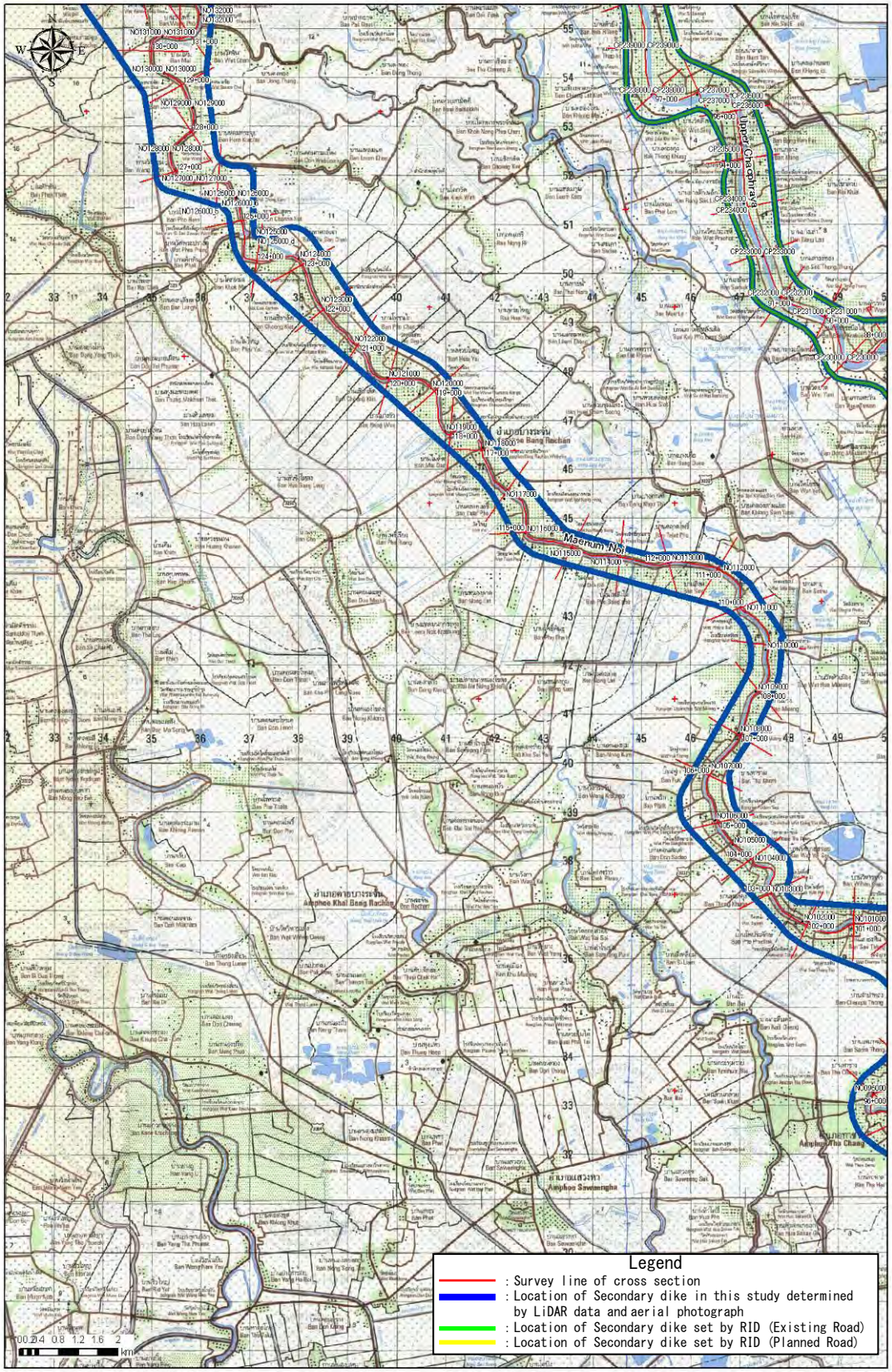


Figure D1.1.89 Location of Cross-section & Secondary dike (87)

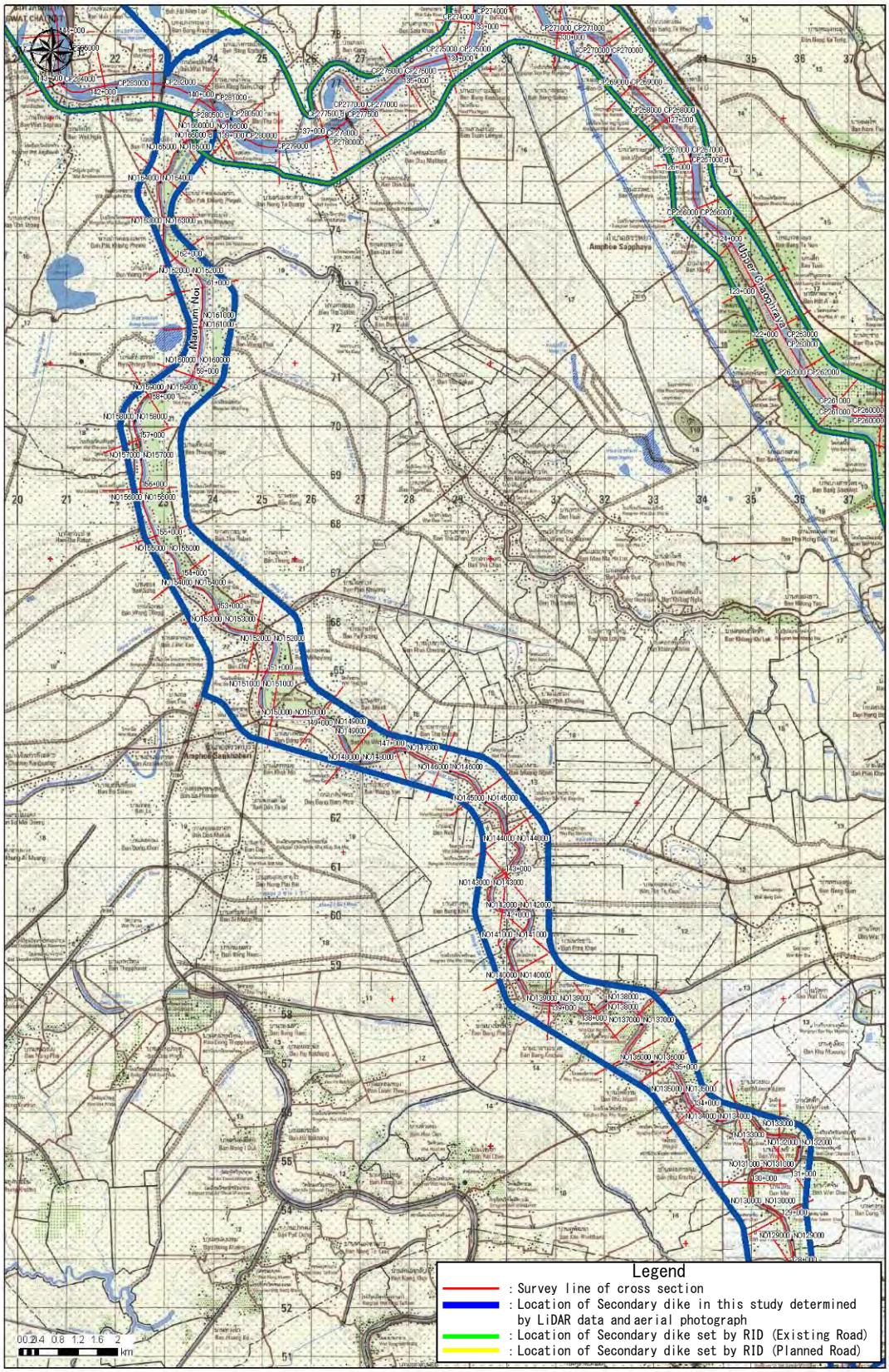


Figure D1.1.90 Location of Cross-section & Secondary dike (88)

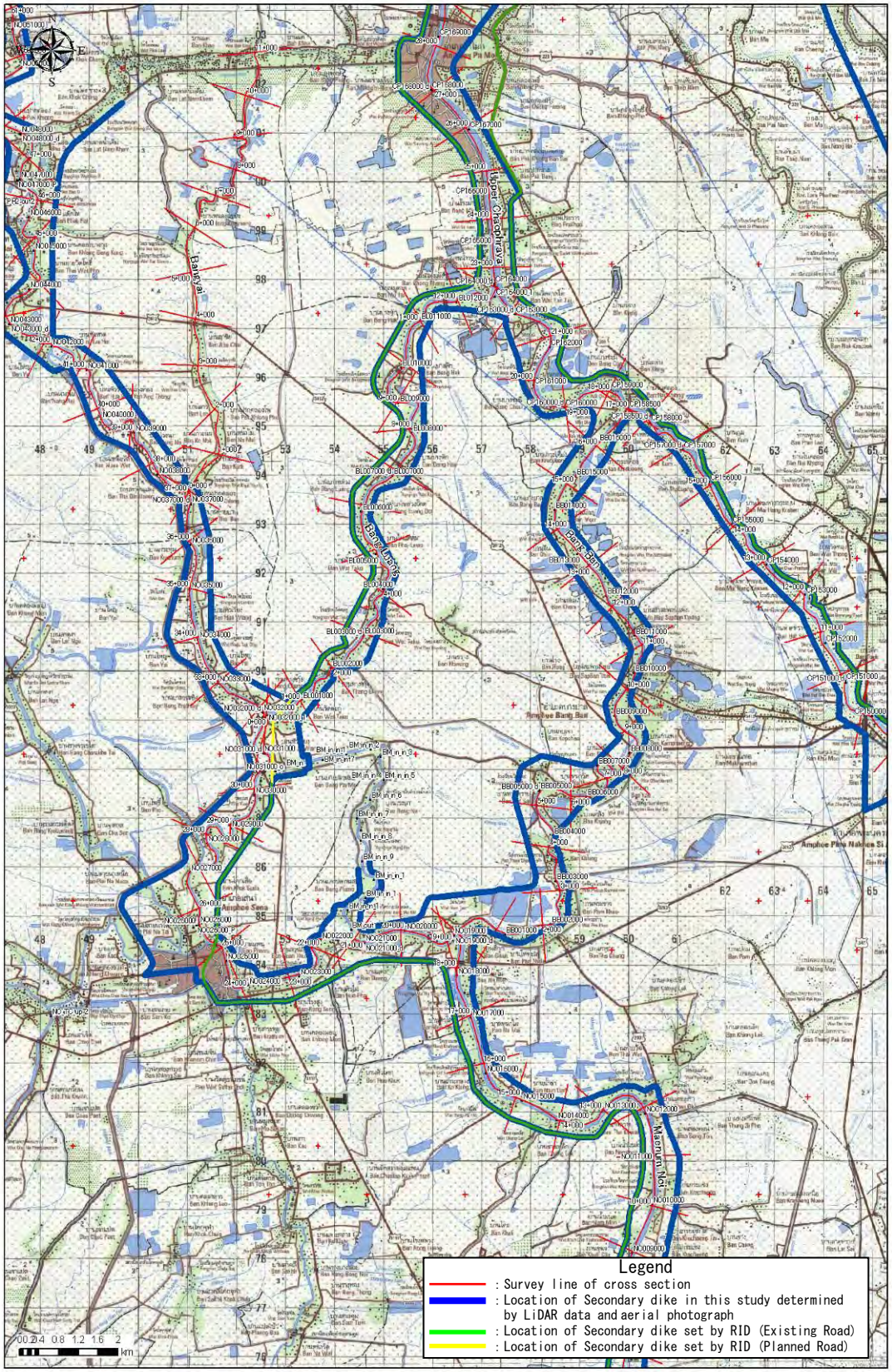


Figure D1.1.91 Location of Cross-section & Secondary dike (89)

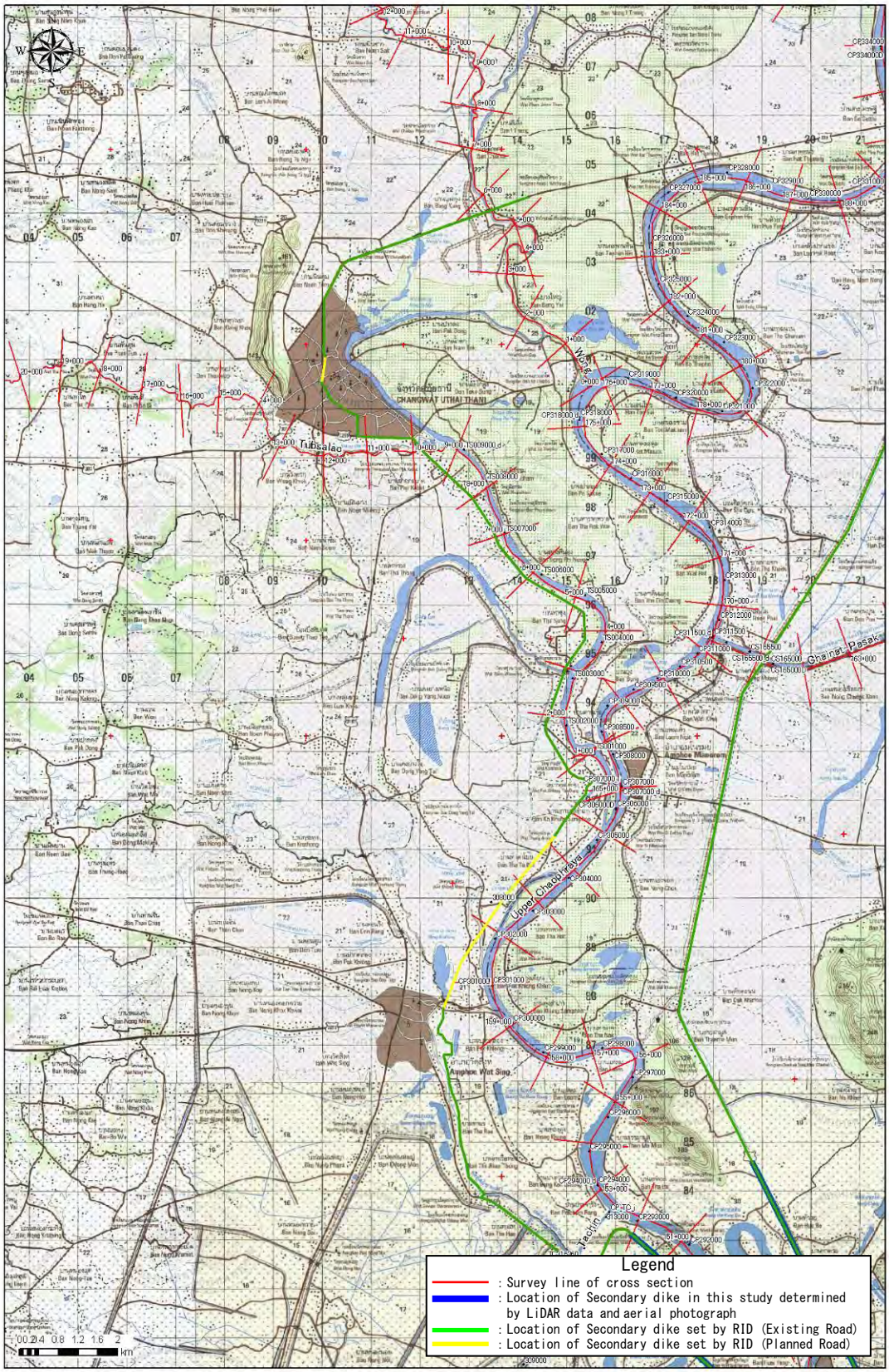


Figure D1.1.92 Location of Cross-section & Secondary dike (90)

Figure D1.1.93 Location of Cross-section & Secondary dike (91)

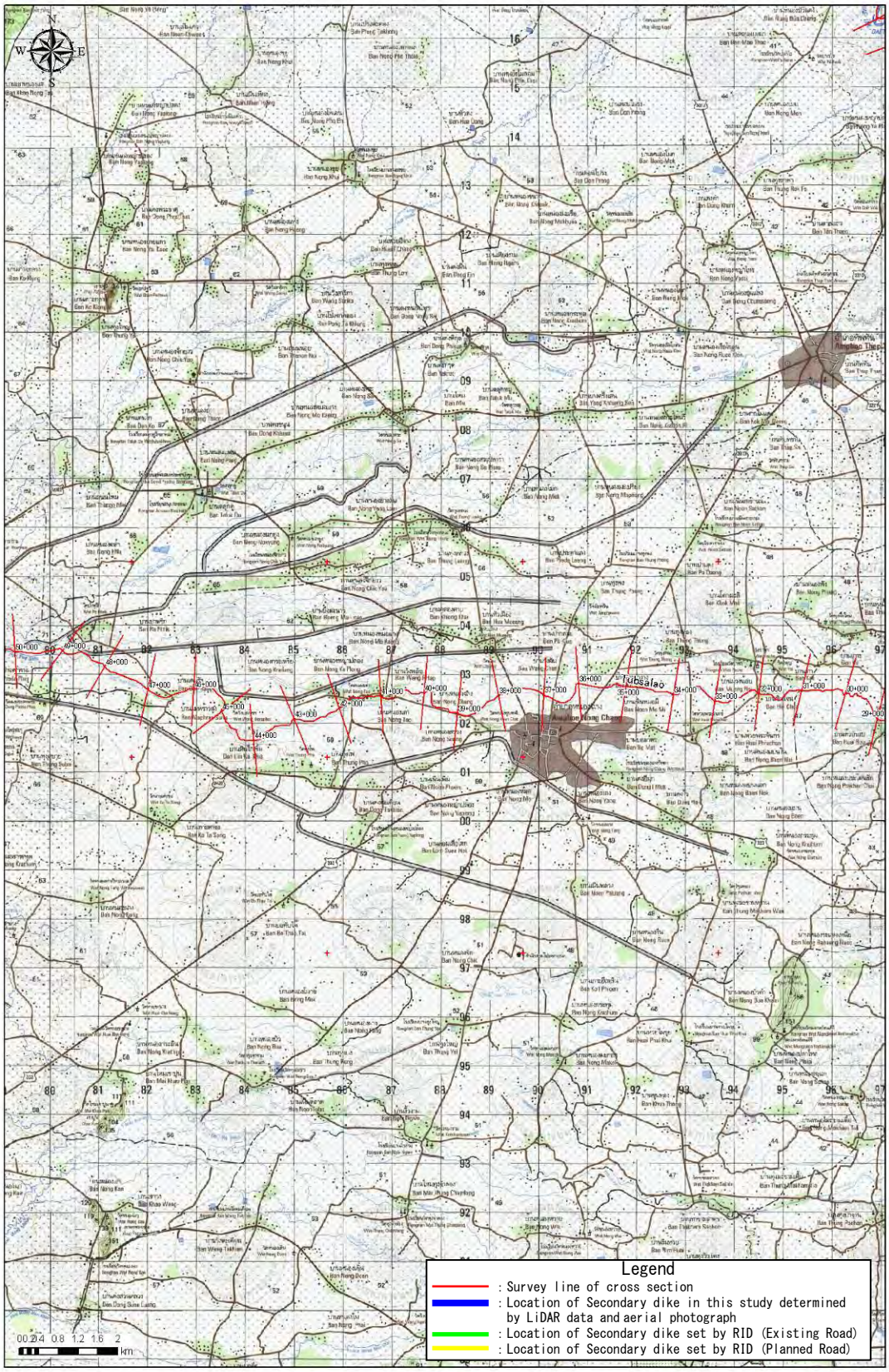


Figure D1.1.94 Location of Cross-section & Secondary dike (92)

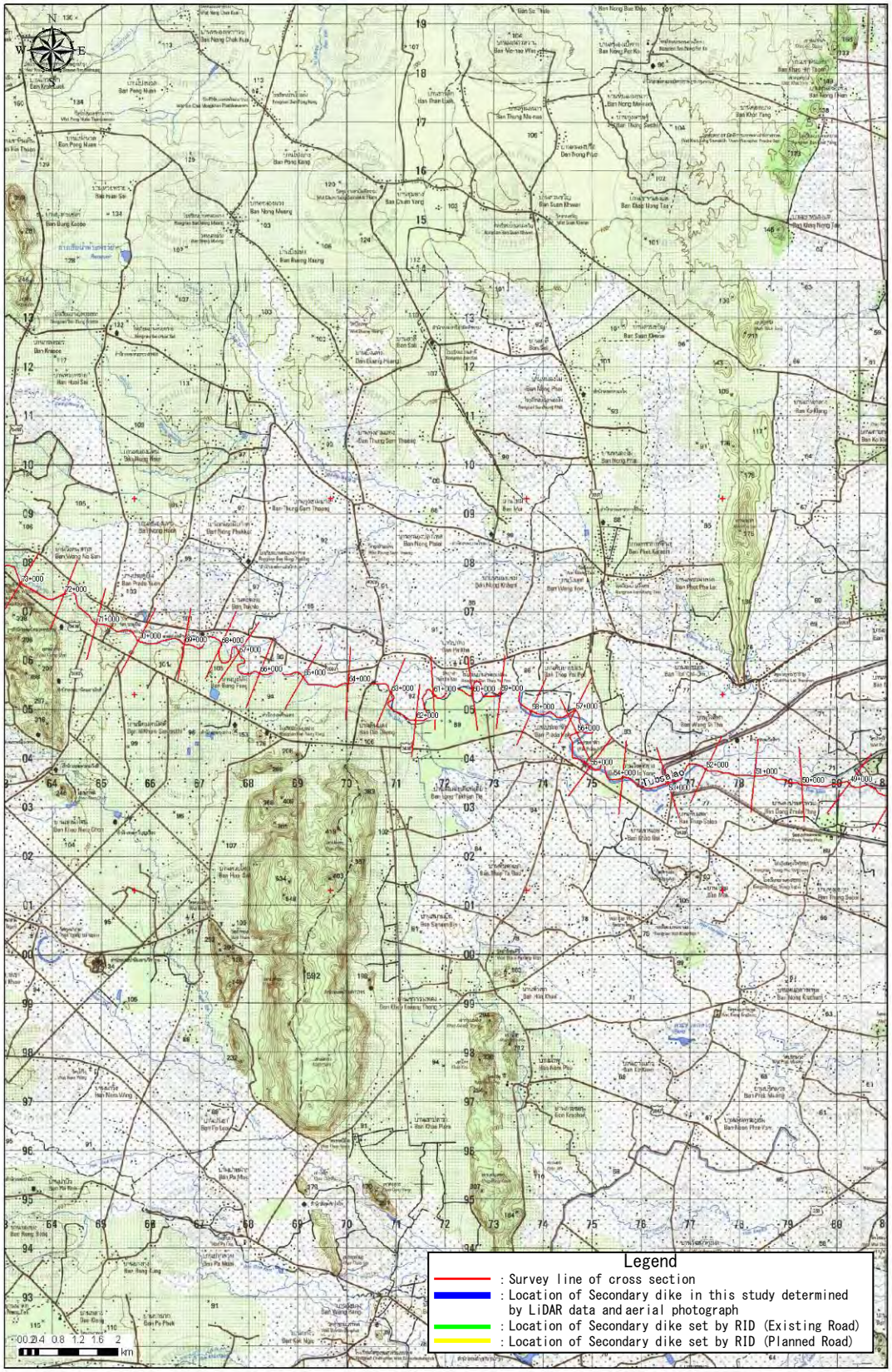


Figure D1.1.95 Location of Cross-section & Secondary dike (93)

Figure D1.1.96 Location of Cross-section & Secondary dike (94)

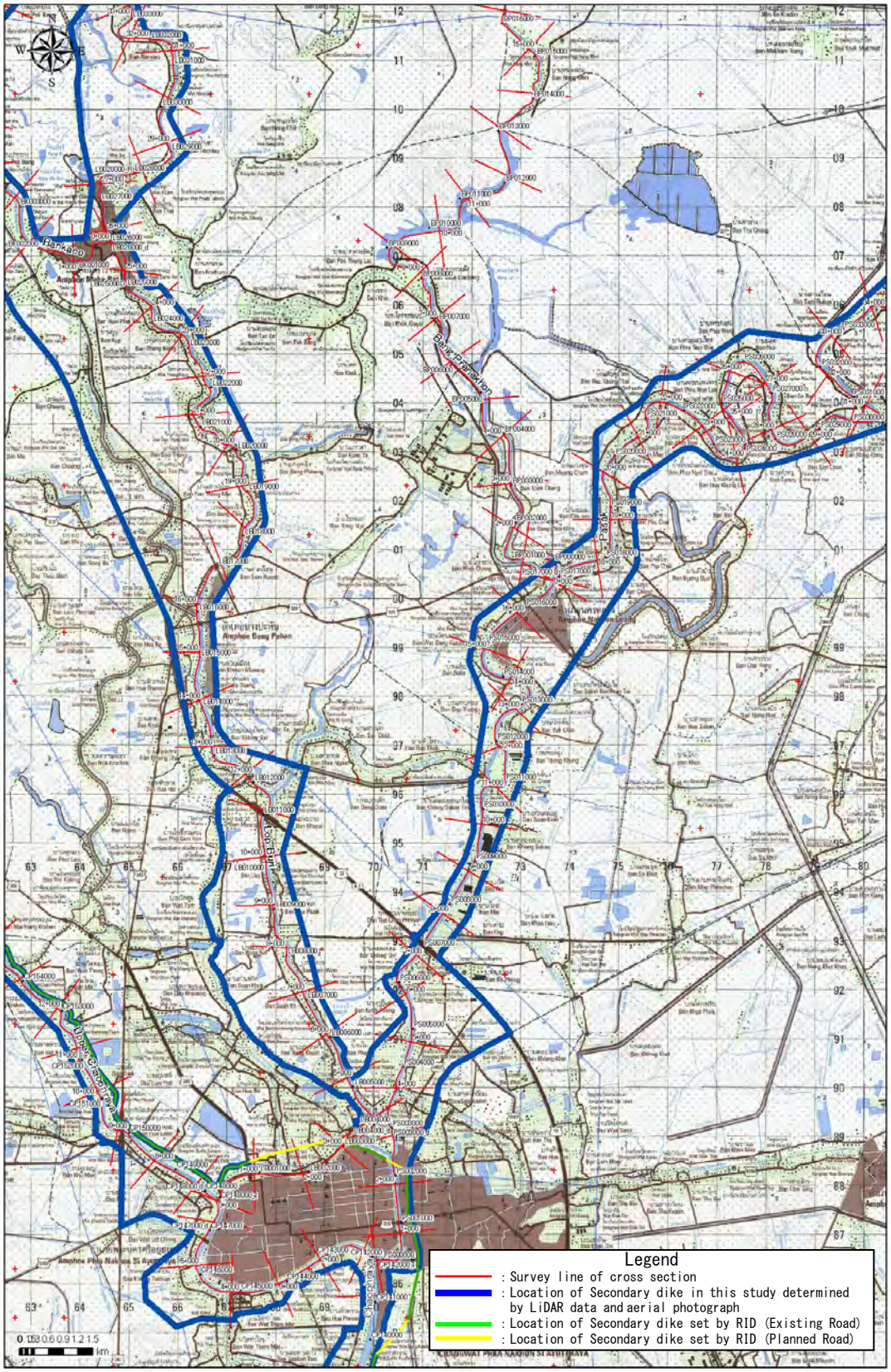


Figure D1.1.97 Location of Cross-section & Secondary dike (95)

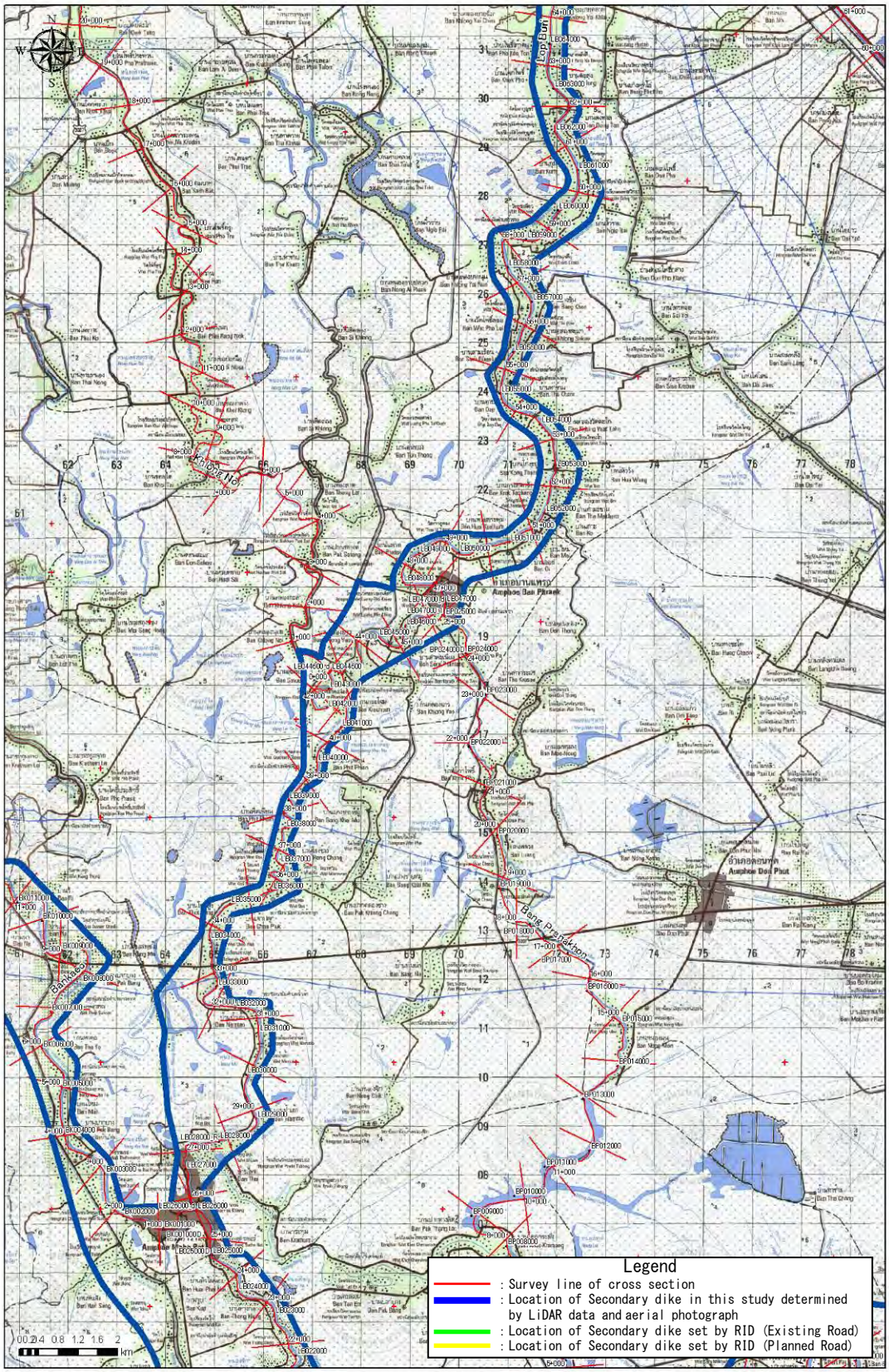


Figure D1.1.98 Location of Cross-section & Secondary dike (96)

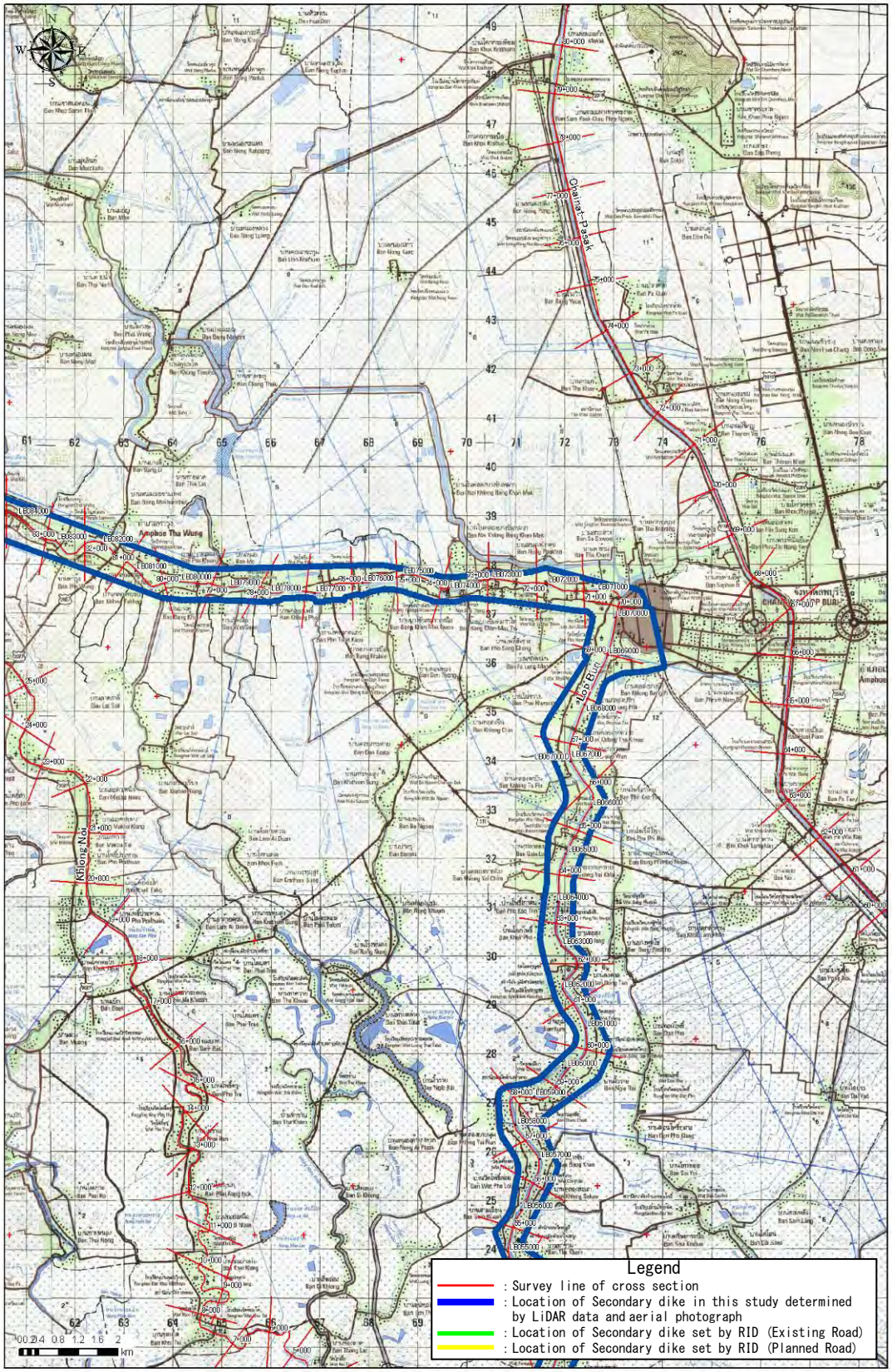


Figure D1.1.99 Location of Cross-section & Secondary dike (97)

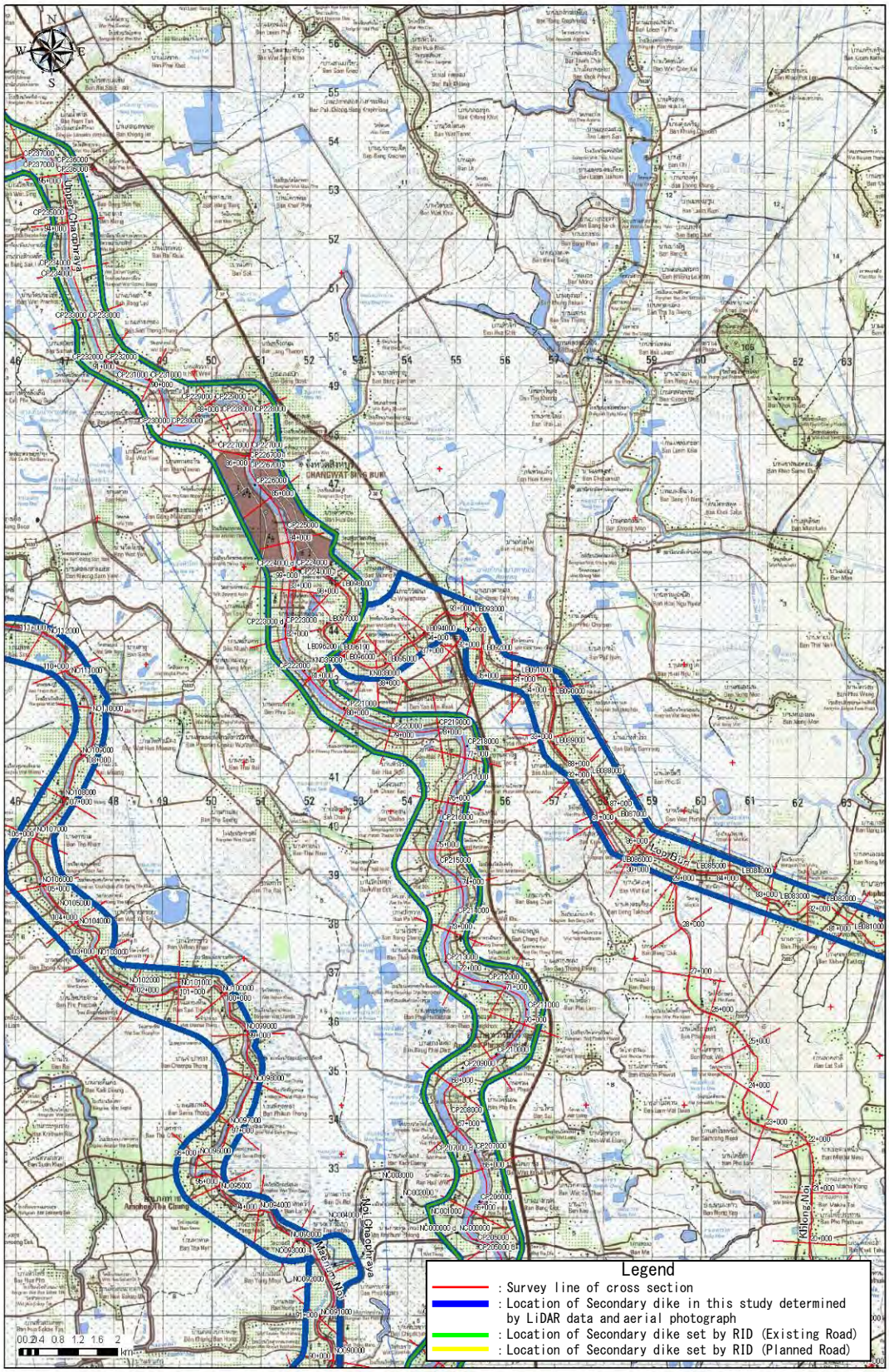


Figure D1.1.100　Location of Cross-section ＆ Secondary dike (98)

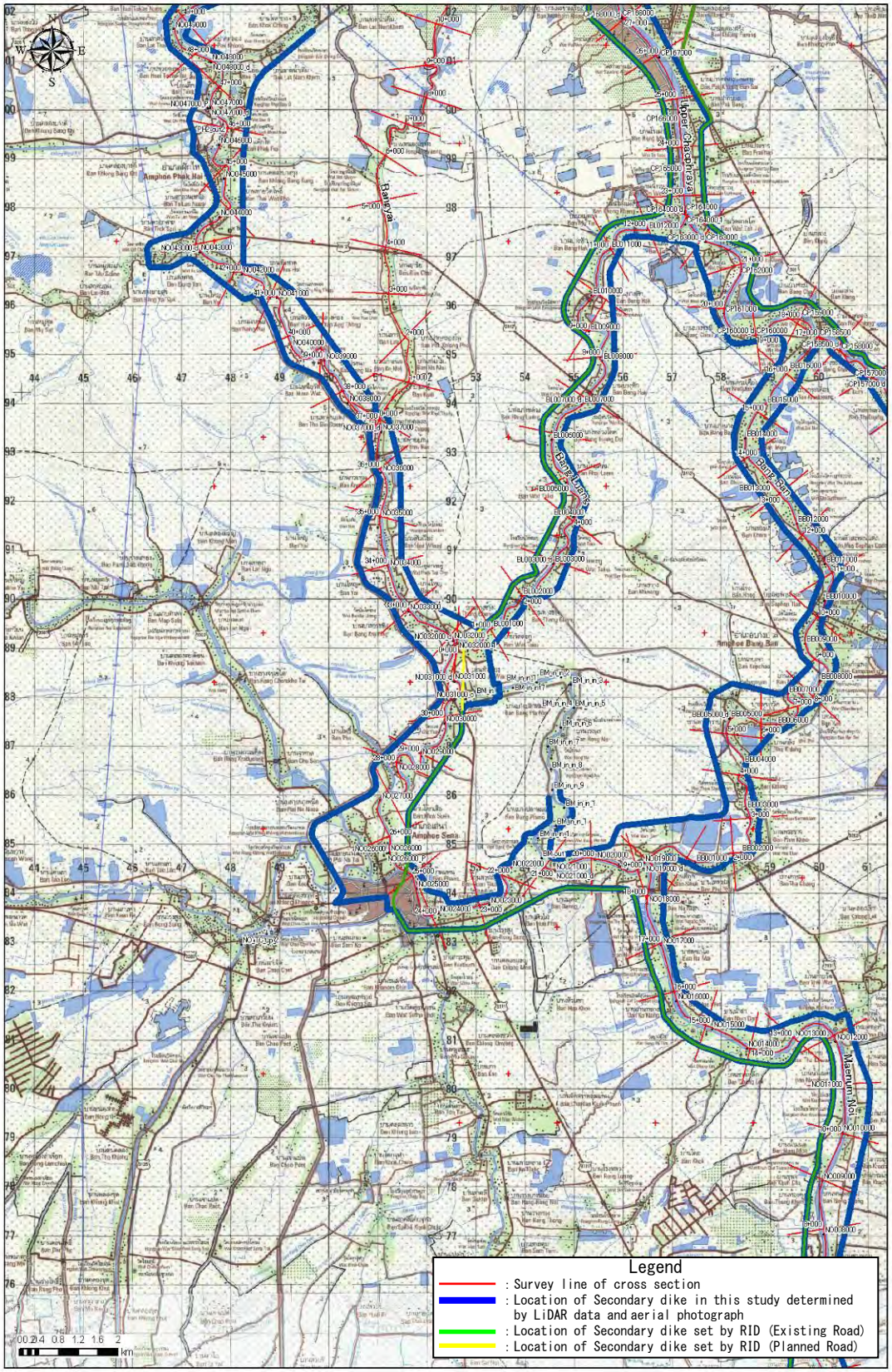


Figure D1.1.101 Location of Cross-section & Secondary dike (99)

CHAPTER D2 HYDROLOGICAL ANALYSIS

D2.1 Simulation Case

To find the best combination of countermeasures, hydrological analysis as shown in Table D 2.4.1 was conducted.

D2.2 Outline of Calculation Case

D2.2.1 Protection Dike around the Economic Zone

Bangkok and its vicinities in the east side of the Tha Chin River and the southern part of Pa Sak River in Ayutthaya are selected as the flood protection area. The Department of Highway (DOH) and the Department of Rural Road (DOR) have started the works to raise surrounding roads and road embankments. Since these works are thus considered as the existing conditions for the Study, it should be one of the criteria for selecting the optimum combination of projects to reduce the risk of dike-breach in the flood protection area.

See "MAIN REPORT / CHAPTER 9 / 9.2.2 Design High Water Level(DHWL)" for details.

D2.2.2 Dike Raising on Chao Phraya River and Pasak River based on the BMA and DOH

The height of secondary dike of Chao Phraya river and Pasak river will be revised in the future by BMA and DOH. In the study these conditions were treated as the existing conditions. Dyke height on simulation is shown in the following table.

Table D2.2.1 The Height of Secondary Dike on Simulation

Chao Phraya River			Pasak River		
Interval	Height		Interval	Height	
	Left side	Right side		Left side	Right side
0.0km to 37.4km	h=2.500m	h=2.500m	0.0km to 6.0km	h=7.110m	-
37.4km to 47.8km	h=2.800m	h=2.800m	6.0km to 9.0km	h=7.084m	-
47.8km to 58.9km	h=3.000m	h=3.000m	9.0km to 15.0km	h=6.594m	-
58.9km to 91.0km	h=3.800m	h=3.800m			
91.0km to 110.0km	h=4.358m	h=4.500m			
110.0km to 117.0km	h=4.684m	-			
117.0km to 120.0km	h=4.100m	-			
120.0km to 133.0km	h=4.000m	-			
133.0km to 141.0km	h=4.250m	-			

D2.2.3 Improving Efficiency of Existing Dam Operation

This case is modeled on implementing new operation rule at the existing dams in order to improve the effectiveness on the flood mitigation function by considering both flood mitigation and irrigation benefits.Intended dams are Bhumibol Dam ,Sirikit Dam,Kwe Noi Dam,and Pasak Dam.

See "MAIN REPORT / CHAPTER 10 / 10.2.2 Effective Operation of Extisting Dams" and "SUPPORTING REPORT / Sector G Study on Efficient Operation of Existing Dam Reservoirs" for details.

D2.2.4 Construction of New Dams

In this case, three dams are modeled on constructing appropriate and sustainable reservoirs (new dams) in major river basins. Intended dams are Keng Sua Ten Dam, Nam Kheg Dam, and Mae Wong Dam.

See "MAIN REPORT / CHAPTER 10 / 10.2.3 Constraction Of New Dams" and "SUPPORTING REPORT / Sector H Construction of New Dams" for details.

D2.2.5 Improvement of the Retention Areas (Monkey Cheeks)

According to "Feasibility Study on the Development of Flood Low Lands in Chao Phraya Basin(2009)", RID has proposed to establish total thirteen (13) retation basins (Monky Cheek) including five (5) location in the northen part of Nakhon Sawan and eight (8) locations in Ayutthaya and its vicinities. In this case, thirteen (13) retation basins (Monky Cheek) is modeled.

See "MAIN REPORT / CHAPTER 10 / 10.2.4 Retarding and Retention Areas" and "SUPPORTING REPORT / Sector I Retarding and Retention Area" for details.

D2.2.6 Dike Raising up to DHWL + freeboard of 0.5m

This case was setting as one of the examination of river improvement works. In this case, the height of dike is elevated up to "DHWL + freeborad of 0.5m".

D2.2.7 Construction of Floodway (East and West Diversion Channel)

In this case, two (2) Diversion Channel to divert water eastward/westward from the upstream of the Chao Phraya Dam to the Gulf of Thailand is modeled. (East Diversion Channel, West Diversion Channel)

See "MAIN REPORT / CHAPTER 10 / 10.2.5 Food Diversion Channel" and "SUPPORTING REPORT / Sector J Construction of Diversion Channel" for details.

D2.2.8 Dike Raising along Primary Dike up to DHWL + freeboard of 0.5m (All River/Channel)

This case was carried out to check a change of discharge according to measures. In this case, the height of dike of all river is elevated along primary dike up to "DHWL + freeborad of 0.5m".

D2.2.9 Ayutthaya Bypass

In this case, Ayutthaya Bypass is modeled. Ayutthaya Bypass is a bypass channel from the upstream of Ayutthaya to just upstream of the confluence of the Noi River and the Chao Phraya River in order to transfer the confluence of the Chao Phraya River and the Pa Sak River.

See "MAIN REPORT / CHAPTER 10 / 10.2.8 Ayutthaya Bypass Channel" and "SUPPORTING REPORT / Sector F Study on River Channel Improvement" for details.

D2.2.10 Construction of Central Floodway (Ring Road)

In this case, Ring Road Diversion Channel is modeled. This is a diversion channel along outer ring road to divert water from the downstream of Ayutthaya to the Gulf of Thailand. The diversion channel has a certain effect in reducing water levels of (i) the Chao Phraya River from Ayutthaya to Bangkok, and (ii) the downstream of Pa Sak River. Hence, it is so effective to reduce the risk of dike breaches along the areas to be protected.

See "MAIN REPORT / CHAPTER 10 / 10.2.5 Food Diversion Channel" and "SUPPORTING REPORT / Sector J Construction of Diversion Channel" for details.

D2.2.11 Improvement of Tha Chin River

This case is modeled to rehabilitation and improvement of Tha Chin river to increase flow capacity shown as below:

(1) Effectiveness of the Countermeasures of M/P for the 2011 flood

(2) Shortcut of Tha Chin River

(3) Widening of Tha Chin River

(4) Flood protection wall of Tha Chin River

See "MAIN REPORT / CHAPTER 10 / 10.2.7 River Improvemant Works of Tha Chin River" and "SUPPORTING REPORT / Sector F Study on River Channel Improvement" for details.

D2.3 Procedure of Calculation

In a simulation case which has a diversion channel, it is necessary to set the diverted discharge from main river to a diversion channel. A diverted discharge of main river is set by cutting the peak of the hydrograph of maximum flow capacity of each diversion channel, and deducting diverted discharge from main river discharge. Since the peak value and a wave pattern of the discharge of main river is different, it is impossible to set a hydrograph of diverted discharge to every calculation case beforehand. The pre-calculation of plural cases without the diversion channel is necessary.

(1) Setup Discharge of Diversion Channel

The method of setting discharge of diversion channel is as follows.

1. By conducting a pre-calculation, calculate dischargeA of main river before the setting diversion.
2. By deducting a maximum discharge capacity of the diversion channel from dischargeA dischargeB, which is the hydrograph of diversion channel, is obtained.
3. The remaining discharge after deducting dischargeB from dischargeA, this is the dischargeC of main river after diversion.

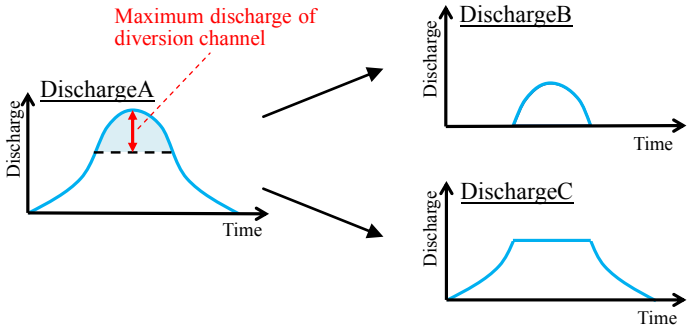


Figure D2.3.1 Setting Hydrograph of Discharge of Diversion Channel

(2) Pre-Calculation of the Plural Case

Location of East-West diversion channels and Ring Road is shown below. The amount of divereted discharge to East Diversion Channel affects the increase and decrease of diverted dicharge to West Diversion Channel and Ring Road. So, the pre-calculation of the plural case is necessary to set both East and West Diversion Channel and Ring Road. The tune of each calculation case is shown in following Figure D2.3.3.

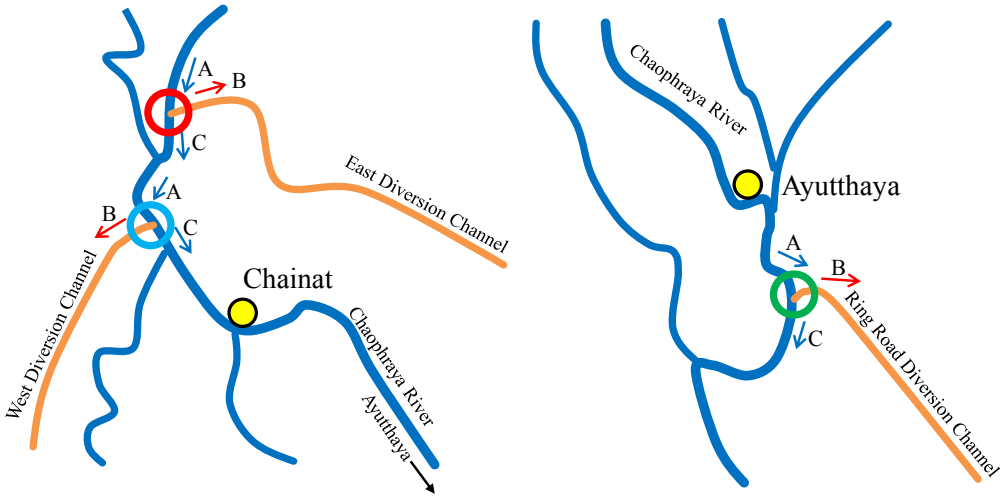


Figure D2.3.2 Location of Diversion Channel

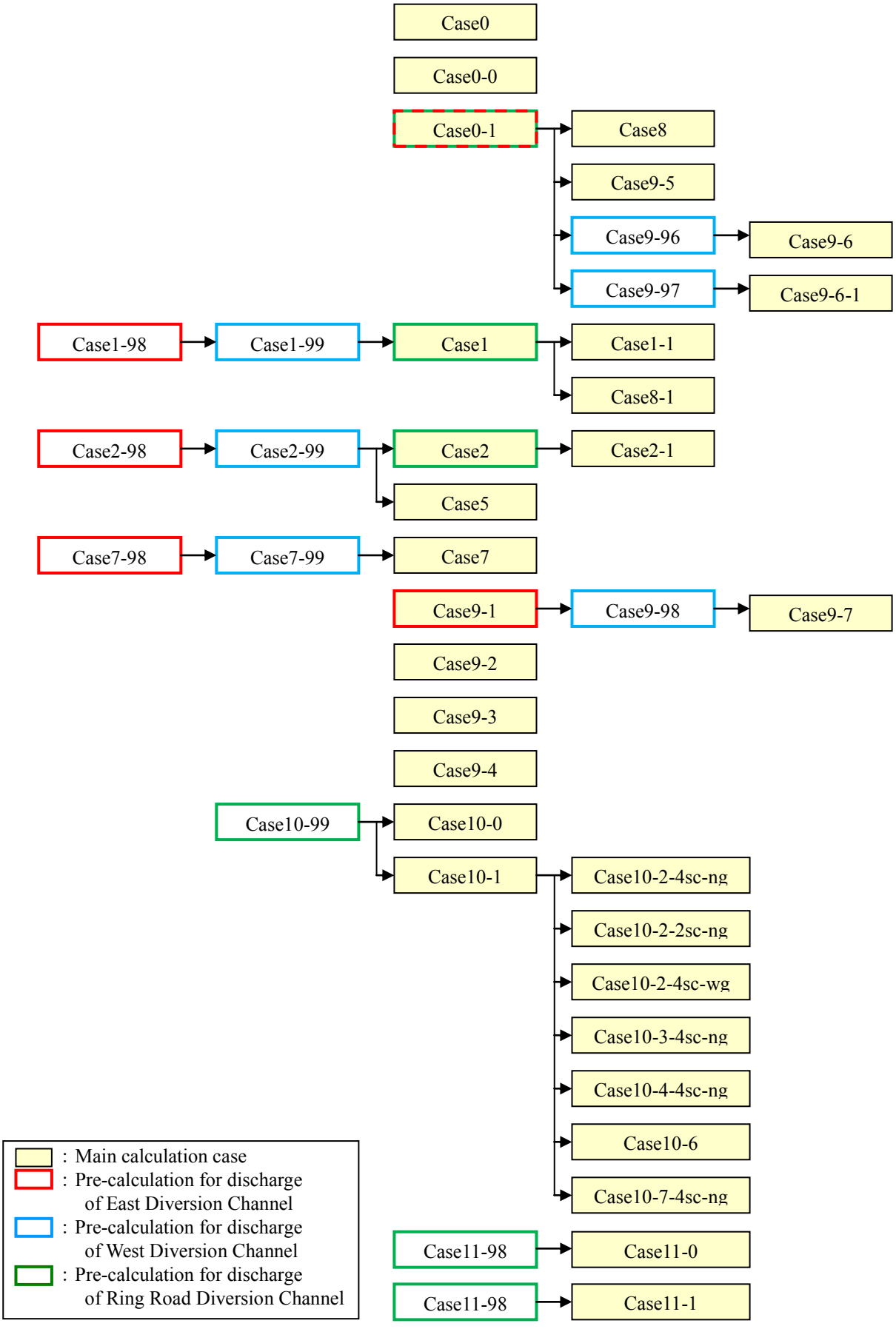


Figure D2.3.3 Procedure of Calculation

D2.4 Items of Result to be Displayed

Longtitudinal profile of caluclated discharge and water level, hydrograph at major hydrologcial stations, estimted inundation area/depth shall be shown below. In addtion, time-series data about inundated volume, depth, and area at each inudation blocks shall be presented.

Table D 2.4.1 List of Calculation Case

Study Case	Rainfall in the Downstream Area	Dyke Breaching	Protection dike around the economic zone	dike raising on Chao phraya river and pasak river based on the BMA and DOH	Improved existing dam operation	Construction of dams(new)	Improvement of the retention areas(monkey cheeks)	dike raising up to DHWH+freeboard of 0.5m	Construction of floodways(east and/or west)	dike raising along primary dike up to DHWL + freeboard of 0.5m(all river/canal)	Ayutthaya Bypass (1,400m^3/s)	Construction of central floodway (capacity 500m^3/s)	Short cut of Tachin River	Widening of Tachin River	Flood protection wall of Tachin River	Flood protection wall of Tachin River	Flood protection wall of Tachin River	Flood protection wall of Tachin River
								(all river/canal)	Upper Chao 171k			Lower Chao 128k	shortcut channel	90k～200k	0k～90k	0k～91k	0k～92k	0k～93k
case0	●	●																
case0-0																		
case0-1			●	●														
case1			●	●	●	●	●	●	● (1,500m^3/s)									
case1-1			●	●	●	●	●	●	● (1,500m^3/s)			● (500m^3/s)						
case2			●	●	●	●	●	●	● (1,500m^3/s)		●							
case2-1			●	●	●	●	●	●	● (1,500m^3/s)		●	● (500m^3/s)						
case5			●	●				●										
case7			●	●				●	● (1,500m^3/s)									
case8			●	●						●								
case8-1			●	●	●	●	●	●		●								
case9-1			●	●	●													
case9-2			●	●		●												
case9-3			●	●			●											
case9-4			●	●							●							
case9-5			●	●								● (500m^3/s)						
case9-6			●	●					● (1,500m^3/s)									
case9-6-1			●	●					● (3,000m^3/s)									
case9-7			●	●	●				● (1,500m^3/s)									
case10-0			●	●	●						●	● (500m^3/s)						
case10-1			●	●	●						●	● (1,000m^3/s)						
case10-2-4sc-ng			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /no gate) *1)					
case10-2-2sc-ng			●	●	●						●	● (1,000m^3/s)	● (2 shortcut /no gate) *2)					
case10-2-4sc-wg			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /with gate) *1)					
case10-3-4sc-ng			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /no gate) *1)	●				
case10-4-4sc-ng			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /no gate) *1)	●	● (Left Embankment)	● (Left Embankment)	● (Left Embankment)	● (Left Embankment)
case10-6			●	●	●						●	● (1,000m^3/s)			● (Right and Left embankment)	● (Right and Left embankment)	● (Right and Left embankment)	● (Right and Left embankment)
case10-7-4sc-ng			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /no gate) *1)		● (Right and Left embankment)	● (Right and Left embankment)	● (Right and Left embankment)	● (Right and Left embankment)
case11-0			●	●	●						●	● (500m^3/s)	● (4 shortcut /no gate) *1)		● (Left Embankment)	● (Left Embankment)	● (Left Embankment)	● (Left Embankment)
case11-1			●	●	●						●	● (1,000m^3/s)	● (4 shortcut /no gate) *1)		● (Left Embankment)	● (Left Embankment)	● (Left Embankment)	● (Left Embankment)

*1) 4 shortcut: No.1(75.9-87.1k), No.2(60.7-70.8k), No.3(29.3-4

*2) 2 shortcut: No.1(75.9-87.1k), No.2(60.7-70.8k)

D2.5 Simulation result

D2.5.1 Longitude Profile of Calculated Discharge and Water Level

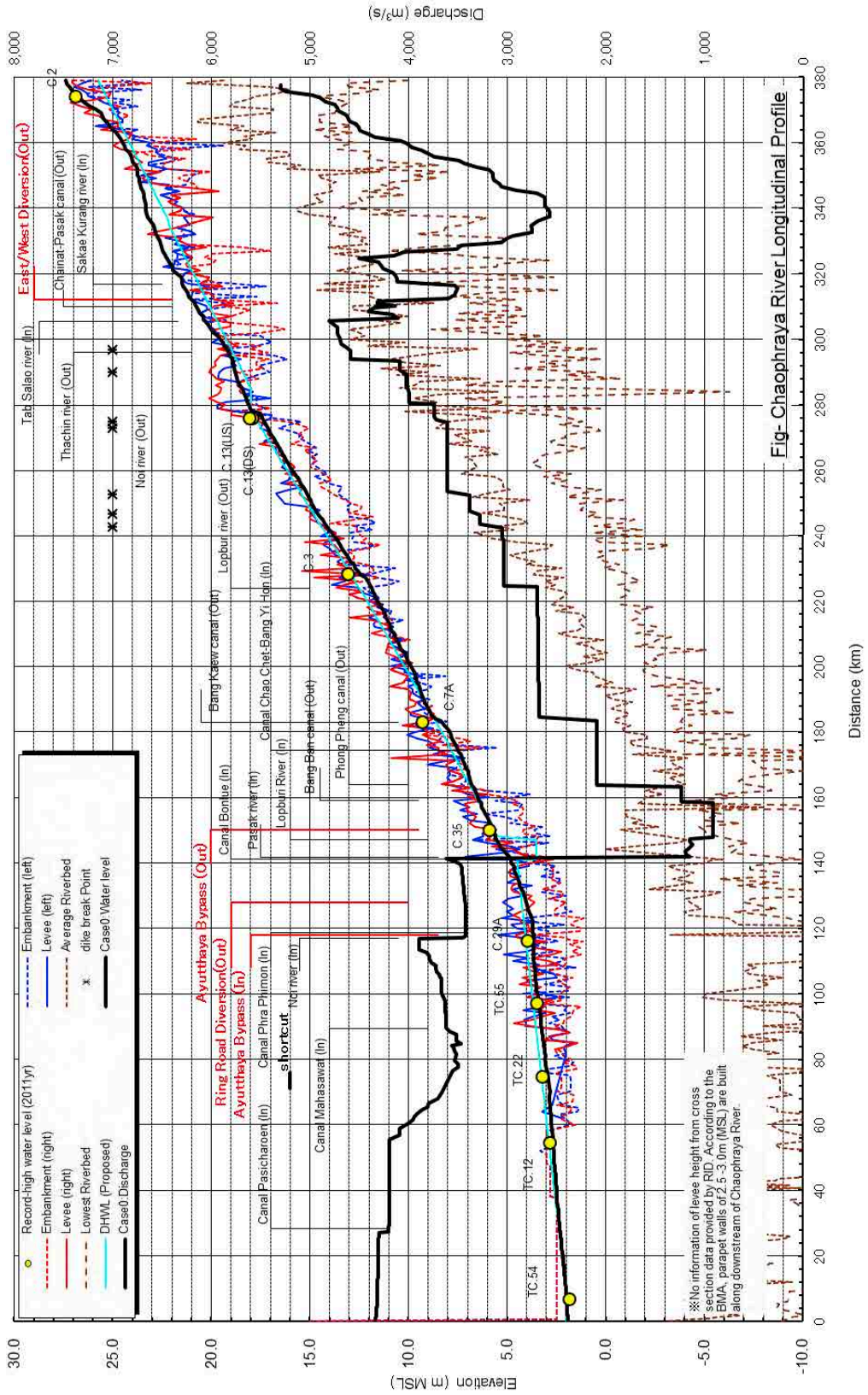


Figure D2.5.1 Longitudinal Section of Chao Phraya River (Case 0 : Reproducing the 2011 Flood)

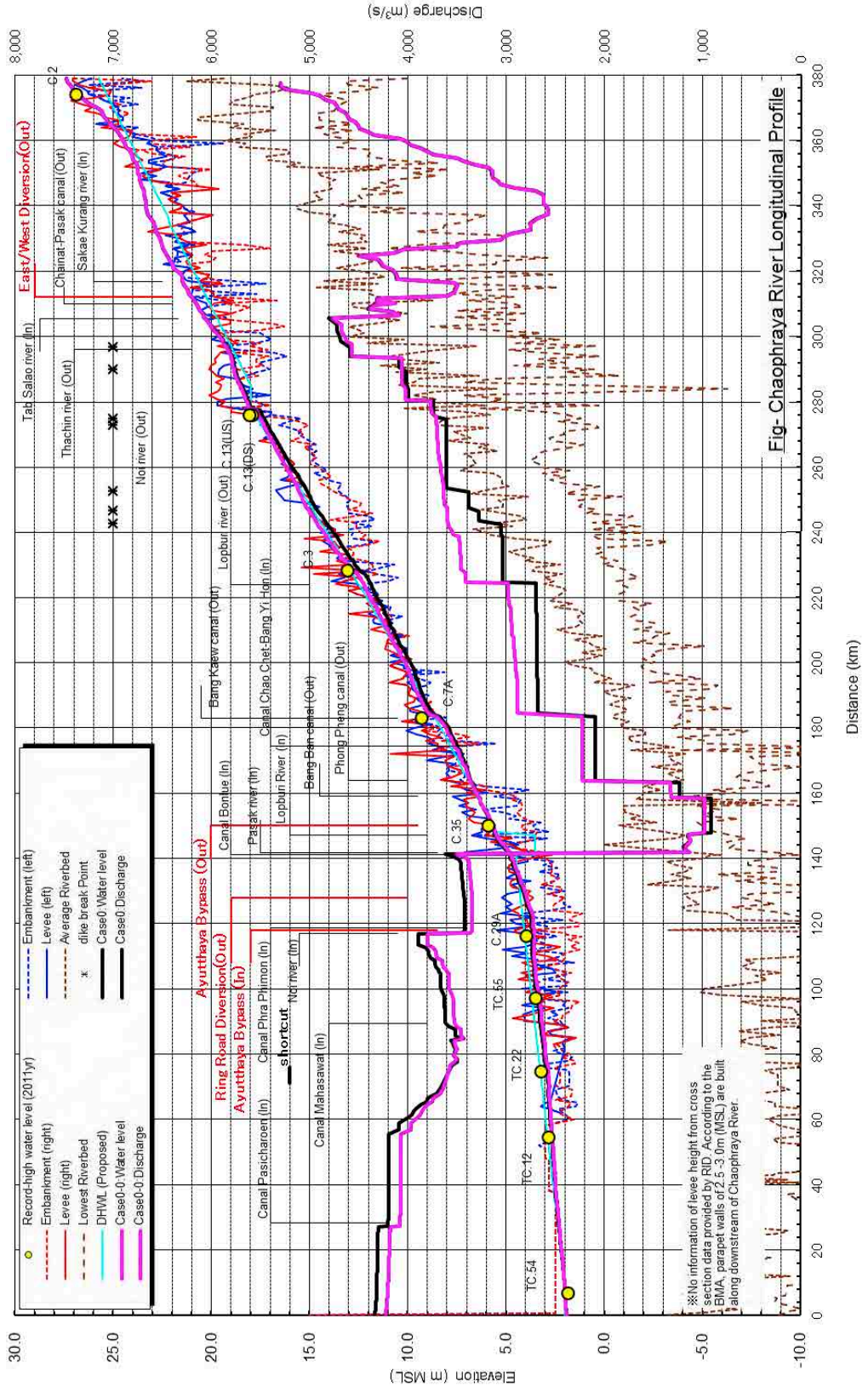


Figure D2.5.2 Longitudinal Section of Chao Phraya River (Case 0-0)
(2011 Flood without Dike breaches)

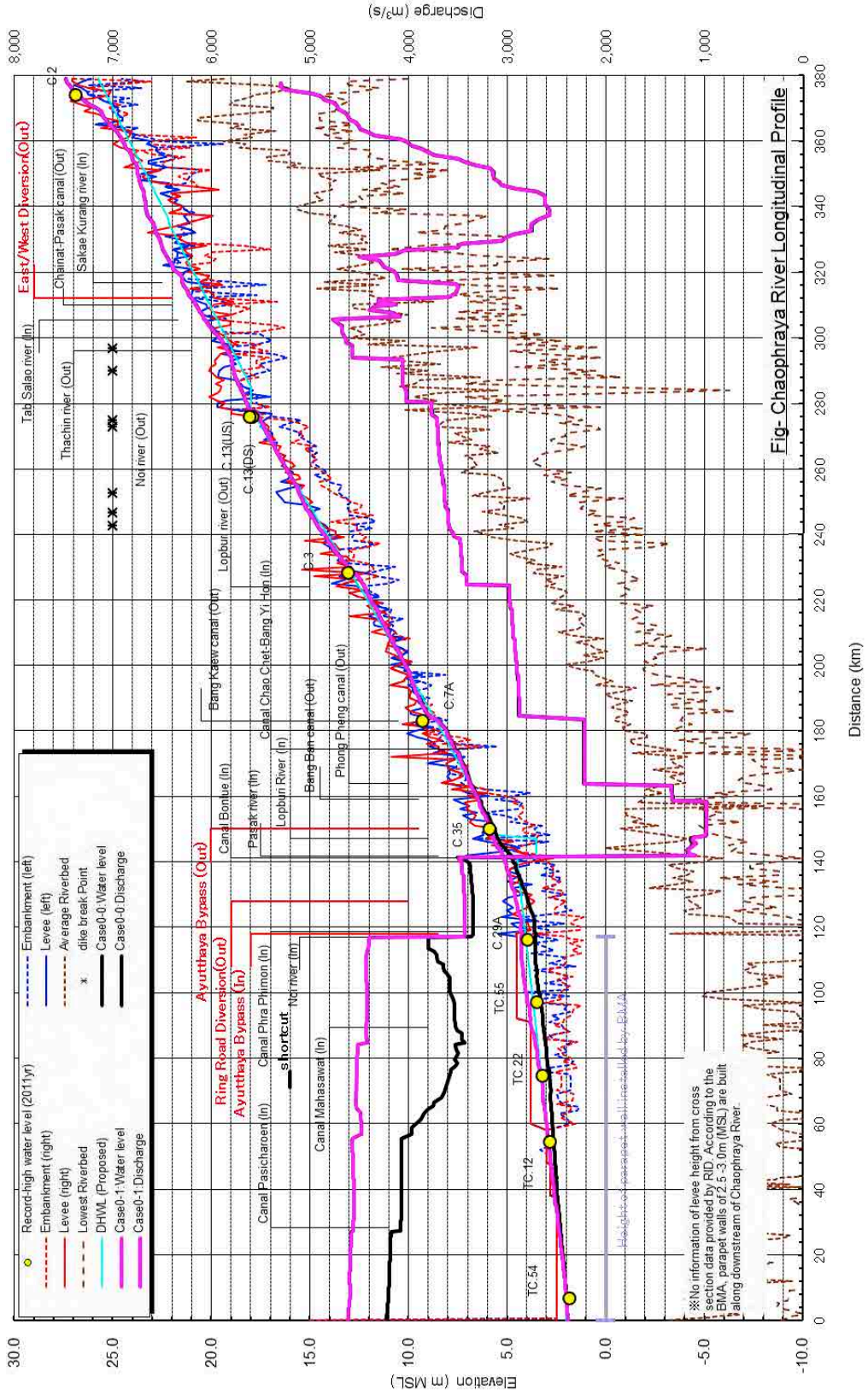


Figure D2.5.3 Longitudinal Section of Chao Phraya River (Case 0-1)
(Dike elevating around the economic zone by DOH, DOR near Bangkok area)

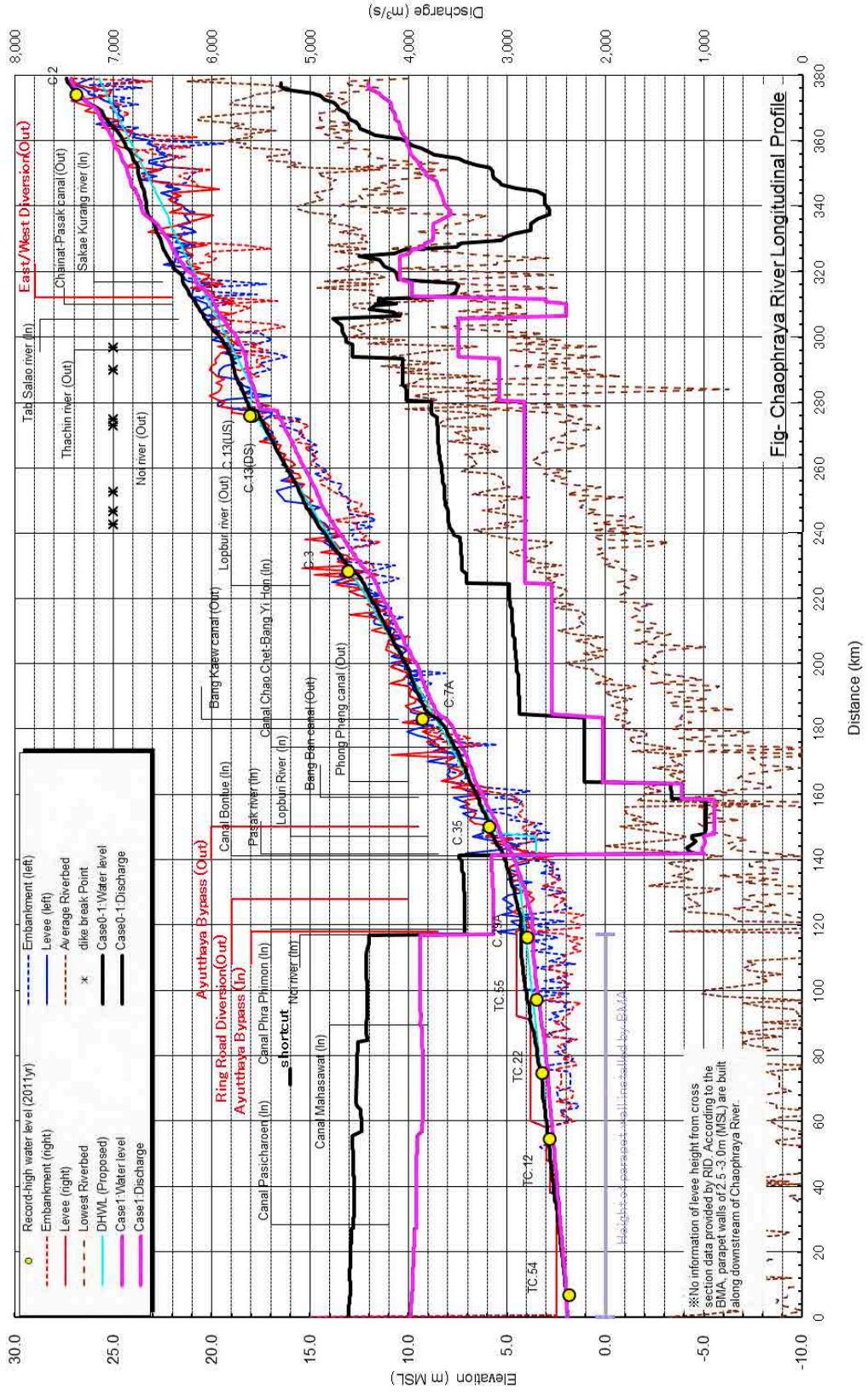


Figure D2.5.4 Longitudinal Section of Chao Phraya River (Case 1)
(C2 : New Dams, C4 : Retention Ponds, C5-1 : Dike DHWL+0.5m, C6-1 : Diversion Channel 1,500 m^3/s, C7 : Dam Operation Rule)

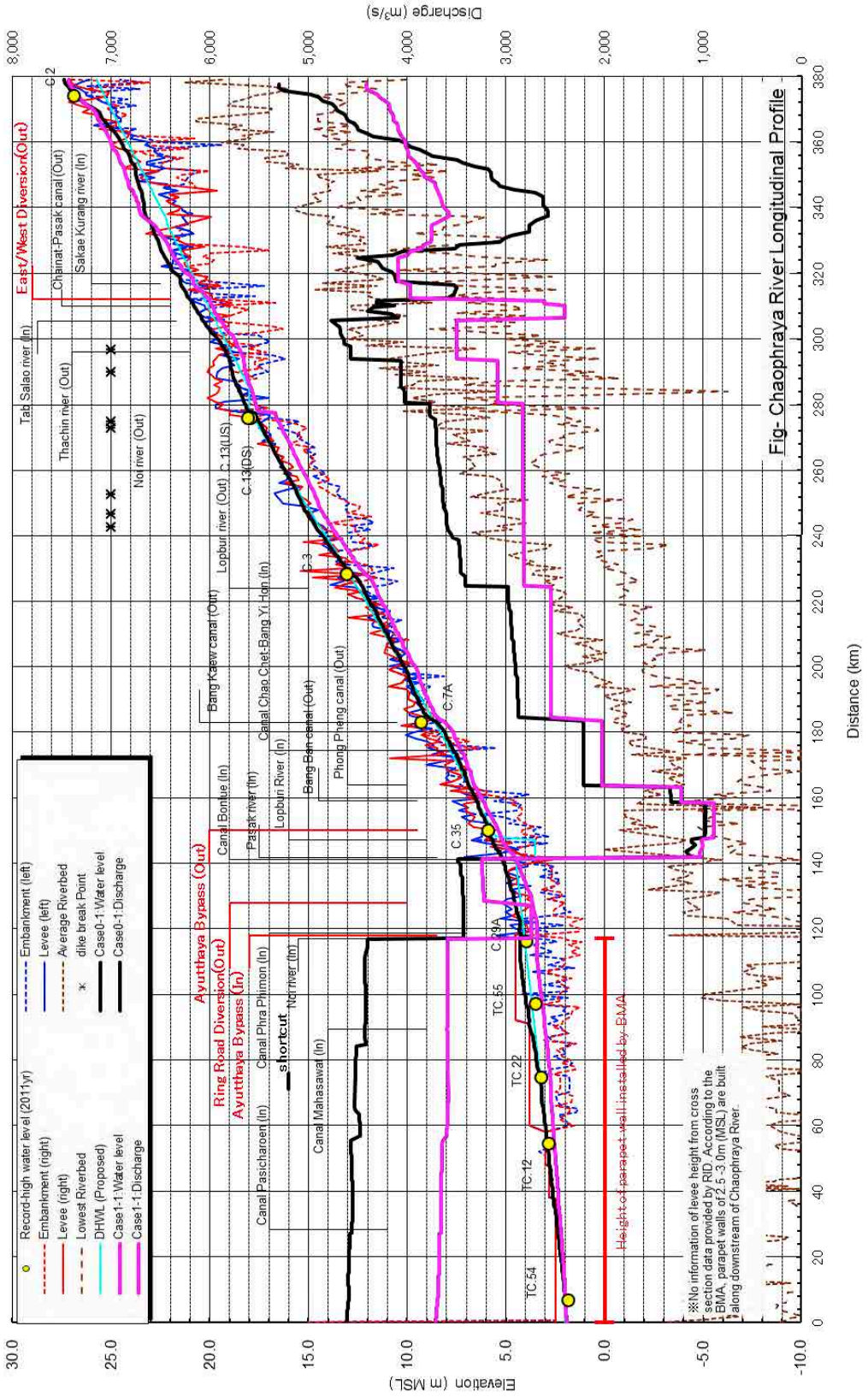


Figure D2.5.5 Longitudinal Section of Chao Phraya River (Case 1-1)
(C2 : New Dams, C4 : Retention Ponds, C5-1 : Dike DHWL+0.5m, C6-1 : Diversion Channel 1,500 m^3/s, C6-2:Central Diversion , C7 : Dam Operation Rule)

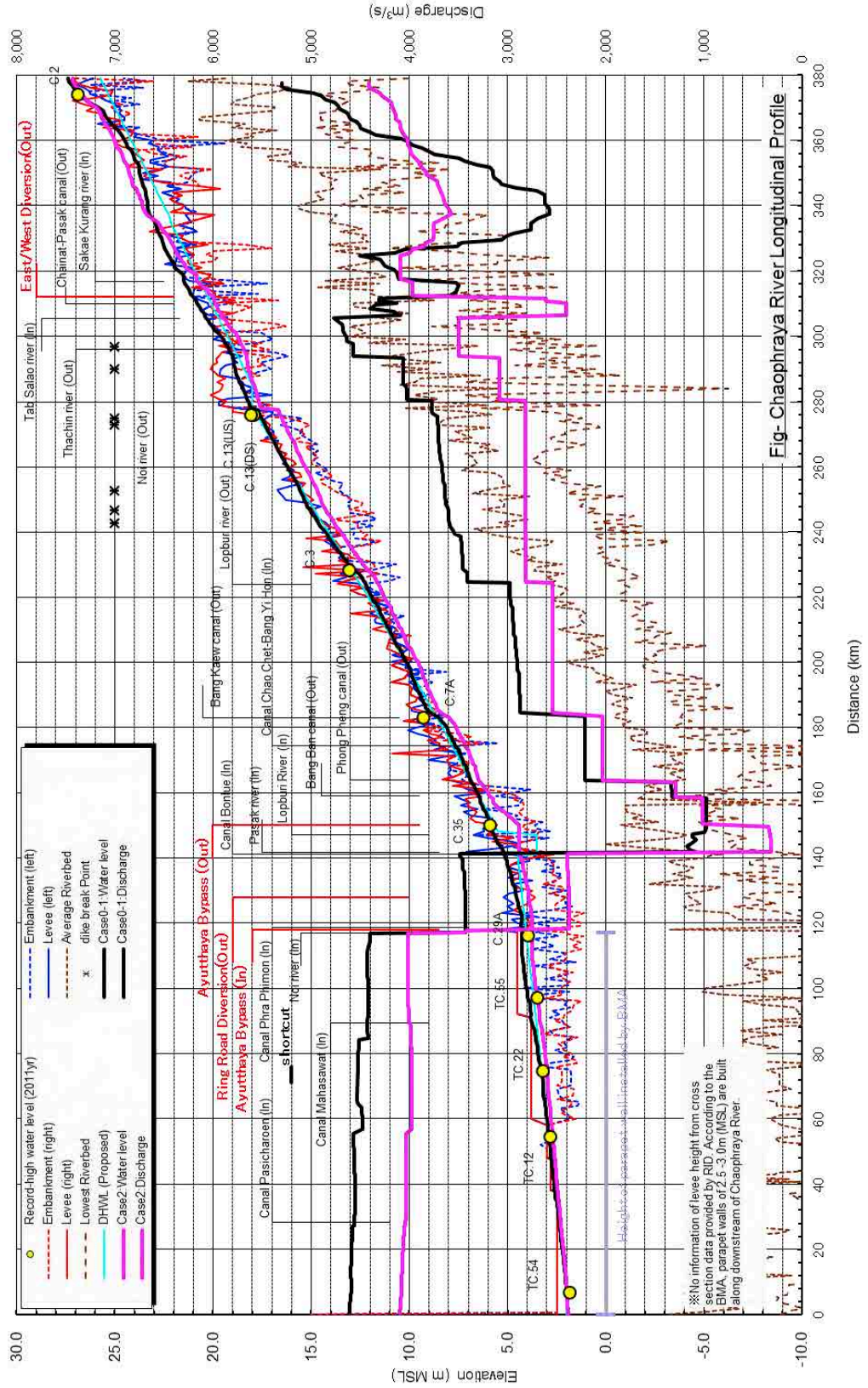


Figure D2.5.6 Longitudinal Section of Chao Phraya River (Case 2)
(C2:New Dams, C4:Retention Ponds, C5-1:Dike DHWL+0.5m, C5-2:AyutthayaAyutthaya Diversion, C6-1:Diversion Channel 1,500m^3/s, C7:Dam Operation Rule)

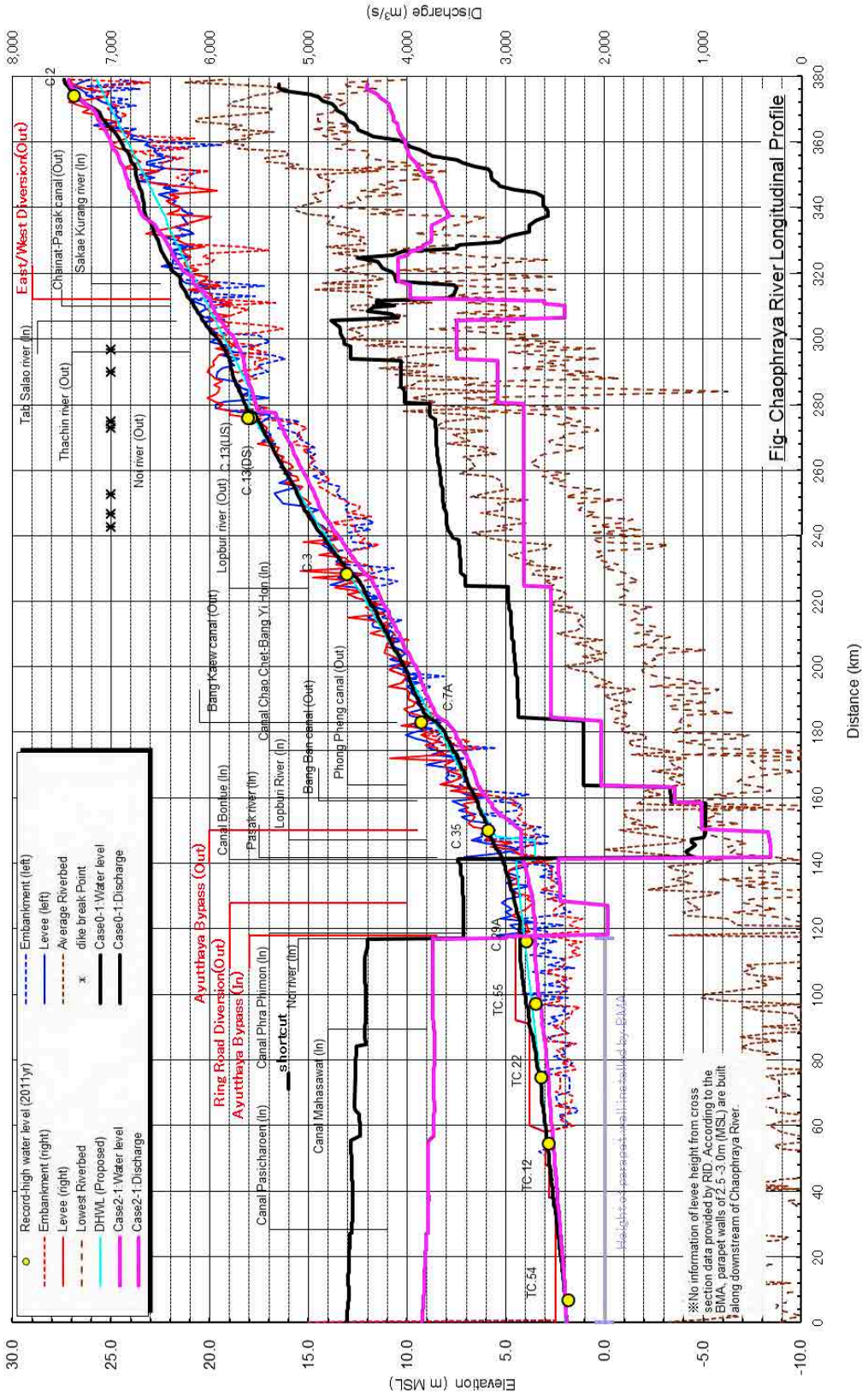


Figure D2.5.7 Longitudinal Section of Chao Phraya River (Case 2-1)
(C2:New Dam, C4:Retention Ponds, C5-1:Dike DHWL+0.5m, C5-2:AyutthayaAyutthaya Diversion, C6-1:Diversion, C6-2:Central Diversion, C7:Dam Operation Rule)

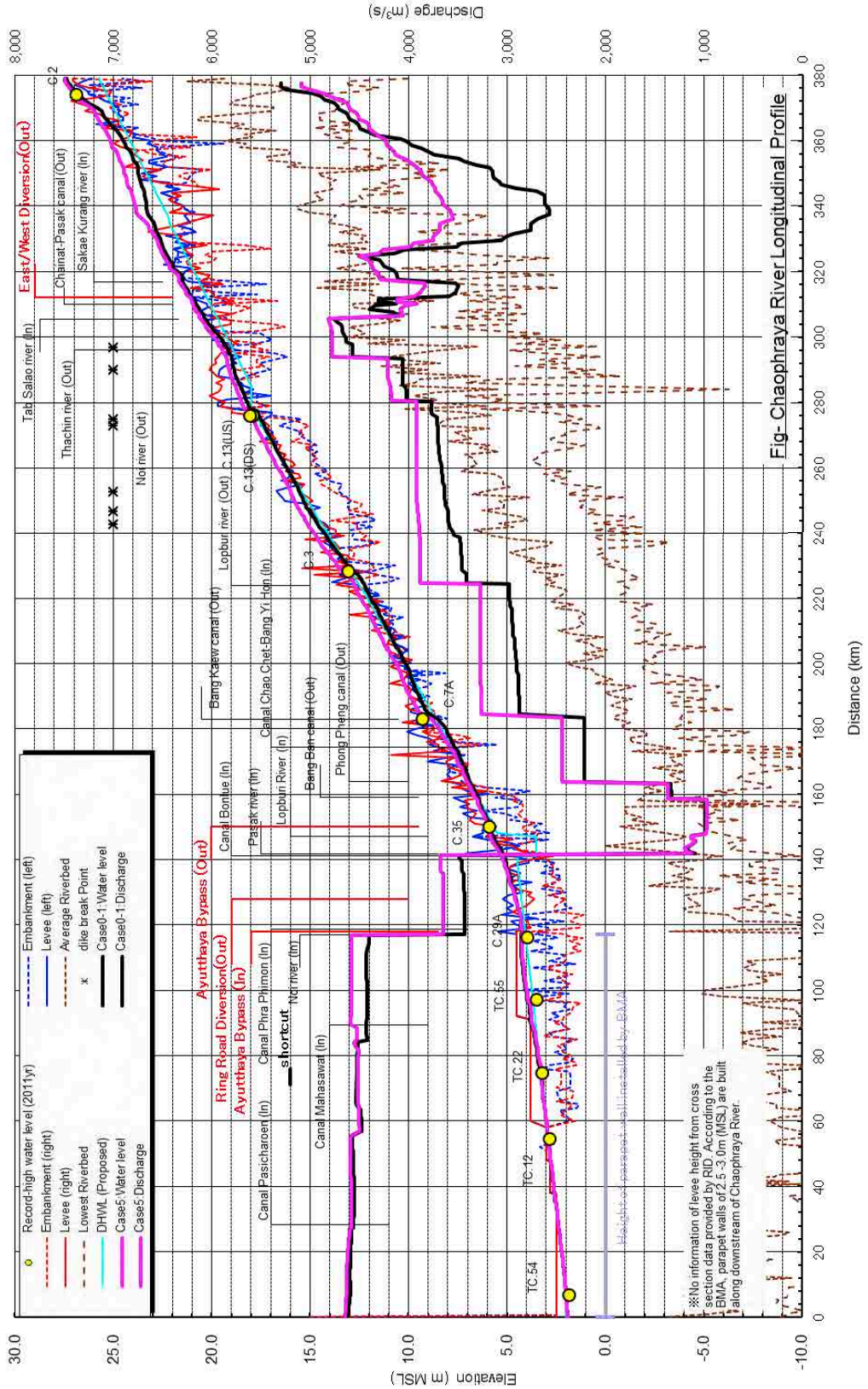


Figure D2.5.8 Longitudinal Section of Chao Phraya River (Case 5)
(C5-1:Dike Elevating up to DHWL+0.5m)

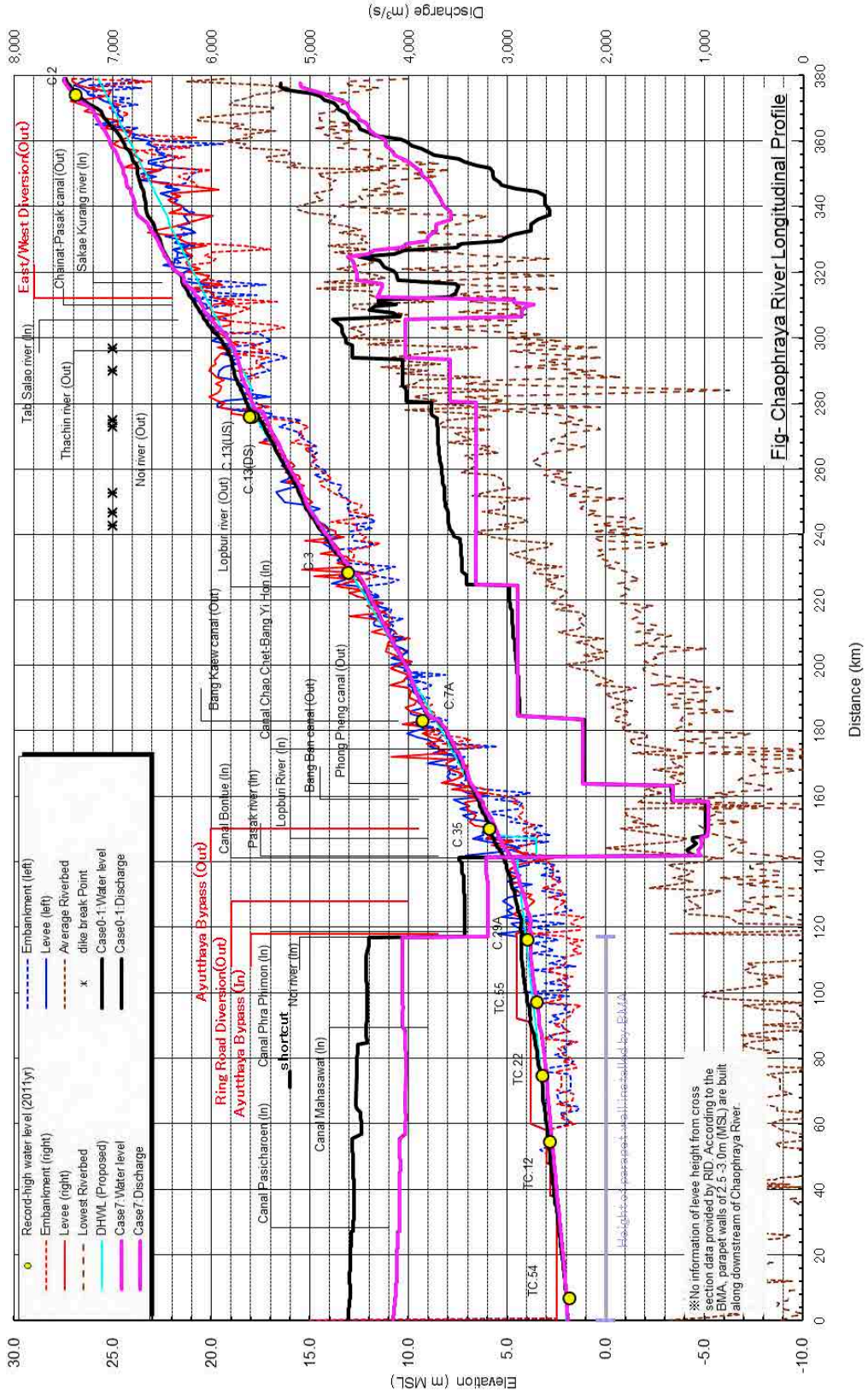


Figure D2.5.9 Longitudinal Section of Chao Phraya River (Case 7)
(C5-1:Dike Elevating up to DHWL+0.5m, C6-1:Diversion Channel 1,500m³/s)

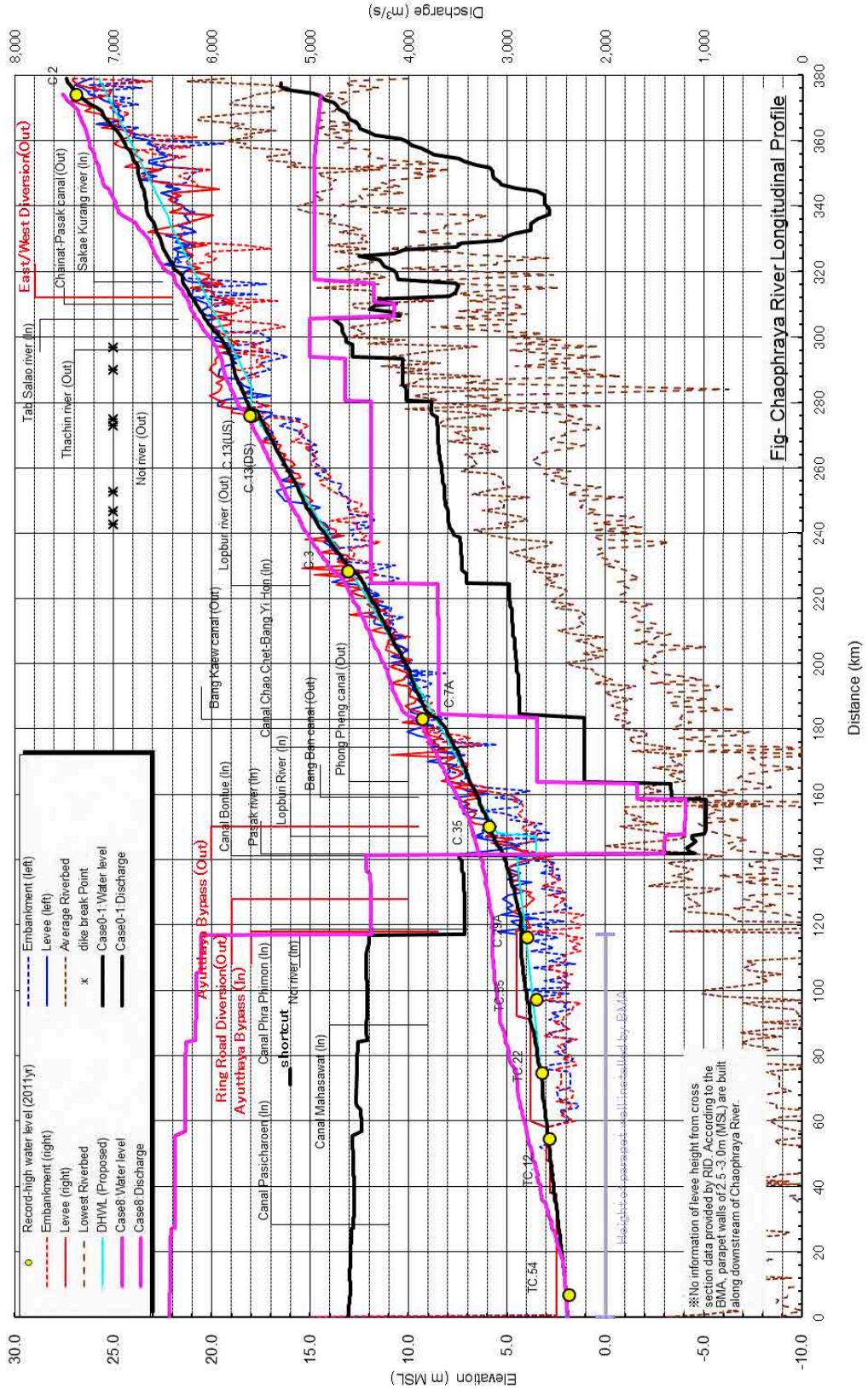


Figure D2.5.10 Longitudinal Section of Chao Phraya River (Case 8-0)
(Primary Dike elevating up to peak water level)

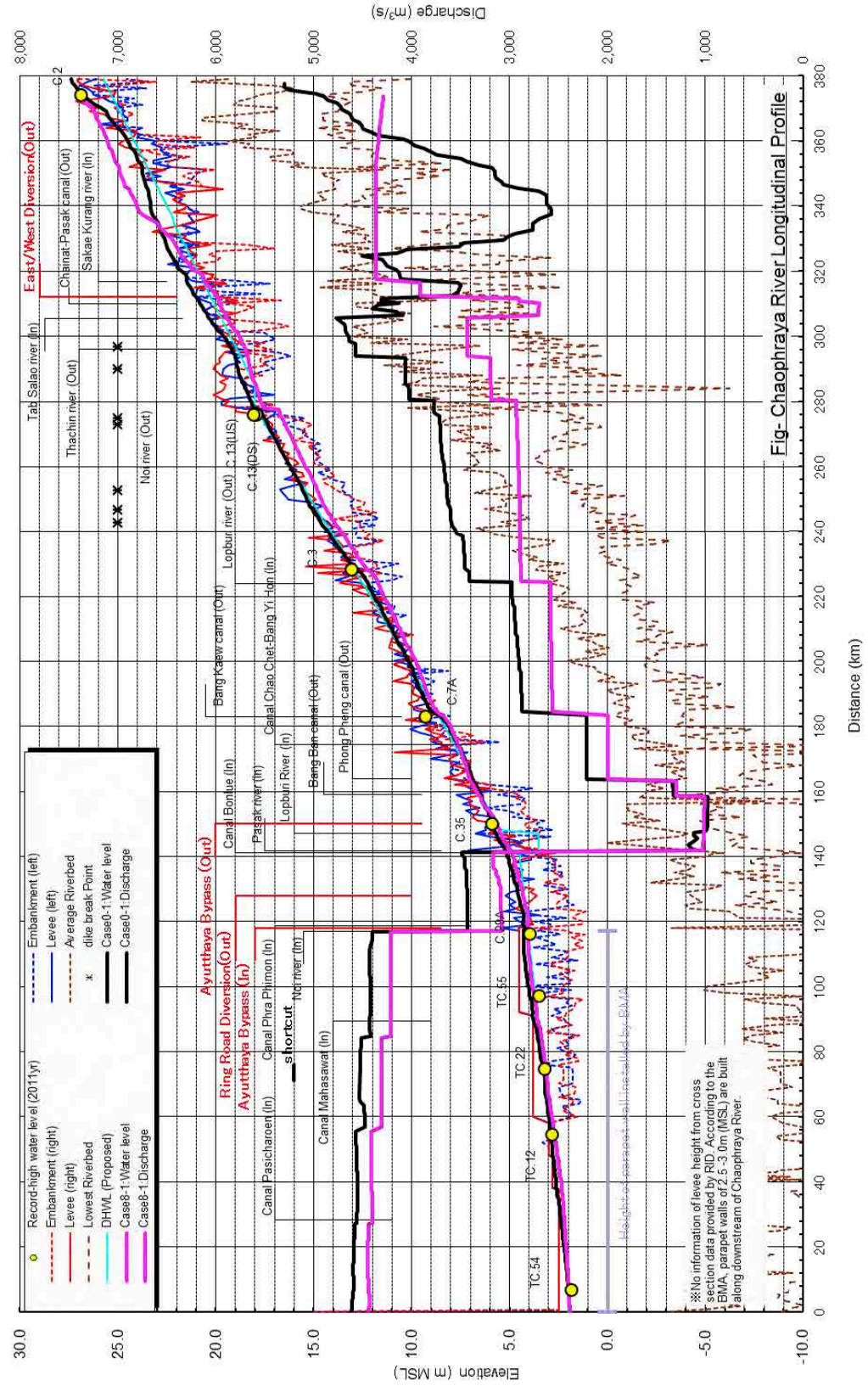


Figure D2.5.11 Longitudinal Section of Chao Phraya River (Case 8-1)
(C2:New Dams, C4:Retention Ponds, C6-1:Diversion Channel 1,500m^3/s, C7:Dam Operation Rule, Primary Dike elevating up to peak water level)

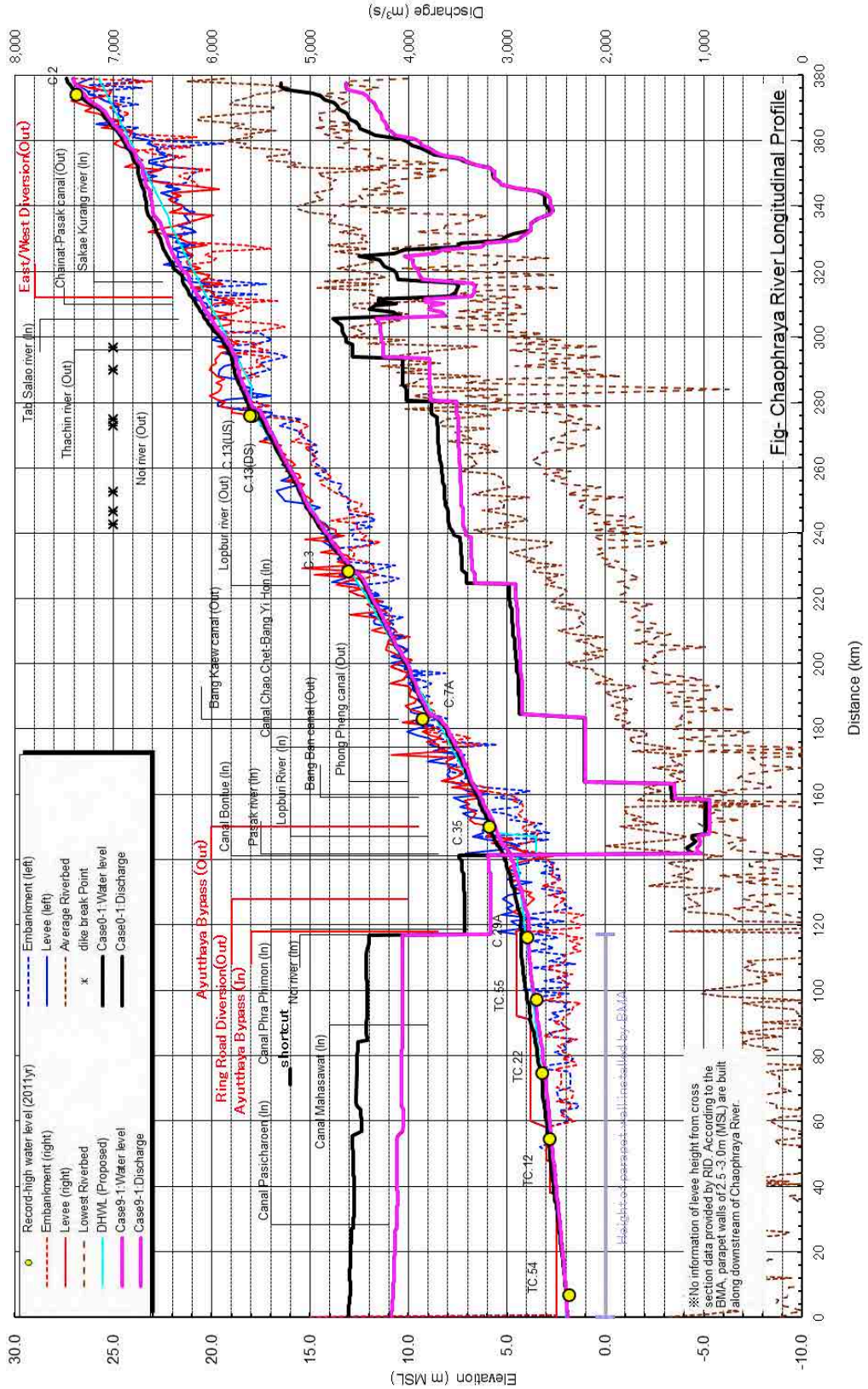


Figure D2.5.12 Longitudinal Section of Chao Phraya River (Case 9-1)
(C7 : Effective operation of existing dams)

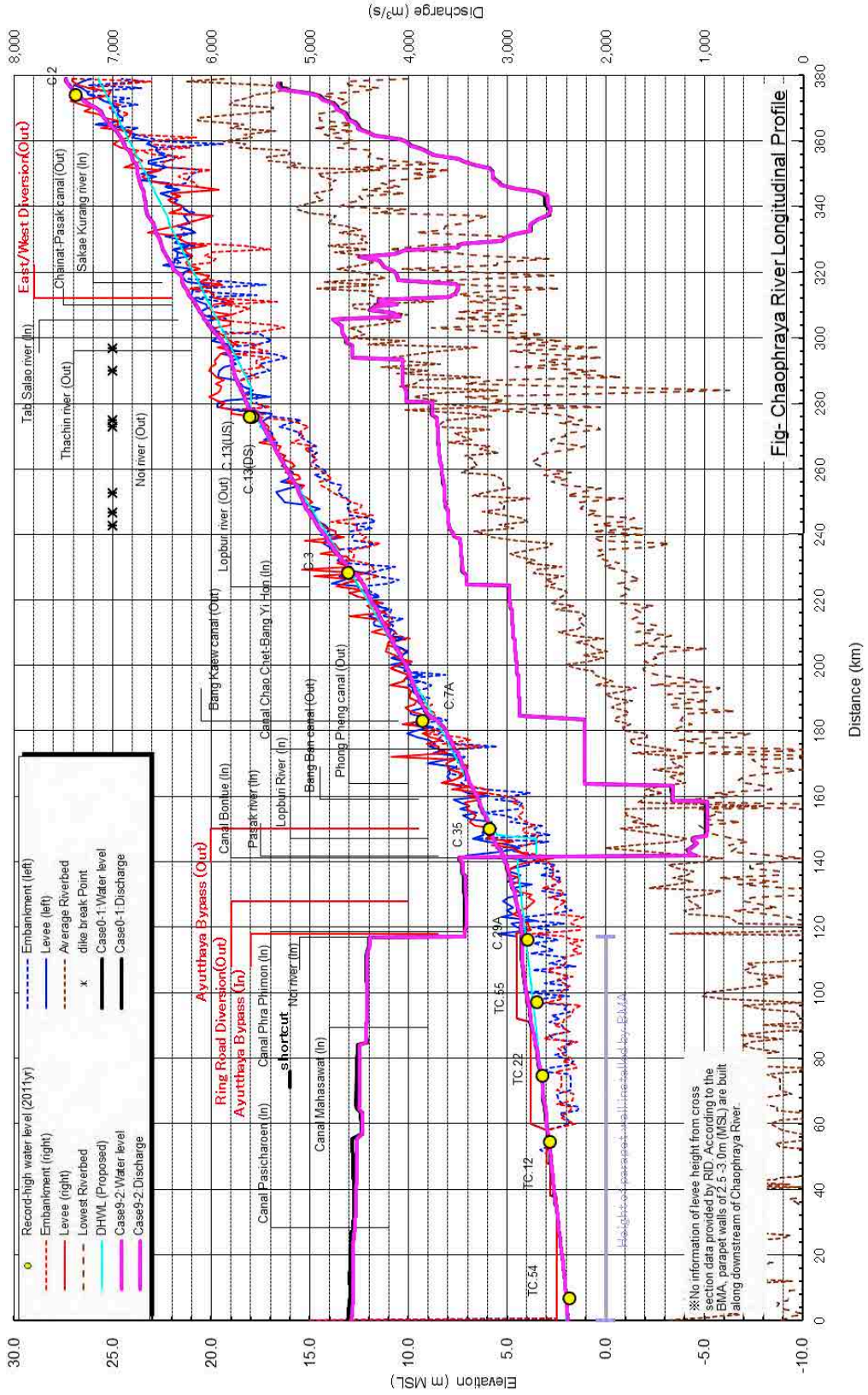


Figure D2.5.13 Longitudinal Section of Chao Phraya River (Case 9-2)
(C2 : Flood control volume with new dams)

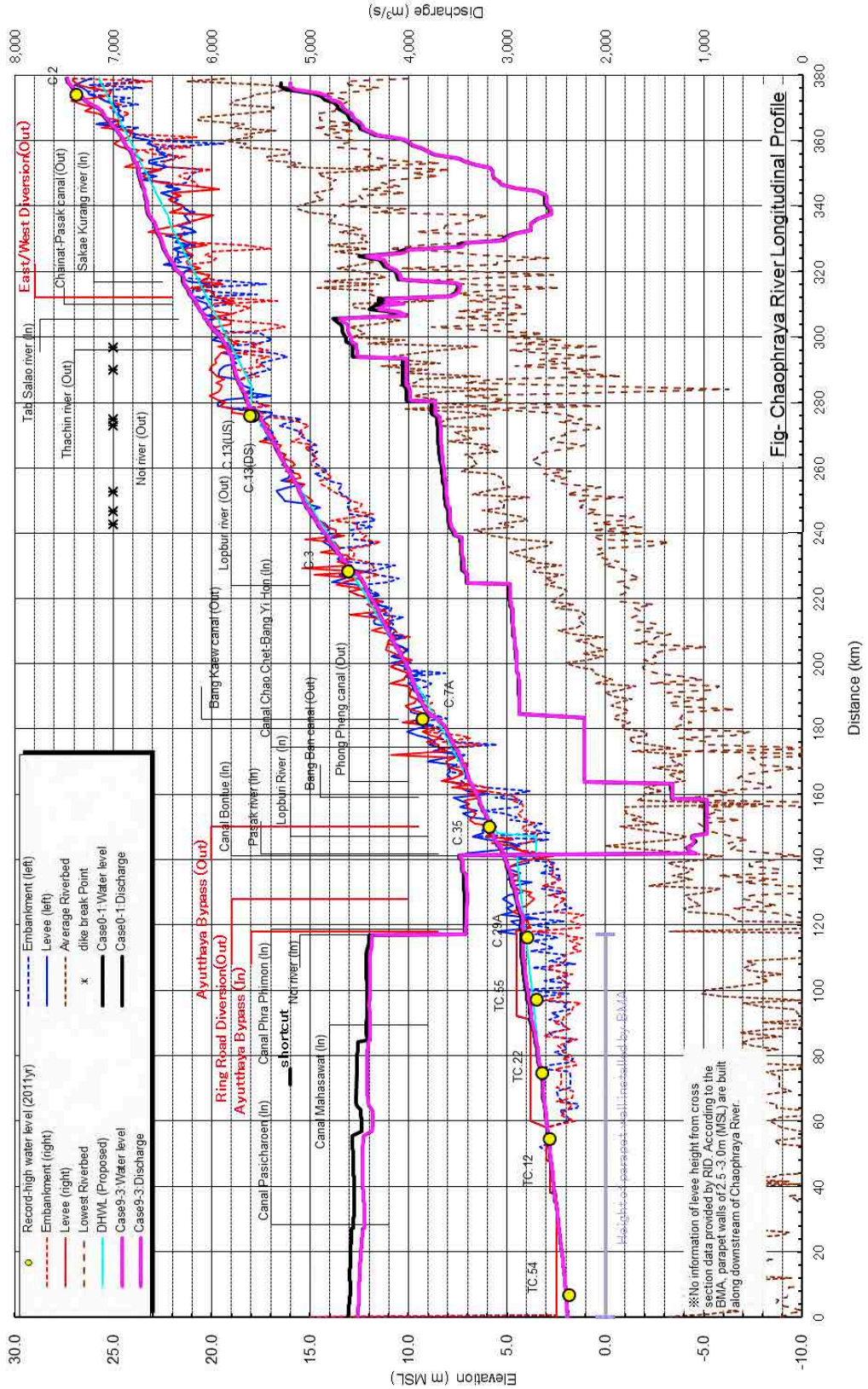


Figure D2.5.14 Longitudinal Section of Chao Phraya River (Case 9-3)
(C4 : Flood control volume in retention ponds)

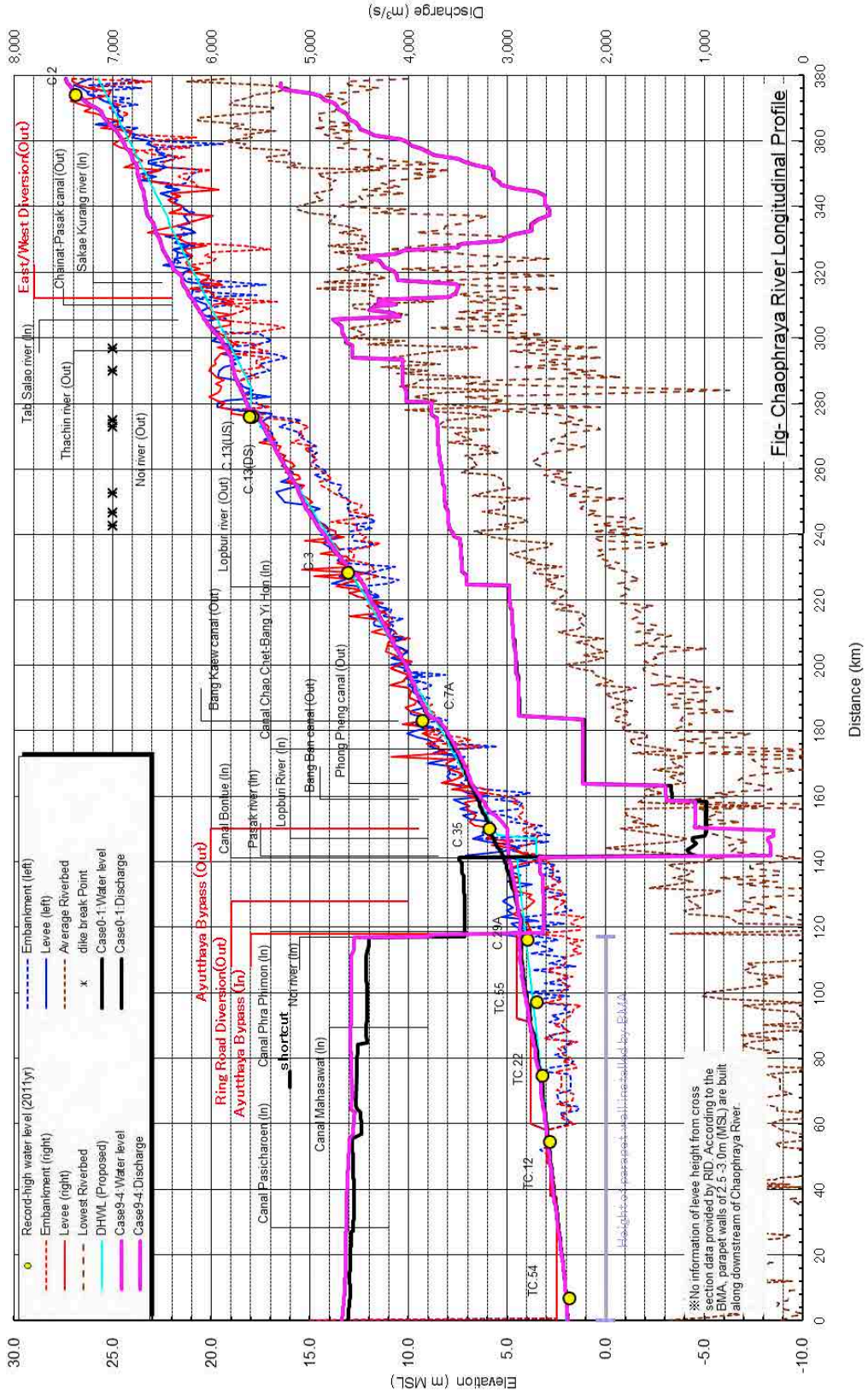


Figure D2.5.15 Longitudinal Section of Chao Phraya River (Case 9-4)
(C5-2 : Flood control with Ayutthaya diversion channel 1,400m^3/s)

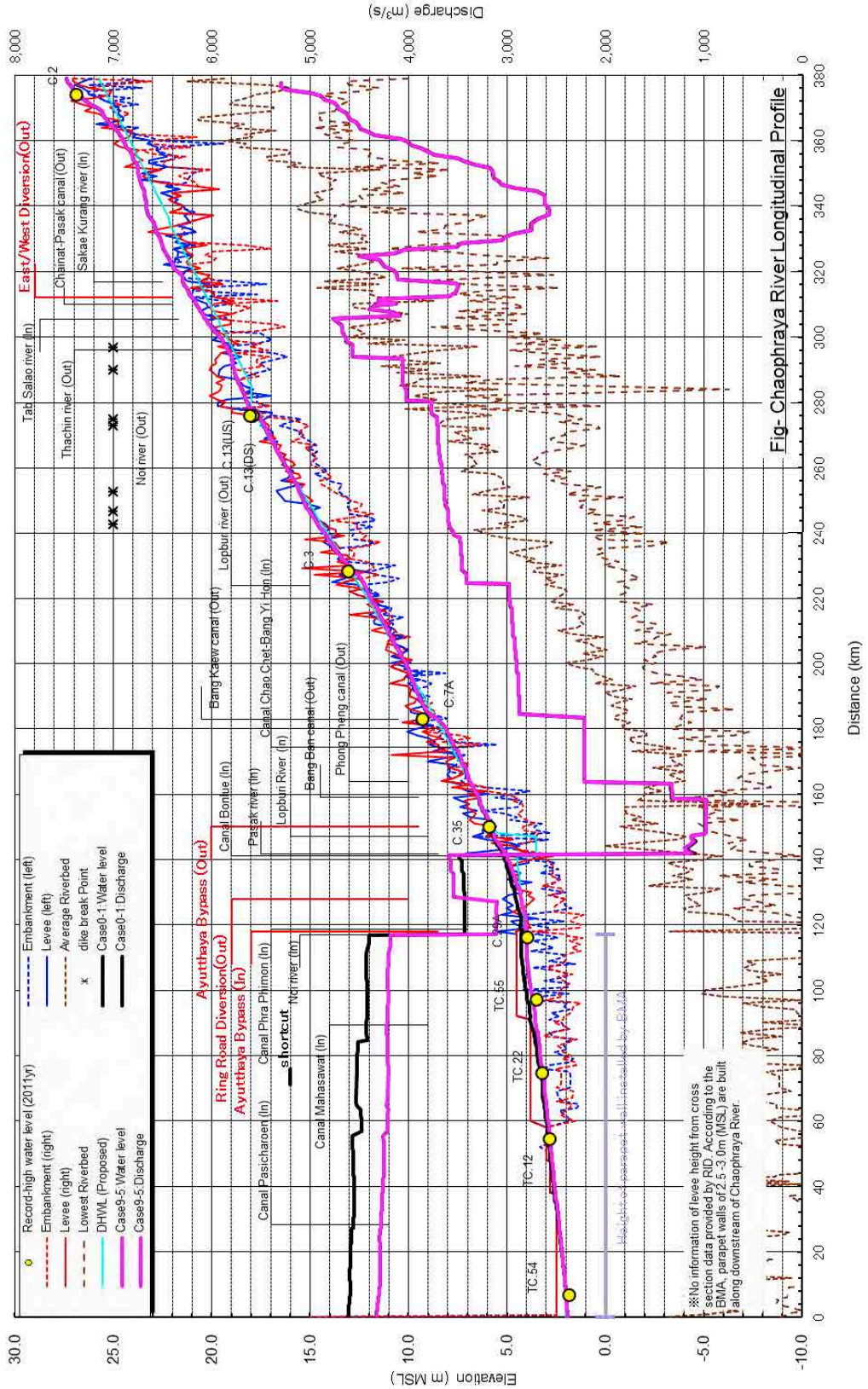


Figure D2.5.16 Longitudinal Section of Chao Phraya River (Case 9-5)
(C6-2 : Flood Control with central diversion channels 500 m^3/s)

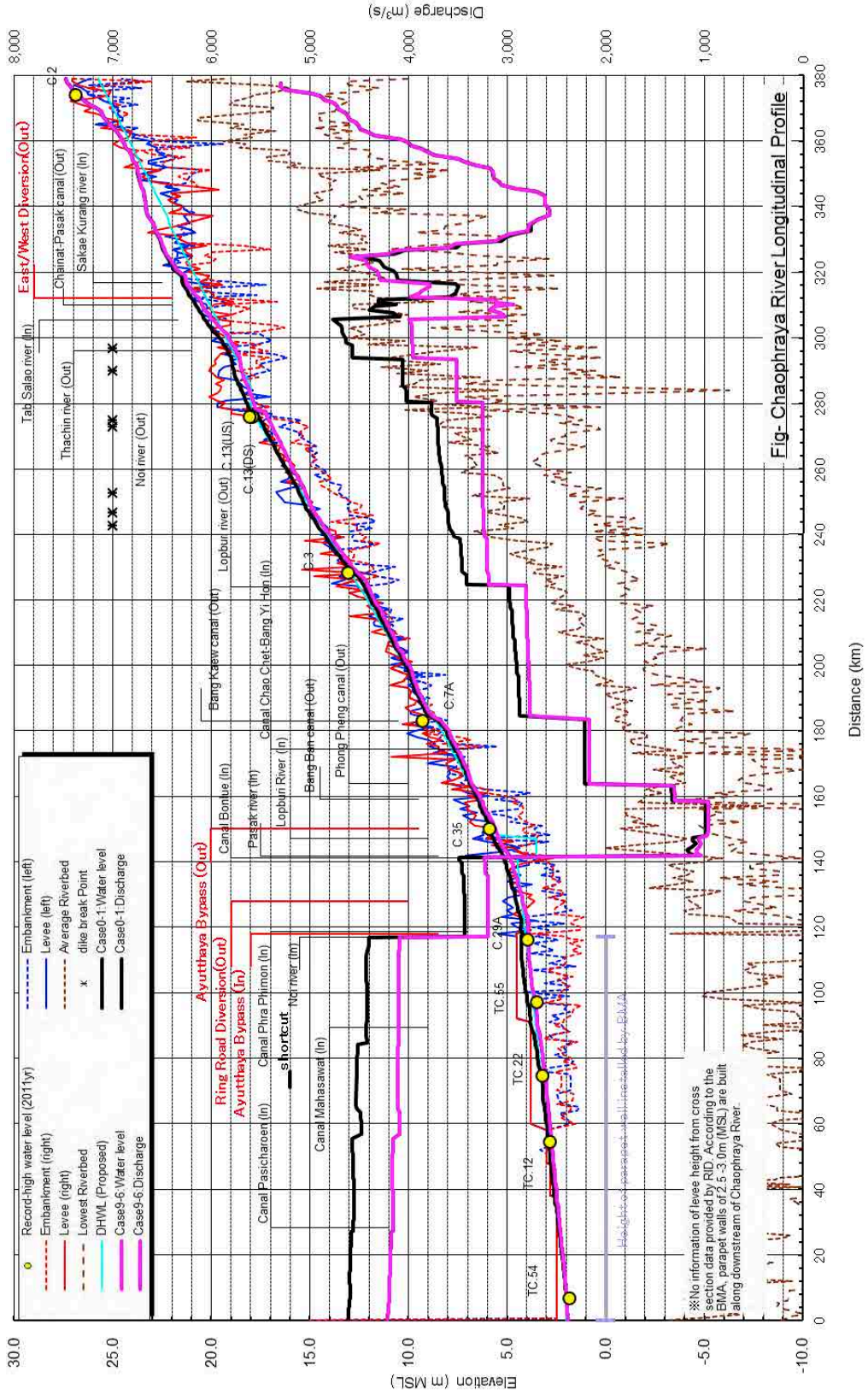


Figure D2.5.17 Longitudinal Section of Chao Phraya River (Case 9-6)
(C6-1 : Flood control with east or west diversion channels 1,500 m³/s)

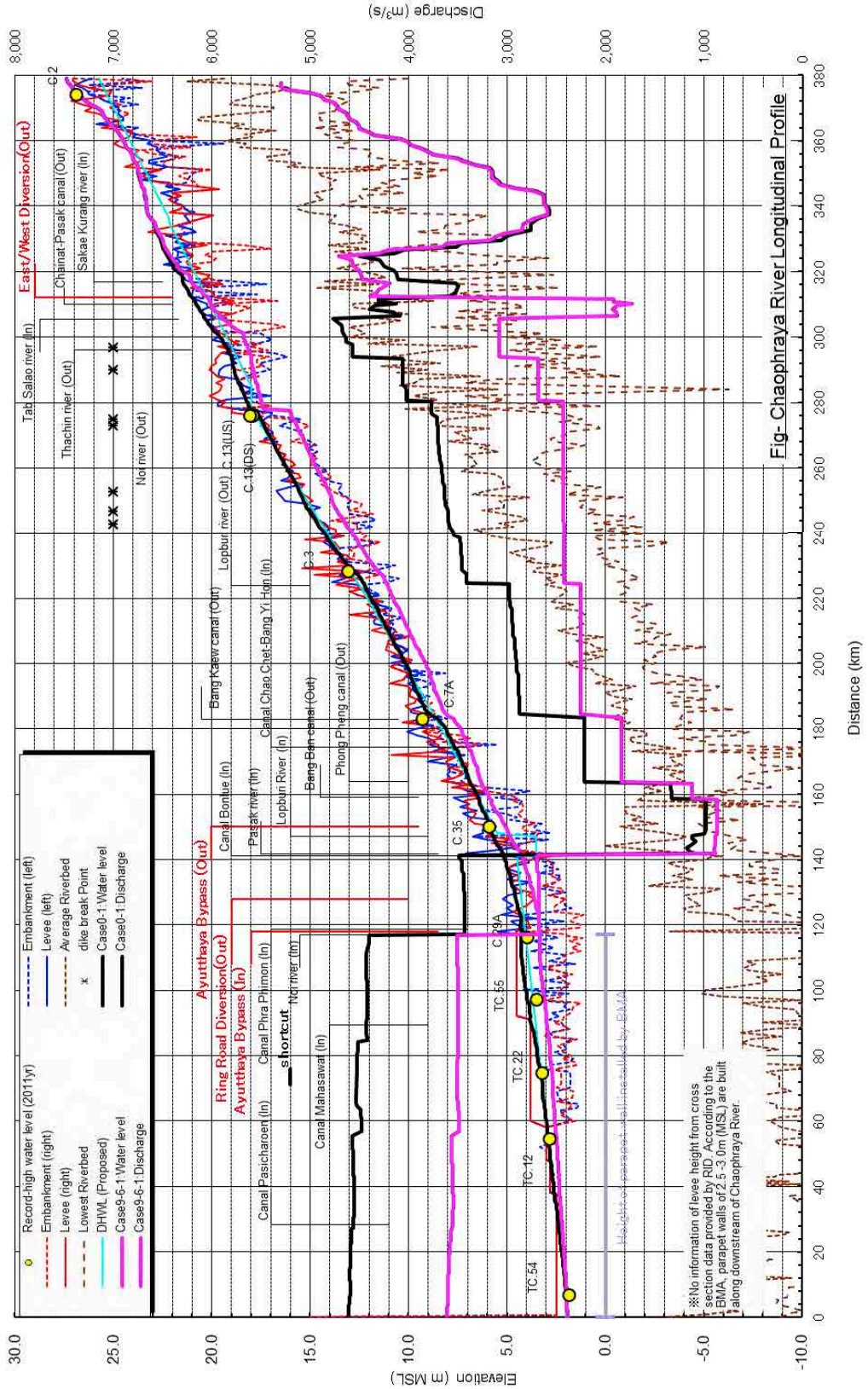


Figure D2.5.18 Longitudinal Section of Chao Phraya River (Case 9-6-1)
(C6-1 : Flood control with east or west diversion channels 1,500 m³/s)

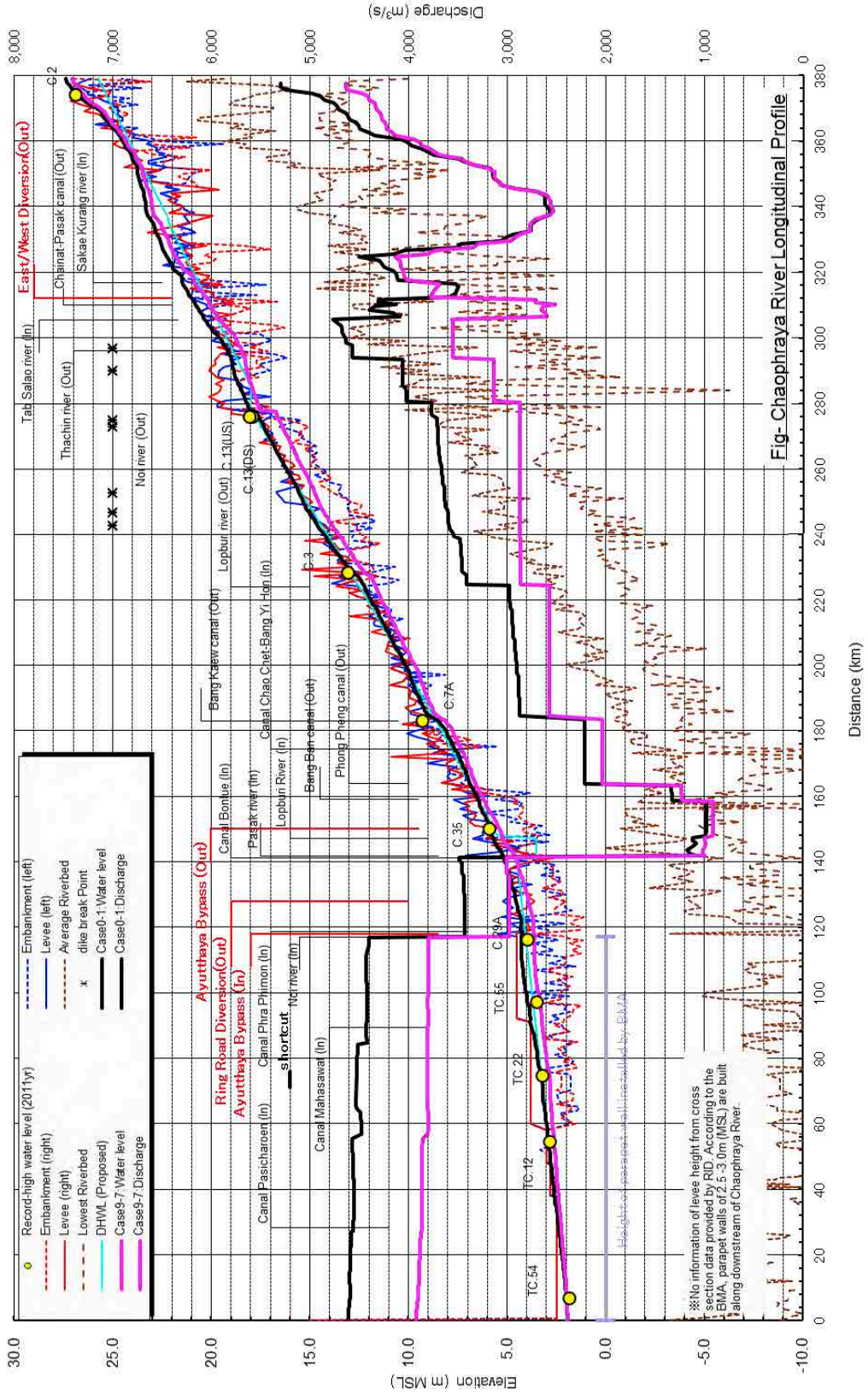


Figure D2.5.19 Longitudinal Section of Chao Phraya River (Case 9-7)

(C6-1 : Effective operation of existing dams, Flood control with east or west diversion channels 1,500 m^3/s)

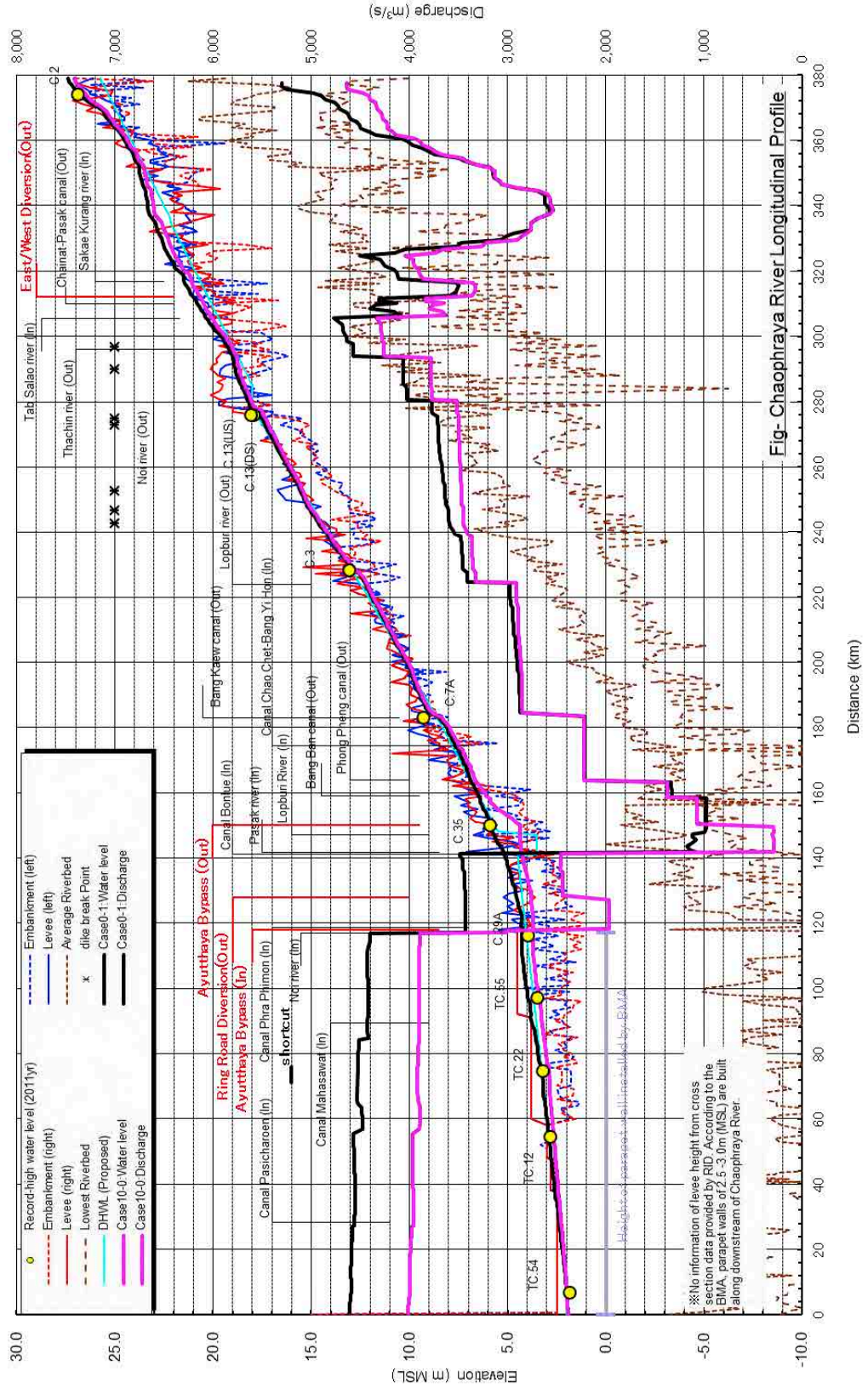


Figure D2.5.20 Longitudinal Section of Chao Phraya River (Case 10-0)
(C5-2 : Ayutthaya diversion channel 1,400m³/s, C6-2 : Central diversion channels 500 m³/s, C7 : Effective operation of existing dams)

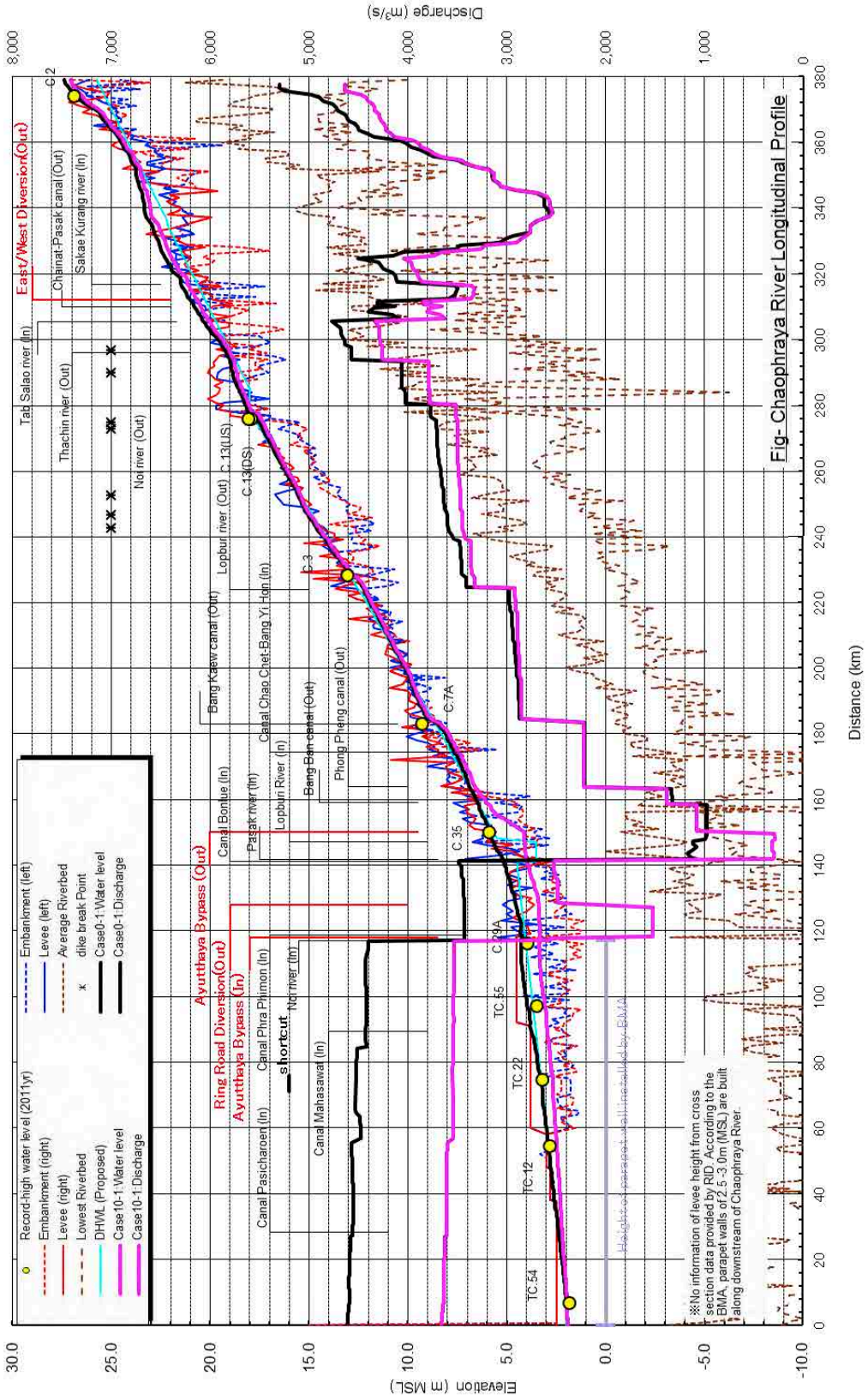


Figure D2.5.21 Longitudinal Section of Chao Phraya River (Case 10-1)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s, C7 : Effective operation of existing dams)

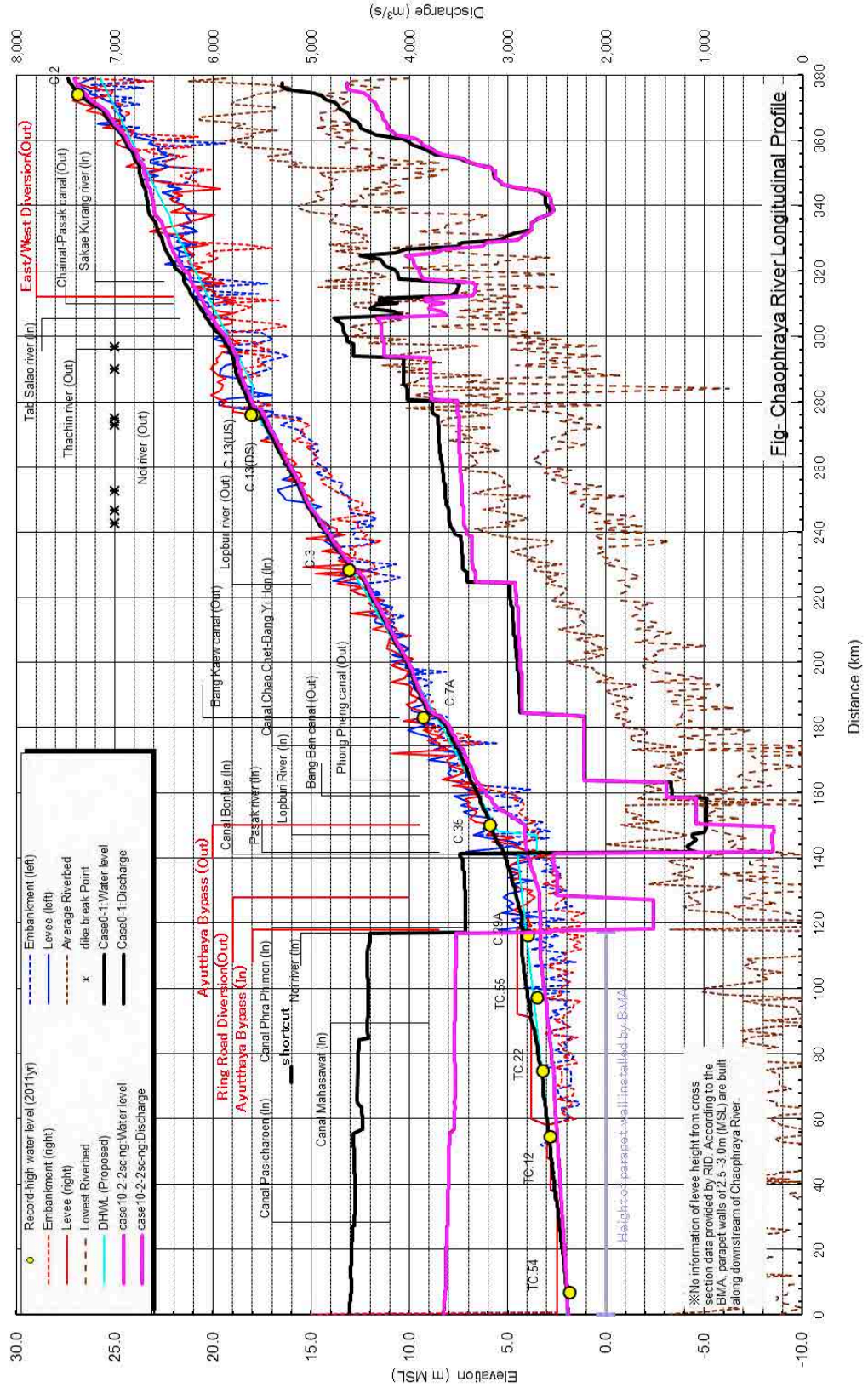


Figure D2.5.22 Longitudinal Section of Chao Phraya River (Case 10-2-4sc-ng)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s,
C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate)

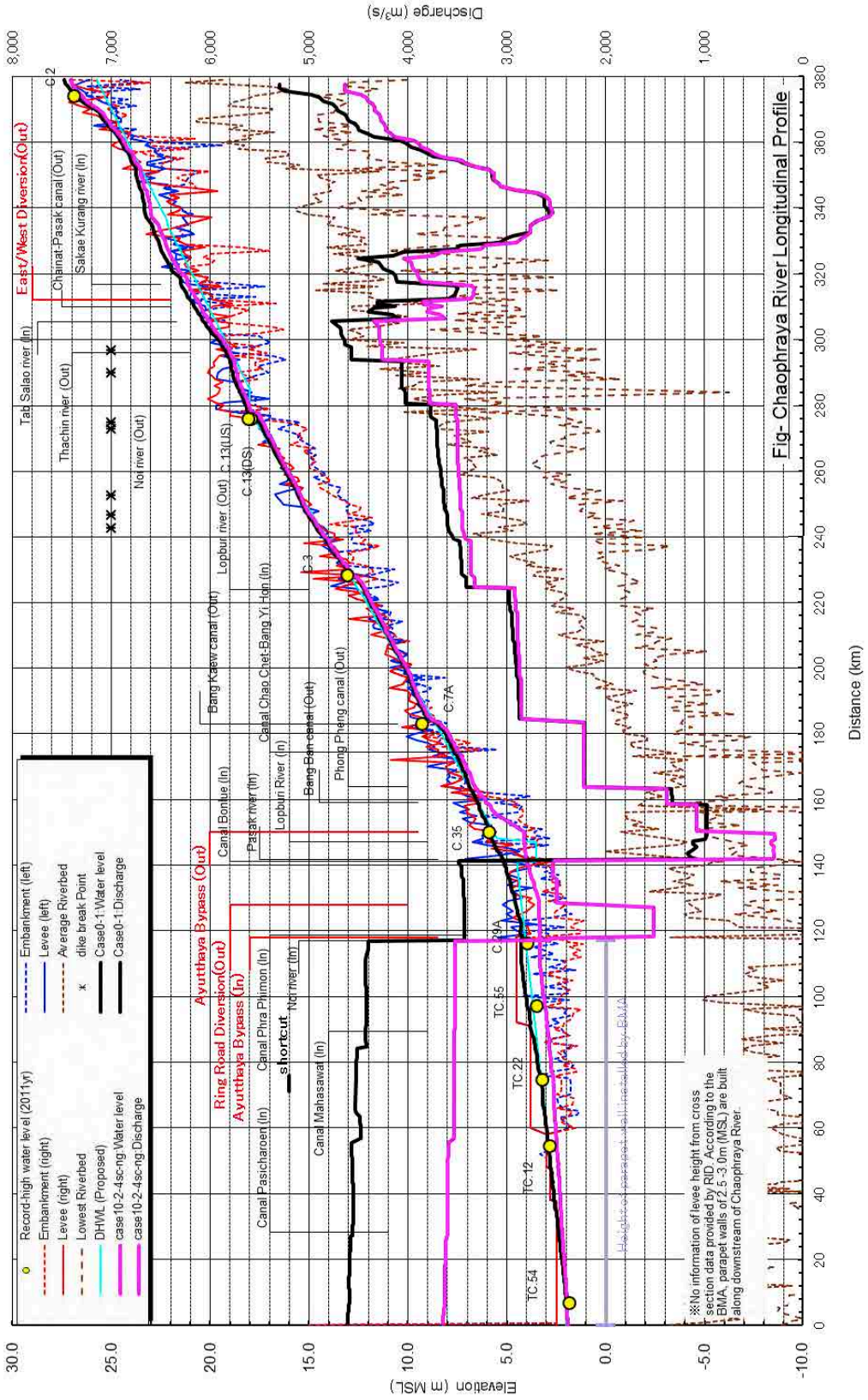


Figure D2.5.23 Longitudinal Section of Chao Phraya River (Case 10-2-2sc-ng)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s,
C7 : Effective operation of existing dams, 2 short cuts of Tha Chin river without gate)

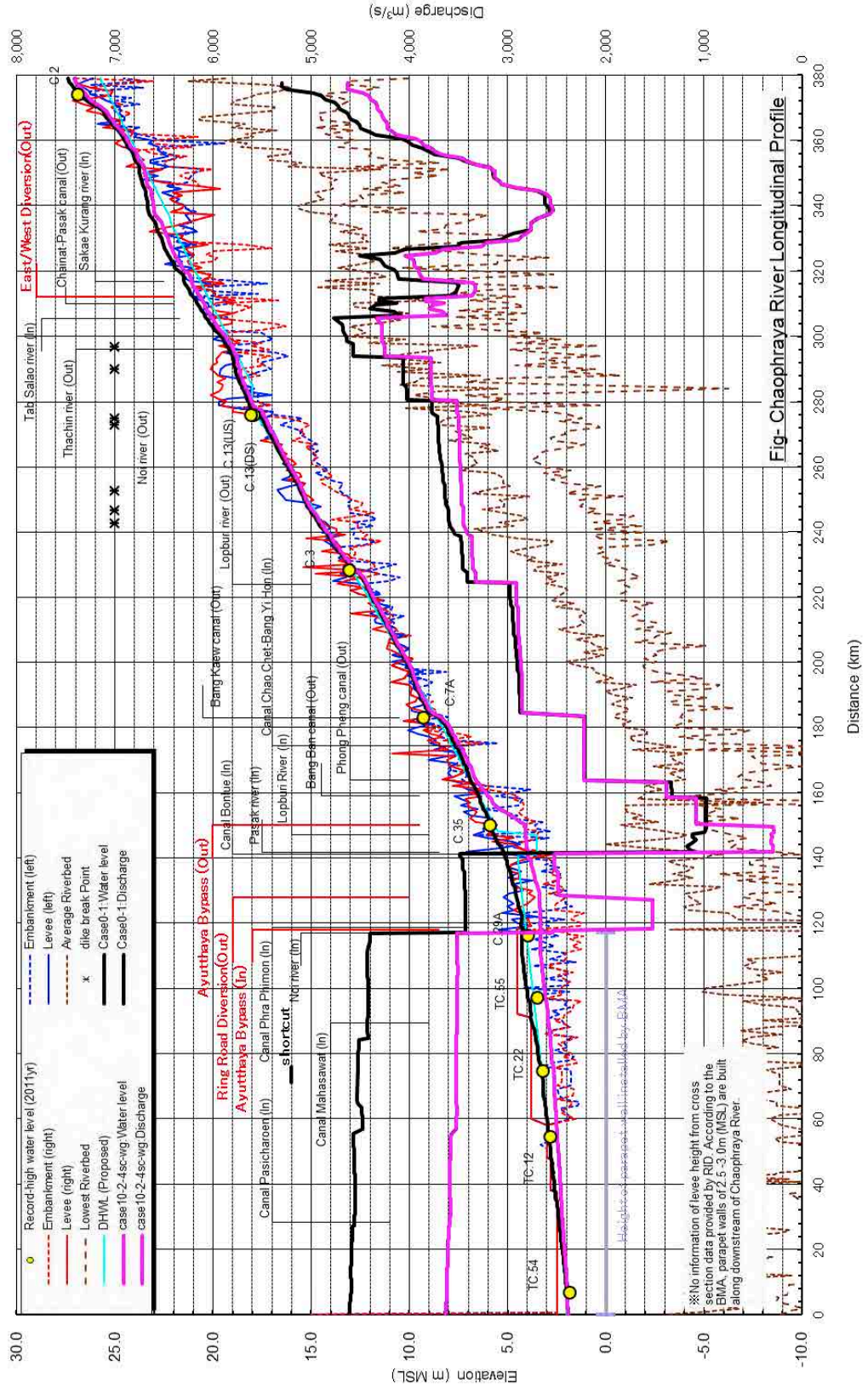


Figure D2.5.24 Longitudinal Section of Chao Phraya River (Case 10-2-4sc-wg)
(C5-2 : Ayutthaya diversion channel 1,400m³/s, C6-2 : Central diversion channels 1,000 m³/s, C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river with gate)

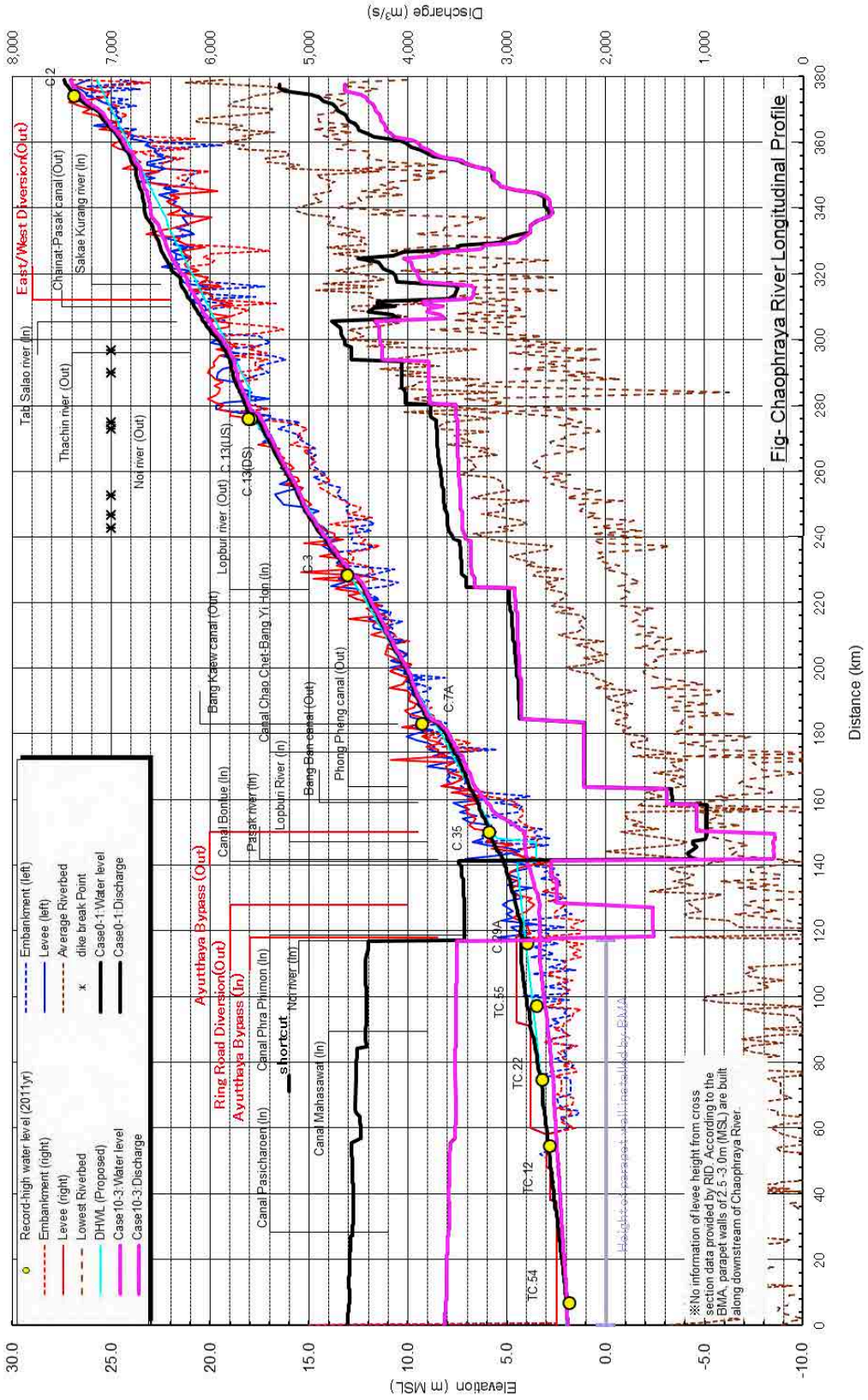


Figure D2.5.25 Longitudinal Section of Chao Phraya River (Case 10-3-4sc-ng)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s,
C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate, Widening of Tha Chin river)

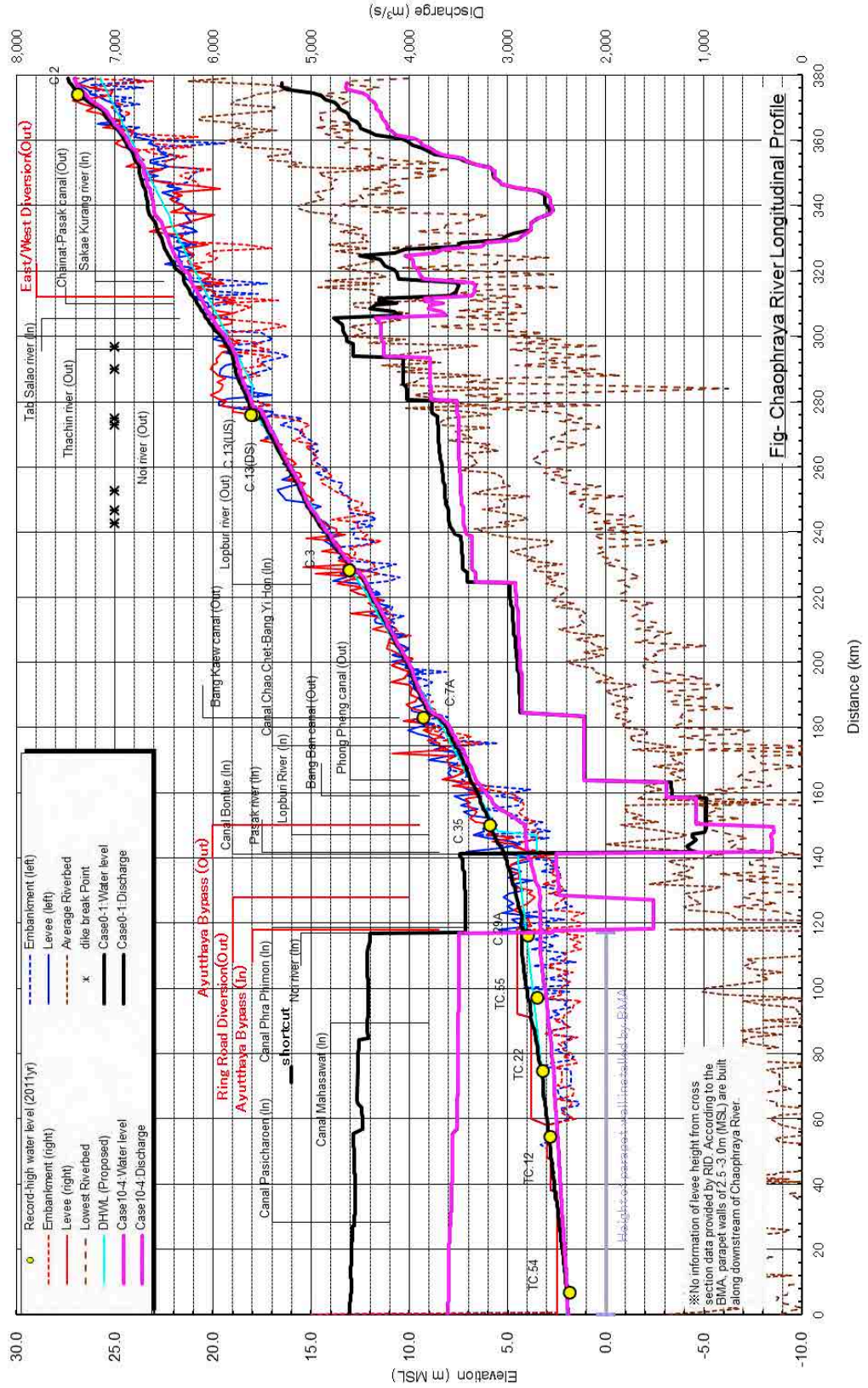


Figure D2.5.26 Longitudinal Section of Chao Phraya River (Case 10-4-4sc-ng)
(C5-2 : Ayutthaya diversion channel 1,400m³/s, C6-2 : Central diversion channels 1,000 m³/s,
C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate, Widening of Tha Chin river)

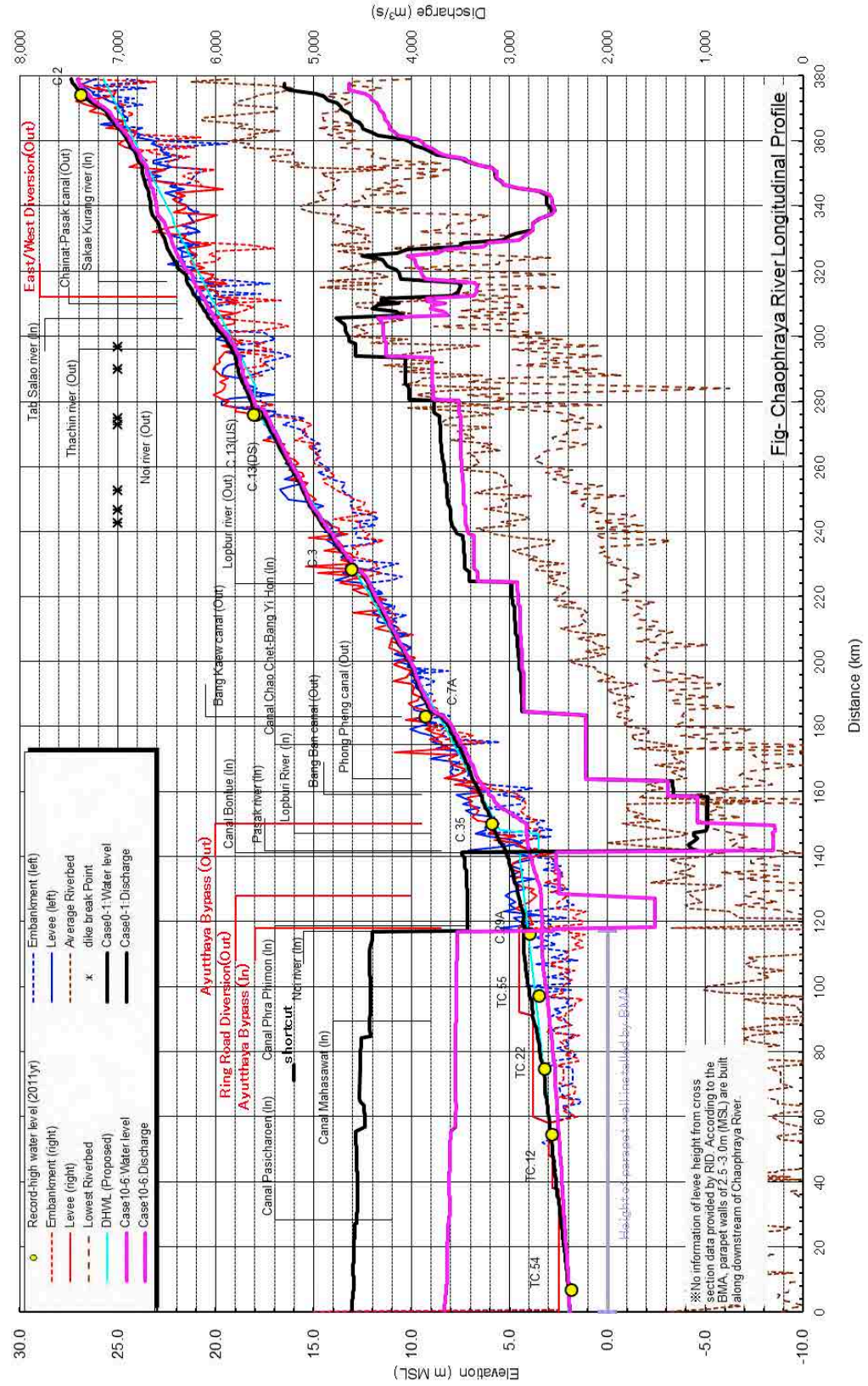


Figure D2.5.27 Longitudinal Section of Chao Phraya River (Case 10-6)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m3/s, C7 : Effective operation of existing dams, Right and Left flood protection wall of Tha Chin River)

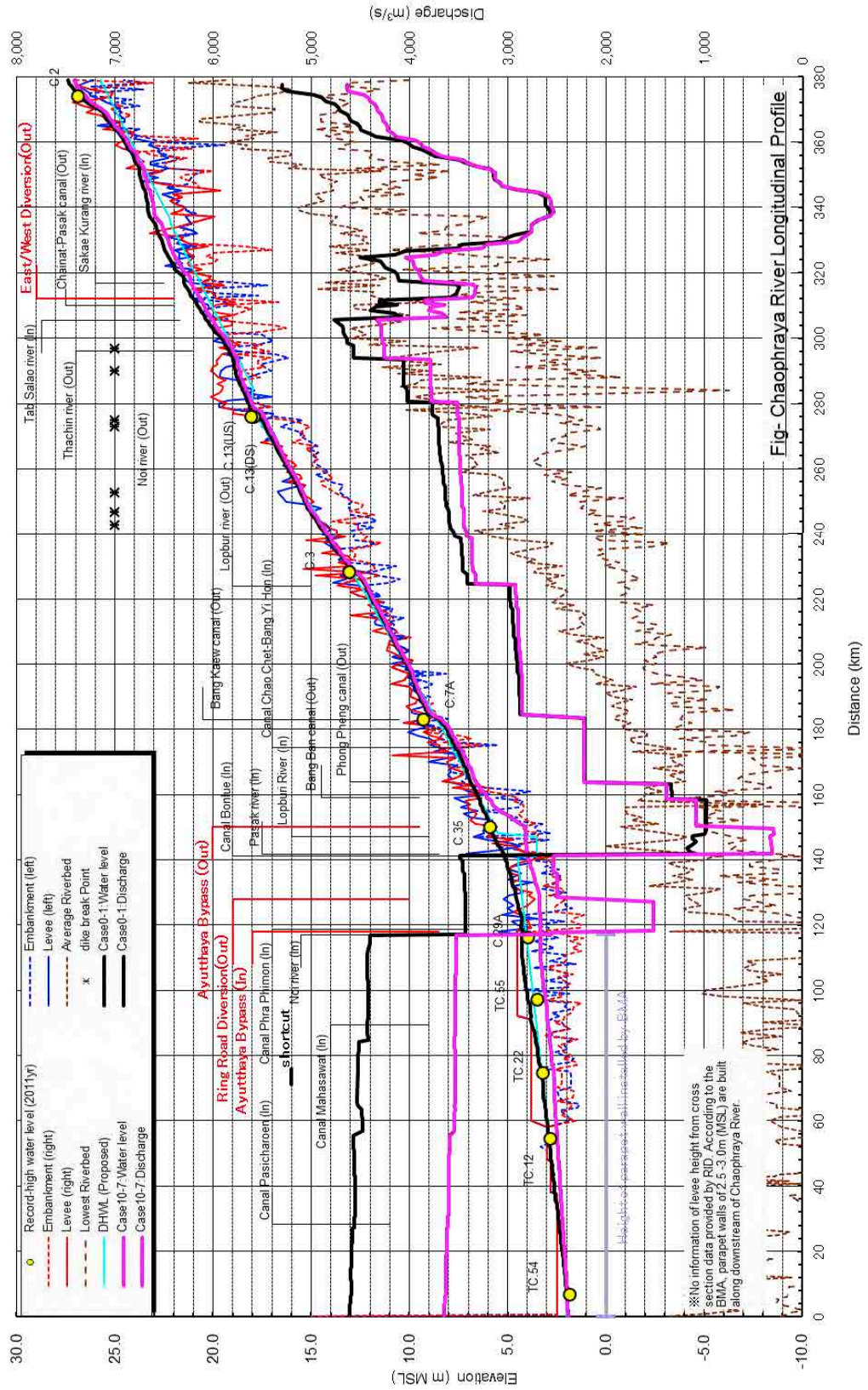


Figure D2.5.28 Longitudinal Section of Chao Phraya River (Case 10-7-4sc-ng)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s, C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate, Right and Left flood protection wall of Tha Chin River)

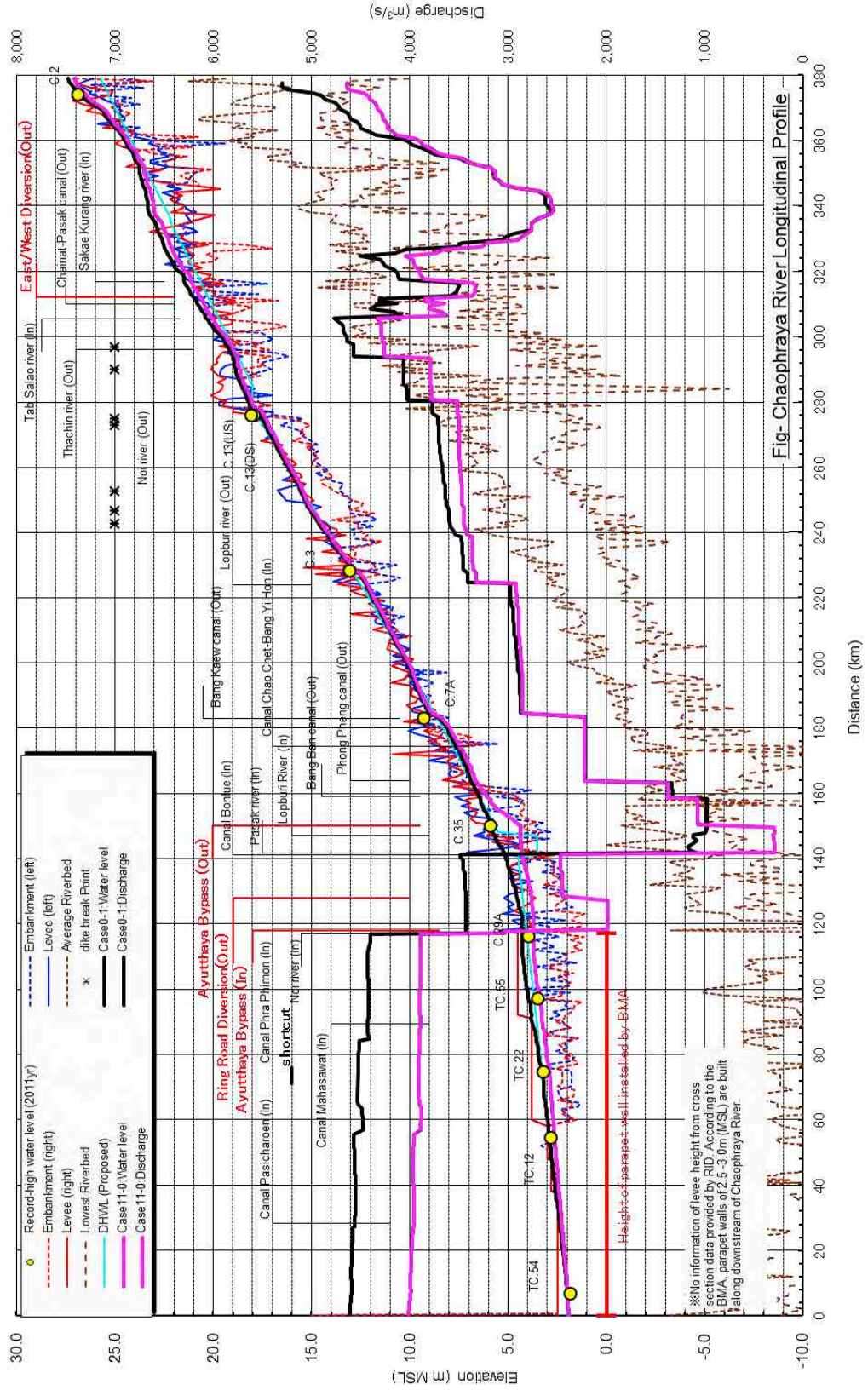


Figure D2.5.29 Longitudinal Section of Chao Phraya River (Case 11-0)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 500 m^3/s, C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate, Left flood protection wall of Tha Chin River)

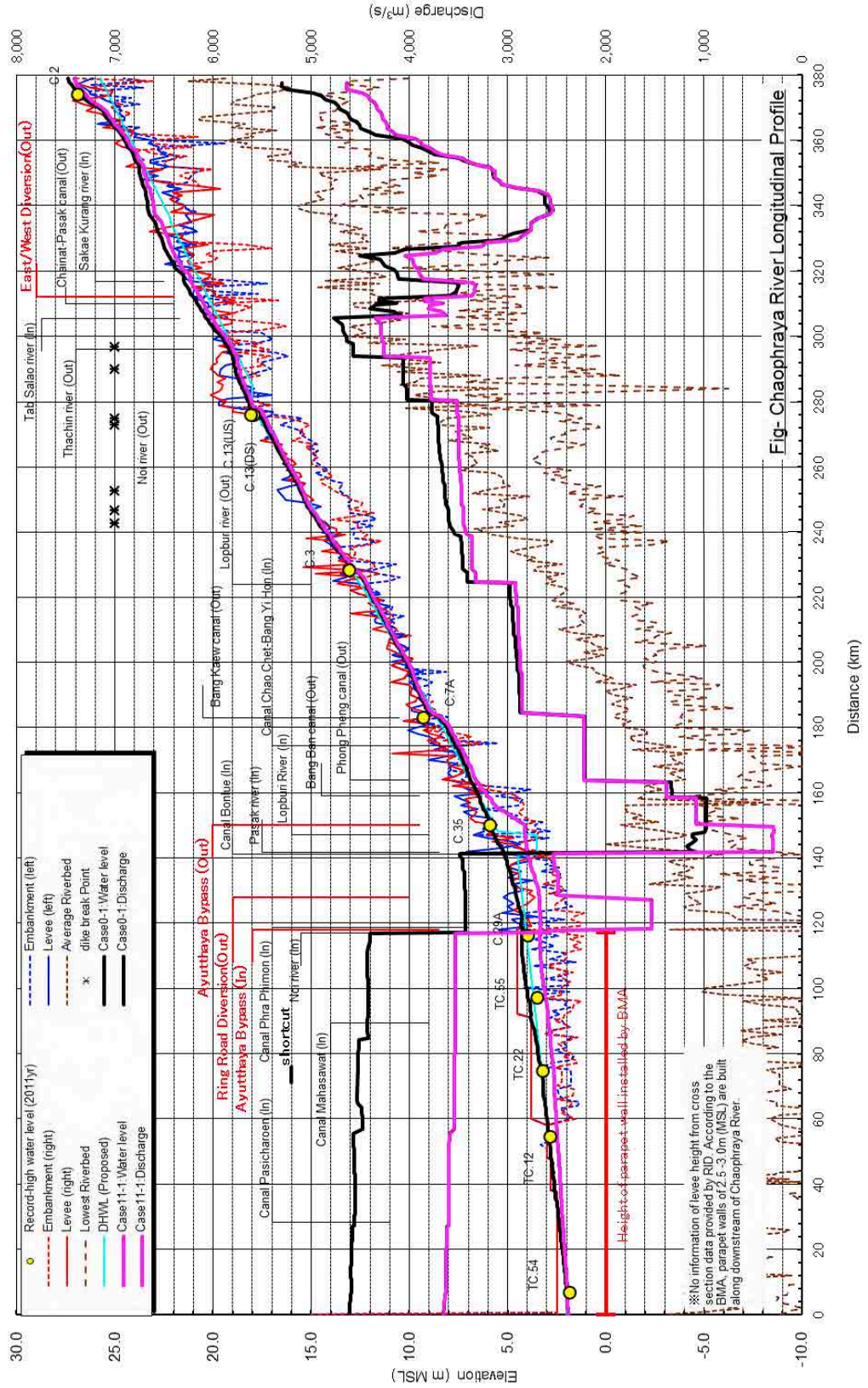
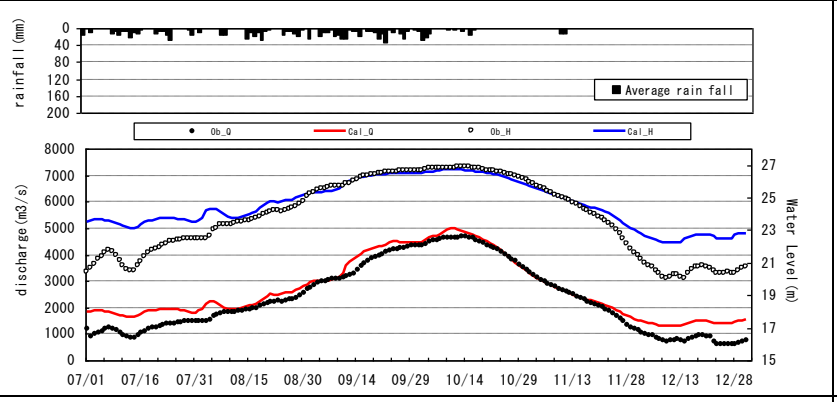
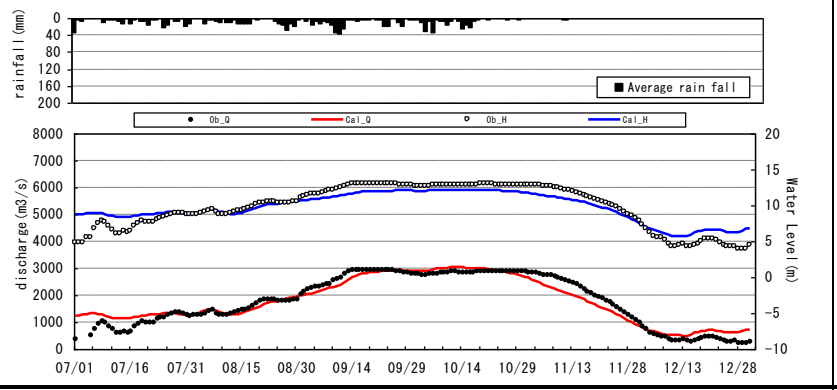
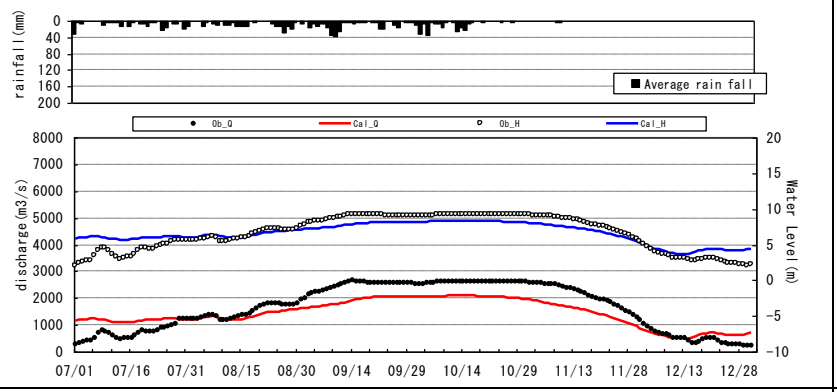
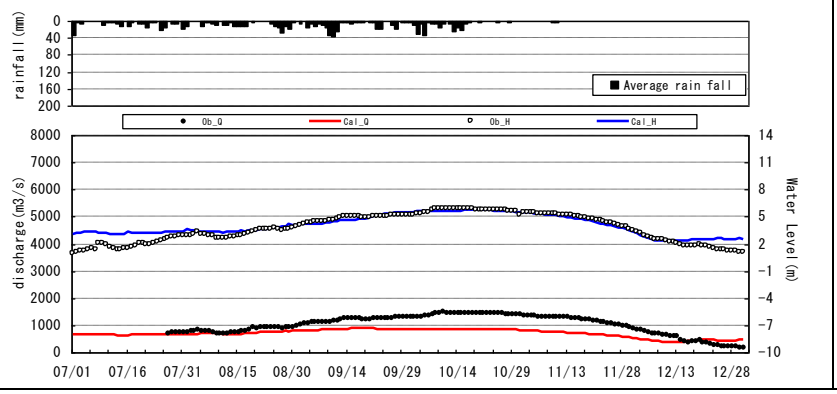


Figure D2.5.30 Longitudinal Section of Chao Phraya River (Case 11-1)
(C5-2 : Ayutthaya diversion channel 1,400m^3/s, C6-2 : Central diversion channels 1,000 m^3/s, C7 : Effective operation of existing dams, 4 short cuts of Tha Chin river without gate, Left flood protection wall of Tha Chin River)

D2.5.2 Hydrograph at Major Hydrological Stations

Table D2.5.1 Hydrograph in Chao Phraya River (Case 0 : Reproducing the 2011 Flood)

Chao Phraya River	Description
	C.2 (Nakhon Sawan)
	C.3 (Sing Buri)
	C.7A (Ang Thong)
	C.35 (Ayutthaya)

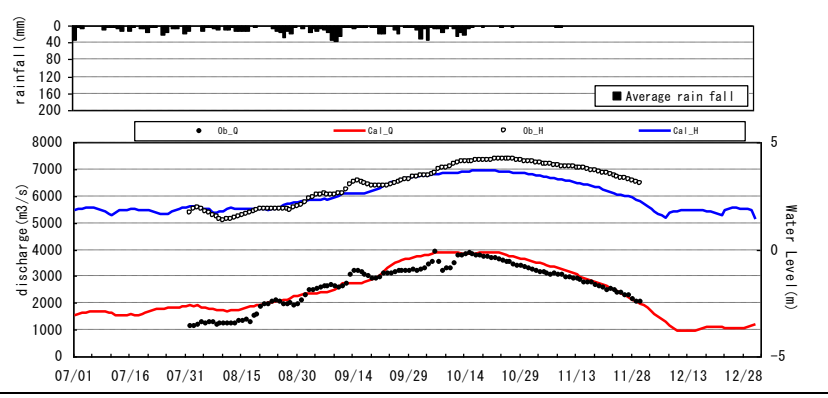
Chao Phraya River	Description
	C.29 (Bang Sai)

Table D2.5.2 Hydrograph in Pasak River (Case 0 : Reproducing the 2011 Flood)

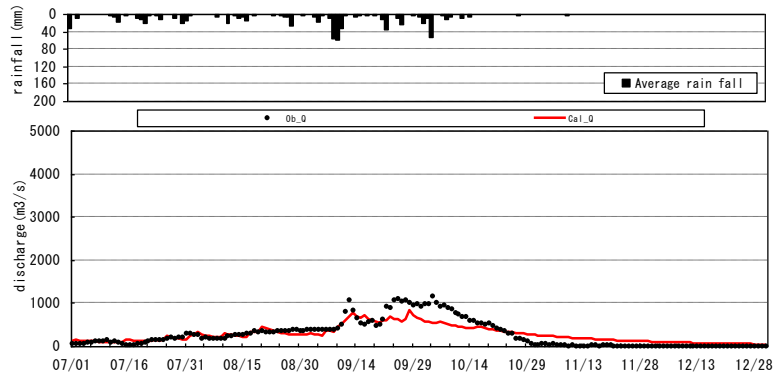
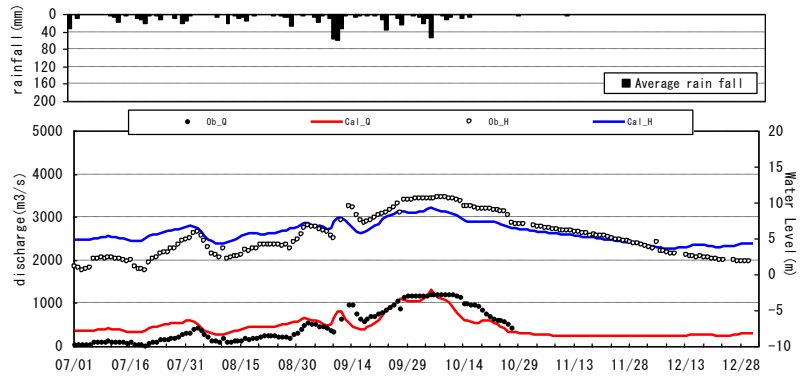
Pasak River	Description
	Pasak Dam Inflow
	S.26 (Downstream of Rama VI Barrage)

Table D2.5.3 Hydrograph in Phon-pen Canal (Case 0 : Reproducing the 2011 Flood)

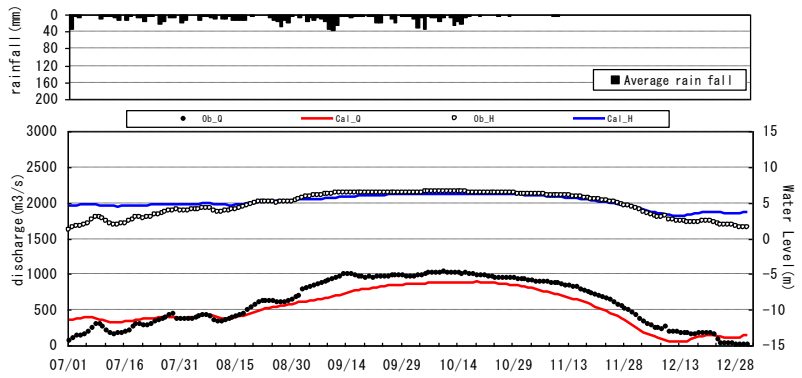
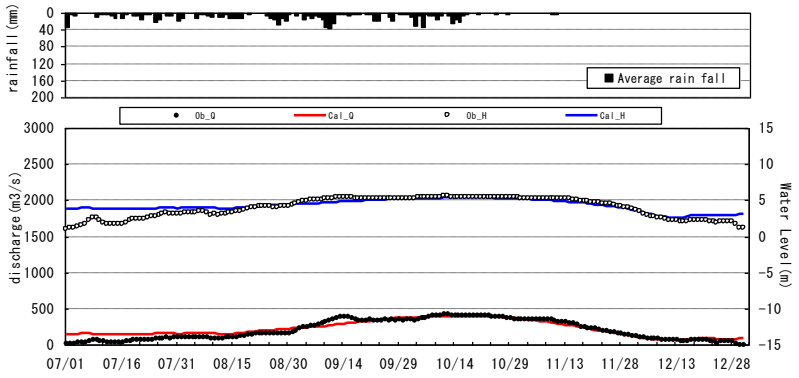
Phon-pen Canal	Description
	C.36

Table D2.5.4 Hydrograph in Bang Ban Canal (Case 0 : Reproducing the 2011 Flood)

Bang Ban Canal	Description
	C.37