SUPPORTING REPORT (1)

ANNEX 9 : PRELIMINARY DESIGN

THE STUDY ON STORM WATER DRAINAGE PLAN
FOR THE COLOMBO METROPOLITAN REGIONS
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

VOLUME III : SUPPORTING REPORT (1)

ANNEX 9 : PRELIMINARY DESIGN

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CHAPTER 1 DESIGN CRITERIA

1.1 General

Criteria were established for the preliminary design of the proposed structures. The design criteria were established referring the following design standards and specifications.

1) Manual for River Works in Japan, 2000, Japan River Association
2) Cabinet Order concerning Structural Standards for River Management Facilities, 2000, Japan River Association
3) Geometric Design of Roads, Sri Lanka Road Development Authority
4) Bridge Design Manual, Sri Lanka Road Development Authority

The design criteria cover river channels, dikes, bridges, culverts, sluiceways, gates, retention areas and retention ponds.

1.2 River Channel Design

(1) Channel Alignment

The channel alignment is to be set along the existing channel course as much as possible to minimize the relocation of houses and properties. Present tight bends or meander of the channel course is to be improved with smooth curves or short cut channels.

(2) Channel Profile

The channel profile is to be set so as to keep the present channel profile as much as possible considering stability of channel bed.

(3) Channel Cross Section

The following rectangular or trapezoidal cross sections and bank slopes are to be applied for the channel design cross section.

Channel Type and Bank Slope

Channel Type	Bank Slope
Trapezoidal Type	
Earth Channel	1 : 2.0
Wet Masonry	1 : 0.5
Rectangular Type	
Gabions	Vertical
Concrete Lining	Vertical

The trapezoidal cross section is to be applied for the channels located in places where adequate space is available.

The rectangular cross section is to be applied for the channels located in the urbanized areas and residential areas where many houses will be affected by the channel improvement.

When the height of the channel bank is more than 3 m, a berm is to be provided in the riverbank every 3 to 5 m of height. The minimum width of the berm is to be 3 m.

(4) Freeboard

The freeboard for channel cross sections is to be as below. Minimum freeboard requirement is 0.6 m for a design discharge of less than 200 m^3/sec. However, if the design discharge is less than 50 m^3/sec and the difference between high water level and ground level along the channel is less than 0.6 m above high water, the freeboard can be reduced to 0.3 m. The freeboards are summarized as follows;

Freeboard for Channel Design

Design Discharge Q (m^3/sec)	Freeboard (m)
$Q<50$	0.3
$50\leq Q<200$	0.6

Source: Cabinet Order concerning Structural Standards for River Management Facilities, etc., 2000, Japan River Association

(5) Maintenance Road

A maintenance road is to be provided on one side of the channel except in dense housing areas. The width of maintenance road is to be 4 m. If an existing road is located along the channel, it is to be used as a maintenance road.

(6) Flow Capacity of Channels

The flow capacity of channels is calculated by the following Manning's Formula assuming uniform flow.

$$Q = I^{1/2} \times R^{2/3} \times A \times 1/n$$

where,

Q : discharge (m^3/sec)
I : channel bed slope
R : hydraulic radius (m)
A : flow cross sectional area (m^2)
n : Manning's roughness coefficient as shown below

Manning's Roughness Coefficient

Lining Type	n
Earth Channel	0.035
Gabion	0.035
Wet Masonry	0.030
Concrete Lining	0.015

Note: Value of roughness coefficients were estimated by JICA Study Team

1.3 Structural Design

(1) Dikes

An earth dike is to be applied in the rural area where sufficient space is available. The bank slope is to be 1:2.0. On the other hand, a wet masonry dike is to be applied in the dense housing areas to minimize the relocation of houses. The minimum width of a dike top is to be 3 m. However, if the design discharge is less than 100 m^3/sec and the difference between high water level and ground level along the channel is less than 0.6m, the minimum width of dike top can be reduced to 2.5 m for a design discharge from 50 to 100 m^3/sec, and 2 m for a design discharge of less than 50 m^3/sec. The minimum widths of dike tops are summarized as follows;

Dike Top Width

Design Discharge Q (m^3/sec)	Dike Top Width (m)
$Q < 50$	2.0
$50 \leq Q < 100$	2.5
$100 \leq Q < 500$	3.0

Source: Cabinet Order concerning Structural Standards for River Management Facilities, etc., 2000, Japan River Association

(2) Bridge

An existing bridge shall be reconstructed if the vertical clearance under the superstructure is lower than required or the bridge length is shorter than the improved channel width.

As a crossing structure for river channels, a bridge is adopted when the proposed channel width is more than or equal to 7 m, while a culvert is adopted when the proposed channel width is less than 7 m.

The design criteria for bridges are established as follows;

1) Location and Width

The location of the bridge is basically to be same as the existing bridge site. The width is to be same as the existing road width except if a future widening plan is available.

2) Span Arrangement

The minimum span length is obtained by the following formula.

$L = 20 + 0.005 \times Q$

Where,

L : minimum span length (m)

Q : design discharge (m^3/sec)

However, if the design discharge is less than 500 m^3/sec, the minimum span length can be read from the following table.

Standard Span Length for Small Bridge

Design Condition	Minimum Span Length (m)
$Q < 500m^3$/sec, W<30m	12.5
$Q < 500m^3$/sec, $30m \leq W$	15.0

Note: Q means Design Discharge, W means Channel Width
Source: Manual for River Works in Japan, 1997, Japan River Association

3) Type of Superstructure

A prestressed concrete girder bridge is to be adopted for the super structure of the bridge in accordance with the design manual of RDA in Sri Lanka. The arrangement of girders is to be made based on the standard design of RDA.

The minimum clearance under the superstructure is to be 1 m referring to the design criteria of RDA.

4) Foundation of Substructure

A cast in-situ concrete pile foundation is to be applied for the foundation of substructure. The diameter of each pile is to be 600 mm, which is normally adopted in Sri Lanka.

(3) Culverts

A culvert is to be applied for a crossing structure instead of a bridge when the width of the channel top is less than 7m. The culvert is to be designed taking the following into account.

The location of the culvert is to be same as the location of the existing bridge or culvert. The length of the culvert is to be determined based on the existing road width.

A box culvert is to be applied. The dimension of opening is to be determined so as to carry the design discharge with a water depth of 0.8D (D = inner height of culvert).

The bearing pile foundation using precast RC pile is to be applied for the foundation of the culvert to ensure the stability of culvert.

(4) Sluiceways

A sluiceway is to be designed as a reinforced concrete structure with a flap gate and a slide gate as a supplementary gate. The sluiceway is to be planned at the discharge point of storm water retention area or pond. The sluiceway is to be designed taking the following into account.

The dimensions of the opening and culvert must be adequate to carry the design discharge with a water depth of 0.8 D (D = inner height of opening). The opening is to be smaller than 3.0 m wide and 3 m high.

The sluiceway is to be equipped with a flap gate on the river side and a slide gate on the inland side.

(5) Flood Gates

The floodgate is to be designed in accordance with the following;

1) Gate Span

The flow section of the gate is to be set at 1.3 times the flow section of the inlet channel under high water level.

The minimum length of gate span is to be 15 m (12.5 m for a wash out gate) for a design discharge of less than 500 m^3/sec.

2) Elevation of the Gate Top

The elevation of the gate top is to be same as the elevation of the dike top that connects with the gate

3) Type of Gate

The gate is to be a roller type of gate.

(6) Pumping Stations

Pumping stations are to be planned to guarantee adequate storm water drainage during high water level of the Kelani Ganga. The discharge capacity of the pump facilities is to be determined in accordance with the following;

1) Design Pump Head

The design pump head is to be determined by the following formula;

H = (The larger of Ha or Hb) + H1

where,

H: design pump head (m)

Ha: (HWL on the outer side) – (SWL on the inner side)

- HWL on the outer side: Design high water level of river side
- SWL on the inner side: Design High water level of inland side

Hb: ((HWL on the outer side) – (LWL on the inner side)) x 0.75

- LWL on the inner side: Design low water level of inland side

H1: 1.0 m as head loss

2) Pump Types

Pumps are classified into three types depending on the streamline inside the pump impeller, i.e., volute (centrifugal) type, mixed flow type and axial flow type.

The axial flow type of pump is suitable for design heads less than 6m and has been adopted for the Study.

3) Number of Pumps

Two is the minimum number of pumps without a standby pump. The capacity of each pump is to be less than 10 m^3/sec. The standard number of pumps is tabulated as follows;

Number of Drainage Pump

Design Discharge Q (m^3/sec)	Number of Pump (nos.)
Q < 30	2 - 4
30 Q <100	3 - 5

Source: Manual for River Works in Japan, 2000, Japan River Association

(7) Periphery Canal for Storm Water Retention Areas

A periphery canal is to be provided along the boundary of a proposed storm water retention area. The channel is designed as a trapezoidal earth channel with a 2 m wide bed and 1.5 m deep. The bank slope is 1:1.0. An earth dike 0.5 m high is to be constructed on both banks. The width of the dike top is set at 3 m for the dike on the retention area side and 2 m for the dike on the opposite side.

CHAPTER 2 PRELIMINARY DESIGN FOR THE MASTER PLAN

2.1 Ja Ela Basin

2.1.1 Ja Ela Channel Improvements

The reaches of Ja Ela to be improved extend from Yakkaduwa to Delature. The general plan of the proposed Ja Ela channel improvement is shown in Figure 2.1.1. The length of channel improvement is 7,000 m.

The design discharge (50-year return period) is taken as 75 m^3/sec. The proposed channel bed slope is set at 1/7,600, the same as the present one. The channel cross section is designed as a compound earth channel with a bank slope of 1:2.0 and a berm 3.0 m wide. The width of the proposed channel top is set at 60 m and the width of channel bed is to be varied. The earth dike is designed to be 1.5 m high and has a 3 m wide dike top on the both banks. The proposed longitudinal profile and cross section are shown in Figures 2.1.2 and 2.1.5. The design features of Ja Ela are summarized below.

Design Features of Ja Ela Channel Improvements

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	75 m^3/sec
(2) Channel Length	7,000 m
(3) Channel Bed Slope	1/7,600
(4) Channel Cross Section	Compound earth channel with bank slope of 1:2.0 and berm of 3 m wide Width of channel top: 60 m Depth of low water channel : 3 m
2. Major Structures	
(1) Bridge	JE1: 60 m (L) x 10 m (B) x 3 spans
	JE2: 60 m (L) x 20 m (B) x 3 spans, Negombo Road
	JE3: 60 m (L) x 15 m (B) x 3 spans, railway bridge

Note: L: length, B: width

The preliminary design for bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.1.2 Dandugam Oya Channel Improvements

The reaches of Dandugam Oya to be improved are divided into two sections at the confluence with Kalu Oya, which is a tributary of Dandugam Oya with 8 m wide, depending on the width of present channel. The general plan of the proposed Dandugam Oya channel improvements is shown in Figure 2.1.3. The length of channel improvement is 9,900 m.

The design discharge (50-year return period) is taken as 195 m^3/sec. The present channel bed slope is almost level and the proposed channel bed elevation is set at 4.9 m below MSL, which is the average elevation of the present channel bed.

The proposed cross section is designed as a compound earth channel with a bank slope of 1:2.0 and berms 3 m wide. The earth dike is designed to be 2 m high and has 3 m wide dike tops on the both banks. The proposed longitudinal profile and cross section are shown in Figure 2.1.4 and 2.1.5. The design features of Dandugam Oya are summarized below.

Design Features of Dandugam Oya Channel Improvements

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	195 m^3/sec
(2) Channel Length	9,900 m
(3) Channel Bed Slope	Level (4.9 m below MSL)
(4) Channel Cross Section	Compound earth channel with bank slope of 1:2.0 and berms of 3 m wide Width of channel top upstream: 70 m, Length: 5,900 m Width of channel top downstream: 80 m, Length: 4,000 m Depth of low water in channel : 4 m
2. Major Structure	
(1) Bridges	DO1: 60 m (L) x 10 m (B) x 3 spans, Nogombo Road
	DO2: 80 m (L) x 15 m (B) x 3 spans, railway bridge
	DO3: 72 m (L) x 10 m (B) x 3spans
	DO4: 72 m (L) x 10 m (B) x 3spans

Note: L: length, B: width

The preliminary design for bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.2 Kalu Oya Basin

2.2.1 Kalu Oya Channel Improvements

The reaches of Kalu Oya to be improved extend from Mabole to the confluence with Kelani Ganga as shown in Figure 2.2.1. The length of channel improvement is estimated at 5,000 m.

The design discharge with a 50-year return period is taken as 50 m^3/sec upstream of the point where the Old Negombo Canal (ONC) branches and 25 m^3/sec downstream of the point of the branch. The slope of the present channel bed is almost level and the proposed channel bed elevation is set at 1.5 m below MSL taking into account the elevation of the present channel bed of Kelani Ganga.

The proposed cross section is designed as a compound earth channel with a bank slope of 1:2.0 except where it is crossing stretches of Colombo – Katunayake

Expressway (CKE). The width of the channel top is set at 50 m. The earth dike is designed to be 2 m high and has 3 m wide dike tops on the both banks

The cross section of reaches crossing the CKE has already been designed under the CKE Project. The cross section is designed as a rectangular shape 25 m wide. The present preliminary design used the existing design as it is.

The proposed longitudinal profile and cross sections are shown in Figures 2.2.2 and 2.2.4. The design features of Kalu Oya are shown below.

Design Features of Kalu Oya Channel Improvements

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	50 m^3/sec (upstream), 25 m^3/sec (downstream)
(2) Channel Length	5,000 m
(3) Channel Bed Slope	Level (1.5 m below MSL)
(4) Channel Cross Section	Compound earth channel with bank slope of 1:2.0 and berms of 3 m wide, Width of channel top: 50 m, Length: 3,800 m Depth of low water in channel : 2 m
	Rectangular shaped channel for stretches crossing CKE, Width of channel top: 25 m, Length: 1,200 m
2. Major Structures	
(1) Bridges	KO1: 50 m (L) x 10 m (B) x 2 spans
	KO2: 50 m (L) x 10 m (B) x 2 spans
	KO3: 50 m (L) x 10 m (B) x 2 spans
	KO4: 50 m (L) x 20 m (B) x 2 spans, Negombo Road
	KO5: 50 m (L) x 10 m (B) x 2 spans
(2)Gates	Wattala Flood Gate (Roller gate: 4.5 m (H) x 22.5 m (B) x 2 each) Sill elevation: 1.5 m above MSL

Note: L: length, B: width, H: height

The present floodgate located at the Hekitta road bridge is to be improved due to insufficient width. The width of the gate is 45 m. Two roller gates, each 22.5 m wide and 3.5 m high are recommended. Preliminary design of the Wattala Flood Gate is shown in Figure 2.2.5.

The preliminary design of the proposed bridge is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.2.2 Old Negombo Canal Improvements

The reaches of Old Negombo Canal (ONC) to be improved extend from the confluence with Kalu Oya to the conservation zone of Muthurajawela Marsh in Pattiyawala as shown in Figure 2.2.1. The total length of channel improvement is 4,500 m.

The design discharge (50-year return period) is taken as 35 m^3/sec. The proposed channel bed slope is set as level at 1.5 m below MSL taking connection with Kalu Oya into account. The cross section is designed as a compound earth channel with a bank slope of 1:2.0. The width of the channel top is set at 40 m in the improved section. The proposed longitudinal profile and cross section are shown in Figures 2.2.3 and 2.2.4. The design features of ONC are shown below.

Design Features of Old Negombo Canal Improvements

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	35 m^3/sec
(2) Channel Length	4,500 m
(3) Channel Bed Slope	Level (1.5 m below MSL)
(4) Channel Cross Section	Compound earth channel with bank slope of 1:2.0 and 3 m wide berms Width of channel top: 40 m Depth of low water in channel : 2 m
2. Major Structures	
(1) Bridges	KO6: 40m (L) x 10m (B) x 2 spans
	KO7: 40m (L) x 10m (B) x 2 spans
	KO8: 40m (L) x 10m (B) x 2 spans

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.2.3 Pumping Station

A pumping station was studied as an alternative structural measure. The proposed site of the pumping station is close to the Hekkita road bridge. The design features are summarized below. Preliminary design of Wattala pumping station is shown in Figure 2.2.6.

Design Features of Wattala Pumping Station

Item	Design Features
1. Pump facility	
(1) Design Capacity	30 m^3/sec
(2) Pump Head	2.2 m
(3) Pump type and number	Axial flow pump (1,500 mm) x 5 each
2. Site size	2,750 m^2

2.3 Greater Colombo Basin

2.3.1 Restoration of the Existing Mutwal Tunnel

The existing Mutwal Tunnel is proposed to be restored to have an arch shaped cross section with an 1,800 mm radius. The length of the tunnel is 554 m. The general plan is shown in Figure 2.3.1. The proposed longitudinal profile and typical section are shown in Figure 2.3.2. The design features for restoration of the existing tunnel are summarized below.

Design Features of Restoration of Existing Mutwal Tunnel

Item	Design Features
(1) Design Discharge	5 m^3/sec
(2) Tunnel Length	554 m (Tunnel), 112 m (Inlet channel), 36 m (Outlet channel)
(3) Tunnel Invert	Level (1.5 m below MSL)
(4) Tunnel Cross Section	Arch shaped cross section: 1,800 mm radius

2.3.2 New Mutwal Tunnel

The New Mutwal Tunnel is planned to discharge the storm water from the Main Drain to the Fishery Harbor north of the existing Mutwal Tunnel outlet. The New Mutwal Tunnel consists of a 740 m long tunnel section, a 122 m inlet channel and 108 m outlet channel as shown in Figure 2.3.3.

The design discharge (50-year return period) is taken as 15 m^3/sec. The tunnel is designed as an arch shaped cross section with a 4,000 mm radius and an invert slope of 1/1,650. The proposed longitudinal profile and typical section are shown in Figure 2.3.4. The design features of New Mutwal Tunnel are summarized below.

Design Features of New Mutwal Tunnel

Item	Design Features
(1) Design Discharge	15 m^3/sec
(2) Tunnel Length	740 m (Tunnel), 112 m (Inlet channel), 108 m (Outlet channel)
(3) Tunnel Slope	1/1,650
(4) Tunnel Cross Section	Arch shaped cross section : 4,000 mm radius

2.3.3 Madiwela South Diversion Channel

The Madiwela South Diversion Channel (MSDC) is planned to divert storm water from the upper catchment of Parliament Lake basin to Weras Ganga basin. The length of the proposed channel is 8,800 m and the channel crosses the railway line and High Level Road around Pannipitiya as shown in Figure 2.3.5. There are nine culverts to be reconstructed on the proposed channel course.

The design discharge (50-year return period) is taken as 45 m^3/sec on the Greater Colombo basin side and 80 m^3/sec on the Weras Ganga basin side. The proposed channel bed slope is set at 1/5,850. The proposed cross section is designed as an earth channel with a bank slope of 1:2.0 and a 32 m wide channel bed. The proposed longitudinal profile and cross section are shown in Figures 2.3.6 and 2.3.7.

The closing bund to store storm water in the Greater Colombo basin is designed as an earth dike with slope of 1:3.0. The elevation of the dike top is set at 4.5 m above MSL taking the future road plan into account. Two outlet sluiceways are to be provided, one is to release maintenance flow to the downstream reach, and the other is to discharge excess storm water so as to keep the water level lower than 2.6 m above MSL. Typical design of the closing bund is shown in Figure 2.3.8.

The design features of MSDC are summarized below.

Design Features of Madiwela South Diversion Channel

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	45 m^3/sec (Colombo Basin), 80 m^3/sec (Weras Ganga Basin)
(2) Channel Length	8,800 m
(3) Channel Bed Slope	1/5,850
(4) Channel Cross Section	Single earth channel with bank slope of 1:2.0 Width of channel bed: 32m
2. Major Structure to be improved	
(1) Closing Bund	Height: 5m (Dike top 4.5 m above MSL), Length: 220 m Max. Water Level: 2.6 m above MSL Flood Outlet: dia.1,800 mm x 2 each, 10 m^3/sec Ordinary Outlet: dia. 800 mm
(1) Bridges	MSD1: 40 m (L) x 10 m (B) x 2 spans
	MSD2: 40 m (L) x 10 m (B) x 2 spans
	MSD3: 40 m (L) x 10 m (B) x 2 span
	MSD4: 40 m (L) x 10 m (B) x 2 span
	MSD5: 40 m (L) x 10 m (B) x 2 spans
	MSD6: 78 m (L) x 20 m (B) x 3 spans, High Level Road
	MSD7: 78 m (L) x 10 m (B) x 3 spans
	MSD8: 78 m (L) x 15 m (B) x 3 spans, railway bridge
	MSD9: 40 m (L) x 10 m (B) x 2 span
	MSD10: 40 m (L) x 10 m (B) x 2 span
	MSD11: 40 m (L) x 10 m (B) x 2 span
	MSD12: 40 m (L) x 10 m (B) x 2 spans

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.3.4 Pumping Stations

Two pumping stations, one each at North Lock and Gatatuwa were studied as an alternative structural measure. The proposed capacities are 15 m^3/sec for the North Lock pumping station and 40 m^3/sec for the Gotatuwa pumping station. The preliminary design of the pumping stations is shown in Figures 2.3.9 and 2.3.10. The design features are shown below.

Design Features of Pumping Stations in Greater Colombo Basin

Item	North Lock P/S	Gotatuwa P/S
1. Pump facility		
(1) Design Capacity	15 m^3/sec	40 m^3/sec
(2) Pump Head	3.4 m	5.2 m
(3) Pump type and number	Axial flow pump (1,500 mm) x 3 each	Mixed flow pump (1,800 mm) x 5 each
2. Site size	2,000 m^2	3,700 m^2

2.4 Weras Ganga Basin

2.4.1 Weras Ganga Scheme

The Weras Ganga scheme consists of dredging of Weras Ganga, construction of a wet masonry dike along the right bank and three sluiceways in Kandawala and Telawala retention ponds.

The reaches of Weras Ganga to be improved are divided into two sections of WG1 and WG2 depending on the design discharge. The lengths of WG1 and WG2 are 3,400 m and 2,100 m, respectively. The general plan is shown in Figure 2.4.1.

The design discharge (50-year return period) is taken as 79 m^3/sec for WG1 and 164 m^3/sec for WG2. The width of dredging is 19 and 40 m, respectively. The elevation of dredging is set at 1.5 m below MSL. The bank slope is 1:3.0. The alignment of dredging is almost along the present river course. The proposed longitudinal profile and cross section are shown in Figures 2.4.2 and 2.4.3.

A wet masonry dike is specified to protect the housing area of Kandawala and Telawala urban drainage areas against the high water level of the Weras Ganga in the rainy season. The elevation of the dike top is set at 1.2 to 1.4 m above MSL. The length of wet masonry dike is 2,300 m. The design features of structural measures in Weras Ganga scheme are summarized below.

Design Features of Weras Ganga Scheme

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	WG1: 79 m^3/sec, WG2: 164 m^3/sec
(2) Channel Length	5,500 m (WG1: 3,400 m, WG2: 2,100 m)
(3) Channel Bed Slope	Level (1.5 m below MSL)
(4) Dredging Work	WG1: dredging width: 40 m, bank slope 1:3.0
	WG2: dredging width: 19 m (Weras Ganga Swamp) to 40 m, Bank slope 1:3.0
(5) Wet Masonry Dike	Top elevation: 1.2 to 1.4 m above MSL Length: 2,300 m
2. Major Structures	
(1) Sluiceways	Kandawala: 2 m (B) x 1.9 m (H) x 2 cells with flap gates
	Telawala North: 2.5 m (B) x 1.9 m (H) x 2 cells with flap gates
	Telawala South: 2.5 m (B) x 1.9 m (H) x 2 cells with flap gates

Note: B: width, H: height

The opening size of the sluiceway is determined so as to keep the water level of the inland side lower than 0.6 m above MSL (2-year return period). The design discharge is 16.5 m^3/sec for Kandawala sluiceway and 24 m^3/sec for Telawala sluiceway. The preliminary design of the sluiceways is shown in Figure 2.4.4.

2.4.2 Bolgoda Canal Scheme

The reaches of Bolgoda Canal to be improved are divided into three sections, BC1, BC2 and BC3 as shown in Figure 2.4.5. The lengths of BC1, BC2 and BC3 are 1,000 m, 400 m and 1,000 m, respectively. Total length of channel improvement is 2,400 m.

The design discharge (10-year return period) is taken as 23 m^3/sec for BC1, 37 m^3/sec for BC2 and 51 m^3/sec for BC3. The alignment of channel improvement is almost along the present channel course. The channel is shifted to Boralesgamuwa side downstream of Elawella road taking the runway extension plan of Ratmalana Airport into account.

The proposed channel bed slope is set at level of 1.5 m below MSL. The cross section is designed as a single earth channel with a bank slope of 1:2.0. The widths of channel beds of BC1, BC2 and BC3 are 19 m, 19 m and 15 m, respectively. The proposed longitudinal profile and cross section are shown in Figures 2.4.6 and 2.4.7. The design features of Bolgoda Canal Scheme are summarized below.

Design Features of Bolgoda Canal Scheme

Item	Design Features
1. Channel Improvement	
(1) Design Discharge	BC1: 51m^3/sec, BC2: 37m^3/sec, BC2: 23m^3/sec
(2) Channel Length	2,400 m (BC1: 1,000 m, BC2: 400 m, BC3: 1,000 m)
(3) Channel Bed Slope	Level (1.5 m below MSL)
(4) Channel Cross Section	BC1 and BC2: Channel bed width of 19 m, bank slope of 1:2.0
	BC3: Channel bed width of 15 m, bank slope of 1:2.0
(5) Maintenance Road	Length: 2,600 m
2. Major Structure	
(1) Bridge	BC1: 30 m (L) x 4.3 m (B) x 2 spans

Note: L: length, B: width

The preliminary design of the proposed bridge is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.4.3 Nugegoda-Rattanapitiya Scheme

The Nugegoda-Rattanapitiya scheme consists of Rattanapitiya Ela channel improvement, Delkanda Ela channel improvement and Nugegoda Ela channel improvement. They are designed as mentioned below.

(1) Rattanapitiya Ela Channel Improvements

The reaches of Rattanapitiya Ela to be improved are divided into two sections, RE1 and RE2 as shown in Figure 2.4.8. The lengths of RE1 and RE2 are 890 m and 1,240 m, respectively. The total length of channel improvement is 2,130 m.

The design discharge (10-year return period) is taken as 25 m^3/sec for RE1 and 53 m^3/sec for RE2. The proposed channel bed is set at 1.5 m below MSL with a slope of 1/2,000 for RE1 and 1/800 for RE2. The cross section of RE1 is designed as a single earth channel with a bank slope of 1:2.0. On the other hand, the cross section of RE2 is designed as a rectangular channel with gabion revetment to minimize the relocation of the many houses along the channel. The width of the channel bed is taken as 19 m for both sections. The proposed longitudinal profile and cross section are shown in Figures 2.4.9 and 2.4.10. The design features are summarized below.

Design Features of Rattanapitiya Ela Channel Improvements

Work Item	Design Features
1. Channel Improvements	
(1) Design Flood Discharge	RE1: 25 m^3/sec, RE2: 53 m^3/sec
(2) Channel Length	2,130 m (RE1: 890 m, RE2: 1,240 m)
(3) Channel Bed Slope	RE1: Level to 1/1,200, RE2: 1/800
(4) Channel Cross Section	RE1: Channel bed width of 19 m, bank slope of 1:2.0
	RE2: Channel bed width of 19 m, Gabion revetment
(5) Maintenance Road	Length: 2,130 m
2. Major Structures	
(1) Bridges	RE1: 29 m (L) x 7.4 m (B) x 2 spans
	RE2: 19 m (L) x 22 m (B) x 1 span
	RE3: 19 m (L) x 4 m (B) x 1 span
	RE4: 19 m (L) x 5 m (B) x 1 span
	RE5: 19 m (L) x 5 m (B) x 1 span

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

(2) Delkanda Ela Channel Improvements

The reaches of Delkanda Ela to be improved are divided into three sections of D1, D2 and D3 as shown in Figure 2.4.8. The lengths of D1, D2 and D3 are 280 m, 790 m and 690 m, respectively. Total length of channel improvement is 1,760 m. The channel of D1 section is designed as a diversion channel connecting with Nugegoda Ela in the Lower Nugegoda Ela Marsh.

The design discharge (10-year return period) is taken as 29 m^3/sec for D1, 22 m^3/sec for D2 and 14 m^3/sec for D3. The proposed channel bed slope is set at 1/700 for D1 and D2, 1/300 for D3. The cross section is designed as a single earth channel with a bank slope of 1:2.0 for D1, rectangular channel with gabion revetment for D2 and channel with wet masonry revetment for D3. The width of the channel bed is set at 13.5 m for D1 and D2 and at 3.0 m for D3. The proposed longitudinal profile and cross section are shown in Figures 2.4.9 and 2.4.10. The design features are summarized below.

Design Features of Delkanda Ela Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Flood Discharge	D1: 29 m^3/sec, D2: 22 m^3/sec, D3: 14 m^3/sec
(2) Channel Length	1,760 m (D1: 280 m, D2: 790 m, D3: 690 m)
(3) Channel Bed Slope	D1 and D2: 1/700, D3: 1/300
(4) Channel Cross Section	D1: Bed width of 13.5 m, bank slope of 1:2.0
	D2: Bed width of 13.5 m, rectangular with gabion
	D3: Bed width of 3 m, bank slope of 1:0.5 with wet masonry
(5) Maintenance Road	Length: 280 m
2. Major Structures	
(1) Bridges	D1: 13.5 m (L) x 7 m (B) x 1 span
	D2: 13.5 m (L) x 4.2 m (B) x 1 span
	D3: 13.5 m (L) x 3 m (B) x 1 span
	D4: 13.5 m (L) x 19.8 m (B) x 1 span
	D5: 13.5 m (L) x 6 m (B) x 1 span
(2) Culverts	D6: 4.6 m (L) x 3 m (B) x 2.1 m (H)
	D7: 5.6 m (L) x 3 m (B) x 1.8 m (H)

Note: L: length, B: width, H: height

The preliminary designs of the proposed bridges and culverts are shown in Figures 2.1.6 and 2.4.13, and structural features are summarized in Table 2.1.1.

(3) Nugegoda Ela Channel Improvements

The reaches of Nugegoda Ela to be improved are divided into three sections, NE1, NE2 and NE3 as shown in Figure 2.4.8. The lengths of NE1, NE2 and NE3 are 940 m, 280 m and 360 m, respectively. Total length of channel improvement is 1,580 m.

The design discharge (10-year return period) is taken as 24 m^3/sec for NE1, 22 m^3/sec for NE2 and 10 m^3/sec for NE3. The proposed channel bed slope is set at 1/700 for NE1 and NE2 and at 1/450 for NE3. The cross section of NE1 is designed as a single earth channel a with bank slope of 1:2.0. The cross sections of NE2 and NE3 are designed as rectangular channels with gabion revetments to minimize the relocation of the many houses in the lower reaches of Delkanda Ela. The width of channel bed is set at 13 m for NE1 and NE2 and at 5 m for NE3. The proposed longitudinal profile and cross sections are shown in Figures 2.4.11 and 2.4.12. The design features are summarized below.

Design Features of Nugegoda Ela Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	NE1: 24 m^3/sec, NE2: 22 m^3/sec, NE3: 10 m^3/sec
(2) Channel Length	1,580 m (NE1: 940 m, NE2: 280 m, NE3: 360 m)
(3) Channel Bed Slope	NE1 and NE2: 1/700, NE3: 1/450
(4) Channel Cross Section	NE1: Channel bed width of 13 m, bank slope of 1:2.0
	NE2: Channel bed width of 13 m, rectangular with gabions
	NE3: Channel bed width of 5 m, rectangular with gabions
(5) Maintenance Road	Length: 1,580 m
2. Major Structures	
(1) Bridges	NE1: 18 m (L) x 4.6 m (B) x 1 span
	NE2: 13 m (L) x 2.3 m (B) x 1 span (pedestrian bridge)
	NE3: 13 m (L) x 4.4 m (B) x 1 span

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.4.4 Boralesgamuwa North Scheme

Depawa Ela is to be improved in the Boralesgamuwa North Scheme as shown in Figure 2.4.14. The reaches of Depawa Ela to be improved are divided into three sections, DE1, DE2 and DE3. The lengths of DE1, DE2 and DE3 are 1,350 m, 1,520 m and 220 m, respectively. The total length of channel improvement is 3,090 m.

The design discharge (10-year return period) is taken as 18 m^3/sec for DE1, 23 m^3/sec for DE2 and 14 m^3/sec for DE3. The proposed channel bed slope is estimated as 1/1,000 for DE1 and 1/700 for DE2 and DE3. The cross sections of DE1 and DE2 are designed as single earth channels with a bank slope of 1:2.0. The cross section of DE3 is designed as a rectangular channel with gabion revetments. The width of the proposed channel bed is 6 m in the three sections. The proposed longitudinal profile and cross sections are shown in Figures 2.4.15 and 2.4.16. The design features are summarized below.

Design Features of Depawa Ela Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	DE1: 18 m^3/sec, DE2: 24 m^3/sec, DE3: 14 m^3/sec
(2) Channel Length	3,090 m (NE1: 1,350 m, NE2: 1,520 m, NE3: 220 m)
(3) Channel Bed Slope	DE1: 1/1,000, DE2 and DE3: 1/700
(4) Channel Cross Section	DE1: Channel bed width of 6 m, bank slope of 1:2.0
	DE2: Channel bed width of 6 m, bank slope of 1:2.0
	DE3: Channel bed width of 6 m, rectangular with gabions
(5) Maintenance Road	Length: 3,090 m
2. Major Structures	
(1) Bridges	DE1: 12.4 m (L) x 6.6 m (B) x 1 span
	DE2: 12.4 m (L) x 22 m (B) x 1 span
	DE3: 12.4 m (L) x 4.3 m (B) x 1 span
	DE4: 12.4 m (L) x 2.6 m (B) x 1 span
(2) Culverts	DE5: 4.6 m (L) x 2.9 m (B) x 1.8m (H) x 2 cells

Note: L: length, B: width, H: height

The preliminary design of the proposed bridges and culverts are shown in Figures 2.1.6 and 2.4.13, and structural features are summarized in Table 2.1.1.

2.4.5 Boralesgamuwa South Scheme

Werahera Tributary channel improvement is proposed as a structural measure in the Boralesgamuwa South Scheme as shown in Figure 2.4.17. The reaches of Werahara Tributary to be improved are divided into two sections, BS1 and BS2. The lengths of BS1 and BS2 are 300 m and 680 m, respectively. The total length of channel improvement is 980 m.

The design discharge (5-year return period) is taken as 28 m^3/sec for both sections. The proposed channel bed slope is estimated as 1/1,000 for both sections. The cross sections are designed as single earth channels with a bank slope 1:2.0 for both sections. The widths of the channel bed are set at 15 m for the both sections. The proposed longitudinal profile and cross section are shown in Figures 2.4.18 and 2.4.19. The design features of the channel improvements are summarized below.

Design Features of Werahera Tributary Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	BS1 and BS2: 28 m^3/sec (5-year return period)
(2) Channel Length	980 m (BS1: 300 m, BS2: 680 m)
(3) Channel Bed Slope	1/1,000
(4) Channel Cross Section	BS1 and BS2: Channel bed width of 15 m, bank slope of 1:2.0
(5) Maintenance Road	Length: 980 m
2. Major Structure	
(1) Bridge	BS1: 22 m (L) x 22 m (B) x 1 span

Note: L: length, B: width

The preliminary design of the proposed bridge is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.4.6 Maha Ela Scheme

Maha Ela Scheme consists of Maha Ela channel improvements and Maha Ela Tributary channel improvements as shown in Figure 2.4.20. They are designed as mentioned below.

(1) Maha Ela Channel Improvements

The reaches of Maha Ela to be improved are divided in to three sections, ME1, ME2 and ME3. The lengths of ME1, ME2 and ME3 are 1,100 m, 770 m and 830 m, respectively. The total length of channel improvement is 2,700 m.

The design discharge (10-year return period) is taken as 47 m^3/sec for ME1, 51 m^3/sec for ME2 and 53 m^3/sec for ME3, respectively. The slope of the proposed channel bed is set at 1/4,600 for ME1 and ME2 and at 1/950 for ME3. The proposed cross section is designed as a single earth channel with a bank slope of 1:2.0 for the three sections. The width of the channel bed is set at 32 m for the three sections. The proposed longitudinal profile and cross section are shown in Figures 2.4.21 and 2.4.22. The design features of the channel improvements are shown below.

Design Features of Maha Ela Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	ME1: 47 m^3/sec, ME2: 51 m^3/sec, ME3: 53 m^3/sec (10-year return period)
(2) Channel Length	2,700 m (ME1: 1,100 m, ME2: 770 m, ME3: 830 m)
(3) Channel Bed Slope	ME1 and ME2: 1/4,600, ME3: 1/950
(4) Channel Cross Section	Channel bed width of 32 m, bank slope of 1:2.0
(5) Maintenance Road	Length; 2,700 m
2. Major Structures	
(1) Bridges	ME1: 38 m (L) x 3.6 m (B) x 2 spans
	ME2: 39 m (L) x 22 m (B) x 2 spans

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

(2) Maha Ela Tributary Channel Improvements

The reaches of Maha Ela Tributary to be improved are divided in to two sections, MET1 and MET2. The lengths of MET1 and MET2 are 780 m and 980 m, respectively. The total length of channel improvement is 1,760 m.

The design discharge (10-year return period) is taken as 28 m^3/sec for MET1 and 29 m^3/sec for MET2. The slope of the proposed channel bed is set at 1/2,000 for MET1 and at 1/850 for MET2. The proposed cross sections are designed as a single earth channel with a bank slope of 1:2.0 for both sections. The widths of the channel bed are set at 15 m for the both sections. The proposed longitudinal profile and cross section are shown in Figures 2.4.23 and 2.4.24. The design features of channel improvement are shown below.

Design Features of Maha Ela Tributary Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	MET1: 28 m^3/sec, MET2: 29 m^3/sec (10-year return period)
(2) Channel Length	1,760 m (MET1: 780 m, MET2: 980 m)
(3) Channel Bed Slope	MET1: 1/2,000, MET2: 1/850
(4) Channel Cross Section	Channel bed width of 15 m, bank slope of 1:2.0
(5) Maintenance Road	Length: 1,760 m
2. Major Structures	
(1) Bridges	MET1: 19.4 m (L) x 4.3 m (B) x 1 span
	MET2: 19.4 m (L) x 22 m (B) x 1 span

Note: L: length, B: width

The preliminary design of the proposed bridges is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.4.7 Ratmalana-Moratuwa Scheme

Ratmalana-Moratuwa Scheme consists of urban drainage improvements, construction of retention ponds and Katubedda Tributary improvements as shown in Figure 2.4.25. They are designed as mentioned below.

(1) Urban Drainage Improvements

Main drains of Ratmalana - Moratuwa urban drainage area are to be improved to obtain sufficient capacity to discharge the design discharge with a 2-year return period.

Almost all main drains are to be installed along the existing roads. The type of drain is concrete flume with cover. The size of the proposed concrete flume varies from 800 mm to 2,000 mm. The total length of concrete flumes is 6,390 m. The open channels with earth bank, wet masonry revetment or gabion revetments are specified for the main drain at the locations with sufficient space. The urban drainage improvement is summarized as follows:

Urban Drainage Improvements of the Ratmalana – Moratuwa Scheme

Channel Type	Length	Width
1.Concrete Flumes	6,390 m	0.8 m to 2 m
2. Wet Masonry Channels	1,150 m	1m to 1.5 m
3. Wet Masonry Revetments	1,650 m	1 m to 3 m
4. Gabion Revetments	790 m	3 m to 6 m
5. Earth Channels	1,140 m	2 m to 6 m
Total	11,120 m	

(2) Storm Water Retention Ponds

A storm water retention ponds are proposed in the Kandawala and Telawala. The extent of the retention ponds is 3 ha at Kandawala and 10 ha at Telawala. The elevation of the proposed pond beds is set at 1.0 m below MSL. The storage volume is estimated at 48,000 m^3 for the Kandawala retention pond and 160,000 m^3 for the Telawala retention pond.

(3) Katubedda Tributary Channel Improvements

The length of Katubedda Tributary channel improvement is 1,250 m. The design discharge (5-year return period) is taken as 11 m^3/sec. The proposed channel bed slope is set at 1/1,600. The cross section is designed as a single earth channel with bank slope of 1:2.0. The width of the proposed channel bed is taken as 8 m. The proposed longitudinal profile and cross section are shown in Figure 2.4.26. The design features of the channel improvements are shown below.

Design Features of Katubedda Tributary Channel Improvements

Item	Design Features
1. Channel Improvements	
(1) Design Discharge	11 m^3/sec (5-year return period)
(2) Channel Length	1,250 m
(3) Channel Bed Slope	1/1,600
(4) Channel Cross Section	Channel bed width of 8 m, bank slope of 1:2.0
(5) Maintenance Road	Length: 1,250 m
2. Major Structures	
(1) Bridges	RM1: 13.2 m (L) x 3.1 m (B) x 1 span
	RM2: 13.2 m (L) x 10.6 m (B) x 1 span

Note: L: length, B: width

The preliminary design of the proposed bridge is shown in Figure 2.1.6 and structural features are summarized in Table 2.1.1.

2.4.8 Periphery Canals for the Storm Water Retention Area

Periphery canals are to be constructed along the boundary of the proposed retention area to protect against encroachment of the proposed retention area. The periphery canals are designed as earth channels with 2 m wide channel beds, a bank slope of

1:1.0, 1.0 m deep and 0.5 m high earth dikes on both banks. The typical section is shown in Figure 2.4.27. The lengths of the proposed periphery canals are summarized below.

Periphery Canal Length

Retention Area	Length (m)
Upper Nugegoda Ela Marsh	1,780
Lower Nugegoda Ela Marsh	2,110
Delkanda Ela Marsh	1,800
Bellanwila-Attidiya Marsh	4,400
Weras Ganga Swamp	4,400
Maha Ela Marsh and Lowlands	6,000

Tables

Table 2.1.1 Principal Features of Proposed Bridges and Culverts (1/2)

Basin	Channel	Code	Present Structures		Proposed Structure		Note
			Type	Dimension	Type	Dimension	
Ja Ela	Ja Ela	JE1	Concrete Girder Bridge	L = 30.4 m, B = 5 m, 4 span	PC girder Bridge	L = 50 m, B = 10 m, 2 span	
		JE2	Concrete Girder Bridge	L = 45.8 m, B = 15 m, 5 span	PC girder Bridge	L = 50 m, B = 20 m, 2 span	
		JE3	Railway Steel Bridge	L = 38.6 m, B = -- m, 1 span	PC girder Bridge	L = 50 m, B = 10 m, 2 span	
	Dandugam Oya	DO1	Concrete Girder Bridge	L = 75.2 m, B = 15 m, 4 span	PC girder Bridge	L = 70 m, B = 20 m, 3 span	
		DO2	Railway Steel Bridge	L = 77.8 m, B = -- m, 2 span	PC girder Bridge	L = 70 m, B = 20 m, 3 span	
		DO3	Concrete Girder Bridge	L = 76.6 m, B = 6 m, 4 span	PC girder Bridge	L = 55 m, B = 10 m, 2 span	
		DO4	Concrete Girder Bridge	L = 30.6 m, B = 6 m, 2 span	PC girder Bridge	L = 55 m, B = 10 m, 2 span	
Kalu Oya	Kalu Oya	KE1	Concrete Girder Bridge	L = 16.7 m, B = 6 m, 3 span	PC girder Bridge	L = 36 m, B = 10 m, 2 span	located at Wattala Gate
		KE2	Concrete Culvert	L = 20.7 m, B = -- m, 2 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		KE3	Concrete Girder Bridge	L = 15.6 m, B = 6 m, 4 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		KE4	Concrete Girder Bridge	L = 31 m, B = 15 m, 2 span	PC girder Bridge	L = 40 m, B = 20 m, 2 span	
		KE5	Concrete Girder Bridge	L = 6 m, B = 4 m, 1 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
	Old Negombo Canal	KE6	Concrete Culvert	L = 14 m, B = 4 m	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		KE7	Concrete Girder Bridge	L = 14 m, B = 6 m, 1 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		KE8	Concrete Girder Bridge	L = 14 m, B = 6 m, 1 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
Greater Colombo	Madiwela South Diversion Channel	MSD1	Concrete Culvert	B x H = 1.4 m x 2.3 m x 2 cell	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		MSD2	Concrete Culvert	L = 5 m, B = 7 m, 1 span	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		MSD3	Concrete Culvert	B x H = 1.8 m x 1.6 m x 2 cell	PC girder Bridge	L = 40 m, B = 10m, 2 span	
		MSD4	Concrete Culvert	B x H = 4.6 m x 1.9 m	PC girder Bridge	L = 50 m, B = 10 m, 2 span	
		MSD5	Concrete Culvert	B x H = 3.2 m x 2.2 m	PC girder Bridge	L = 50 m, B = 10 m, 2 span	
		MSD6	High Level Road	--	PC girder Bridge	L = 78 m, B = 20 m, 4 span	
		MSD7	Local road	--	PC girder Bridge	L = 78 m, B = 10 m, 4 span	
		MSD8	Railway	--	PC girder Bridge	L = 78 m, B = 15 m, 4 span	
		MSD9	Concrete Culvert	B x h = 2.4 m x 2.4 m	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		MSD10	Concrete Culvert	B x h = 2 m x 1.5 m	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		MSD11	Concrete Culvert	B x h = 2.25 m x 0.6 m	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
		MSD12	Concrete Culvert	B x H = 1.8 m x 1.1 m	PC girder Bridge	L = 40 m, B = 10 m, 2 span	
Weras Ganga Basin	Bolgoda Canal	BC1	Concrete Culvert	B x H = 1.7 m x 2.9 m x 6 cell	PC girder Bridge	L = 30 m, B = 4.3 m, 2 span	
	Rattanapitiya Ela	RE1	Concrete Girder Bridge	L = 10 m, B = 6 m, 1 span	PC girder Bridge	L = 29 m, B = 7.4 m, 2 span	
		RE2	Concrete Girder Bridge	L = 6 m, B = 8 m, 1 span	PC girder Bridge	L = 19 m, B = 22 m, 1 span	

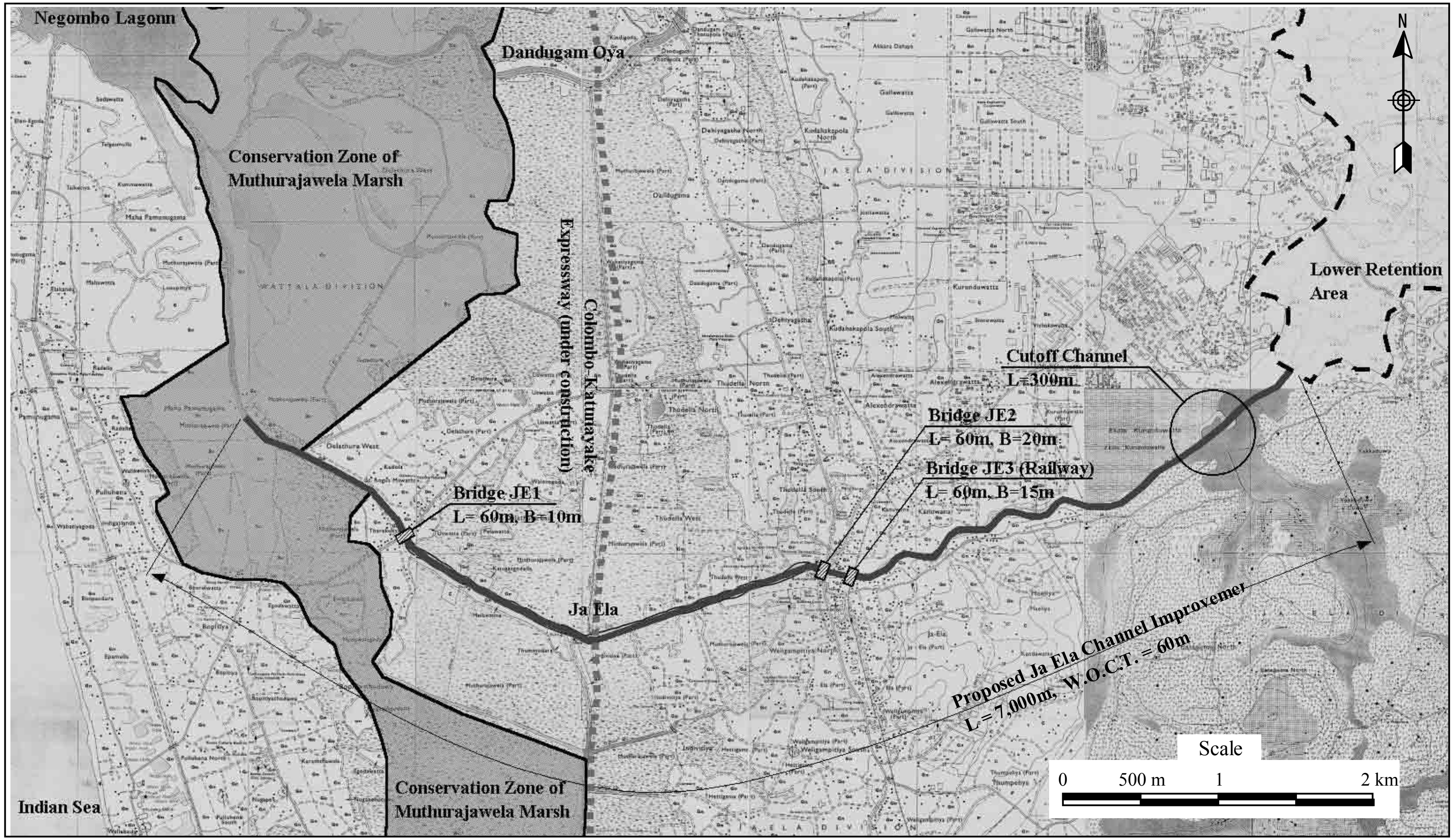
Note: L: Length, B: Width, H: Height

Table 2.1.1 Principal Features of Proposed Bridges and Culverts (2/2)

Basin	Channel	Code	Present Structures		Proposed Structure		Note
			Type	Dimension	Type	Dimension	
Weras Ganga Basin		RE3	Concrete Girder Bridge	--	PC girder Bridge	L = 19 m, B = 4 m, 1 span	
		RE4	Concrete Culvert	--	PC girder Bridge	L = 19 m, B = 5 m, 1 span	
		RE5	Concrete Culvert	--	PC girder Bridge	L = 19 m, B = 5 m, 1 span	
	Delkanda Ela	D1	Concrete Girder Bridge	--	PC girder Bridge	L = 13.5 m, B = 7 m, 1 span	
		D2	Concrete Girder Bridge	L = 6 m, B = 5 m, 1 span	PC girder Bridge	L = 13.5 m, B = 4.2 m, 1 span	
		D3	Concrete Girder Bridge	L = 6 m, B = 2.5 m, 1 span	PC girder Bridge	L = 13.5 m, B = 3 m, 1 span	
		D4	Concrete Girder Bridge	L = 5.5 m, B = 13.2 m, 1 span	PC girder Bridge	L = 13.5 m, B = 19.8 m, 1 span	
		D5	Concrete Girder Bridge	L = 5.5 m, B = 6 m, 1 span	PC girder Bridge	L = 13.5 m, B = 6 m, 1 span	
		D6	Concrete Culvert	B x H = 2.5 m x 1.5 m	PC girder Bridge	L = 9 m, B = 4.6 m, 1 span	
		D7	Concrete Culvert	B x H = 2 m x 1.5 m	RC box Culvert	B x H = 5 m x 2.5 m	
	Nugegoda Ela	NE1	Concrete Culvert	B x H = 2 m x 1 m	PC girder Bridge	L = 18 m, B = 4.6 m, 1 span	
		NE2	Temporary Bridge	--	PC girder Bridge	L = 13 m, B = 2.3 m, 1 span	
		NE3	Concrete Culvert	Dia. 1,200 mm x 2 nos	PC girder Bridge	L = 13 m, B = 4.4 m, 1 span	
	Depawa Ela	DE1	Concrete Culvert	B x H = 3 m x 0.6 m	PC girder Bridge	L = 12.4 m, B = 6.6 m, 1 span	
		DE2	Concrete Culvert	B x H = 2 m x 1 m	PC girder Bridge	L = 12.4 m, B = 22 m, 1 span	
		DE3	Concrete Culvert	B x H = 1.5 m x 1 m	PC girder Bridge	L = 12.4 m, B = 4.3 m, 1 span	
		DE4	Concrete Culvert	B x H = 3 m x 1.5 m	PC girder Bridge	L = 12.4 m, B = 2.6 m, 1 span	
		DE5	Concrete Culvert	Dia. 600 mm x 1 & 900 mm x 1	RC box Culvert	B x H = 2.9 m x 1.8 m x 2 cell	
	Boralesgamuwa South	BS1	Concrete Culvert	B x H = 2 m x 1.5 m	PC girder Bridge	L = 22.2 m, B = 22 m, 1 span	
	Maha Ela	ME1	Concrete Culvert	B x H = 1.4 m x 2.3 m x 2 cell	PC girder Bridge	L = 38 m, B = 3.6 m, 2 span	
		ME2	Concrete Girder Bridge	L = 5 m, B = 7 m, 1 span	PC girder Bridge	L = 39 m, B = 22 m, 2 span	
	Maha Ela Tributary	MET1	Concrete Culvert	B x H = 2 m x 1 m	PC girder Bridge	L = 19.4 m, B = 4.3 m, 1 span	
		MET2	Concrete Culvert	B x H = 2 m x 1 m	PC girder Bridge	L = 19.4 m, B = 4.5 m, 1 span	
	Ratmalana-Motuwa	RM1	Concrete Culvert	Dia. 1,000mm x 1, B x H = 1m x 1.5m	PC girder Bridge	L = 13.2 m, B = 3.1 m, 1 span	
		RM2	Concrete Culvert	--	PC girder Bridge	L = 13.2 m, B = 10.6 m, 1 span	

Note: L: Length, B: Width, H: Height

Figures



Note: W.O.C.T. means width of channel top

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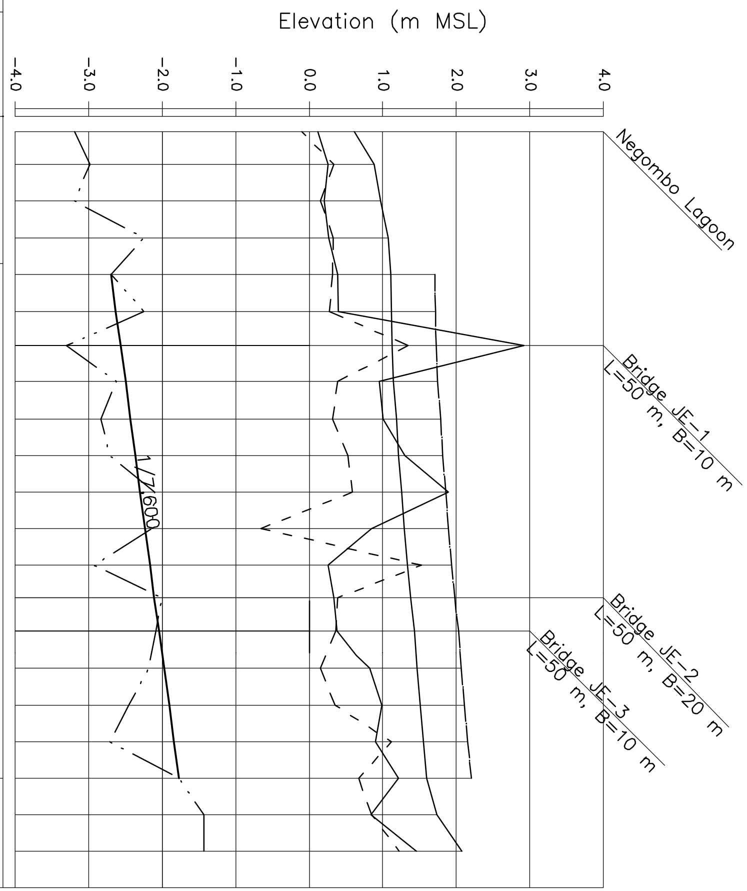
Figure 2.1.1
General Plan of Proposed Ja Ela Channel Improvement

Station	Partial Distance (m)	Accum. Distance (m)	Right Bank (EL m)	Left Bank (EL m)	Original Riverbed (EL m)	Design: Crest of Dike (EL m)	Design: Riverbed (EL m)	Design: HWL (50year) (EL m)	Remark
ST 0+000	0	0	0.121	−0.101	−3.189			0.611	
ST 0+442	442	442	0.253	0.336	−2.980			0.882	
ST 0+942	500	942	0.208	0.154	−3.192			0.966	
ST 1+442	500	1,442	0.265	0.328	−2.247			1.076	
ST 1+942	500	1,942	0.388	0.316	−2.694	1.706	−2.694	1.106	Channel Improvement: Q=75 m3/sec, L=7,000 m
ST 2+442	500	2,442	0.394	0.274	−2.246	1.714	−2.628	1.114	
ST 2+949	507	2,949	2.916	1.346	−3.306	1.723	−2.561	1.123	
ST 3+442	493	3,442	0.951	0.384	−2.621	1.747	−2.496	1.147	
ST 3+942	500	3,942	1.007	0.319	−2.832	1.787	−2.431	1.187	
ST 4+442	500	4,442	1.296	0.528	−2.712	1.814	−2.365	1.214	
ST 4+947	505	4,947	1.895	0.588	−2.101	1.855	−2.298	1.255	
ST 5+442	495	5,442	0.846	−0.656	−2.139	1.893	−2.233	1.293	
ST 5+949	507	5,949	0.253	1.523	−2.927	1.934	−2.166	1.334	
ST 6+397	448	6,397	0.338	0.393	−1.994	1.983	−2.107	1.383	
ST 6+917	520	6,917	0.374	0.367	−2.082	2.035	−2.039	1.435	
ST 7+433	516	7,433	0.821	0.154	−2.181	2.073	−1.971	1.473	
ST 7+942	509	7,942	0.987	0.362	−2.453	2.119	−1.904	1.519	
ST 8+442	500	8,442	0.898	1.123	−2.708	2.159	−1.838	1.559	
ST 8+942	500	8,942	1.211	0.673	−1.772	2.203	−1.772	1.603	
ST 9+442	500	9,442	0.839	0.844	−1.432			1.741	
ST 9+942	500	9,942	1.460	1.225	−1.428			2.077	



The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka

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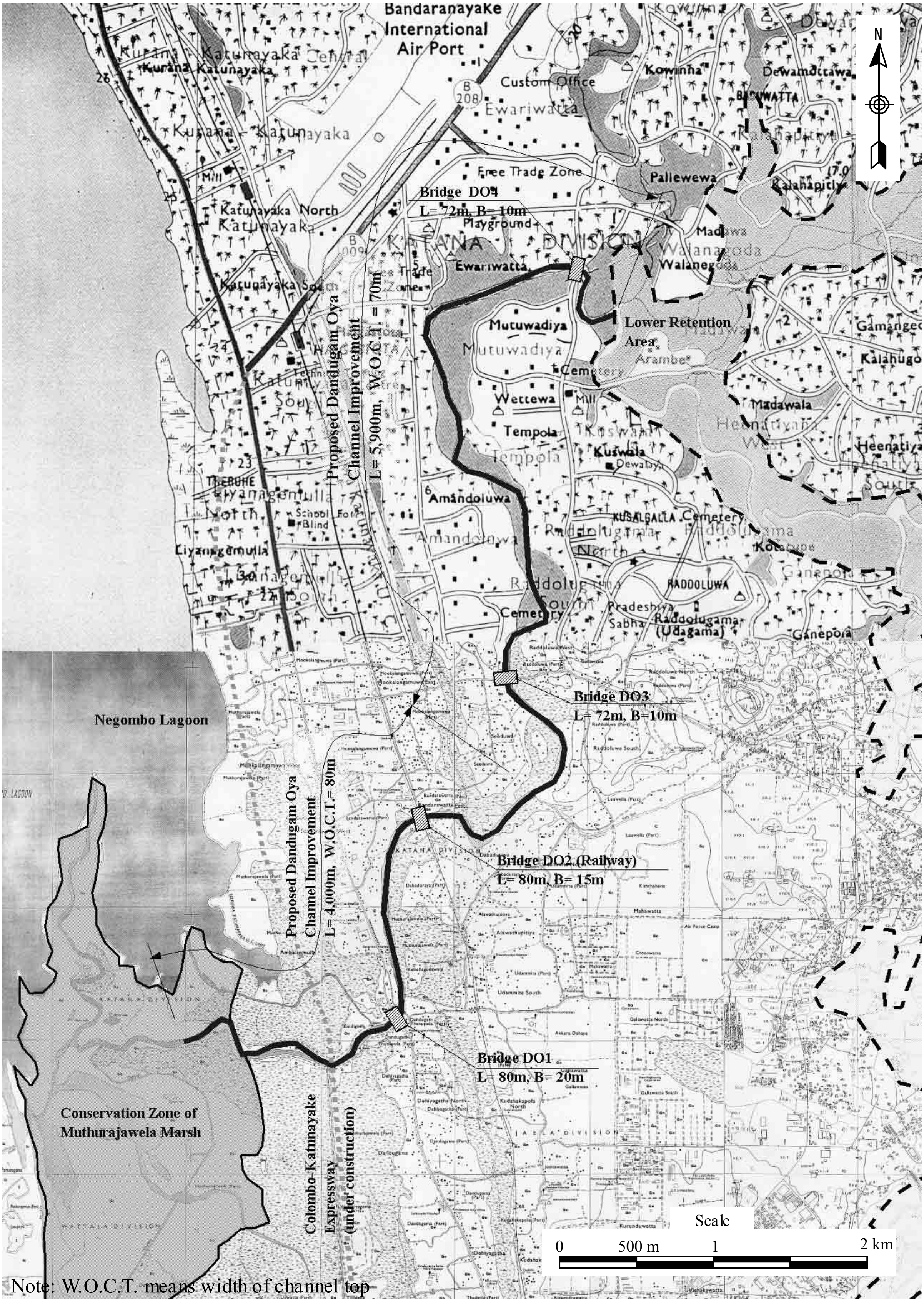
Figure 2.1.2
Longitudinal Profile of Proposed Ja Ela Channel Improvement



The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka	Figure 2.1.3 General Plan of Proposed Dandugam Oya Channel Improvement
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Figure 2.1.4
Longitudinal Profile of Proposed Dandugam Oya Channel Improvement

Station	Partial Distance (m)	Accum. Distance (m)	Right Bank (EL m)	Left Bank (EL m)	Original Riverbed (EL m)	Design: Crest of Dike (EL m)	Design: Riverbed (EL m)	Design: HWL (50year) (EL m)	Remark
ST 0+000	0	0	0.321	0.277	−3.820			0.549	
ST 0+500	500	500	0.427	0.377	−4.452			0.730	
ST 1+000	500	1,000	0.317	0.302	−4.478			0.916	
ST 1+500	500	1,500	0.500	0.472	−3.256			1.056	
ST 2+000	500	2,000	0.527	0.477	−4.270			1.188	
ST 2+450	450	2,450	0.300	0.347	−4.300			1.277	
ST 3+000	550	3,000	0.306	−0.014	−4.375			1.329	
ST 3+500	500	3,500	0.232	−0.038	−3.928	2.178	−4.926	1.378	Channel Improvement: Q=195 m3/sec, L=4,000 m
ST 4+025	525	4,025	0.631	−0.191	−4.639	2.200	−4.926	1.400	
ST 4+495	470	4,495	0.337	−0.151	−6.281	2.221	−4.926	1.421	
ST 4+025	465	4,960	0.939	0.559	−5.343	2.235	−4.926	1.435	
ST 5+510	550	5,510	1.081	0.853	−3.939	2.255	−4.926	1.455	
ST 6+000	490	6,000	1.026	0.886	−5.874	2.272	−4.926	1.472	
ST 6+480	480	6,480	0.372	−0.662	−5.571	2.284	−4.926	1.484	
ST 7+040	560	7,040	−1.006	0.565	−4.653	2.303	−4.926	1.503	
ST 7+500	460	7,500	−0.243	−0.147	−5.804	2.314	−4.926	1.514	Channel Improvement: Q=195 m3/sec, L=5,900 m
ST 8+000	500	8,000	0.967	1.007	−5.258	2.333	−4.926	1.533	
ST 8+500	500	8,500	0.551	0.301	−5.014	2.354	−4.926	1.554	
ST 9+000	500	9,000	0.903	0.333	−4.768	2.374	−4.926	1.574	
ST 9+477	477	9,477	1.376	0.792	−6.755	2.400	−4.926	1.600	
ST 10+000	523	10,000	0.639	0.619	−6.211	2.416	−4.926	1.616	
ST 10+540	540	10,540	0.937	0.257	−4.743	2.438	−4.926	1.638	
ST 11+000	460	11,000	0.415	0.625	−5.125	2.461	−4.926	1.661	
ST 11+500	500	11,500	0.265	0.385	−5.725	2.488	−4.926	1.688	
ST 12+000	500	12,000	−0.156	0.304	−6.056	2.509	−4.926	1.709	
ST 12+500	500	12,500	0.462	0.082	−3.445	2.532	−4.926	1.732	
ST 13+005	505	13,005	1.939	1.349	−4.931	2.551	−4.926	1.751	
ST 13+430	425	13,430	0.653	1.009	−4.569	2.571	−4.926	1.771	
ST 14+000	570	14,000	0.870	1.130	−3.950			1.760	

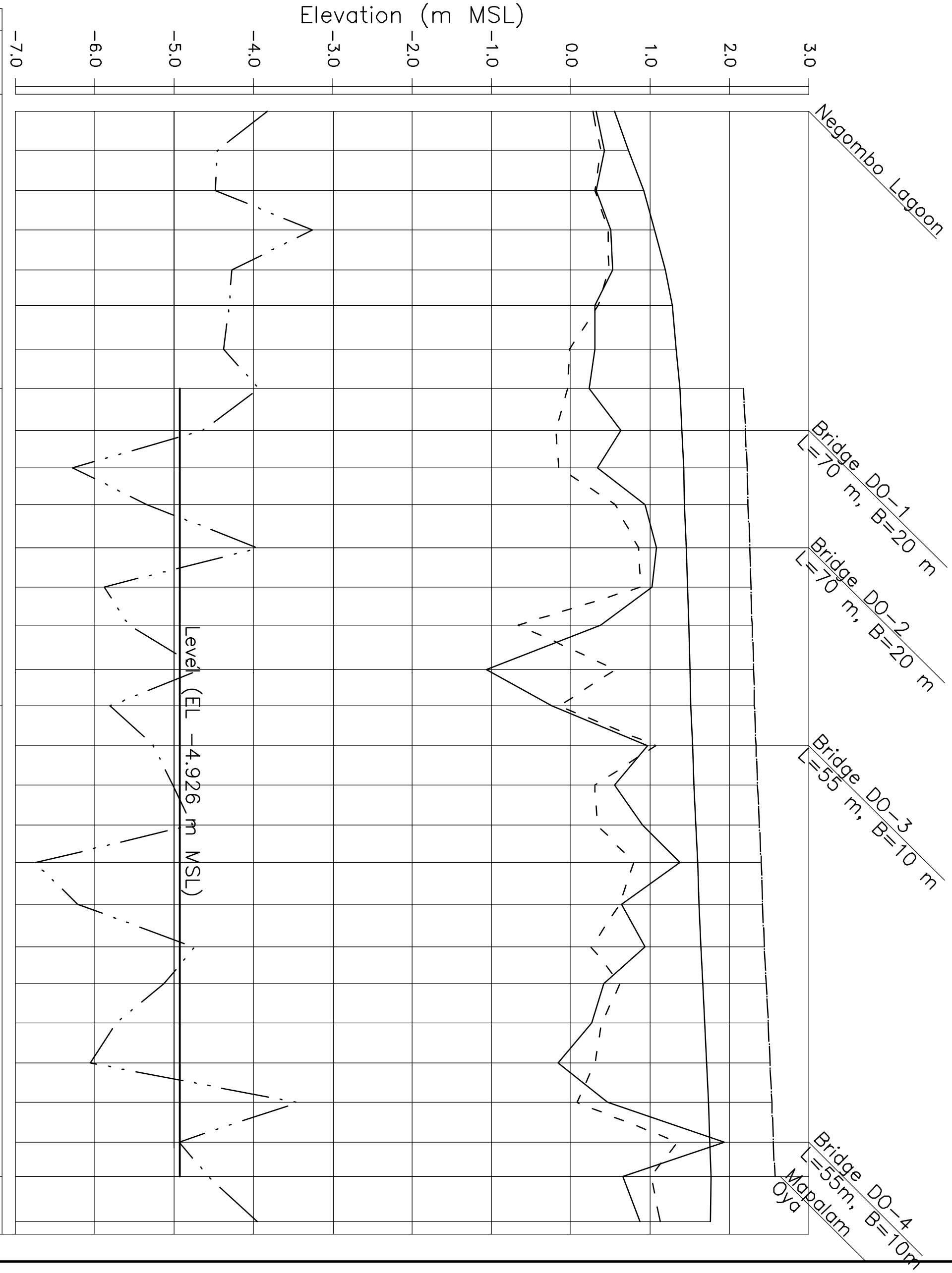

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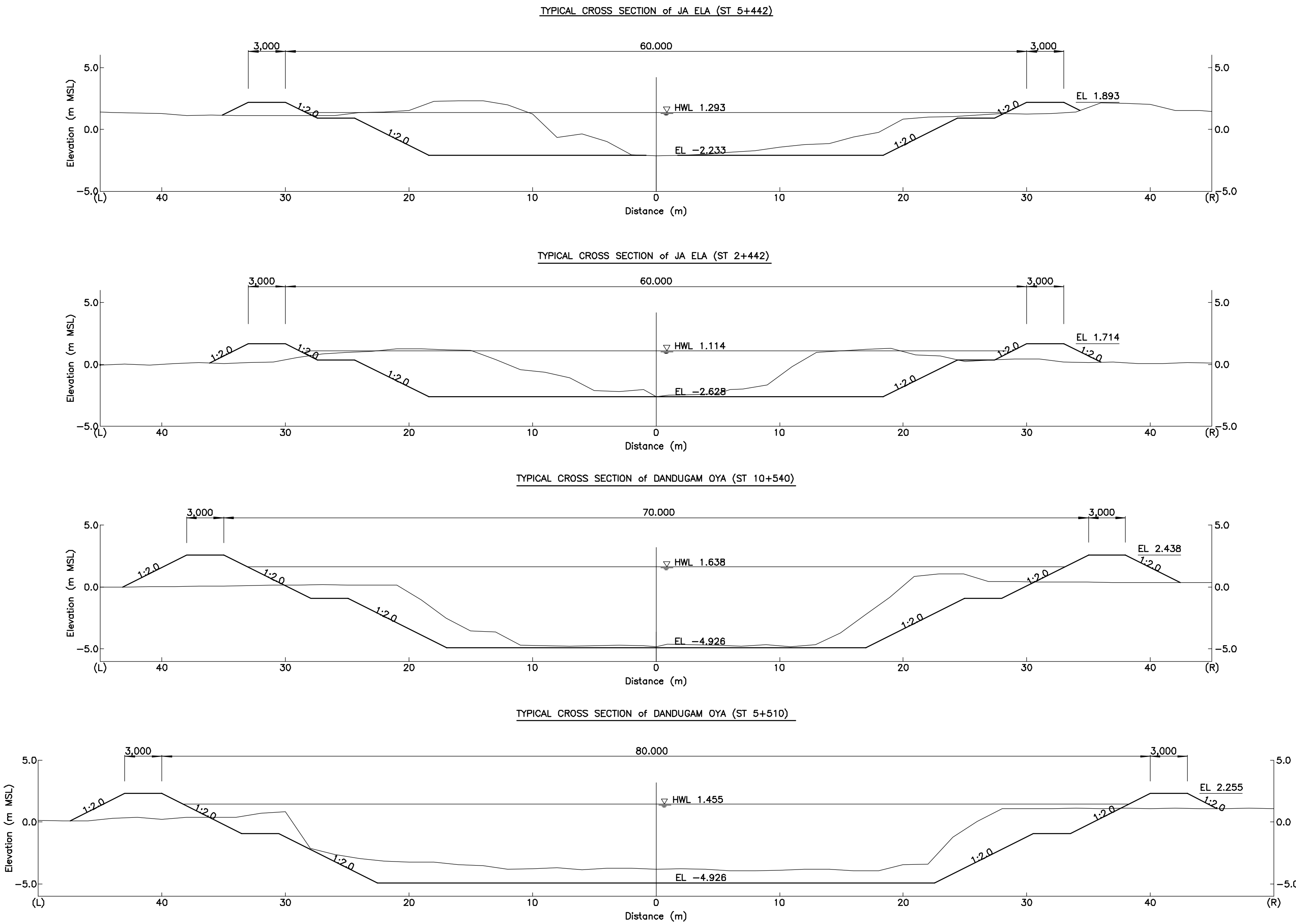
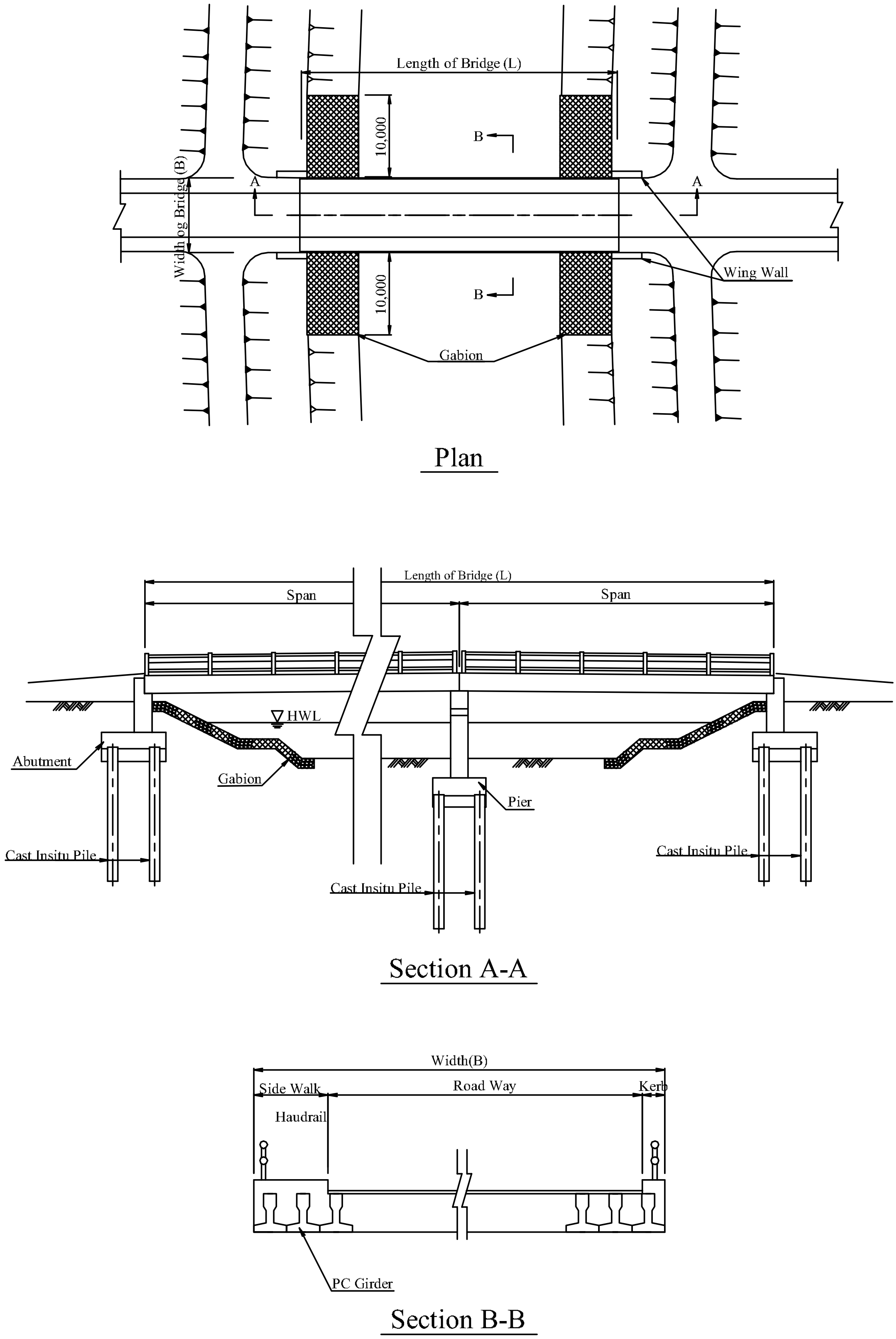
Figure 2.1.5
Typical Cross Section of Proposed Ja Ela and Dandugam Oya Channel Improvement





The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka	Figure 2.1.6 Typical Design of Proposed Bridge
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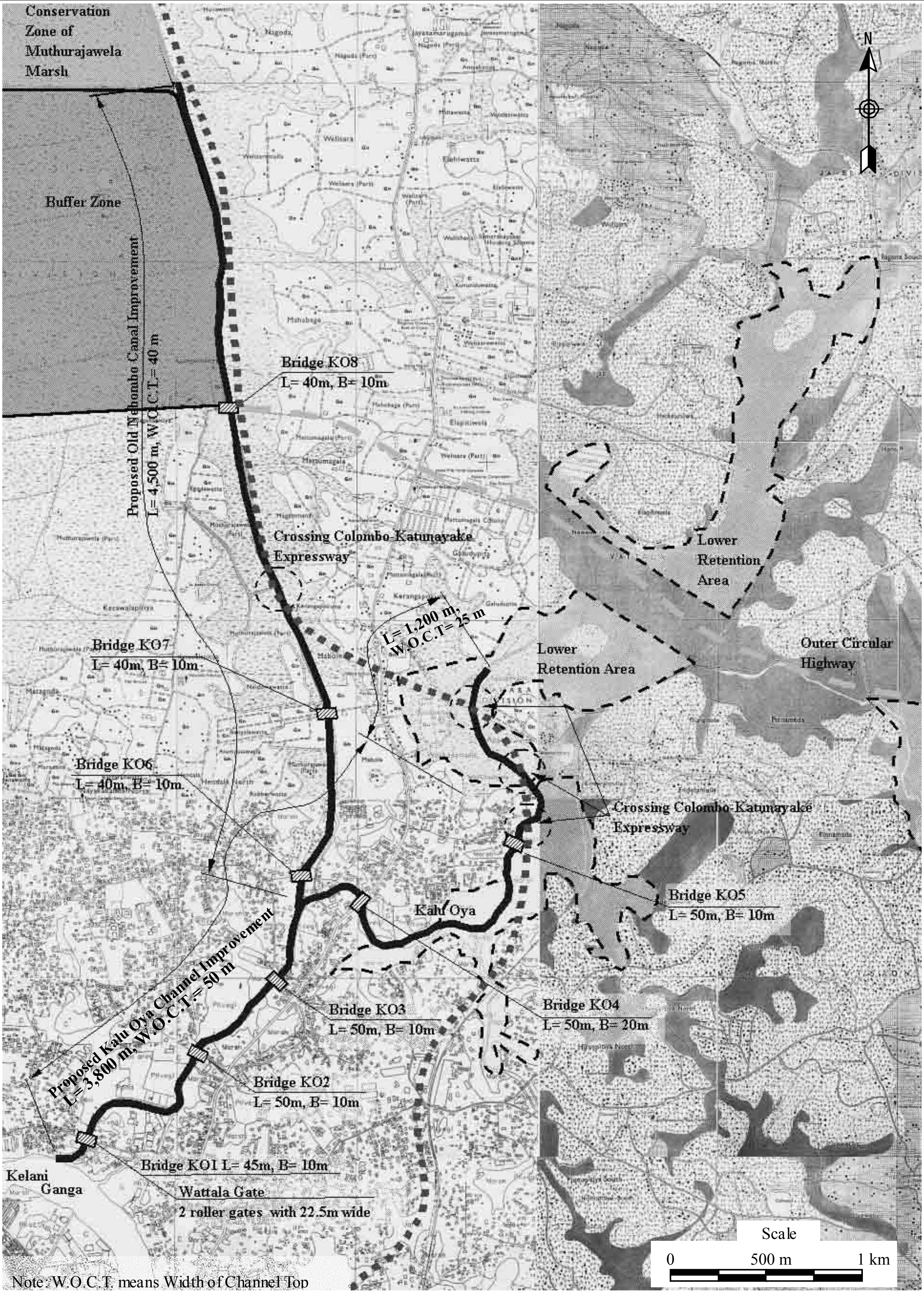

The Study on Storm Water Drainage Plan for the Colombo Metropolitan Region in the Democratic Socialist Republic of Sri Lanka	Figure 2.2.1 General Plan of Proposed Kalu Oya and Old Negombo Canal Improvement
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