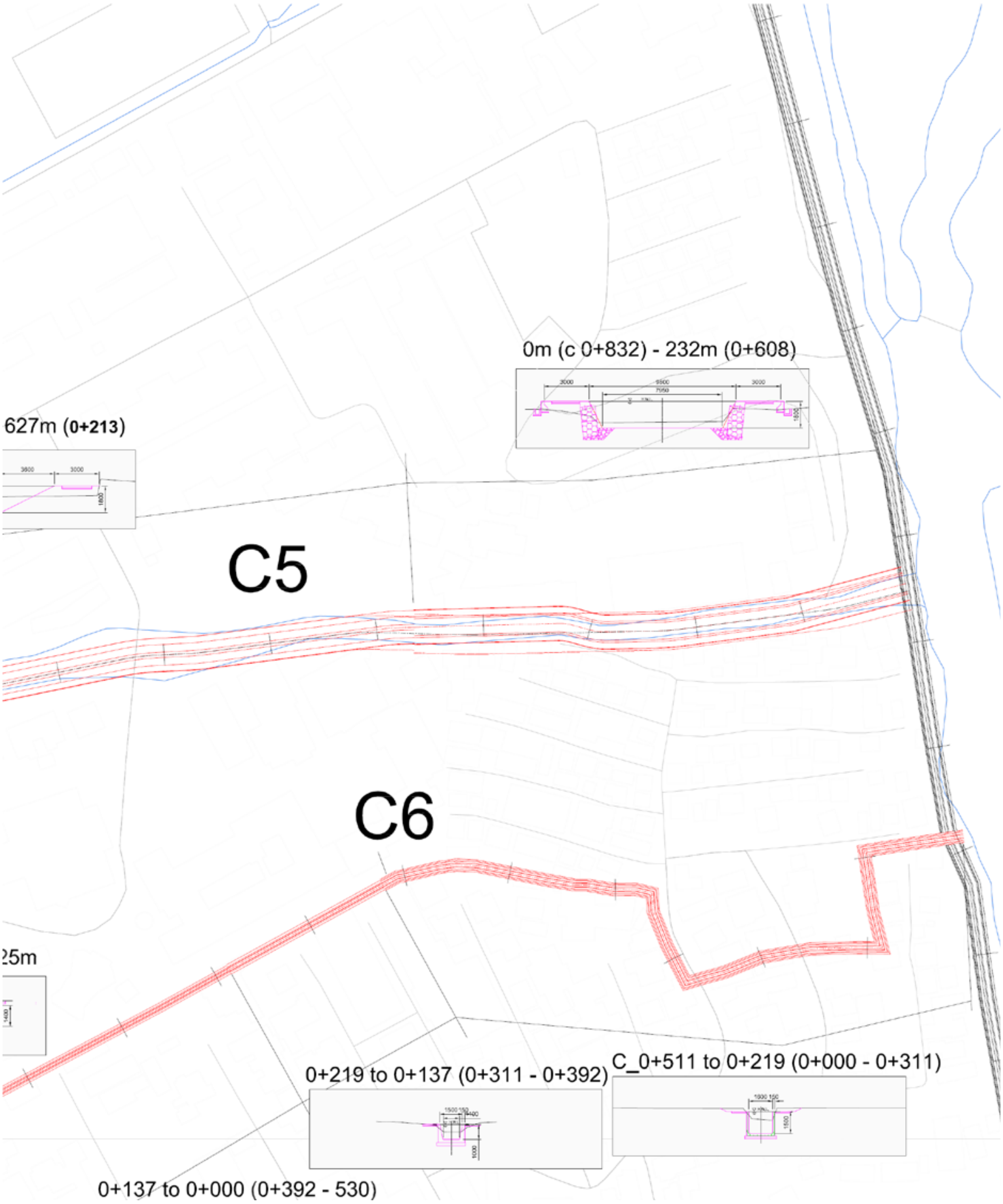
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.7 Plan Map for the Pre-F/S at Weras Ganga Right Bank Dike (1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



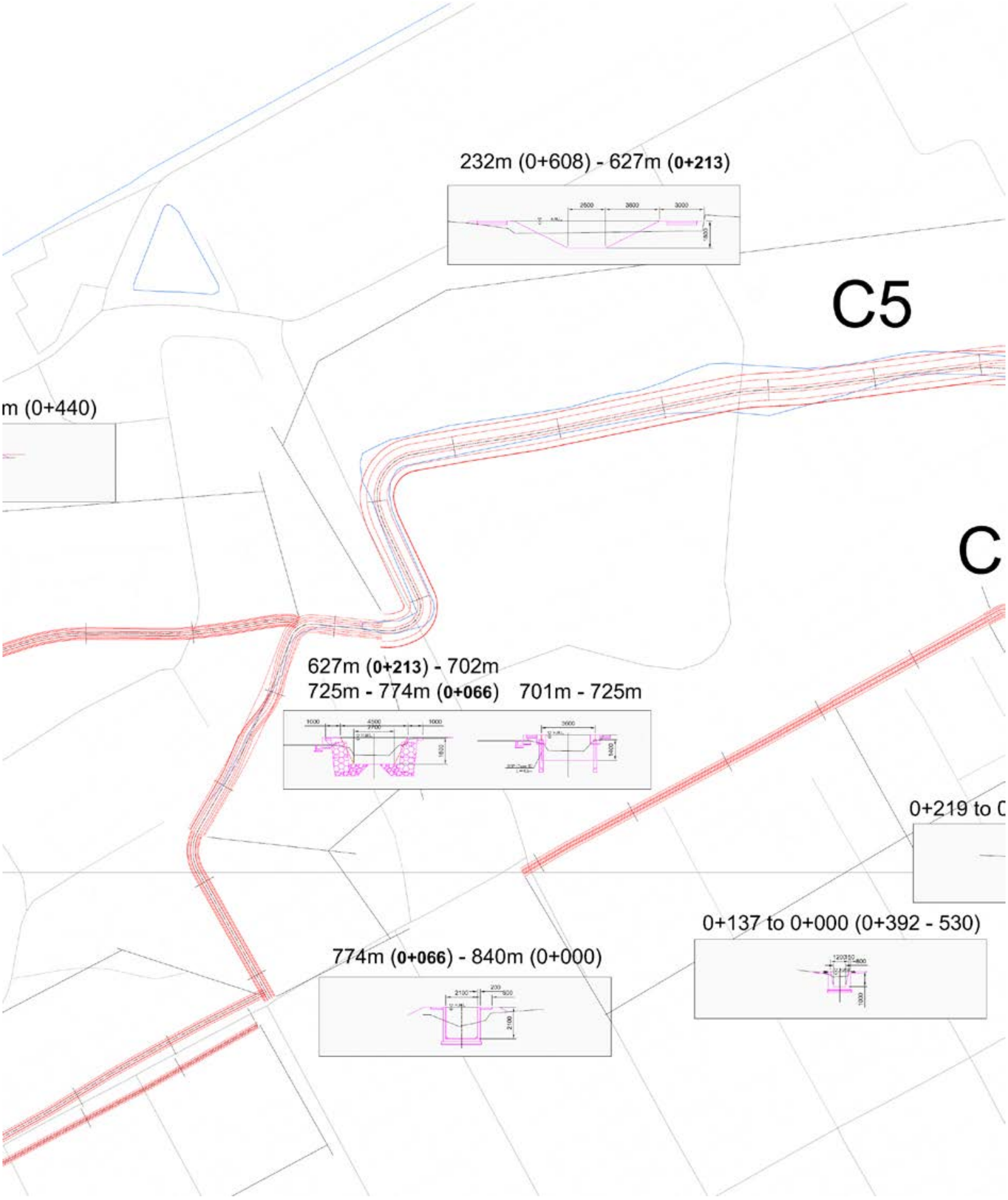
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.8 Plan Map for the Pre-F/S at Weras Ganga Right Bank Dike (2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



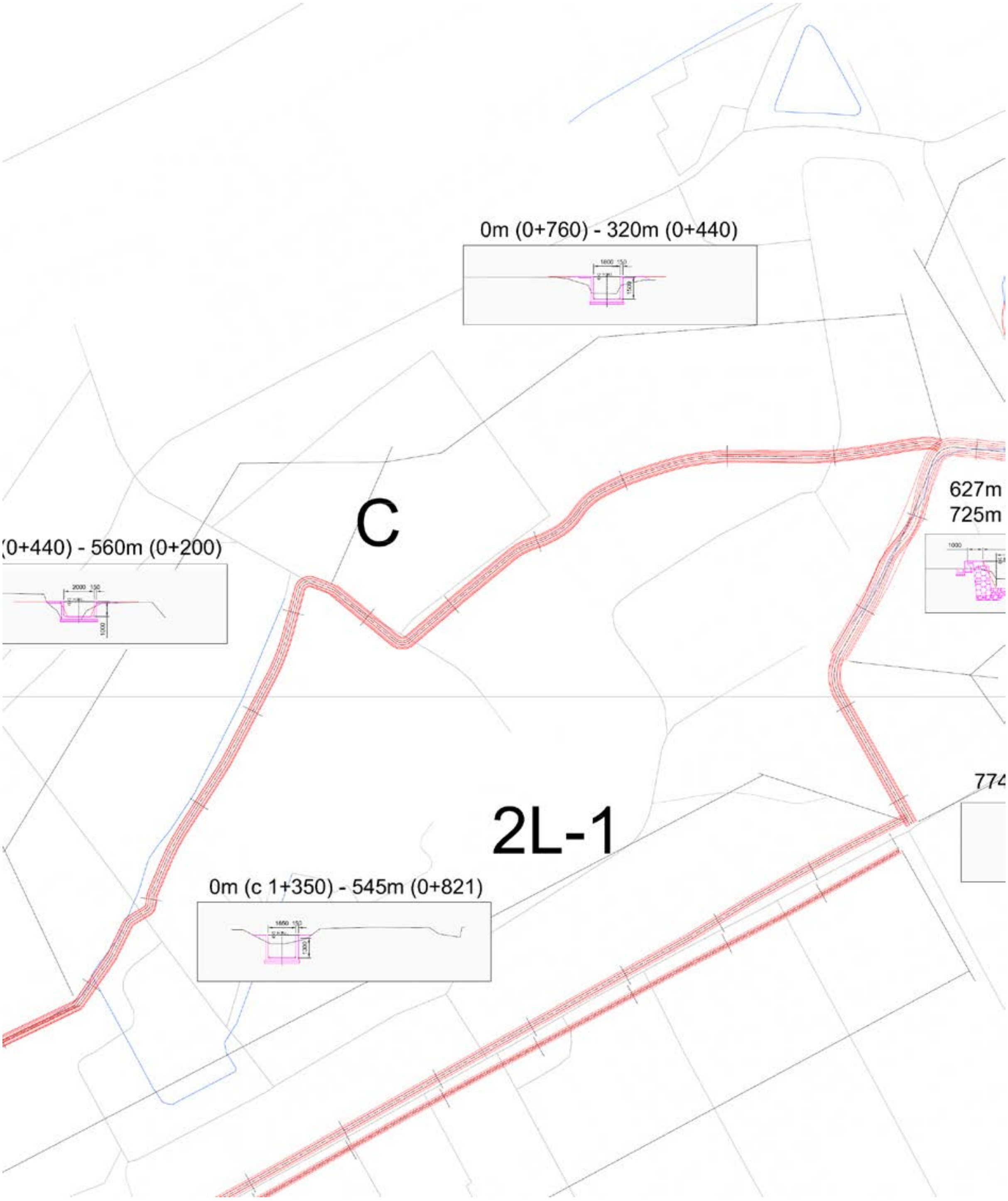
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.9 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C5, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



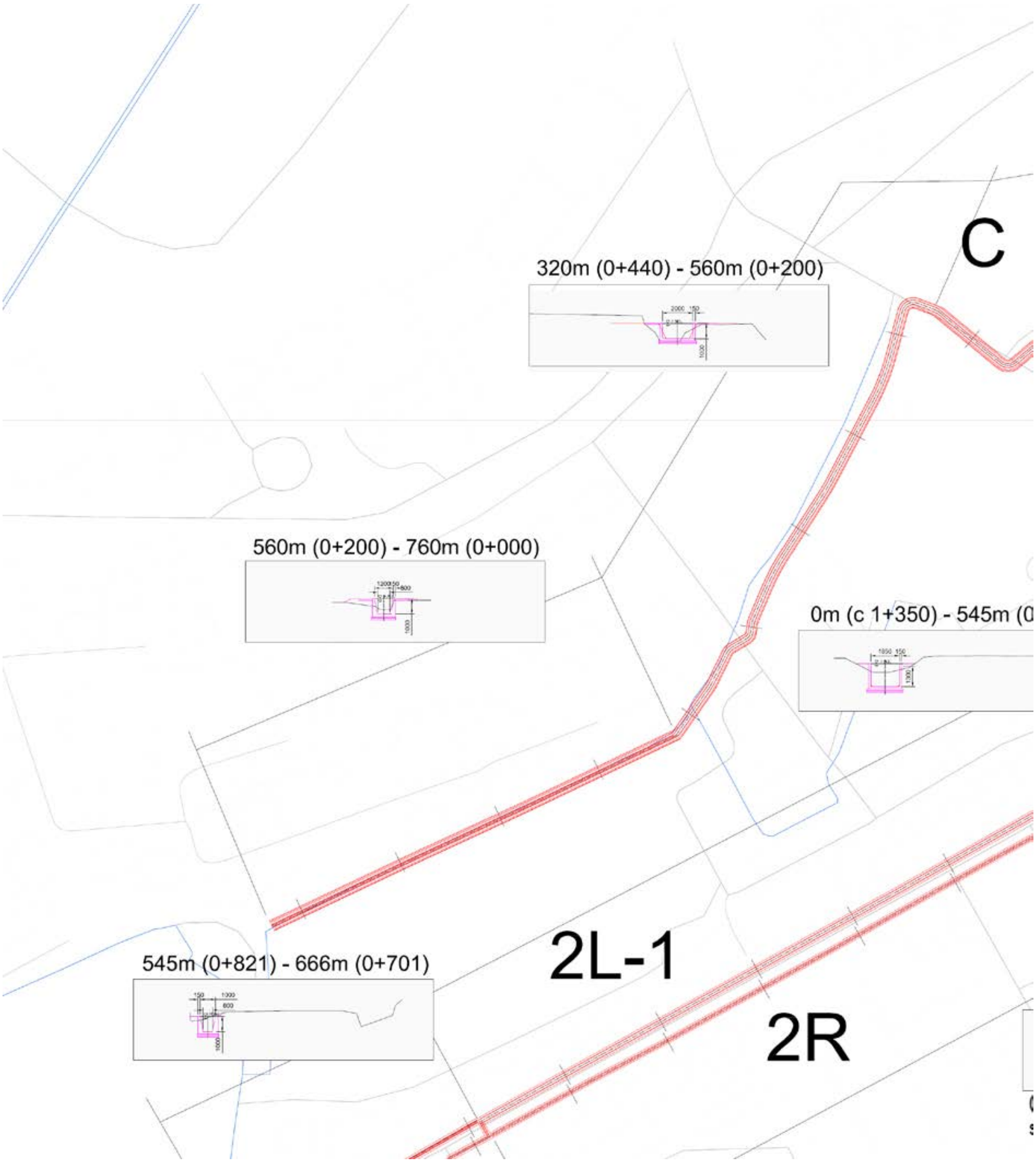
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.10 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C5, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



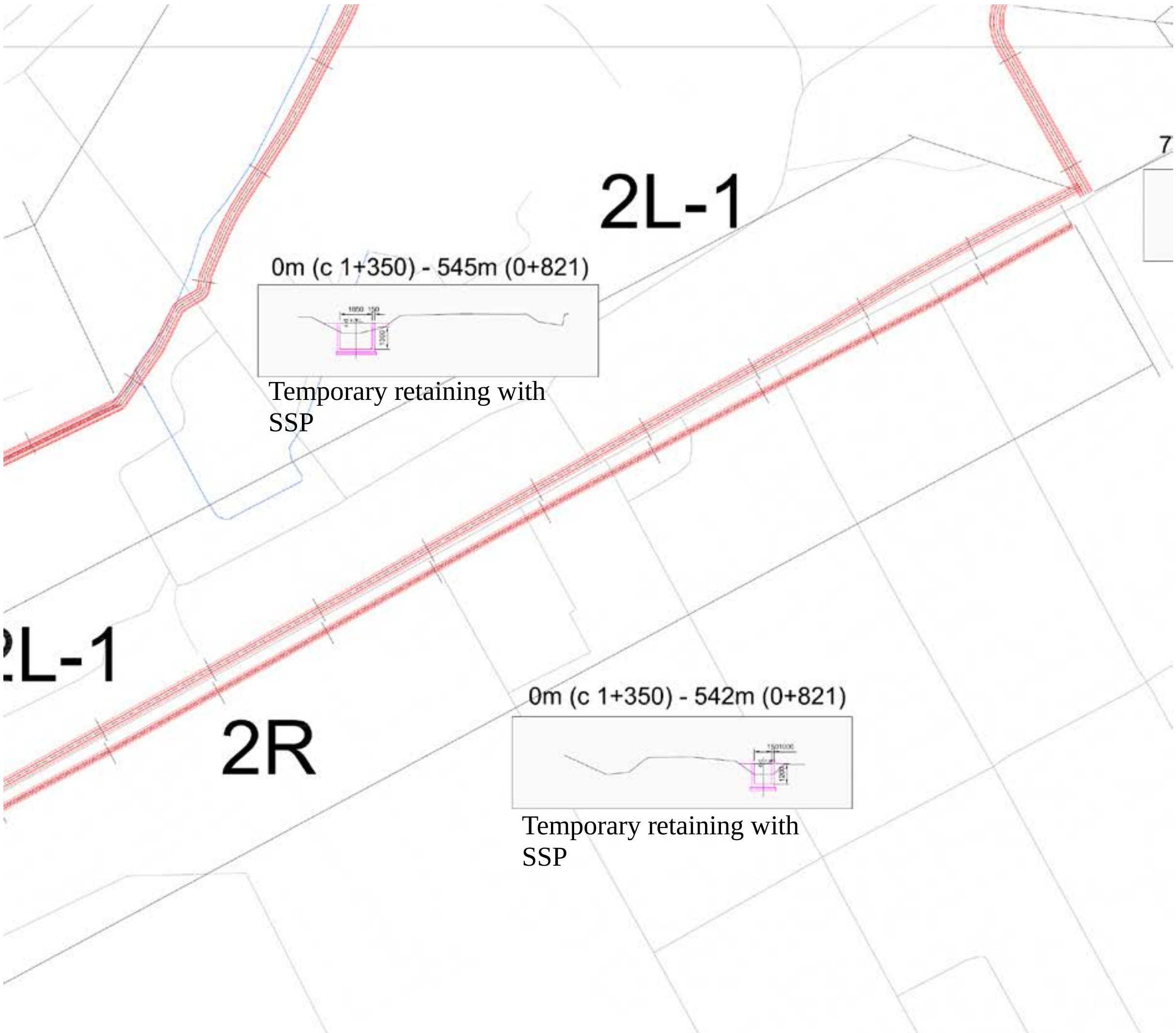
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.11 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



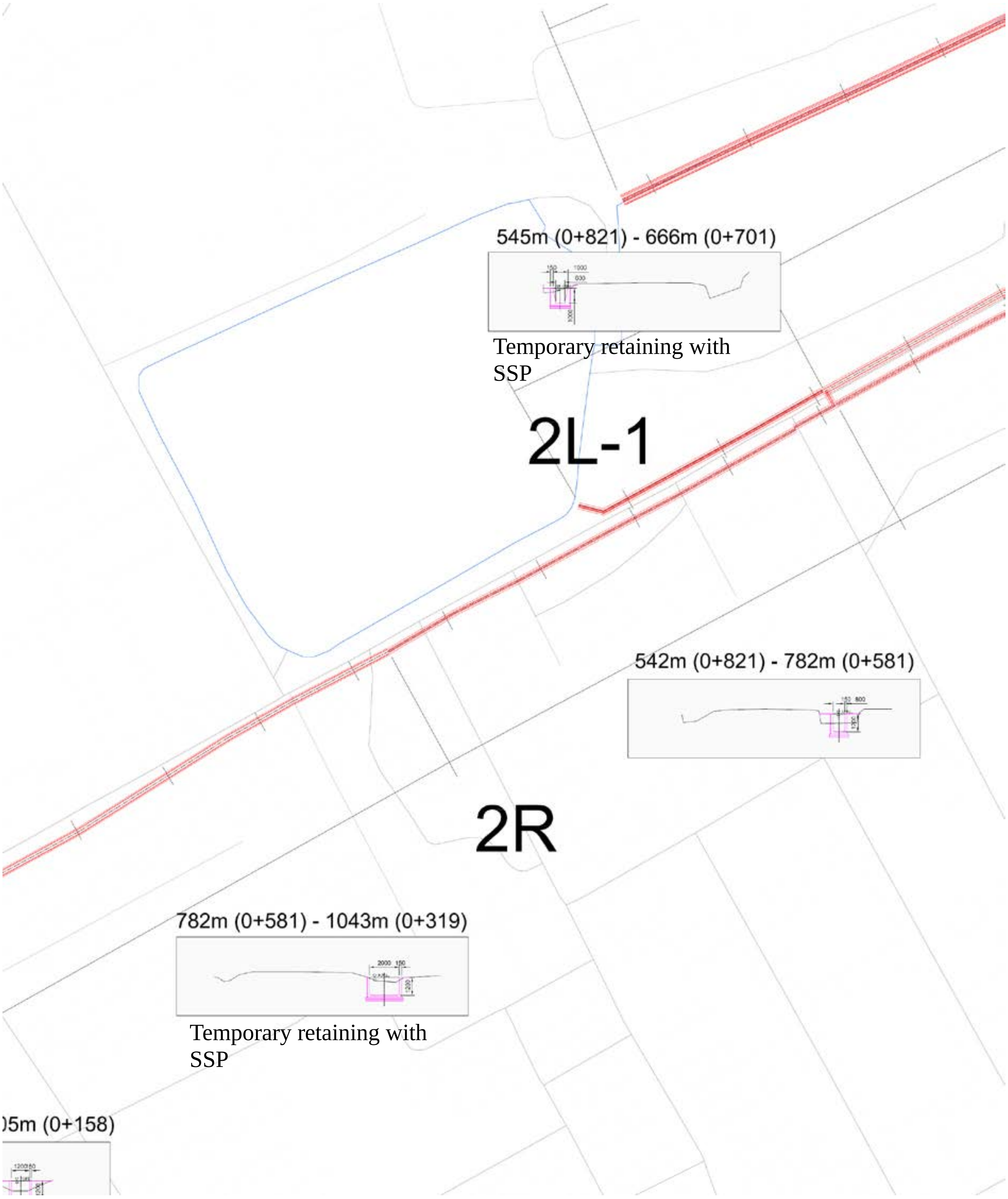
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.12 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



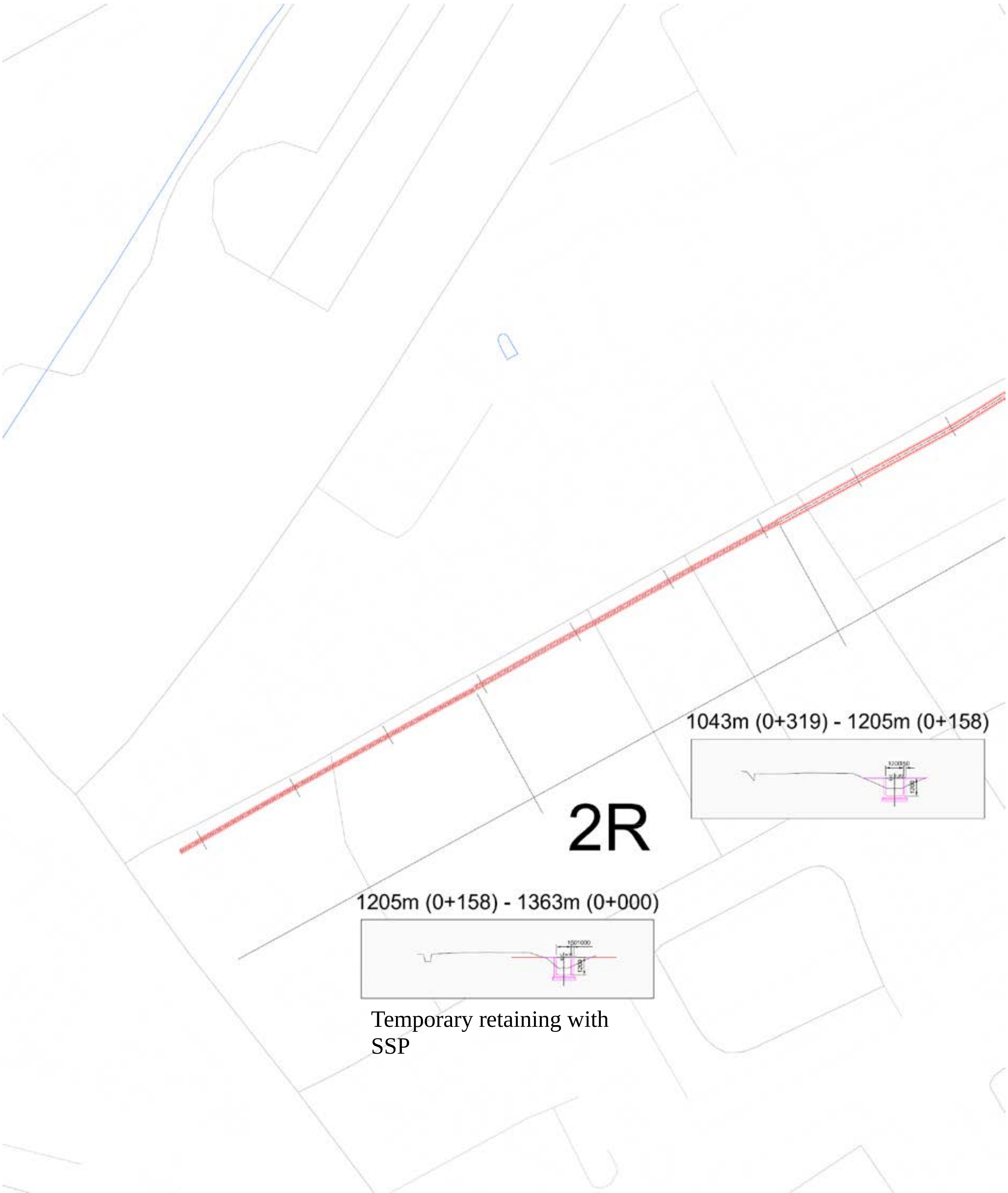
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.13 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_2L-1, 2R, 1/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



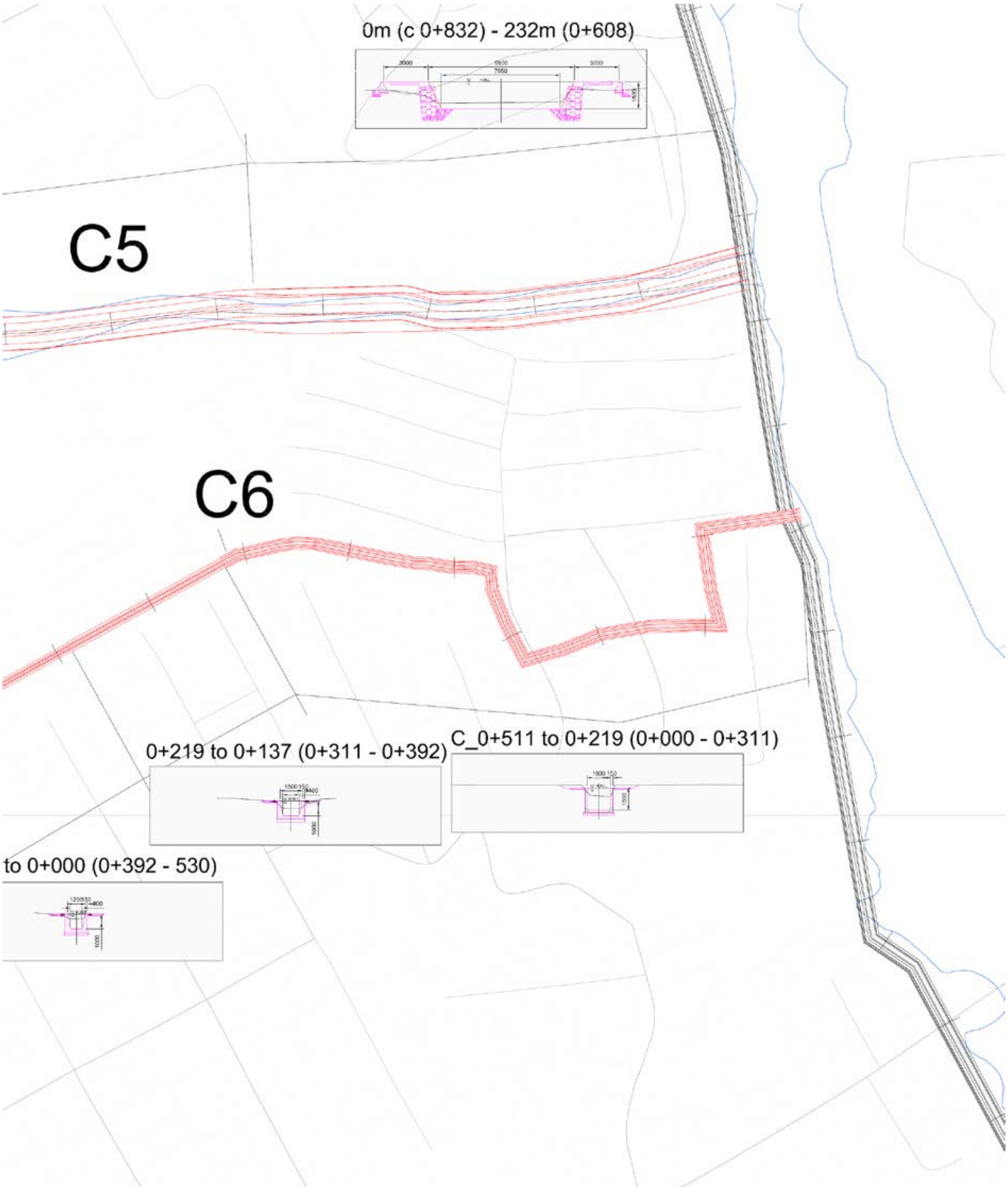
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.14 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_2L-1, 2R, 2/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



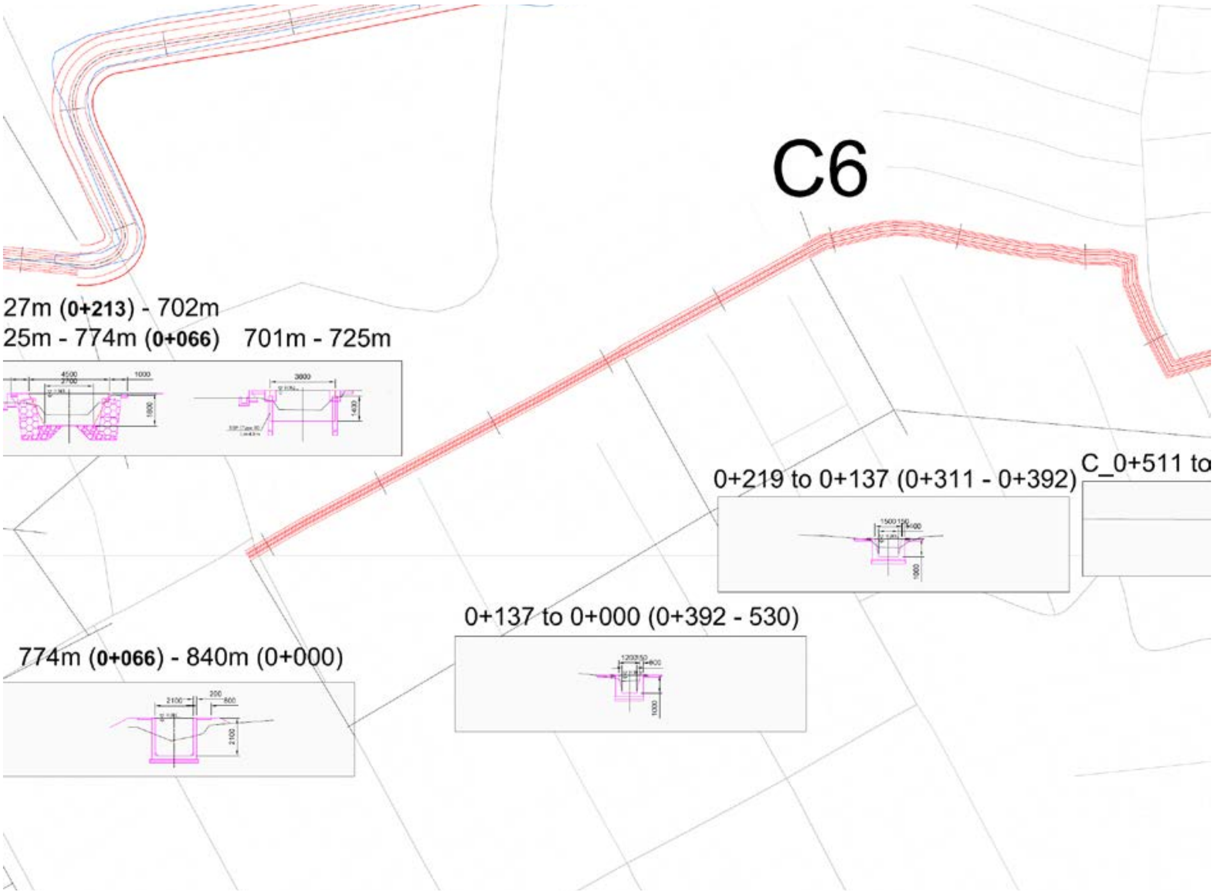
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.15 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_2L-1, 2R, 3/3)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.16 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C6, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

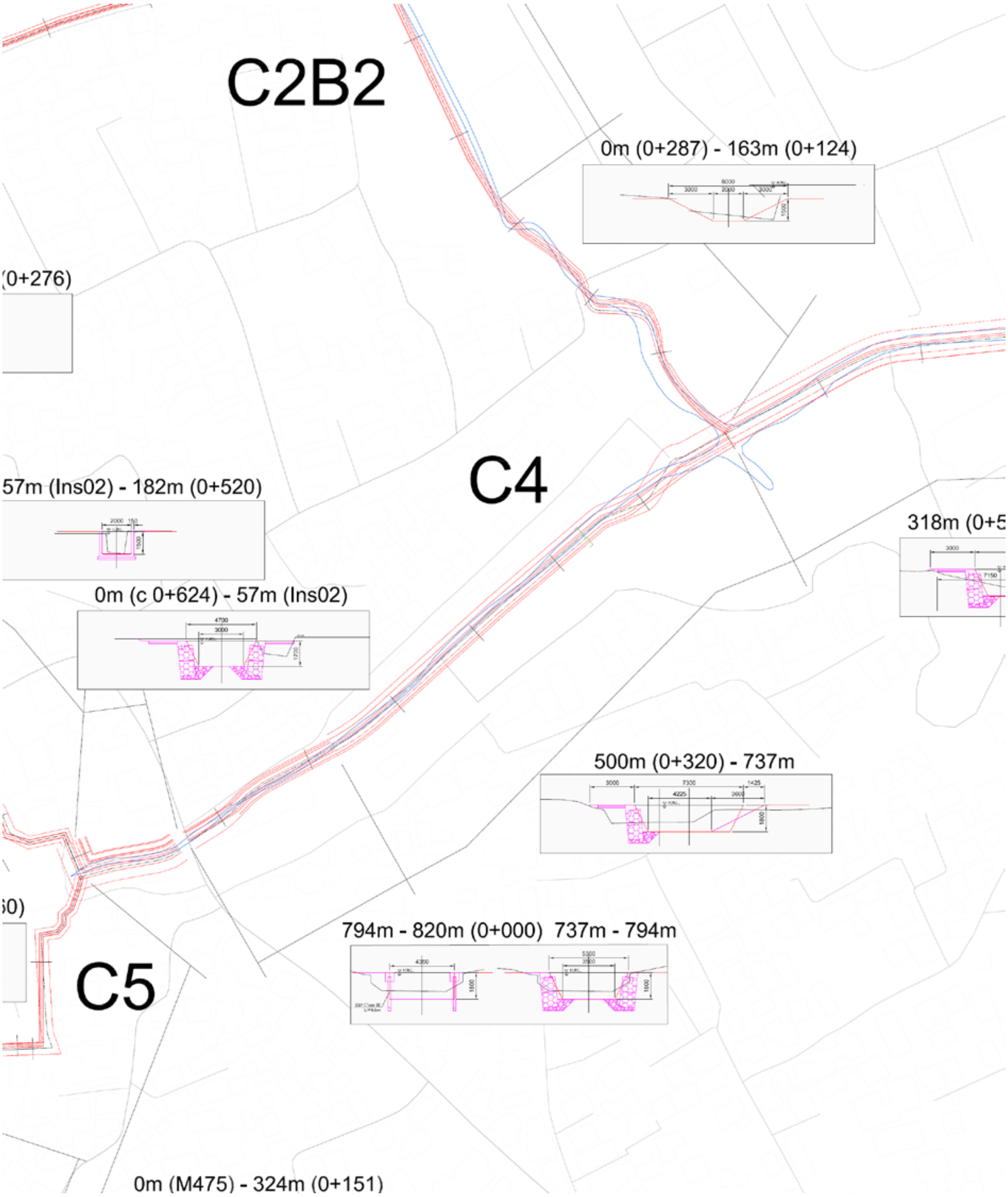


Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.17 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C6, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

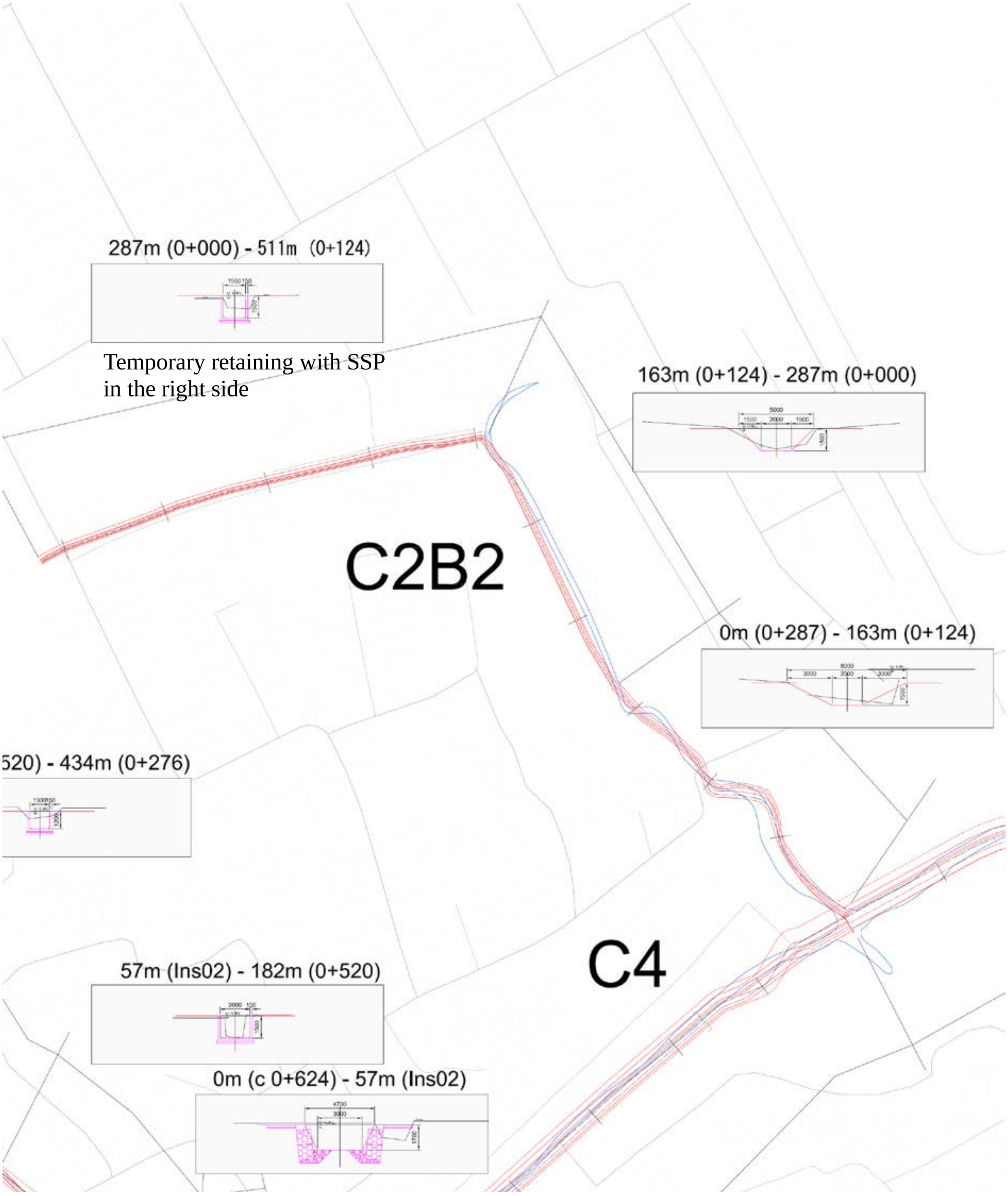
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.18 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C4, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



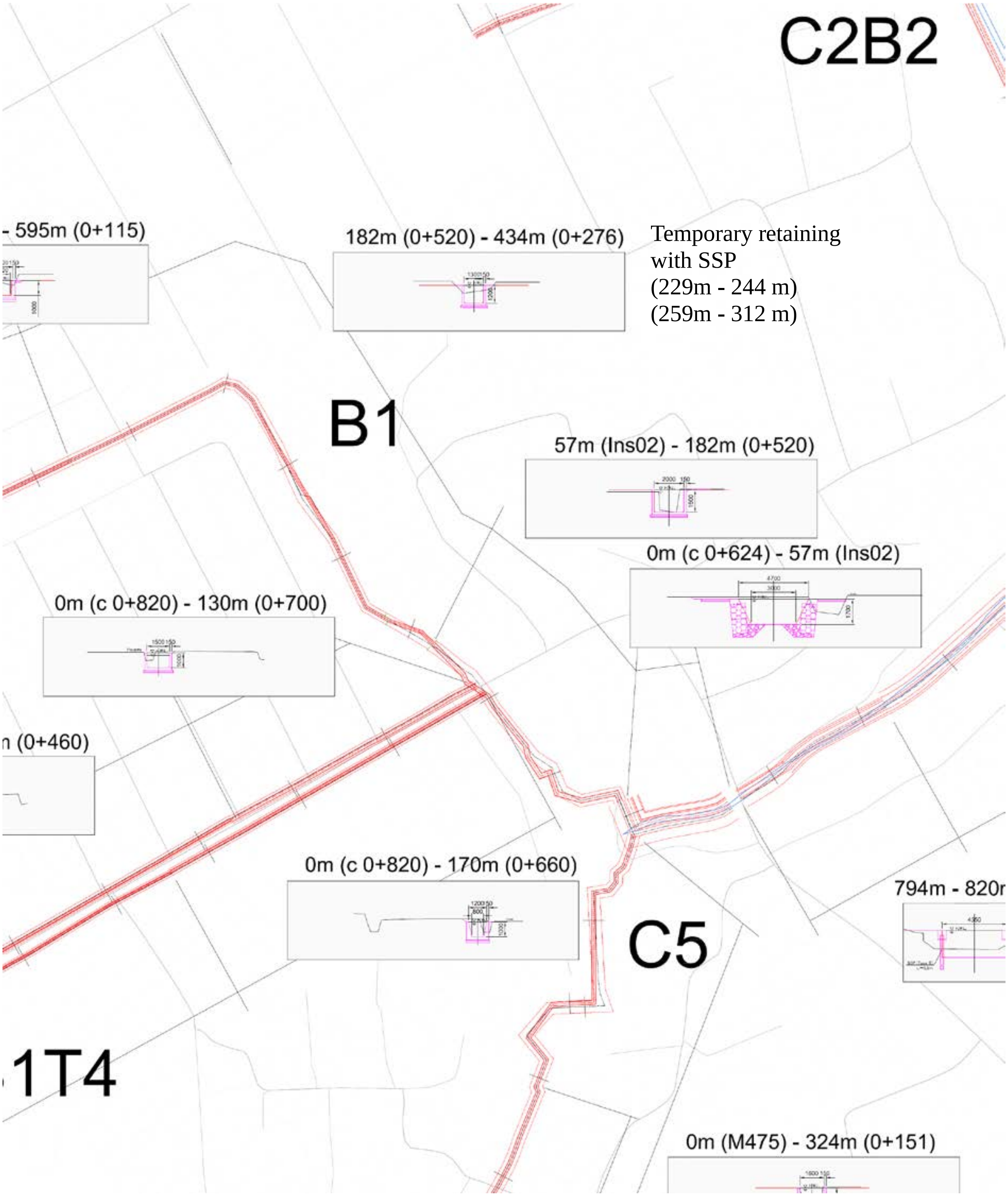
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.19 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C4, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.20 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C2B2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

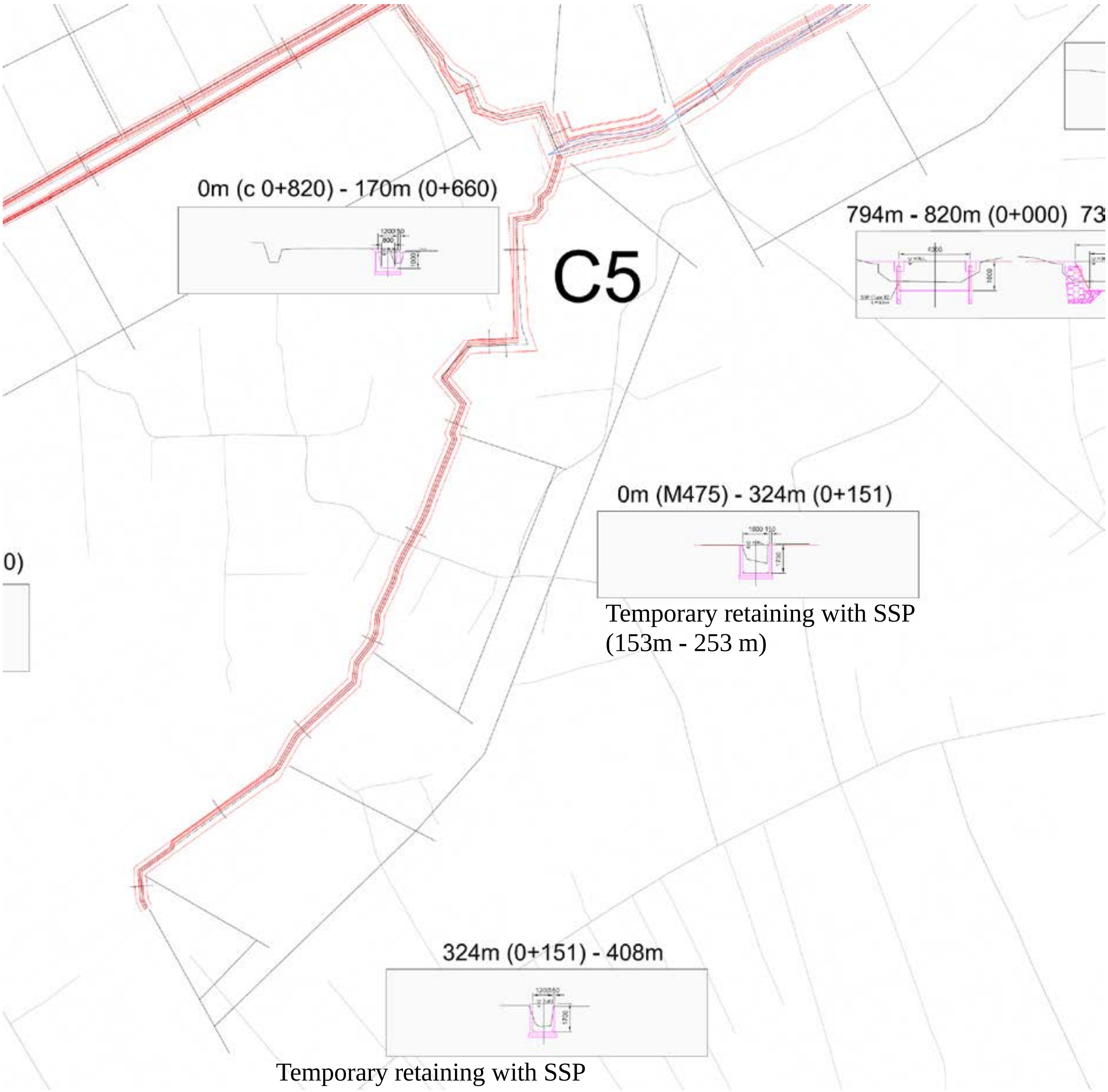


Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.21 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

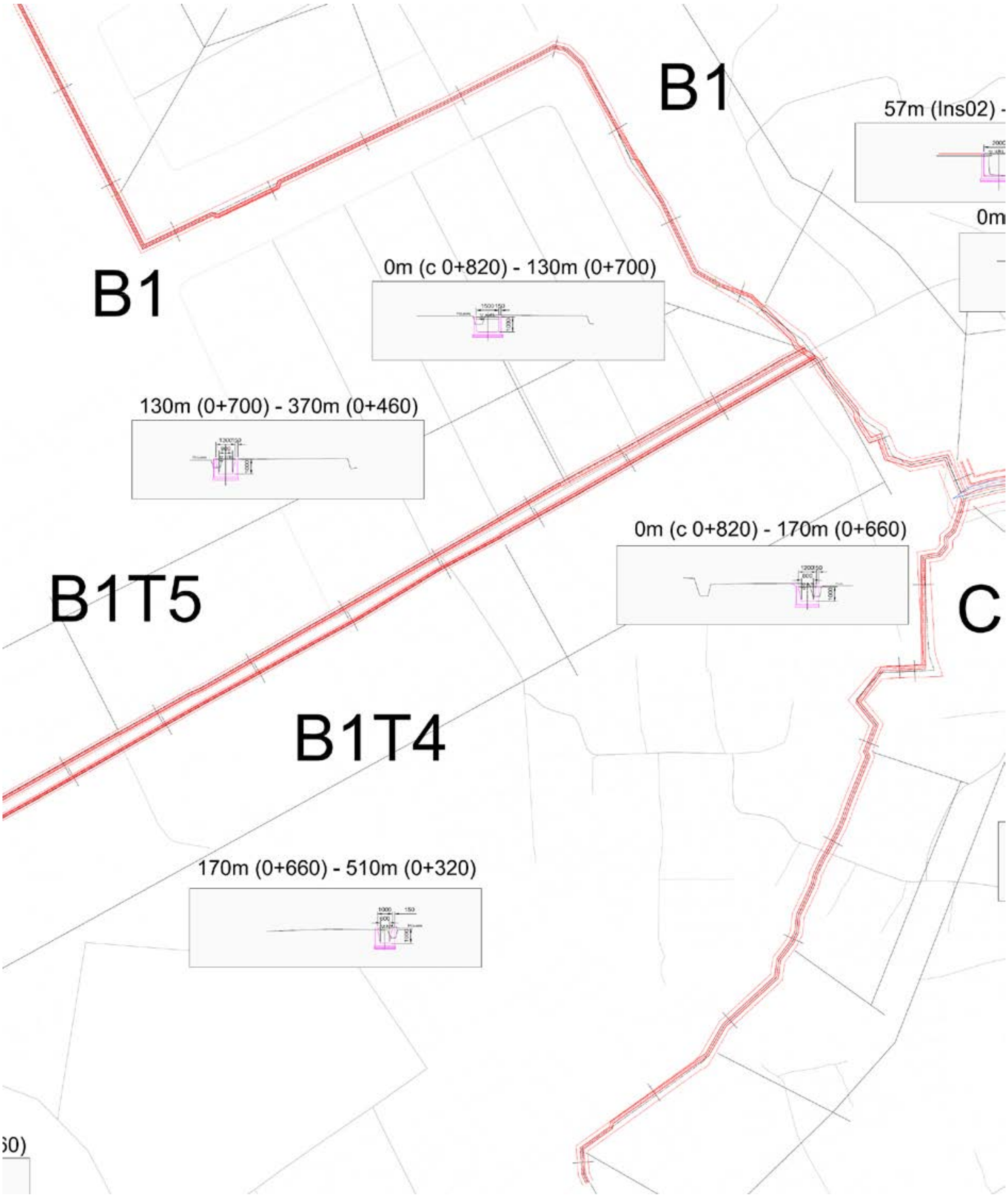
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.22 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



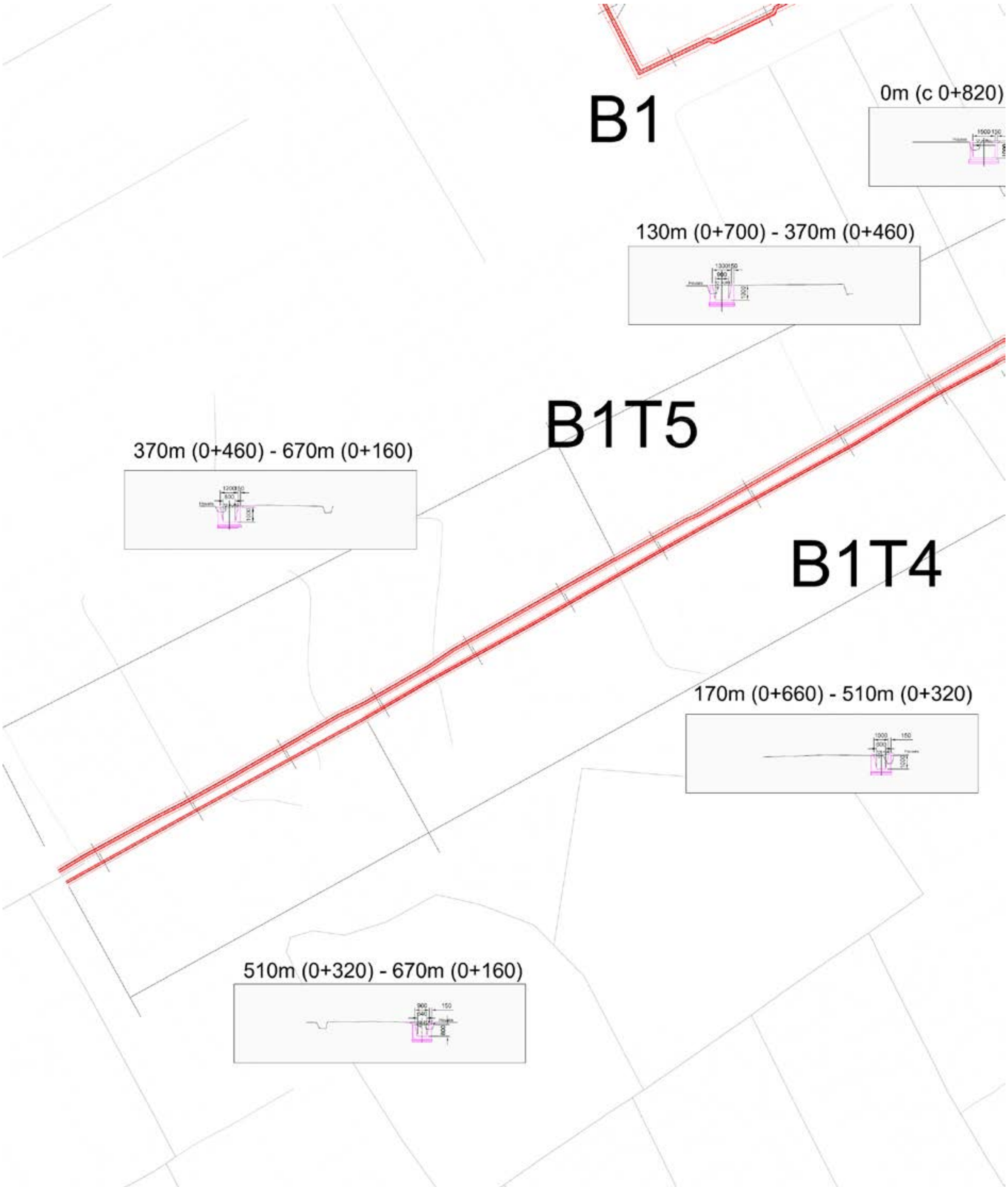
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.23 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



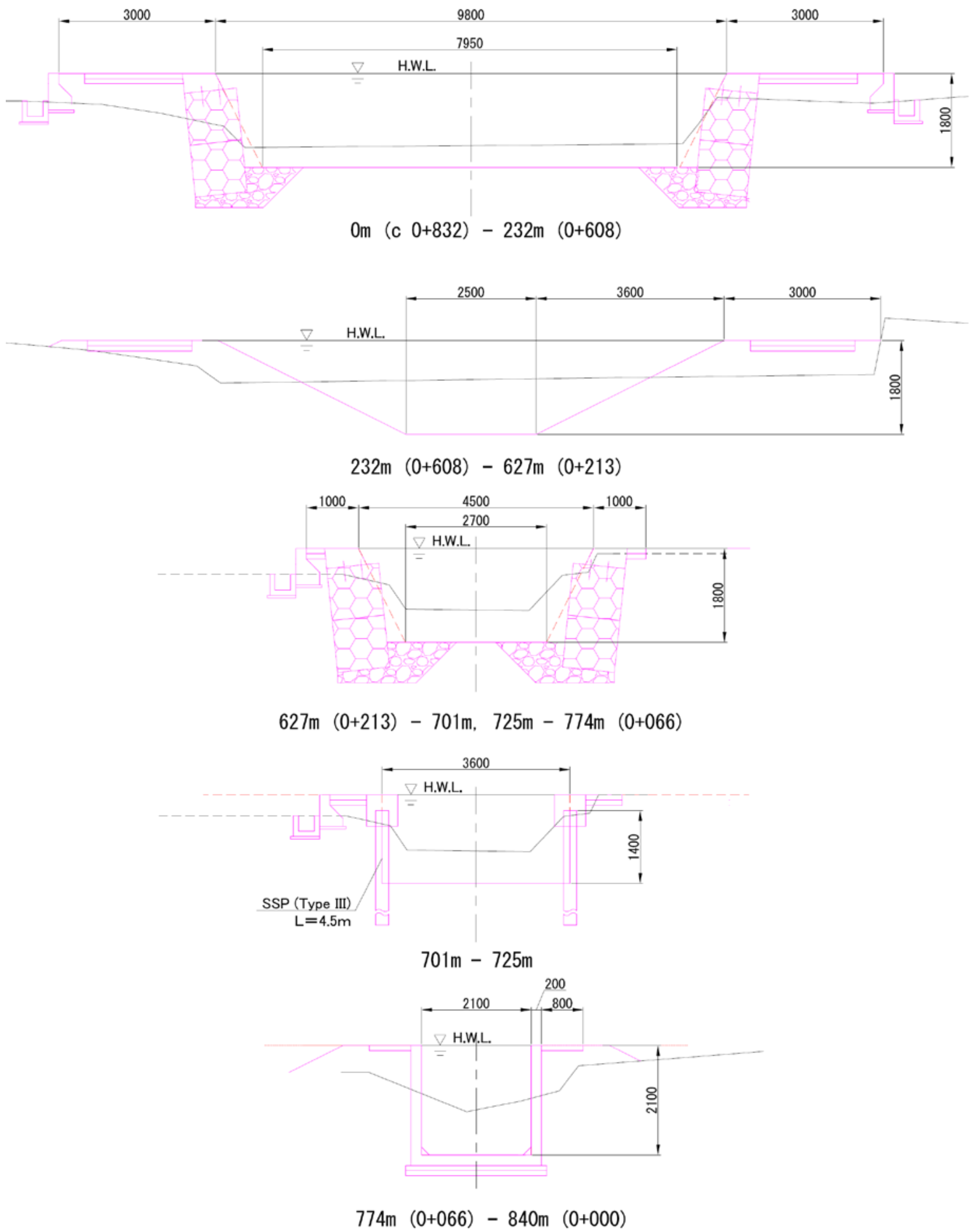
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.24 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1T4, B1T5, 1/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



Source: JICA Study Team

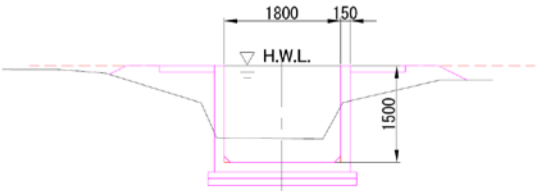
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.25 Plan Map for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1T4, B1T5, 2/2)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



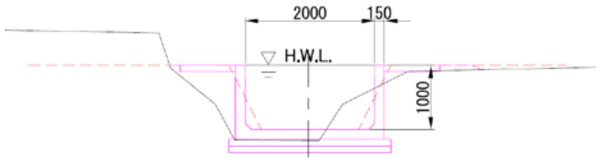
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.26 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

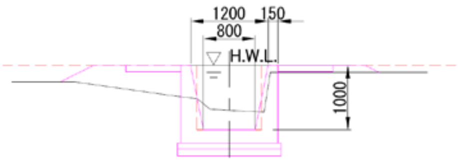
Standard Cross Section (Zone A_C)



0m (0+760) – 320m (0+440)



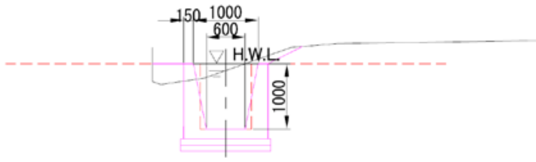
320m (0+440) – 560m (0+200)



560m (0+200) – 760m (0+000)

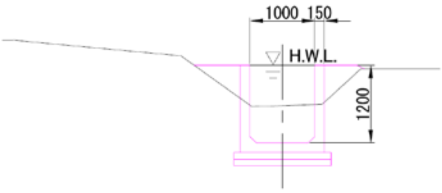
Standard Cross Section (Zone A_2L-1)

0m (c 1+350) – 545m (0+821)

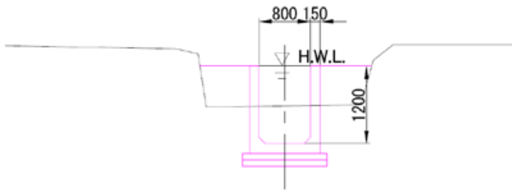


545m (0+821) – 666m (0+701)

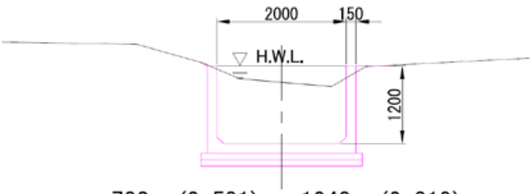
Standard Cross Section (Zone A_2R)



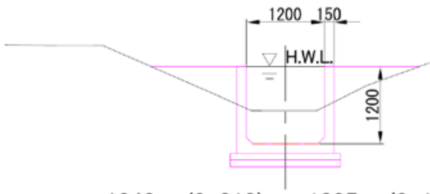
0m (c 1+350) – 542m (0+821)



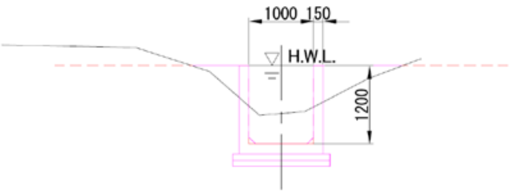
542m (0+821) – 782m (0+581)



782m (0+581) – 1043m (0+319)



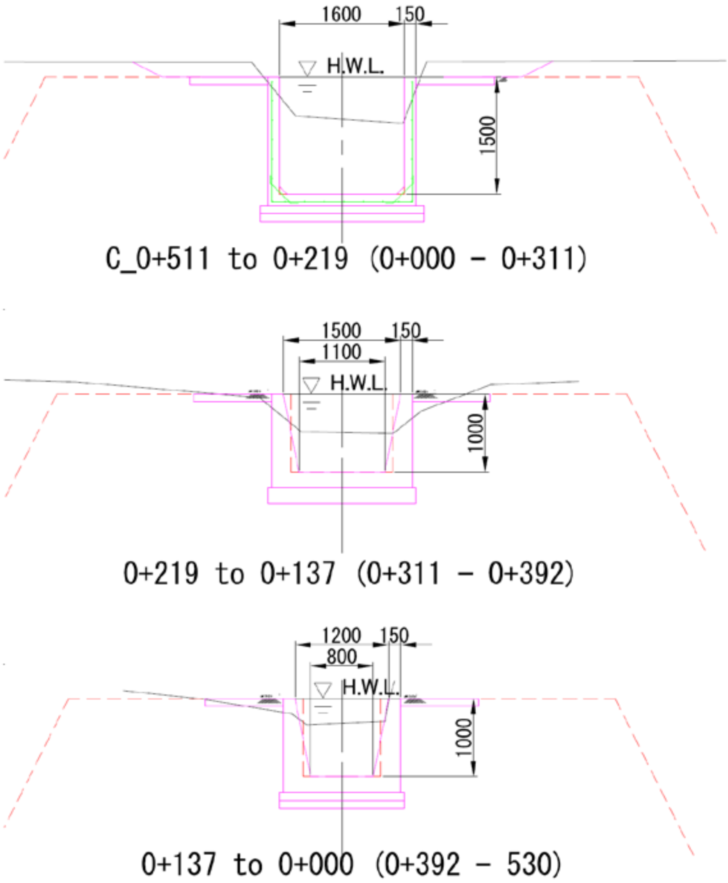
1043m (0+319) – 1205m (0+158)



1205m (0+158) – 1363m (0+000)

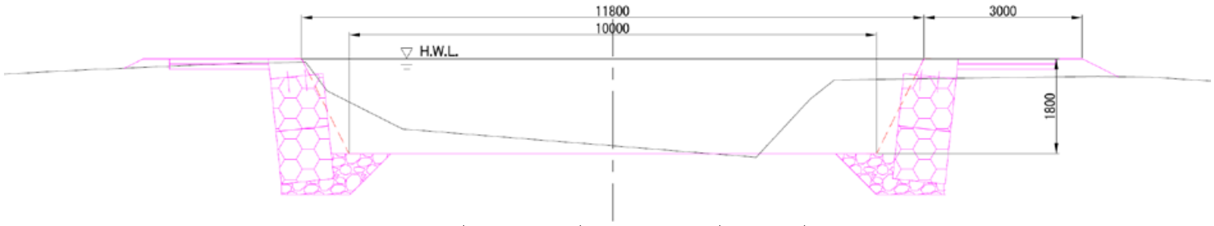
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.27 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C, 2L-1, 2R)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

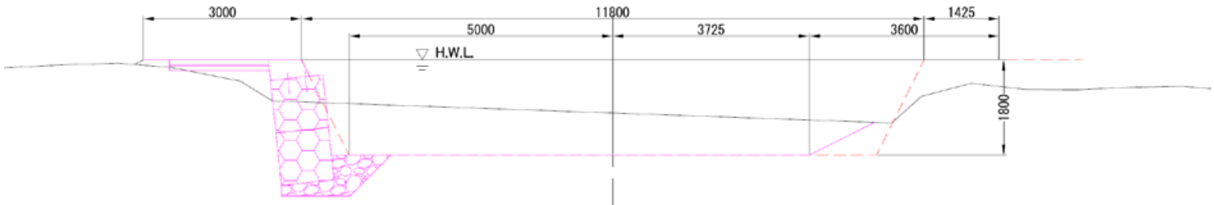


Source: JICA Study Team

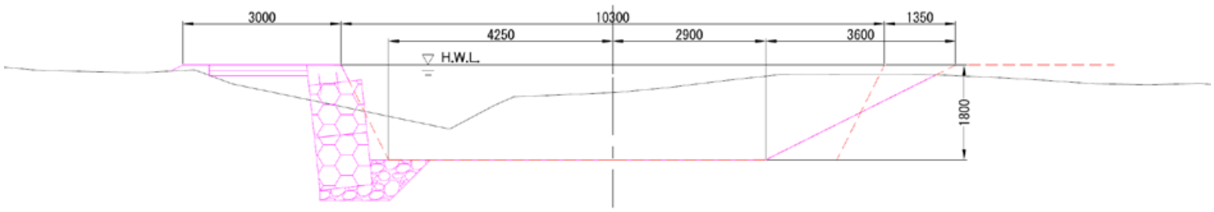
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.28 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone A_C6)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



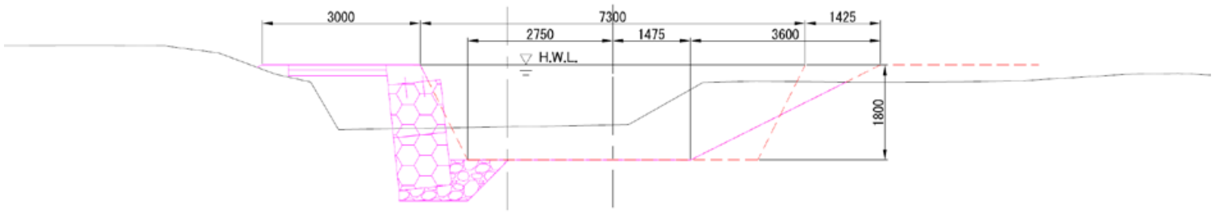
0m (c 0+812) - 46m (0+774)



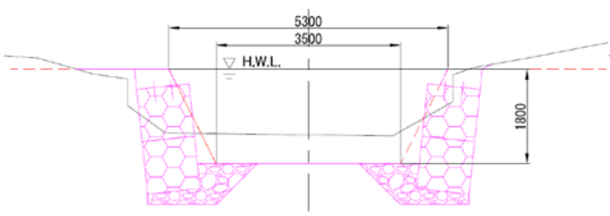
46m (0+774) - 318m (0+502)



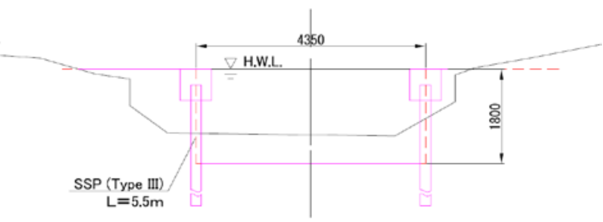
318m (0+502) - 500m (0+320)



500m (0+320) - 737m



794m - 820m (0+000)

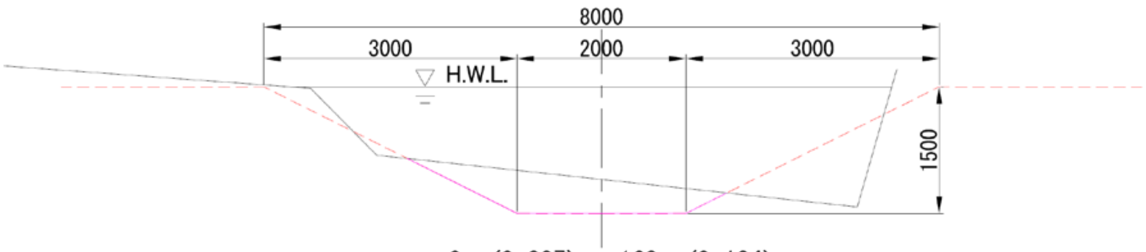


737m - 794m

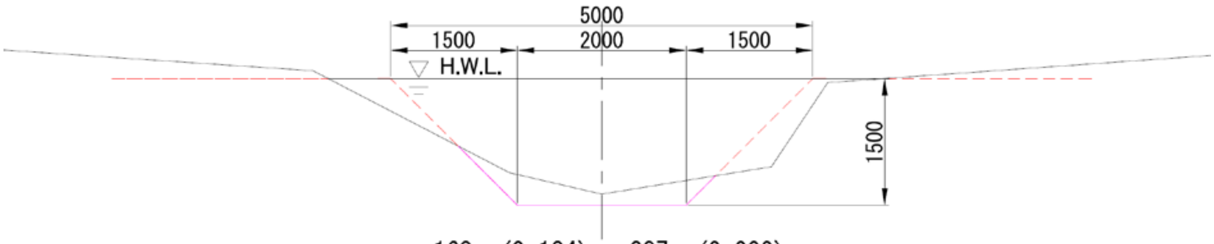
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.29 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C4)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

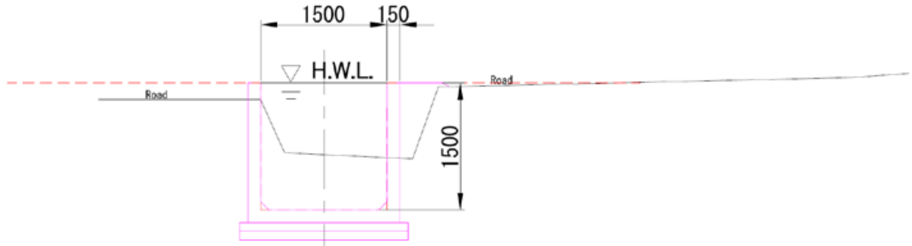
Standard Cross Section (Zone B_C2B2)



0m (0+287) – 163m (0+124)

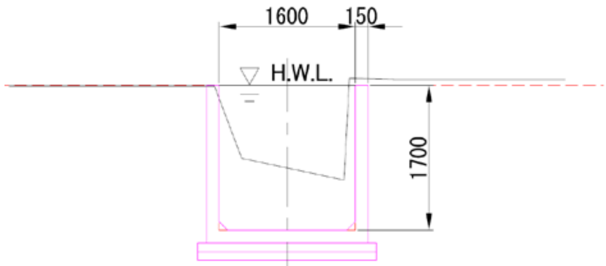


163m (0+124) – 287m (0+000)

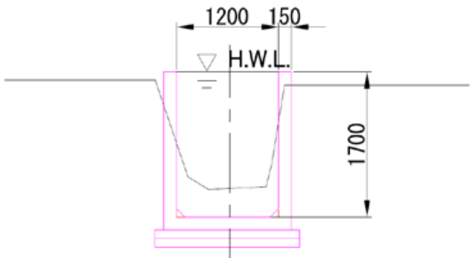


287m (0+000) – 635m (0+000)

Standard Cross Section (Zone B_C5)



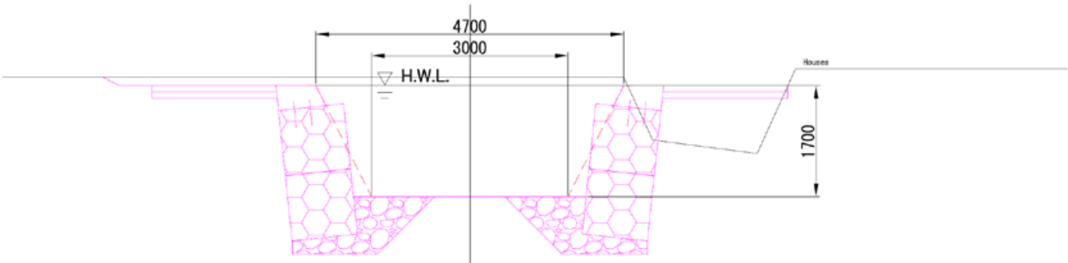
0m (M475) – 324m (0+151)



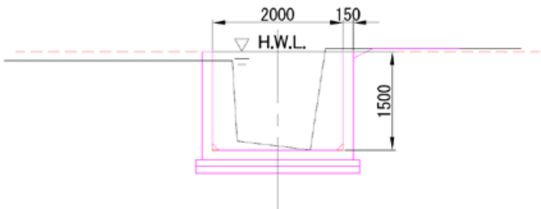
324m (0+151) – 408m

Source: JICA Study Team

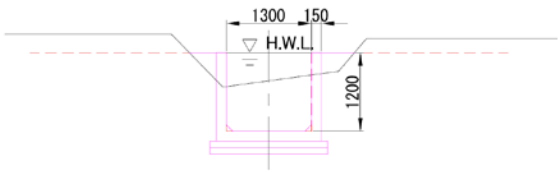
The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.30 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_C2B2, C5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	



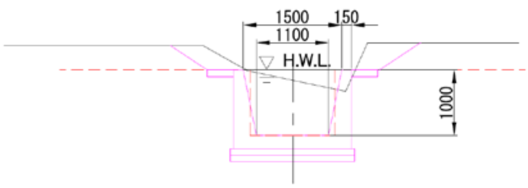
0m (c 0+624) – 57m (Ins02)



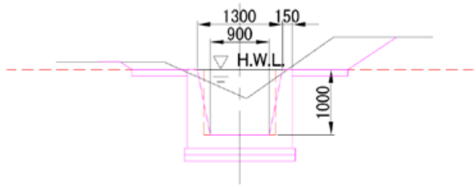
57m (Ins02) – 182m (0+520)



182m (0+520) – 434m (0+276)



434m (0+276) – 595m (0+115)

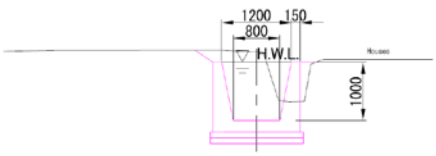


595m (0+115) – 710m (0+000)

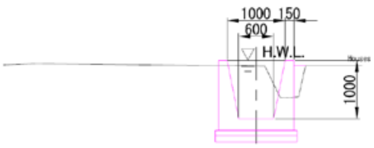
Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.31 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	

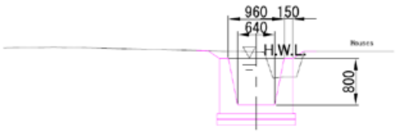
Standard Cross Section (Zone B1-T4)



0m (c 0+820) - 170m (0+660)

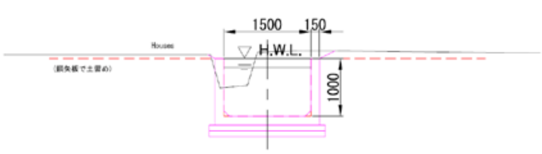


170m (0+660) - 510m (0+320)

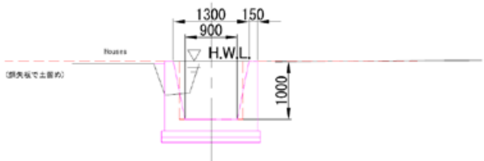


510m (0+320) - 670m (0+160)

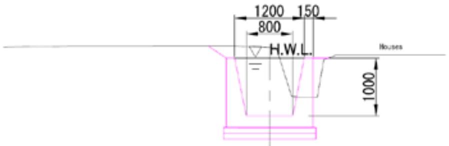
Standard Cross Section (Zone B1-T5)



0m (c 0+820) - 130m (0+700)



130m (0+700) - 370m (0+460)



370m (0+460) - 670m (0+160)

Source: JICA Study Team

The Project for Storm Water Drainage Plan in Selected Areas in Colombo Metropolitan Region	Annex-F 3.2.32 Standard Cross Section for the Pre-F/S at Moratuwa-Rathmalana Area (Zone B_B1T4, B1T5)
CTI Engineering International Co., Ltd. Nippon Koei Co., Ltd. Earth System Science Co., Ltd.	