ANNEX 3E WATER QUALITY IMPACT ASSESSMENT FOR CMPS LOCATED AT WEST OF THE KEY AREA

3E.1 Introduction

To ensure the water quality impact assessment provide sufficient coverage in terms of potential worse case for the Water Sensitive Receiver (WSRs) to the west of the Project, two additional scenarios, Scenario C1A and Scenario C2A, which were not described in the *Method Statement for Water Quality Modelling Assessment (**Annex 3A**)*, were conducted to assess the potential water quality impact of concurrent dredging, backfilling and capping works at west of the Key Area. The adopted modelling assumptions for these two additional scenarios (C1A and C2A) are entirely the same as Scenarios C1 and C2, except for the locations of sediment sources under this Project. These two scenarios are described below.

- Scenario C1A - assume three CMPs located at west of the Key Area (closer to Cheung Chau) to be constructed and operated concurrently; hopper barge backfilling at the northernmost CMP, grab dredging (with 2 grab dredgers) at the middle CMP and hopper barge capping at the southernmost CMP as well as other concurrent projects; and
- Scenario C2A - similar to scenario C1A except dredging would be conducted by one Trailing Suction Hopper Dredger (TSHD).

3E.2 Impact Assessment on Changes in Water Quality due to Construction and Operation Activities

3E2.1 Suspended Solids (SS) Dispersion and Sedimentation

Scenario C1A

In this scenario, three CMPs located at west of the Key Area (closer to Cheung Chau) are assumed to be constructed and operated concurrently. For conservative assessment on the hydrodynamic regime in the Assessment Area, the coastline of potential artificial islands in the Central Waters has been taken into account in the modelling (1). Concurrent backfilling in the northernmost pit at rate of 26,700 m^3/day, grab dredging by two grab dredgers at the middle pit with rate of 50,000 m^3/week per dredger, as well as capping at the southernmost pit at rate of 26,700 m^3/day are modelled.

Predicted levels of maximum SS elevation at the identified WSRs are provided in ***Table 3E.1***. Contour plots of predicted maximum SS elevation (depth-averaged, surface, middle and bottom depths) at dry and wet seasons are provided in ***Figures 3E.1*** and ***3E.2***, respectively. The predicted maximum SS elevations at all identified WSRs are below the corresponding assessment criteria, and thus are in compliance with the relevant WQO. The maximum SS elevation of 0.8 mg L^{-1} is predicted to occur at CR22 (corals at Pak Kok) in dry season and 1.1 mg L^{-1} at both MP1-A (Potential South Lamma MP) and CR01 (corals at Cheung Chau) in wet season. The Potential South Lamma MP is located over 2 km from the Project site. As shown in ***Figures 3E.1*** and ***3E.2***, the predicted SS elevation is mostly contributed by the concurrent TSHD dredging under Improvement Dredging for Lamma Power Station Navigation Channel. When compared with Scenario C1, the sediment sources located at west of the Key Area resulted in slightly higher SS elevation at WSRs around Cheung Chau, including B1 (Cheung Chau Tung Wan Beach), B2 (Kwun Yum Wan Beach) and NB4 (Po Yue Wan). The overall elevation levels for both scenarios are however very low (<0.6 mg/L) and well below the maximum allowable change of WQO. The predicted sedimentation flux at nearby coral locations are also below the corresponding assessment criterion of 100 g/m^2/day and thus no unacceptable impacts to coral communities are expected due to sediment deposition from the Project.

(1) The coastline is referenced from the information paper on "Studies related to artificial islands in the Central Waters" discussed on 14 May 2019 for Public Works Subcommittee of Finance Committee (PWSC(2019-20)5)

The maximum sedimentation flux is predicted to occur at CR22 (Pak Kok) in dry season (38 g/m^2/day) and CR01 (Cheung Chau) in wet season (47 g/m^2/day) (***Figure 3E.5*** and ***Table 3E.2***).

The sediment plume under this scenario is very similar to that of Scenario C1, but has significantly reduced overlap with the sediment plume under the concurrent TSHD dredging under Improvement Dredging for Lamma Power Station Navigation Channel. On the other hand, interaction with the sediment plume from the open sea disposal at South of Cheung Chau is observed. Such interaction of sediment plume would not result in notable cumulative sediment impact.

Scenario C2A

In this scenario, three CMPs located at west of the Key Area (closer to Cheung Chau) are assumed to be constructed and operated concurrently. For conservative assessment on the hydrodynamic regime in the Assessment Area, the coastline of potential artificial islands in the Central Waters has been taken into account in the modelling. Concurrent backfilling in the northernmost pit at rate of 26,700 m^3/day, TSHD dredging at the middle pit with rate of 256,200 m^3/week, as well as capping at the southernmost pit at rate of 26,700 m^3/day are modelled.

Predicted maximum levels of SS elevation at the identified WSRs are provided in ***Table 3E.1***. Contour plots of predicted maximum SS elevation (depth-averaged, surface, middle and bottom depths) at dry and wet seasons are provided in ***Figures 3E.3*** and ***3E.4***, respectively. The predicted maximum SS elevations at the identified WSRs are relatively low and similar to the prediction under Scenario C1A. The maximum SS elevation of 0.8 mg L^{-1} is predicted to occur at CR22 (corals at Pak Kok) in dry season and 1.0 mg L^{-1} at both MP1-A (Potential South Lamma MP) and CR01 (corals at Cheung Chau) in wet season. The Potential South Lamma MP is located over 2 km from the Project site. As shown in ***Figures 3E.3*** and ***3E.4***, the predicted elevation is mostly contributed by the concurrent TSHD dredging under Improvement Dredging for Lamma Power Station Navigation Channel. Similar levels of sedimentation flux were predicted at nearby coral WSRs as well. The maximum sedimentation flux is predicted to occur at CR22 (Pak Kok) in dry season (38 g/m^2/day) and CR01 (Cheung Chau) and CR23 (Shek Kok Tsui) in wet season (43 g/m^2/day) (***Figure 3E.5*** and ***Table 3E.2***), which are both below the proposed assessment criterion.

The sediment plume under this scenario is similar to that of Scenario C1A given the same hydrodynamics and sediment source locations. The increased sediment loss rate from TSHD dredging have limited impact on the extent of the sediment plume while the increased sediment loss from the disposal works at South of Cheung Chau resulted in slight increase in plume extent, resulting in slightly more overlapping of sediment plumes from this Project and the open sea disposal at South of Cheung Chau. Nevertheless, significant cumulative impact to water quality is not anticipated.

Time series plots of predicted SS elevation at WSRs with highest SS elevation (MP1-B, MP1-C, CR01 and CR22) and predicted sedimentation flux with the highest values at CR01 and CR22 under Scenarios C1A and C2A are presented in ***Figures 3E.6 - 3E.15***. The predicted SS elevation varies with tidal conditions and reaches the maximum at about once in each 15-day tidal cycle. Surface level SS elevation is typically lower than the corresponding level near the bottom, and the depth-averaged level is typically in between the two.

It should be highlighted that in Scenarios C1A and C2A, the assumed sediment loss rates under the construction and operation activities of the Project (i.e. dredging, backfilling and capping) were at the respective maximum. Similarly, it is also assumed that all the identified concurrent marine works would be conducted with their maximum allowed sediment loss rates. This means the predicted SS elevation in all scenarios would be conservative. Under these representative and conservative scenarios, no unacceptable adverse impacts from SS dispersion and sedimentation are anticipated.

Table 3E.1 Predicted SS Elevation at Identified WSRs

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
Fisheries Sensitive Receivers												
Fish Culture Zone (FCZ)	Cheung Sha Wan FCZ	FCZ1	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.0	0.0	100%
	Lo Tik Wan FCZ	FCZ2 (3)	SM3	Depth-averaged	3.1	0.0	0.0	100%	2.9	0.2	0.1	100%
	Sok Kwu Wan FCZ	FCZ3 (3)	SM4	Depth-averaged	2.5	0.0	0.0	100%	2.3	0.0	0.0	100%
	Ma Wan FCZ	FCZ4	WM4	Depth-averaged	6.3	0.1	0.1	100%	4.0	0.2	0.2	100%
Marine Ecological Sensitive Receivers												
Marine Park (MP)	Potential South Lamma MP	MP1-A (2)(3)	SM5	Depth-averaged	4.1	0.0	0.0	100%	3.0	0.1	0.1	100%
		MP1-B (2)(3)	SM6	Depth-averaged	3.7	0.6	0.6	100%	3.1	0.6	0.6	100%
		MP1-C (2)(3)	SM6	Depth-averaged	3.7	0.0	0.0	100%	3.1	0.3	0.3	100%
	South Lantau MP	MP2 (2)(3)	SM12	Depth-averaged	6.1	0.1	0.1	100%	4.2	0.0	0.0	100%
Corals	Cheung Chau	CR01 (1)(3)	SM12	Bottom	6.6	0.0	0.0	100%	5.4	1.1	1.0	100%
		CR11 (1)(3)	SM12	Bottom	6.6	0.0	0.0	100%	5.4	0.7	0.6	100%
		B1 (1)(3)	SM12	Bottom	6.6	0.0	0.0	100%	5.4	0.7	0.7	100%
	Hei Ling Chau	CR02 (1)	SM11	Bottom	6.0	0.1	0.1	100%	5.1	0.4	0.4	100%
		CR03 (1)	SM11	Bottom	6.0	0.1	0.1	100%	5.1	0.5	0.5	100%

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
		CR09 (1)	SM11	Bottom	6.0	0.0	0.0	100%	5.1	0.0	0.0	100%
	Chi Ma Wan Peninsula	CR04	SM12	Bottom	6.6	0.0	0.0	100%	5.4	0.0	0.0	100%
	Sunshine Island	CR05 (1)	SM11	Bottom	6.0	0.0	0.0	100%	5.1	0.1	0.1	100%
		CR06 (1)	SM11	Bottom	6.0	0.0	0.0	100%	5.1	0.1	0.0	100%
		CR07 (1)	SM11	Bottom	6.0	0.1	0.1	100%	5.1	0.1	0.1	100%
		CR08 (1)	SM11	Bottom	6.0	0.1	0.1	100%	5.1	0.1	0.1	100%
	Kau Yi Chau	CR10	SM9	Bottom	3.9	0.0	0.0	100%	7.8	0.0	0.0	100%
		CR26	SM9	Bottom	3.9	0.0	0.0	100%	7.8	0.0	0.0	100%
		CR27	SM9	Bottom	3.9	0.0	0.0	100%	7.8	0.1	0.1	100%
	Siu Kau Yi Chau	CR28	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.1	0.1	100%
		CR29	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.1	0.1	100%
		CR30	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.1	0.1	100%
	Hung Shing Yeh	CR20 (1)	SM5	Bottom	4.8	0.0	0.0	100%	4.2	0.0	0.0	100%
	Ha Mei Wan	CR21 (1)(3)	SM5	Bottom	4.8	0.0	0.0	100%	4.2	0.1	0.1	100%
	Pak Kok	CR22 (1)	WM1	Bottom	4.8	0.8	0.8	100%	4.8	0.5	0.5	100%
	Shek Kok Tsui	CR23 (1)	SM7	Bottom	4.2	0.6	0.6	100%	5.4	0.6	0.6	100%
	Sandy Bay	CR24	WM2	Bottom	5.7	0.2	0.2	100%	5.7	0.2	0.2	100%
	Green Island	CR25	VM8	Bottom	6.9	0.4	0.4	100%	5.7	0.5	0.5	100%
	Peng Chau	CR31	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.1	0.1	100%
		CR32	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.0	0.0	100%
		CR33	SM10	Bottom	5.4	0.0	0.0	100%	5.2	0.0	0.0	100%

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
		CR34	SM9	Bottom	3.9	0.0	0.0	100%	7.8	0.0	0.0	100%
		CR35	SM9	Bottom	3.9	0.0	0.0	100%	7.8	0.0	0.0	100%
	Sham Wan	TNG (1)(3)	SM4	Bottom	3.0	0.0	0.0	100%	3.0	0.0	0.0	100%
Green Turtle Nesting Ground / SSSI	Sham Wan	TNG (1)(3)	SM4	Depth-averaged	2.5	0.0	0.0	100%	2.3	0.0	0.0	100%
Water Sensitive Receivers												
Gazetted Beaches	Cheung Chau Tung Wan Beach	B1 (1)(3)	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.6	0.5	100%
	Kwun Yam Wan Beach	B2 (1)(3)	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.3	0.3	100%
	Hung Shing Yeh Beach	B3 (1)(3)	SM5	Depth-averaged	4.1	0.0	0.0	100%	3.0	0.0	0.0	100%
	Lo So Shing Beach	B4 (1)(3)	SM5	Depth-averaged	4.1	0.0	0.0	100%	3.0	0.0	0.0	100%
	Tung Wan Beach, Ma Wan	B5	WM4	Depth-averaged	6.3	0.0	0.0	100%	4.0	0.0	0.0	100%
	Approach Beach	B6	WM4	Depth-averaged	6.3	0.1	0.1	100%	4.0	0.1	0.1	100%
	Ting Kau Beach	B7	WM4	Depth-averaged	6.3	0.0	0.0	100%	4.0	0.0	0.0	100%
	Lido Beach	B8	WM4	Depth-averaged	6.3	0.0	0.0	100%	4.0	0.1	0.1	100%
	Casam Beach	B9	WM4	Depth-averaged	6.3	0.1	0.1	100%	4.0	0.1	0.1	100%

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
	Hoi Mei Wan Beach	B10	WM4	Depth-averaged	6.3	0.1	0.1	100%	4.0	0.1	0.1	100%
	Gemini Beach	B11	WM4	Depth-averaged	6.3	0.3	0.3	100%	4.0	0.2	0.2	100%
	Anglers' Beach	B12	WM4	Depth-averaged	6.3	0.2	0.2	100%	4.0	0.2	0.2	100%
Non-gazetted Beaches	Tai Kwai Wan	NB3 (1)(3)	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.0	0.0	100%
	Po Yue Wan	NB4 (1)(3)	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.0	0.1	100%
Seawater Intakes	Sha Wan Drive	C1	WM2	Bottom	5.7	0.0	0.0	100%	5.7	0.0	0.0	100%
	Wah Fu Estate	C2	WM1	Bottom	4.8	0.0	0.0	100%	4.8	0.0	0.0	100%
	Lamma Power Station (b)	C3 (1)(3)	SM5	Bottom	84.0	0.0	0.0	100%	86.0	0.0	0.0	100%
	Integrated Waste Management Facilities at Shek Kwu Chau	C4 (1)(3)	SM12	Bottom	6.6	0.0	0.0	100%	5.4	0.0	0.0	100%
	Offshore LNG Terminal	C5 (3)	SM12	Bottom	6.6	0.0	0.0	100%	5.4	0.0	0.0	100%
	Tsuen Wan	C6	VM14	Bottom	4.8	0.0	0.0	100%	3.9	0.0	0.0	100%
	MTR Tsing Yi Station	C7	VM12	Bottom	8.1	0.0	0.0	100%	7.7	0.0	0.0	100%

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
	MTR Kowloon Station	C8	VM6	Bottom	4.5	0.0	0.0	100%	4.2	0.0	0.0	100%
	China H.K. City	C9	VM6	Bottom	4.5	0.0	0.0	100%	4.2	0.0	0.0	100%
	Queen Mary Hospital	C10	WM2	Bottom	5.7	0.0	0.0	100%	5.7	0.0	0.0	100%
	Kwai Chung Hospital	EMSD1	VM12	Bottom	8.1	0.0	0.0	100%	7.7	0.0	0.0	100%
WSD Flushing Intakes	Tsing Yi	WSD1	VM12	Depth-averaged	6.8	0.1	0.1	100%	5.3	0.1	0.1	100%
	Kennedy Town	WSD2	VM8	Depth-averaged	5.2	0.3	0.3	100%	3.5	0.2	0.2	100%
	Sheung Wan	WSD3	VM7	Depth-averaged	4.1	0.0	0.0	100%	3.2	0.1	0.1	100%
	Centrol Water Front	WSD4	VM6	Depth-averaged	3.3	0.0	0.0	100%	0.2	0.0	0.0	100%
	Ap Lei Chau	WSD5	SM3	Depth-averaged	3.1	0.0	0.0	100%	0.5	0.1	0.1	100%
	Kowloon South	WSD6	VM6	Depth-averaged	3.3	0.0	0.0	100%	0.2	0.0	0.0	100%
	Cheung Sha Wan	WSD7	VM15	Depth-averaged	4.5	0.0	0.0	100%	4.1	0.0	0.0	100%
	Tsuen Wan	WSD8	VM14	Depth-averaged	4.6	0.0	0.0	100%	3.4	0.0	0.0	100%
	Near Hong Kong Garden	WSD9	WM4	Depth-averaged	6.3	0.2	0.2	100%	4.0	0.1	0.1	100%

Description	Location	Model Output Location	EPD Station	Relevant Depth	Dry Season (WQO Allowable Change) (mg L^{-1})	Dry Season Max Increase (mg L^{-1})		Dry Season Compliance Time %	Wet Season (WQO Allowable Change) (mg L^{-1})	Wet Season Max Increase (mg L^{-1})		Wet Season Compliance Time %
						Scenario C1A	Scenario C2A			Scenario C1A	Scenario C2A	
	Pumping Station at Tai Kwai Wan	NB3	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.0	0.0	100%
Typhoon Shelters	Cheung Chau	TS1 (3)	SM12	Depth-averaged	6.1	0.0	0.0	100%	4.2	0.0	0.0	100%
	Hei Ling Chau	TS2	SM10	Depth-averaged	4.8	0.0	0.0	100%	4.5	0.0	0.0	100%
	Aberdeen	TS3	WM1	Depth-averaged	3.2	0.0	0.0	100%	3.1	0.0	0.0	100%
	Rambler Channel	TS4	VM14	Depth-averaged	4.6	0.0	0.0	100%	3.4	0.0	0.0	100%
	New Yau Ma Tei	TS5	VM15	Depth-averaged	4.2	0.0	0.0	100%	4.1	0.0	0.0	100%
	Government Dockyard	TS6	VM15	Depth-averaged	4.2	0.0	0.0	100%	4.1	0.0	0.0	100%

Notes:

1. The WSR also represents secondary contact recreation subzone.
2. The WSR also represents habitat for FP.
3. The WSR also represents nursery area and spawning ground for commercial fisheries resources.

Table 3E.2 Predicted Sedimentation Flux (g/m^2/day) at the Identified Coral WSRs

Location	Model Output Location	EPD Station	Assessment Criterion (g/m^2/day)	Dry Season Max Increase (g/m^2/day)		Wet Season Max Increase (g/m^2/day)	
				Scenario C1A	Scenario C2A	Scenario C1A	Scenario C2A
Cheung Chau	CR01	SM12	100	0	0	32	43
	CR11	SM12	100	1	1	38	35
	B1	SM12	100	0	0	32	30
Hei Ling Chau	CR02	SM11	100	3	3	17	15
	CR03	SM11	100	4	4	23	20
	CR09	SM11	100	0	0	0	0
Chi Ma Wan Peninsula	CR04	SM12	100	0	0	0	0
Sunshine Island	CR05	SM11	100	1	1	3	3
	CR06	SM11	100	1	1	1	1
	CR07	SM11	100	3	3	4	4
	CR08	SM11	100	2	2	3	3
Kau Yi Chau	CR10	SM9	100	0	0	2	2
	CR26	SM9	100	0	0	1	1
	CR27	SM9	100	0	0	3	3
Siu Kau Yi Chau	CR28	SM10	100	2	2	4	4
	CR29	SM10	100	2	2	3	3
	CR30	SM10	100	1	1	3	3
Hung Shing Yeh	CR20	SM5	100	0	0	1	1
Ha Mei Wan	CR21	SM5	100	0	0	4	3
Pak Kok	CR22	WM1	100	38	38	39	36
Shek Kok Tsui	CR23	SM7	100	29	29	44	43
Sandy Bay	CR24	WM2	100	7	7	9	9
Green Island	CR25	VM8	100	20	20	20	20
Peng Chau	CR31	SM10	100	0	0	0	0
	CR32	SM10	100	0	0	0	0
	CR33	SM10	100	0	0	0	0

Location	Model Output Location	EPD Station	Assessment Criterion ($g/m^2/day$)	Dry Season Max Increase ($g/m^2/day$)		Wet Season Max Increase ($g/m^2/day$)	
				Scenario C1A	Scenario C2A	Scenario C1A	Scenario C2A
	CR34	SM9	100	0	0	0	0
	CR35	SM9	100	0	0	0	0
Sham Wan	TNG	SM4	100	0	0	0	0

Note: Sedimentation flux predicted by the model is instantaneous even though the output unit was based on daily. The values presented are the amount of sediment in gram settled on one square meter of area if the maximum sedimentation rate sustained for one day. In reality such instantaneous maximum would occur just once in the entire modelling period and would be far shorter than 1 day. Thus the presented results are conservative when interpreted based on the assessment criterion.

3E2.2 Dissolved Oxygen Depletion

As discussed in ***Section 3.7.1.2***, the degree of DO depletion exerted by a sediment plume is a function of the sediment oxygen demand of the sediment, its concentration in the water column and the rate of oxygen replenishment. For Scenarios C1A and C2A, the predicted maximum SS elevation level is 1.1 mg L^{-1} at CR01 and the corresponding level of DO depletion is calculated to be:

DO (mg O_2 L^{-1}) = 1.1 (g DW m^{-3}) × 28,000 (mg O_2 kg^{-1} DW) = 30.8 (mg O_2 m^{-3}) = 0.0308 mg L^{-1}

The maximum predicted DO depletion level is around 0.03 mg L^{-1} (at CR01, where allowable DO depletion is 3.2 mg/L), which is considered to be insignificant. DO depletion levels at other identified WSRs would be even lower due to insignificant SS elevation from the Project. The estimated maximum levels of DO depletion from backfilling, dredging and capping are presented in ***Figure 3E.16*** to illustrate the spatial coverage.

Note that there are WSRs with low DO baseline levels which make allowable DO depletion level close to zero. These WSRs include Lo Tik Wan FCZ (FCZ2), Sok Kwu Wan FCZ (FCZ3), Ma Wan FCZ (FCZ4), Anglers' Beach (B12) and Rambler Channel (TS4). Among these WSRs, SS elevation was predicted to be at detectable level of 0.2 mg/L at FCZ2 (wet season only), FCZ4 (wet season only), and B12 (both dry and wet seasons), while the predicted SS elevation at TS4 was negligible. The level of DO depletion corresponding to 0.2 mg/L of SS elevation is 0.0056 mg/L, which is considered to be negligible. Therefore, the negligible levels of DO depletion is not expected to result in notable deterioration of water quality at these WSRs. Overall, no unacceptable water quality impact from DO depletion is anticipated.

3E2.3 Release of Sediment-bounded Contaminants

As discussed in ***Section 3.7.1.3***, the risk of release of sediment-bounded contaminants was assessed with the aid of computational modelling using Delft3D. Similar to the case of sediment dispersion modelling, two modelling scenarios were simulated, namely:

- Scenario C3A – assume three CMPs located at west of the Key Area (closer to Cheung Chau) to be constructed and operated concurrently; hopper barge backfilling at the northernmost CMP and grab dredging (with 2 grab dredgers) at the middle CMP; and
- Scenario C4A - similar to scenario C3A except the dredging would be conducted by one TSHD.

In the model simulation, conservative tracer was released into the water column at the same rate as sediment of the corresponding sources for backfilling and dredging of the Project specified in Scenarios C1A and C2A respectively. Note that given the use of uncontaminated filling materials for capping, it is assumed there would be no release of contaminants from capping and thus there is no conservative tracer release modelled for capping. Contaminant levels at WSRs were estimated based on the predicted concentration of conservative tracer, as well as levels of contaminants in sediment.

Contaminant Level at WSR (µg L^{-1})
= Conservative Tracer Concentration for Backfilling (mg L^{-1}) × Tracer-to-Contaminant Conversion Ratio for Backfilling (µg kg^{-1}) + Conservative Tracer Concentration for Dredging (mg L^{-1}) × Tracer-to-Contaminant Conversion Ratio for Dredging (µg kg^{-1})

The contour plots for the modelled maximum depth-averaged levels of conservative tracers from backfilling and dredging activities are shown in ***Figure 3E.17*** and ***Figure 3E.18***, respectively. The WSRs with the maximum predicted conservative tracer concentrations under various modelling scenarios are provided in ***Table 3E.3***. The maximum levels of conservative tracer were predicted for a few WSRs, namely, CR01 (Cheung Chau), CR03 (Hei Ling Chau) CR23 (Shek Kok Tsui) and NB4 (Po Yue Wan). This means the potential maximum levels of contaminants (which would be proportional to the predicted tracer concentration), would be maximum among these WSRs. The predicted concentration of two kinds of conservative tracers, the corresponding tracer-to-contaminant

ratios as well as the calculated levels of contaminants at these four WSRs are presented in ***Table 3E.4***.

As shown in ***Table 3E.4***, the predicted levels of contaminants at the most impacted WSRs were all below the corresponding assessment criteria shown in ***Table 3.12 of Section 3*****.** Compliance at all other identified WSRs in the Assessment Area is also expected for all the contaminants considered. Therefore, it is concluded that no unacceptable water quality impact associated with release of sediment-bounded contaminants is anticipated.

Table 3E.3 Predicted Maximum Conservative Tracer Concentrations at WSRs under various Scenarios

Season	Dry				Wet			
Scenario	C3A		C4A		C3A		C4A	
WSR	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging
FCZ1	3.1456	0.9784	3.1456	1.0677	1.4883	0.5651	1.4883	0.7340
FCZ2	0.0165	0.0023	0.0165	0.0028	1.0767	0.4060	1.0767	0.2943
FCZ3	0.0062	0.0008	0.0062	0.0010	0.7592	0.2882	0.7592	0.2270
FCZ4	0.2230	0.0462	0.2230	0.0539	0.4946	0.1793	0.4946	0.1583
MP1-A	0.0044	0.0004	0.0044	0.0005	1.6047	0.6684	1.6047	0.5317
MP1-B	0.0213	0.0010	0.0213	0.0016	1.2069	0.5455	1.2069	0.4242
MP1-C	0.0069	0.0002	0.0069	0.0004	0.8719	0.3633	0.8719	0.3929
MP2	3.0991	1.2596	3.0991	1.3329	0.7883	0.3305	0.7883	0.4234
CR01	5.0844	1.7250	5.0844	1.8616	**2.6439**	**1.1324**	**2.6439**	**1.5471**
CR11	5.3538	1.8270	5.3538	1.9581	2.4250	1.0647	2.4250	1.4609
CR02	5.6766	2.1052	5.6766	2.2569	2.4741	0.8958	2.4741	1.2429
CR03	**5.9750**	**2.2249**	**5.9750**	**2.3859**	2.5610	0.9544	2.5610	1.3874
CR09	3.5480	1.1065	3.5480	1.2079	1.4449	0.5871	1.4449	0.7401
CR04	3.3166	1.0245	3.3166	1.1189	1.7320	0.6526	1.7320	0.8676
CR05	4.8148	1.4524	4.8148	1.5958	1.9291	0.6466	1.9291	0.7805
CR06	4.9393	1.4746	4.9393	1.6234	1.8388	0.6247	1.8388	0.7034
CR07	5.2891	1.5907	5.2891	1.7383	1.6049	0.4940	1.6049	0.5296
CR08	4.5821	1.2405	4.5821	1.3922	1.4595	0.4685	1.4595	0.4789
CR10	1.5200	0.3247	1.5200	0.3751	1.1085	0.3734	1.1085	0.3342
CR26	1.4054	0.2960	1.4054	0.3434	0.9558	0.3317	0.9558	0.2988
CR27	1.4987	0.3344	1.4987	0.3860	0.9087	0.3122	0.9087	0.3116
CR28	2.0477	0.4587	2.0477	0.5294	1.1529	0.3948	1.1529	0.4110
CR29	2.0451	0.4602	2.0451	0.5308	1.1947	0.4072	1.1947	0.4246
CR30	2.0871	0.4675	2.0871	0.5396	1.2115	0.4121	1.2115	0.4296
CR20	0.0032	0.0003	0.0032	0.0004	1.0821	0.4881	1.0821	0.4751
CR21	0.0042	0.0004	0.0042	0.0005	1.0793	0.4594	1.0793	0.4484
CR22	0.0844	0.0129	0.0844	0.0155	1.0660	0.4184	1.0660	0.3454
CR23	0.1023	0.0127	0.1023	0.0158	1.5523	0.5701	1.5523	0.3740
CR24	0.0238	0.0037	0.0238	0.0045	1.2537	0.4668	1.2537	0.3354
CR25	0.0619	0.0113	0.0619	0.0134	0.8623	0.3109	0.8623	0.2485
CR31	2.0472	0.5334	2.0472	0.6004	1.0372	0.3679	1.0372	0.3924
CR32	1.2975	0.3036	1.2975	0.3475	0.8299	0.2951	0.8299	0.3154
CR33	1.8887	0.4812	1.8887	0.5434	0.9859	0.3515	0.9859	0.3749
CR34	2.1788	0.4945	2.1788	0.5694	1.2314	0.4241	1.2314	0.4538
CR35	2.6012	0.5600	2.6012	0.6549	1.2517	0.4321	1.2517	0.4818
TNG	0.0001	0.0000	0.0001	0.0000	0.5240	0.2310	0.5240	0.2570

Season	Dry				Wet			
Scenario	C3A		C4A		C3A		C4A	
WSR	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging	Tracer for Backfilling	Tracer for Dredging
B1	5.1231	1.7972	5.1231	1.9388	2.3440	0.8796	2.3440	1.1905
B2	5.1587	1.7734	5.1587	1.9136	2.3279	0.9053	2.3279	1.1989
B3	0.0034	0.0003	0.0034	0.0004	1.0924	0.4925	1.0924	0.4780
B4	0.0039	0.0004	0.0039	0.0004	1.2145	0.5426	1.2145	0.5413
B5	0.1526	0.0313	0.1526	0.0365	0.5113	0.1858	0.5113	0.1633
B6	0.1179	0.0241	0.1179	0.0281	0.4286	0.1560	0.4286	0.1331
B7	0.1070	0.0217	0.1070	0.0254	0.3560	0.1306	0.3560	0.1117
B8	0.1172	0.0239	0.1172	0.0279	0.4396	0.1601	0.4396	0.1329
B9	0.1173	0.0239	0.1173	0.0279	0.4480	0.1631	0.4480	0.1359
B10	0.1170	0.0238	0.1170	0.0278	0.4784	0.1743	0.4784	0.1458
B11	0.1350	0.0273	0.1350	0.0320	0.5148	0.1877	0.5148	0.1602
B12	0.1313	0.0265	0.1313	0.0310	0.4978	0.1812	0.4978	0.1538
NB3	4.6799	1.5360	4.6799	1.6719	1.1320	0.4854	1.1320	0.6259
NB4	5.4675	2.1242	5.4675	2.2681	1.4318	0.5892	1.4318	0.7968
C1	0.0279	0.0044	0.0279	0.0054	1.4740	0.5657	1.4740	0.3987
C2	0.0112	0.0016	0.0112	0.0019	1.5119	0.5442	1.5119	0.3840
C3	0.0035	0.0003	0.0035	0.0004	1.0589	0.4809	1.0589	0.4726
C4	4.2967	1.6642	4.2967	1.7612	1.4160	0.5880	1.4160	0.7847
C5	2.0745	0.8538	2.0745	0.8983	0.5195	0.2188	0.5195	0.2804
C6	0.0818	0.0165	0.0818	0.0193	0.4186	0.1518	0.4186	0.1241
C7	0.0577	0.0113	0.0577	0.0133	0.4370	0.1586	0.4370	0.1388
C8	0.0018	0.0003	0.0018	0.0004	0.6884	0.2473	0.6884	0.1840
C9	0.0012	0.0002	0.0012	0.0003	0.6508	0.2324	0.6508	0.1706
C10	0.0254	0.0040	0.0254	0.0048	1.6895	0.6483	1.6895	0.4543
EMSD1	0.0281	0.0054	0.0281	0.0063	0.4625	0.1677	0.4625	0.1412
WSD1	0.0643	0.0127	0.0643	0.0149	0.4488	0.1628	0.4488	0.1400
WSD2	0.0461	0.0078	0.0461	0.0094	1.2236	0.4700	1.2236	0.3276
WSD3	0.0108	0.0019	0.0108	0.0023	0.8231	0.3001	0.8231	0.2339
WSD4	0.0049	0.0008	0.0049	0.0010	0.7218	0.2567	0.7218	0.1912
WSD5	0.0040	0.0005	0.0040	0.0006	0.9654	0.3557	0.9654	0.2592
WSD6	0.0028	0.0005	0.0028	0.0006	1.0166	0.3523	1.0166	0.2425
WSD7	0.0014	0.0003	0.0014	0.0003	0.5994	0.2105	0.5994	0.1625
WSD8	0.0849	0.0172	0.0849	0.0201	0.4206	0.1526	0.4206	0.1248
WSD9	0.1221	0.0244	0.1221	0.0286	0.4650	0.1693	0.4650	0.1403

Table 3E.4 Estimation of Contaminant Levels at the Most Impacted WSRs

					Contaminant Concentration (µg/L) [a]		Assessment Criteria (µg/L)
					Dry Season	Wet Season	
Scenario C3A							
Most Impacted WSRs					CR03	CR01	
Tracer Conc. (mg/L) from Backfilling					5.9750	2.6439	
Tracer Conc. (mg/L) from Dredging					2.2249	1.1324	
	Contaminant Release Rate (g/s)						
Parameters	**Modelled Backfilling [b]**	**Actual Backfilling [b]**	**Modelled Dredging [b]**	**Actual Dredging [b]**			
Arsenic	60000	2.52	1405.4	1.546E-02	0.2754	0.1235	13
Cadmium	60000	0.24	1405.4	3.514E-04	0.0245	0.0109	5.5
Chromium	60000	9.6	1405.4	6.887E-02	1.0650	0.4785	4.4
Copper	60000	6.6	1405.4	6.043E-02	0.7529	0.3395	1.3
Lead	60000	6.6	1405.4	6.465E-02	0.7596	0.3429	4.4
Mercury	60000	0.06	1405.4	5.762E-04	0.0069	0.0031	0.4
Nickel	60000	2.4	1405.4	3.373E-02	0.2924	0.1329	70
Silver	60000	0.12	1405.4	1.181E-03	0.0138	0.0062	1.4
Zinc	60000	16.2	1405.4	1.546E-01	1.8580	0.8384	8
Total PCB	60000	0.0108	1405.4	2.530E-05	1.12E-03	4.96E-04	0.03
LMW PAHs	60000	0.1896	1405.4	3.373E-04	0.0194	0.0086	0.2 [c]
HMW PAHs	60000	0.576	1405.4	1.661E-03	0.0600	0.0267	
TBT	60000	0.00495	1405.4	7.730E-09	4.93E-04	2.18E-04	0.006
Scenario C4A							
Most Impacted WSRs					CR03	CR01	
Tracer Conc. (mg/L) from Backfilling					5.9750	2.6439	
Tracer Conc. (mg/L) from Dredging					2.3859	1.5471	
	Contaminant Release Rate (g/s)						
Parameters	**Modelled Backfilling [b]**	**Actual Backfilling [b]**	**Modelled Dredging [b]**	**Actual Dredging [b]**			
Arsenic	60000	2.52	17792.0	1.957E-01	0.2772	0.1281	13
Cadmium	60000	0.24	17792.0	4.448E-03	0.0245	0.0110	5.5
Chromium	60000	9.6	17792.0	8.718E-01	1.0729	0.4988	4.4
Copper	60000	6.6	17792.0	7.650E-01	0.7598	0.3574	1.3
Lead	60000	6.6	17792.0	8.184E-01	0.7670	0.3620	4.4
Mercury	60000	0.06	17792.0	7.295E-03	0.0070	0.0033	0.4
Nickel	60000	2.4	17792.0	4.270E-01	0.2963	0.1429	70
Silver	60000	0.12	17792.0	1.495E-02	0.0140	0.0066	1.4
Zinc	60000	16.2	17792.0	1.957E+00	1.8757	0.8840	8
Total PCB	60000	0.0108	17792.0	3.203E-04	1.12E-03	5.04E-04	0.03
LMW PAHs	60000	0.1896	17792.0	4.270E-03	0.0195	0.0087	0.2 [c]
HMW PAHs	60000	0.576	17792.0	2.103E-02	0.0602	0.0272	
TBT	60000	0.00495	17792.0	9.785E-08	4.93E-04	2.18E-04	0.006

Notes:

(a) Contaminant concentrations (µg L^{-1}) = Conservative Tracer Concentration for Backfilling (mg L^{-1}) [***Table 3E.3*** referred] × Tracer-to-Contaminant Conversion Ratio for Backfilling (µg kg^{-1}) + Conservative Tracer Concentration for Dredging (mg L^{-1}) [***Table 3E.3*** referred] × Tracer-to-Contaminant Conversion Ratio for Dredging (µg kg^{-1})

(b) The modelled backfilling / dredging rates refer to the release rates of conservative tracers in the model, which is chosen to be the same as that of the corresponding sediment loss rate (i.e. 60 kg/s as discussed in Table 3.2 of ***Annex 3A***). The actual release rates refer to the release rates of each contaminant from each sediment sources from this Project, including dredging and backfilling. Please refer to Table 3.4 of *Annex 3A* for the actual backfilling / dredging rates.

(c) Assessment criterion is applicable to total PAHs, i.e. sum of estimated LMW PAHs and HMW PAHs.

3E2.4 Release of Sediment-bounded Nutrients

As discussed in ***Section 3.7.1.4***, the release of sediment-bounded nutrient is estimated based on ammonia and organic nitrogen (Org-N) content. The predicted maximum SS elevation at the most impacted WSR (MP1-A) for both Scenarios C1A and C2A is only 1.1 mg L^{-1}. The corresponding Total Inorganic Nitrogen (TIN) elevation at this most impacted WSR is calculated to be 1.1 mg L^{-1} × 270.32 mg kg^{-1} = 0.00030 mg L^{-1}, which is less than 1% of the corresponding WQO in the Southern WCZ (as well as all other WCZs) and considered insignificant. The expected level of TIN elevation at other identified WSRs would be even lower. No unacceptable water quality impact from TIN elevation is anticipated. Similarly the potential increase in unionized ammonia (UIA) is calculated to be 0.021 µg L^{-1}, which is below 1% of the corresponding WQO and is considered inconsequential at the most impacted WSR. The expected level of UIA elevation at other identified WSRs would be even lower. No unacceptable water quality impact from UIA elevation is anticipated. The modelled maximum depth-averaged levels of TIN and UIA from backfilling, dredging and capping activities are presented in ***Figures 3E.19*** and ***3E.20*** to illustrate the spatial coverage.

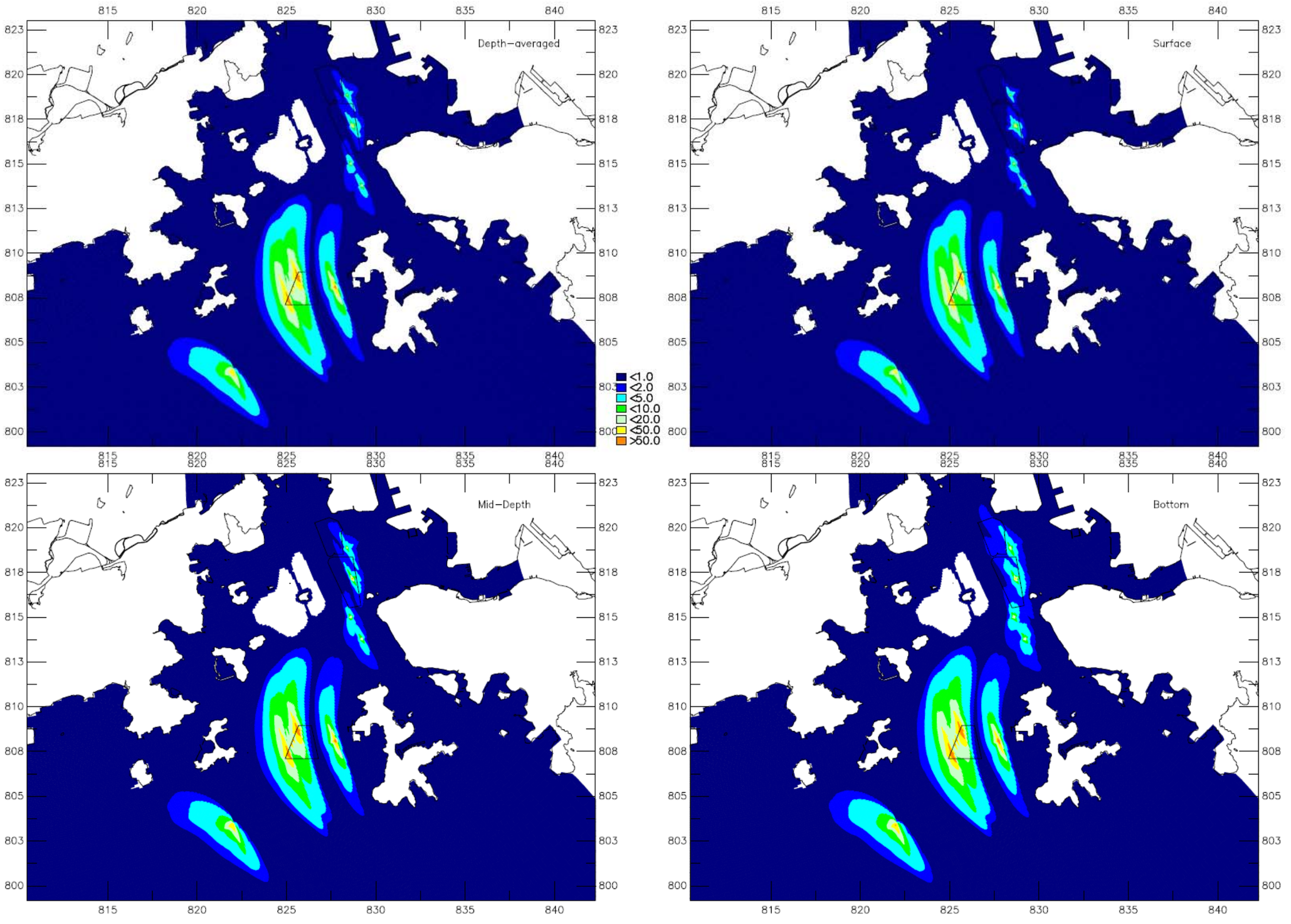


Figure 3E.1 **Predicted Maximum Suspended Solids (SS) Elevation (mg/L) Scenario C1A (Dry Season)**

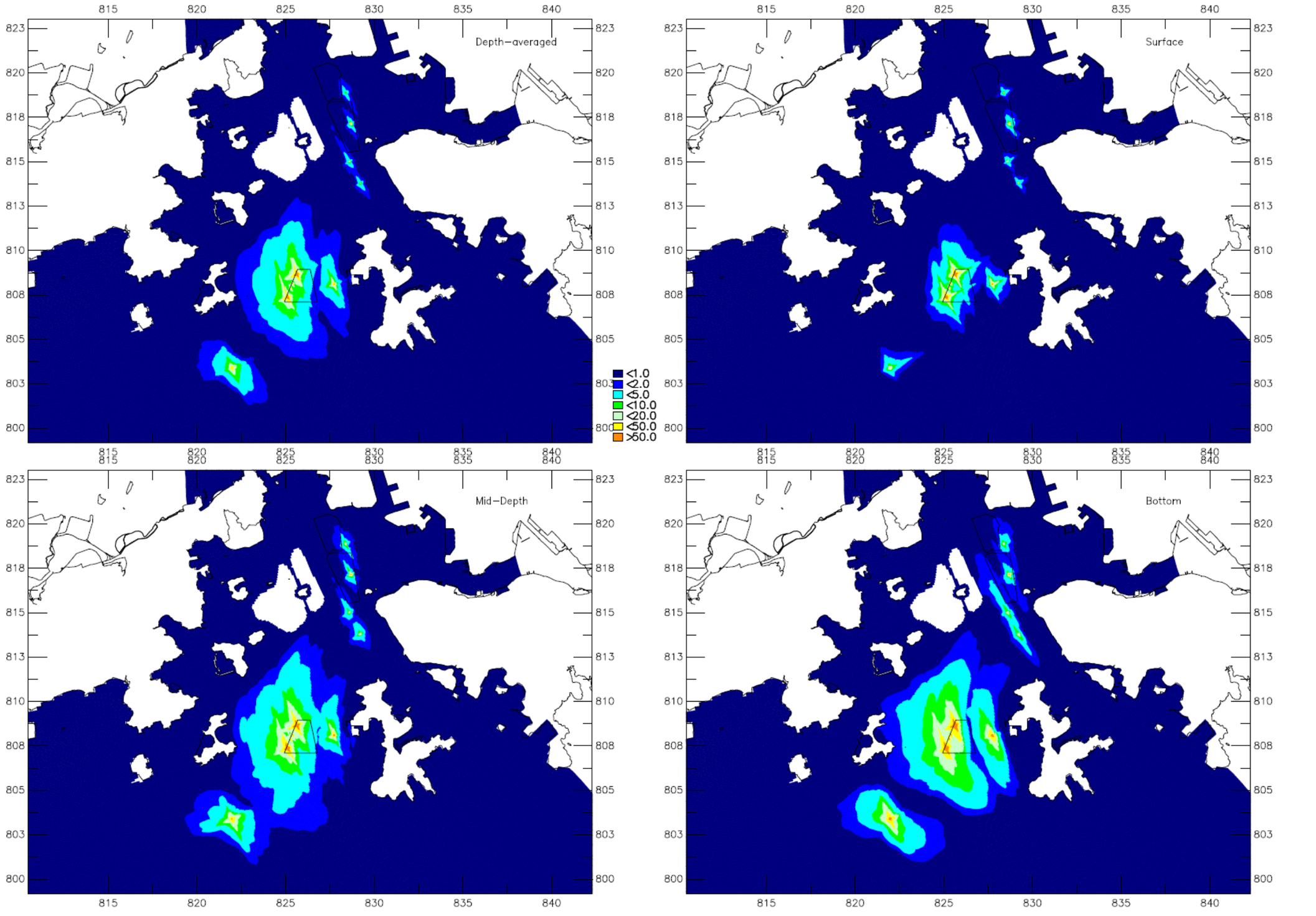


Figure 3E.2 **Predicted Maximum Suspended Solids (SS) Elevation (mg/L) Scenario C1A (Wet Season)**

FILE: 0567994_Annex 3E_1.pptx DATE: MAR 2022

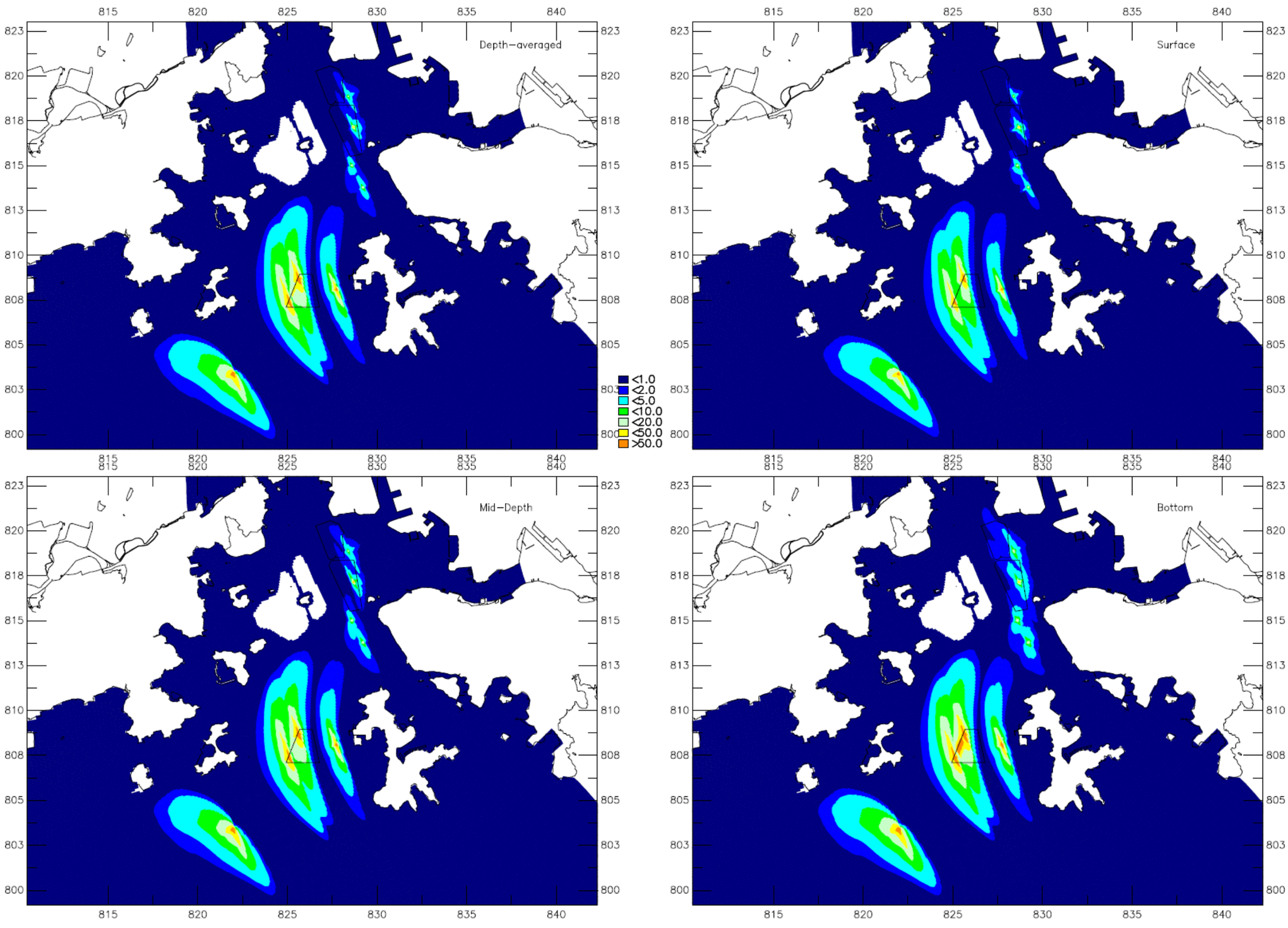


Figure 3E.3 **Predicted Maximum Suspended Solids (SS) Elevation (mg/L) Scenario C2A (Dry Season)**

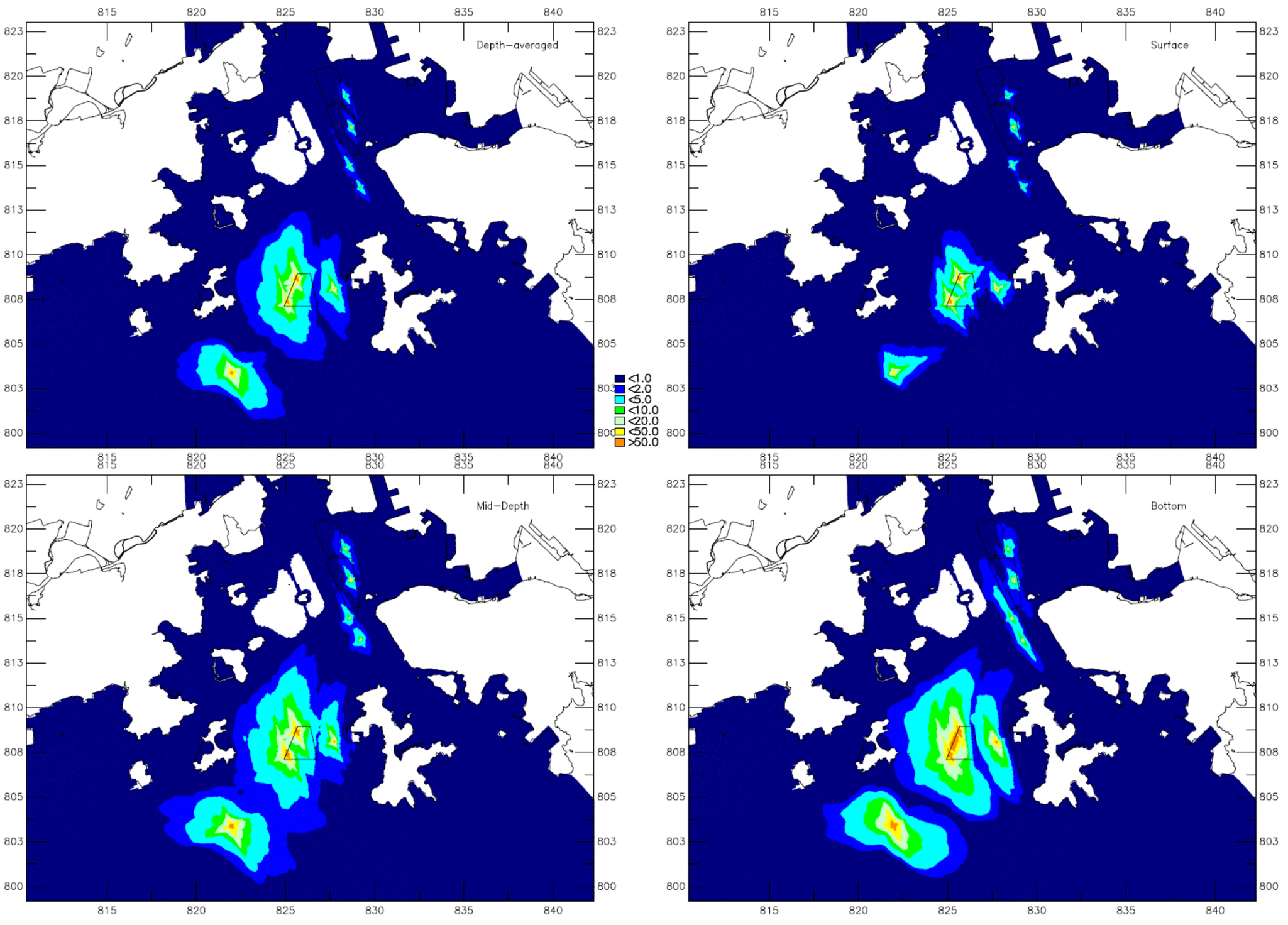


Figure 3E.4 **Predicted Maximum Suspended Solids (SS) Elevation (mg/L) Scenario C2A (Wet Season)**

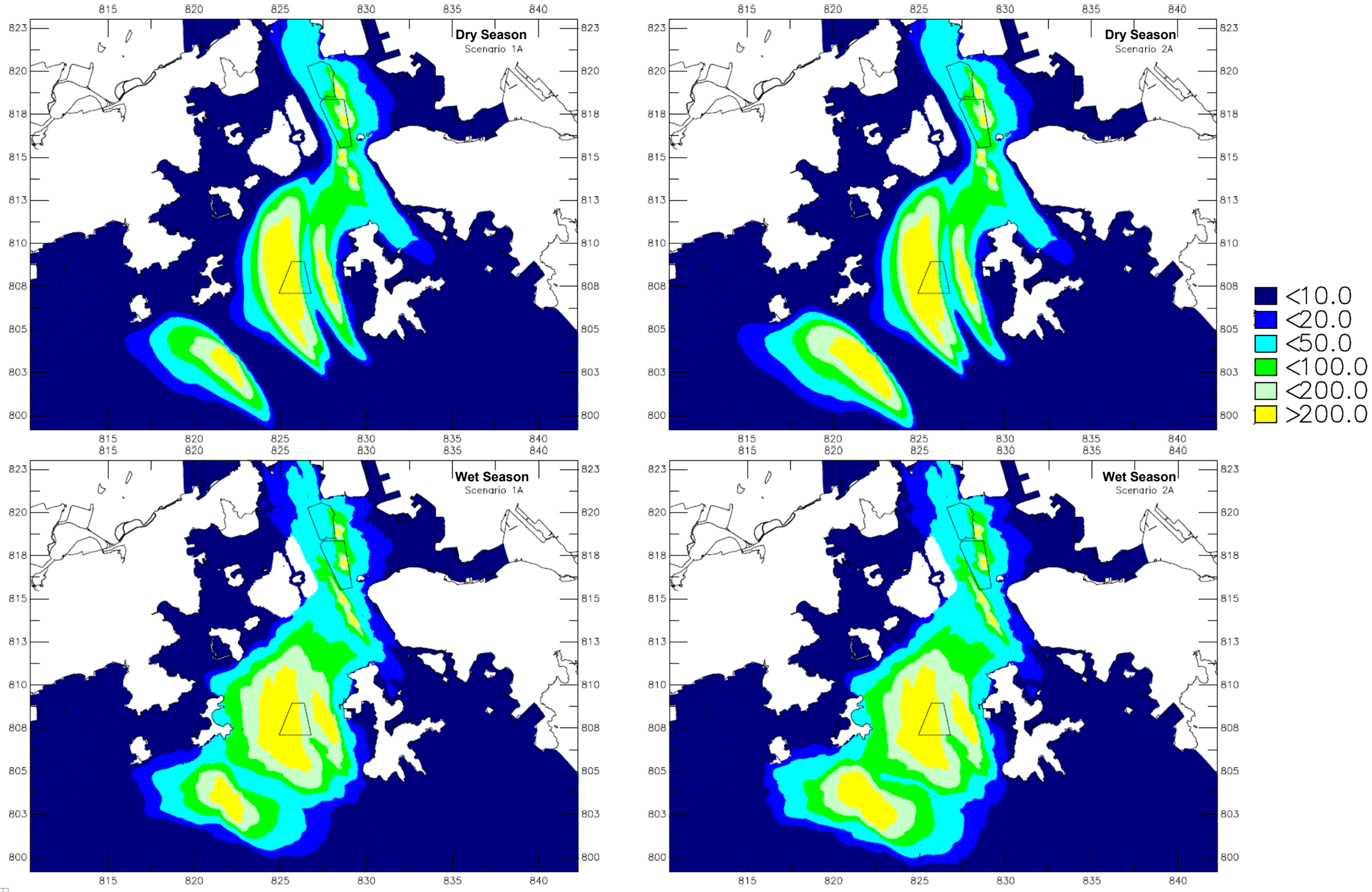
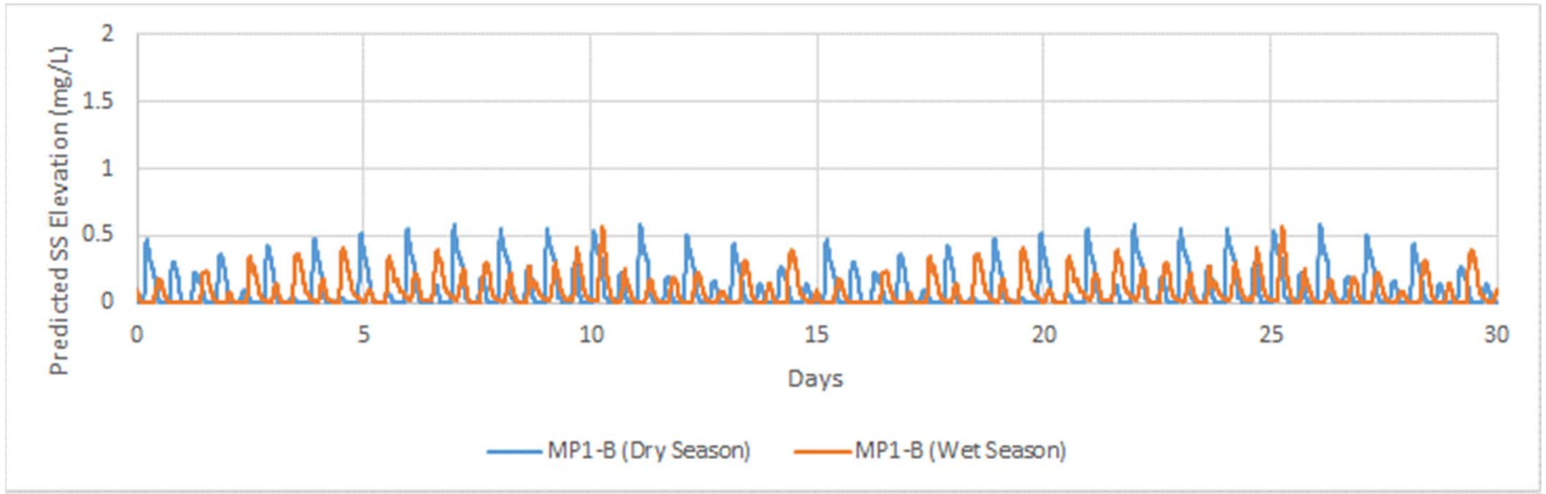


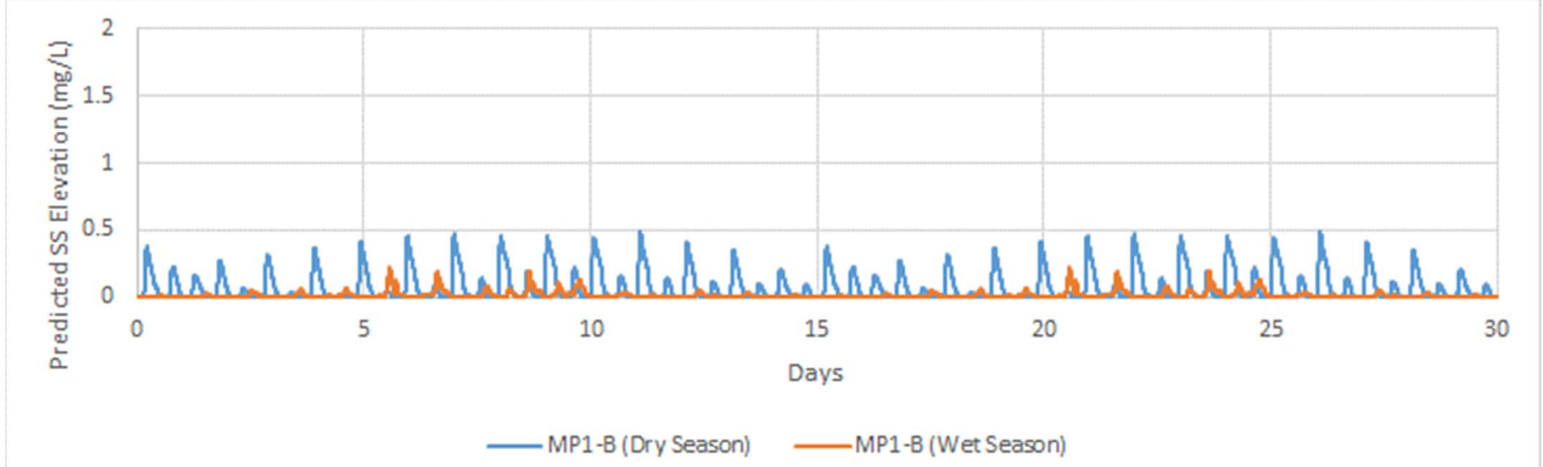
Figure 3E.5 **Predicted Maximum Sedimentation Flux (g/m²/day) Scenario C1A and Scenario C2A (Dry and Wet Seasons)**

FILE: 0567994_Annex 3E_1.pptx DATE: MAR 2022

Scenario C1A Depth-averaged



Scenario C1A Surface



Scenario C1A Bottom

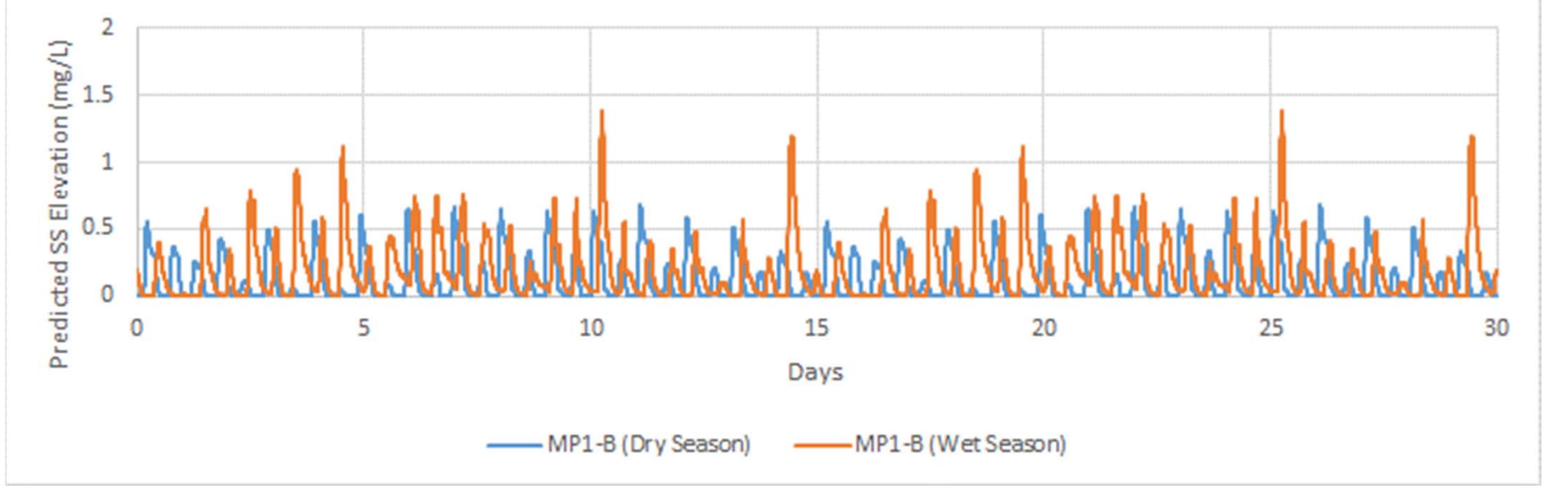
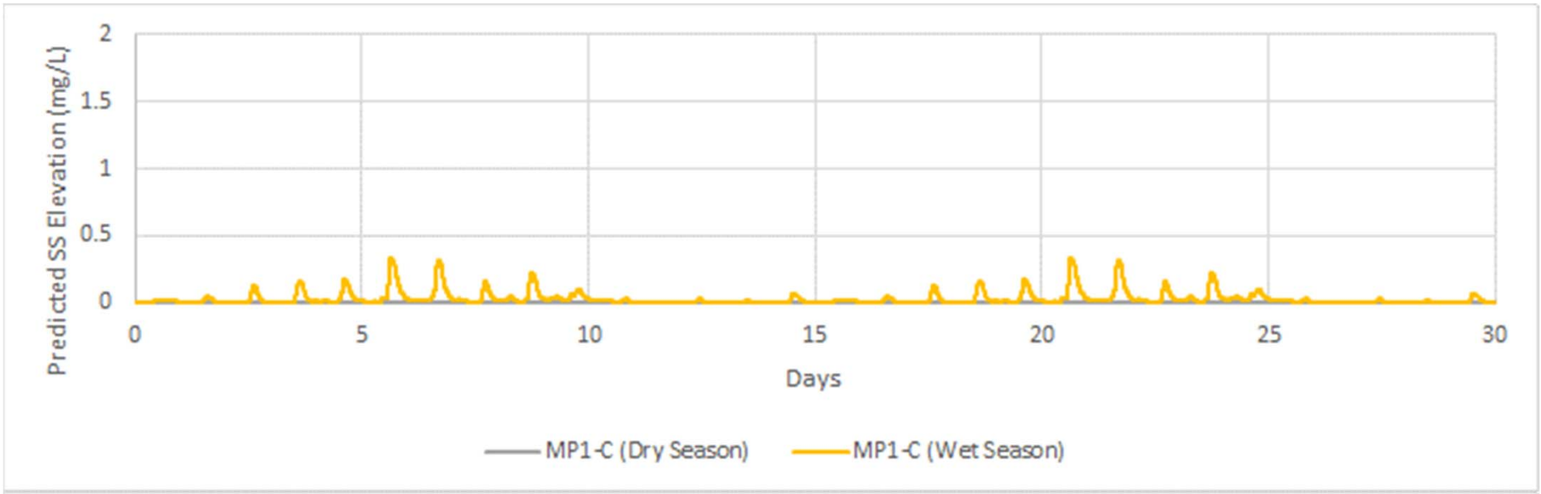
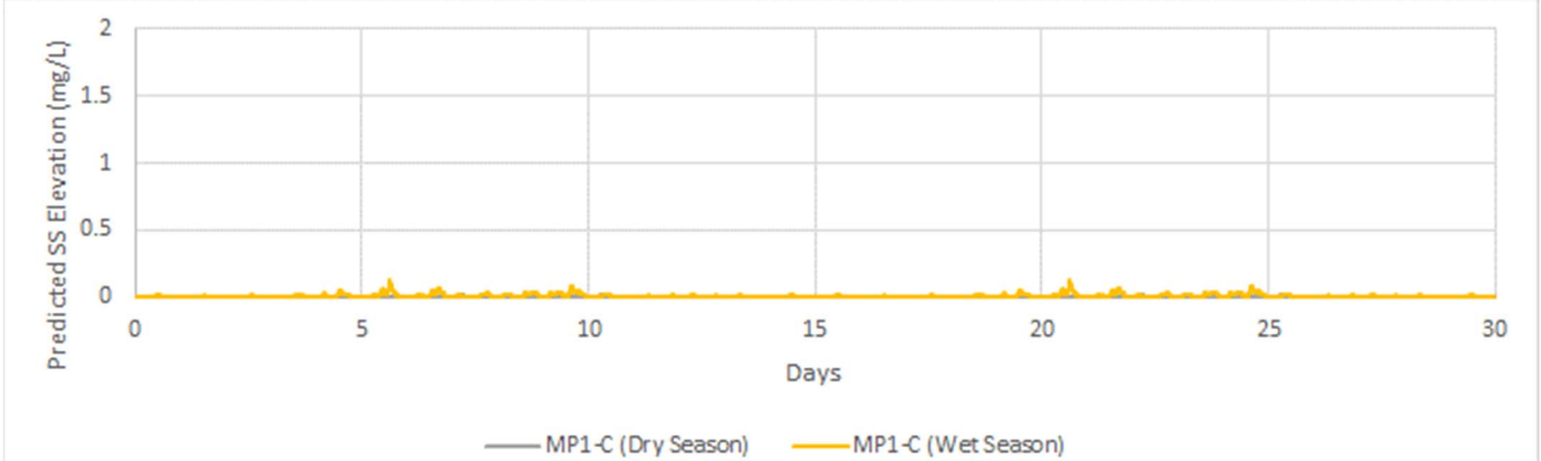


Figure 3E.6 **Time Series of Predicted SS Elevation at MP1-B Scenario C1A**

Scenario C1A Depth-averaged



Scenario C1A Surface



Scenario C1A Bottom

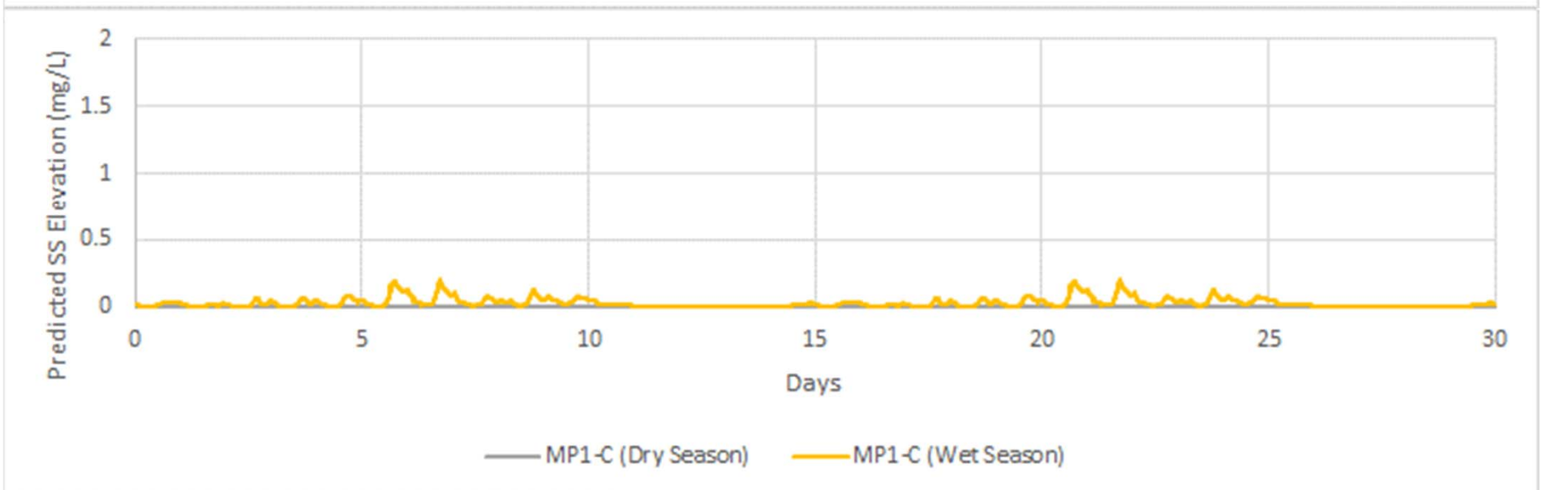
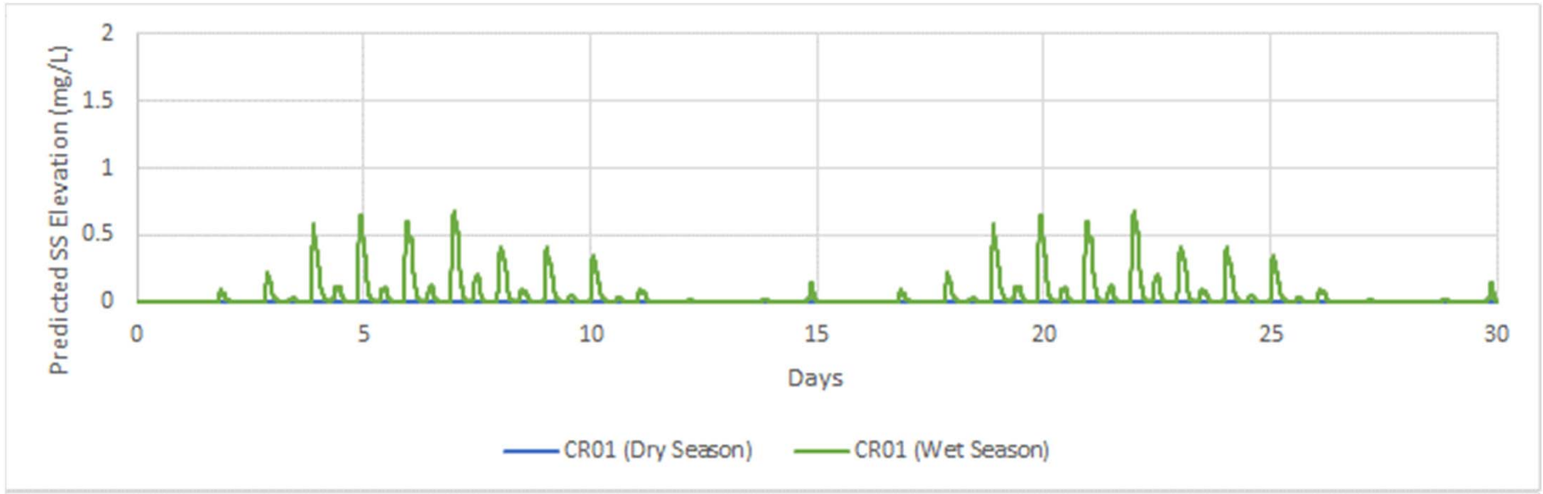
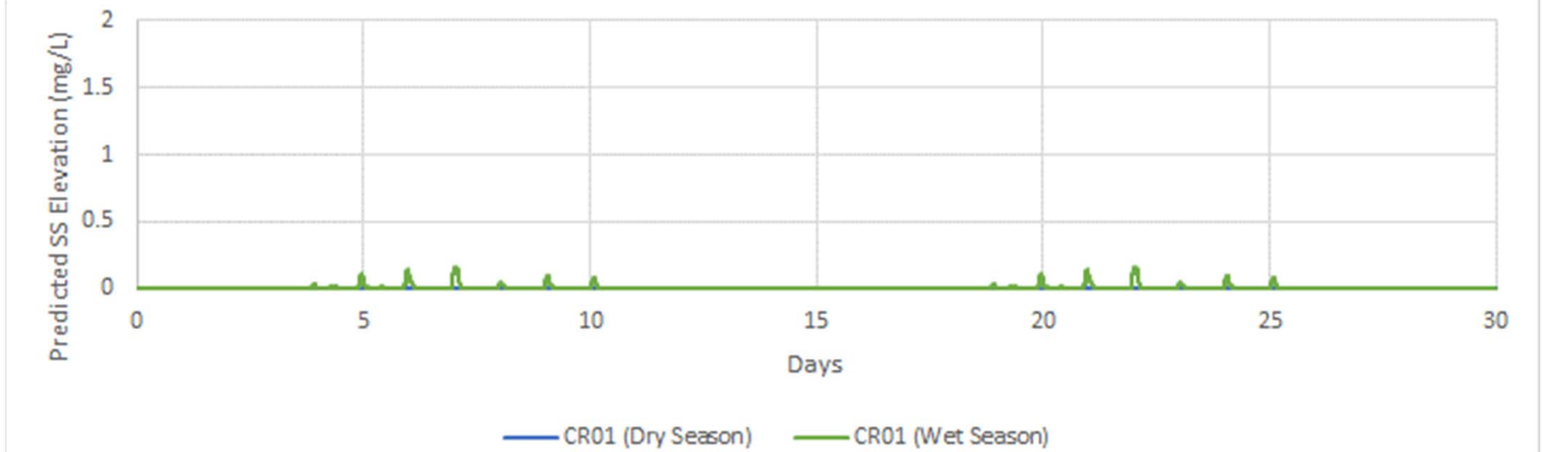


Figure 3E.7 **Time Series of Predicted SS Elevation at MP1-C Scenario C1A**

Scenario C1A Depth-averaged



Scenario C1A Surface



Scenario C1A Bottom

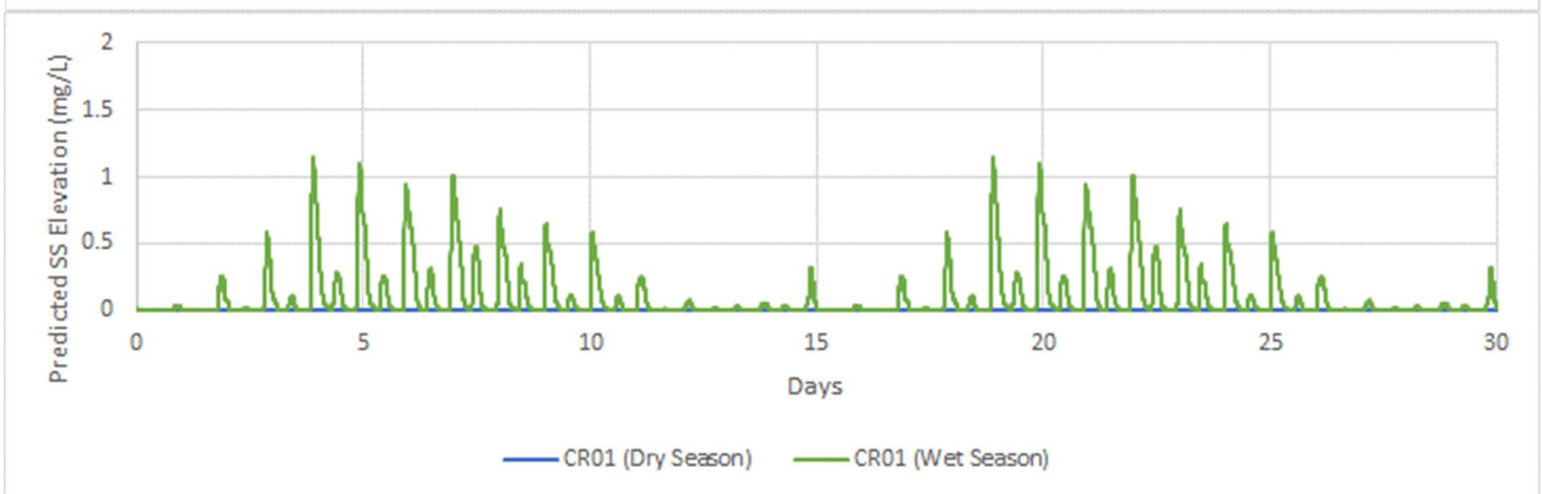
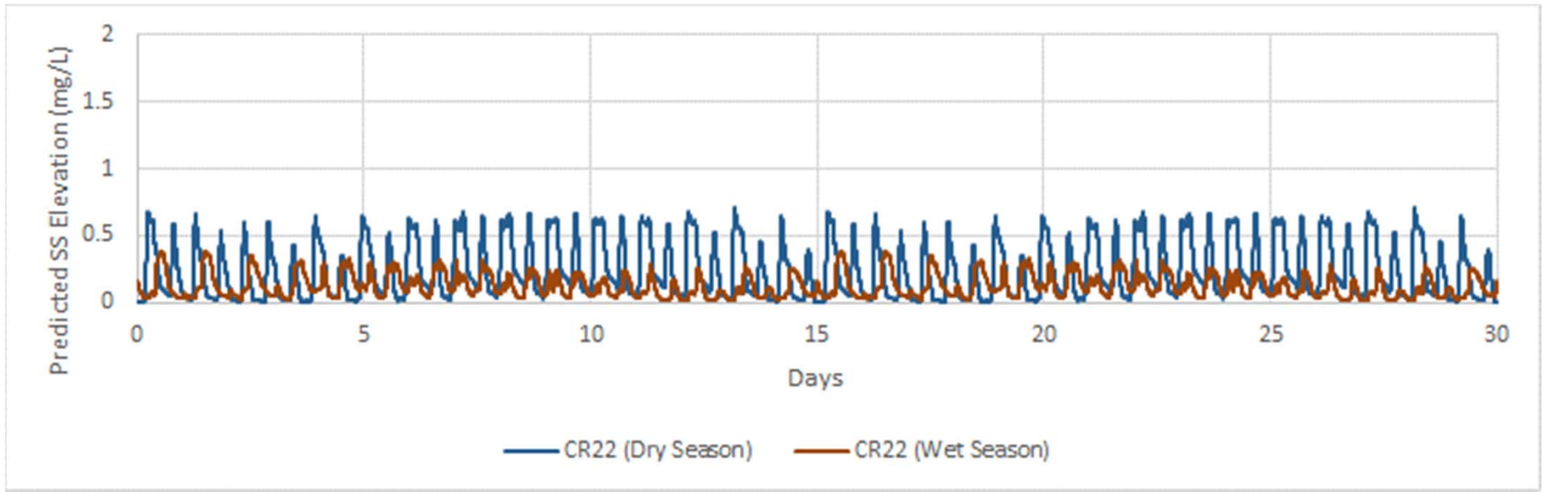
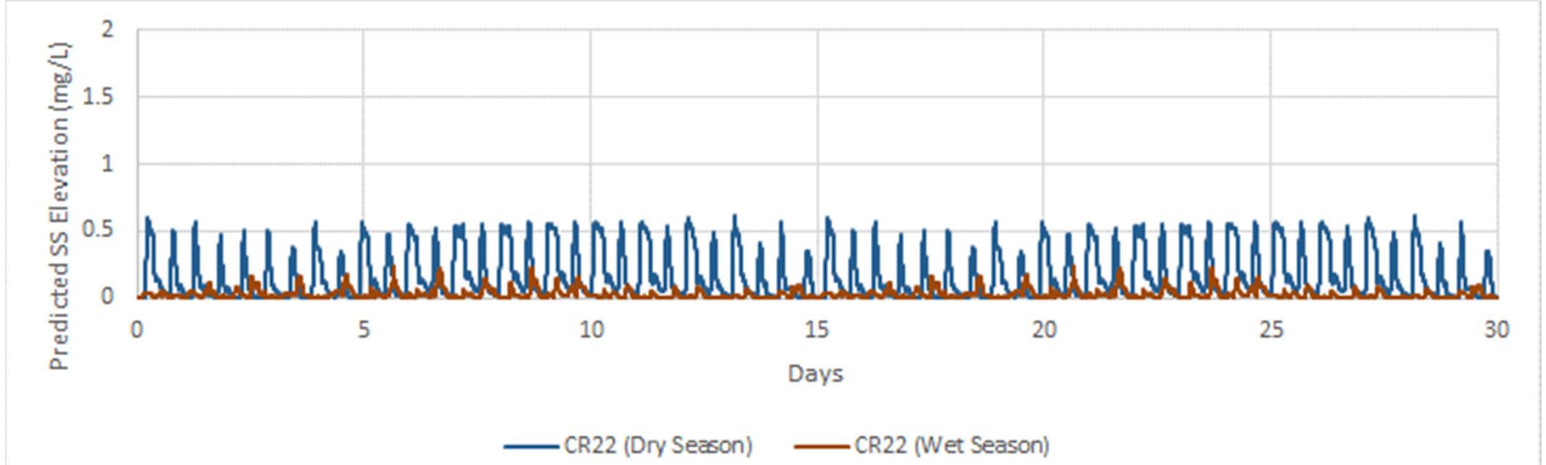


Figure 3E.8 **Time Series of Predicted SS Elevation at CR01 Scenario C1A**

Scenario C1A Depth-averaged



Scenario C1A Surface



Scenario C1A Bottom

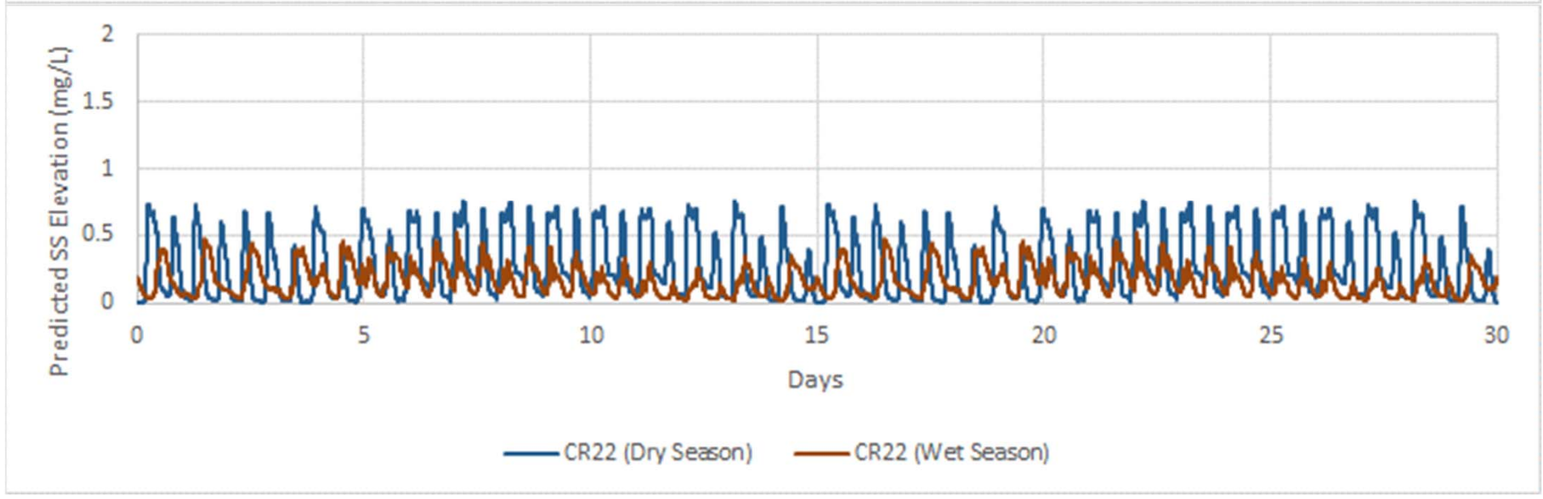
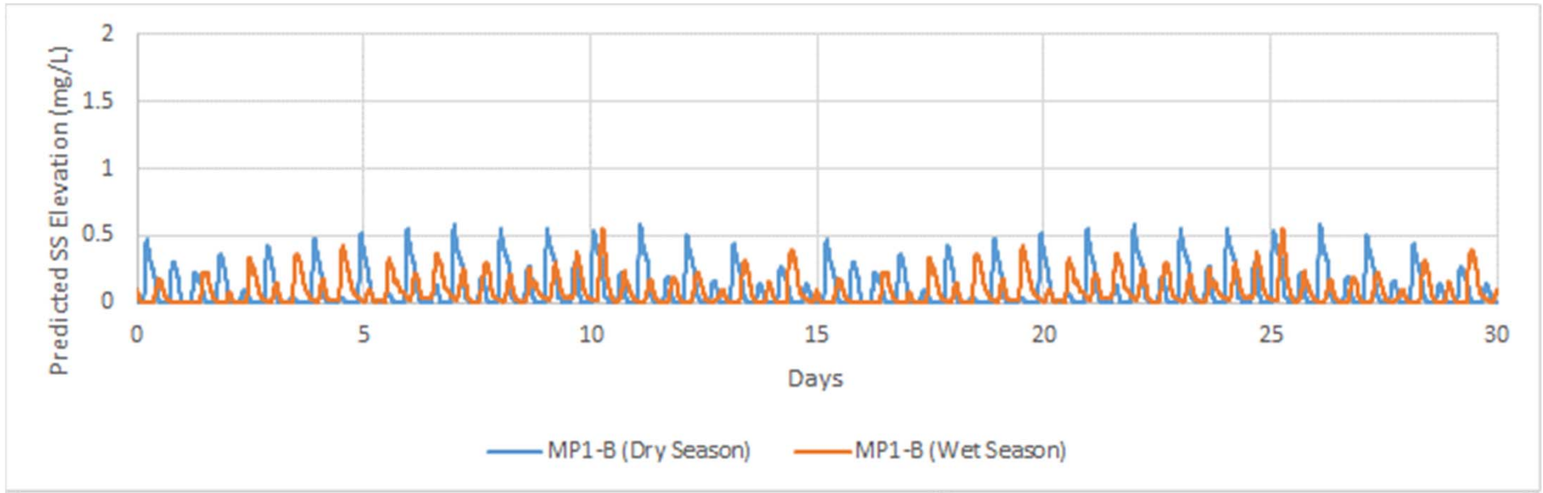
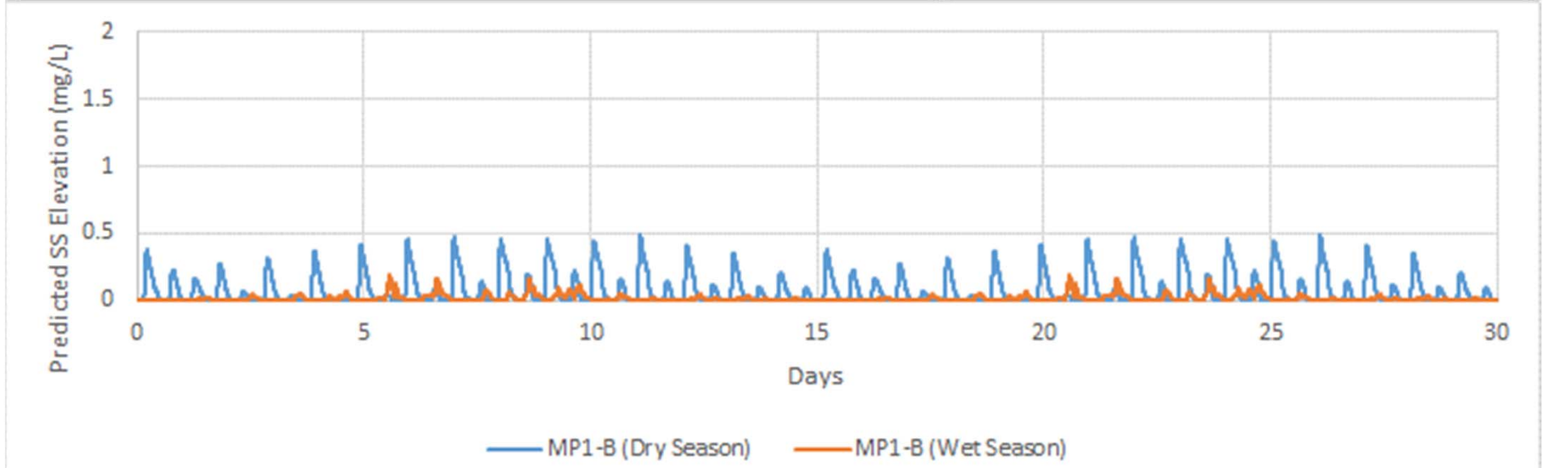


Figure 3E.9 **Time Series of Predicted SS Elevation at CR22 Scenario C1A**

Scenario C2A Depth-averaged



Scenario C2A Surface



Scenario C2A Bottom

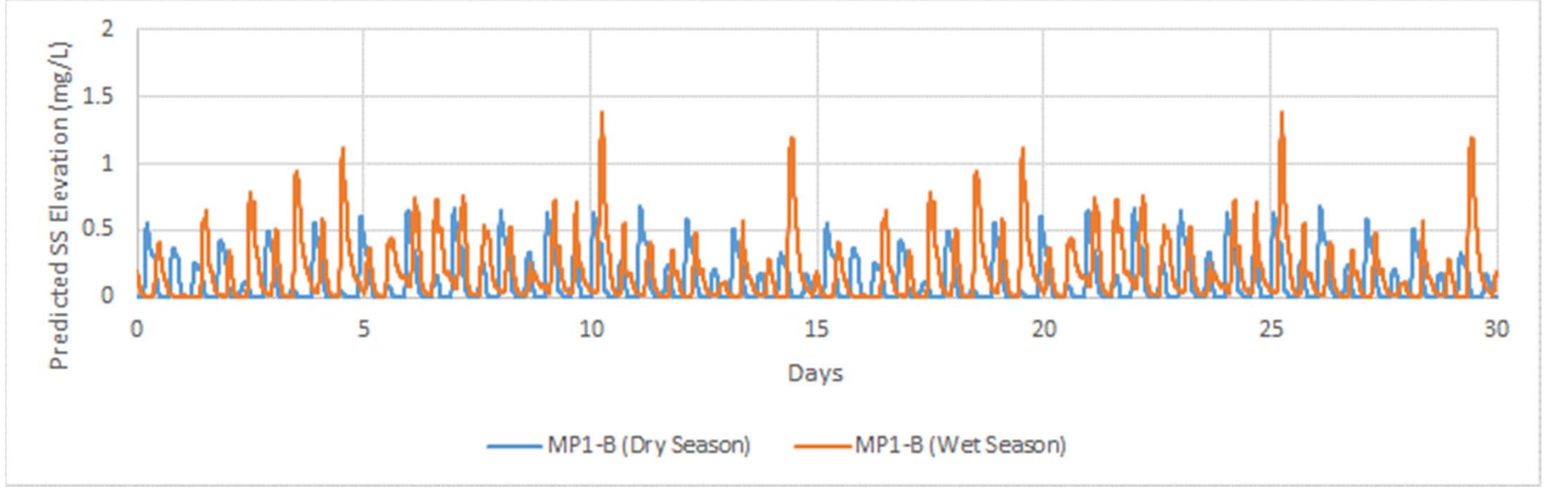
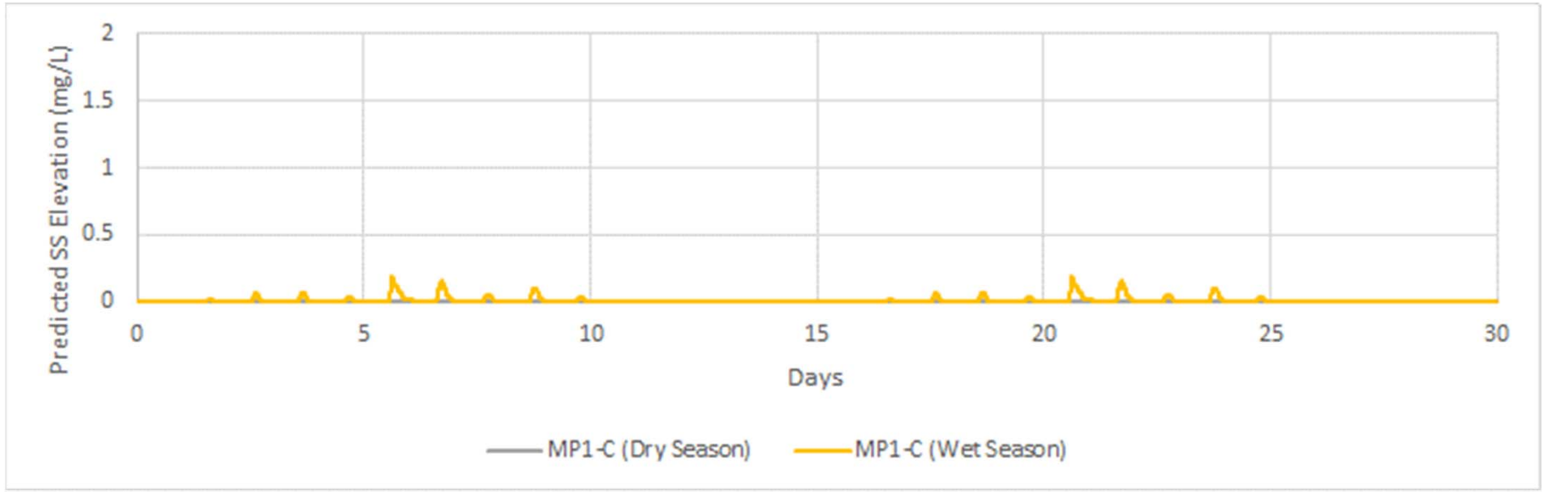
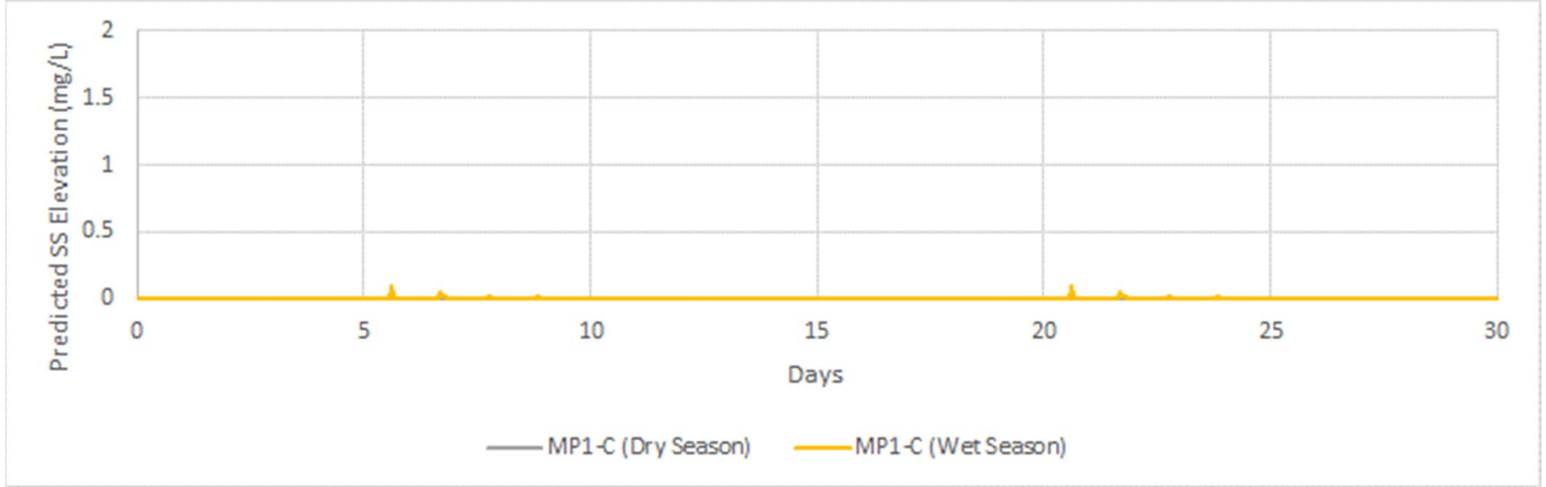


Figure 3E.10 **Time Series of Predicted SS Elevation at MP1-B Scenario C2A**

Scenario C2A Depth-averaged



Scenario C2A Surface



Scenario C2A Bottom

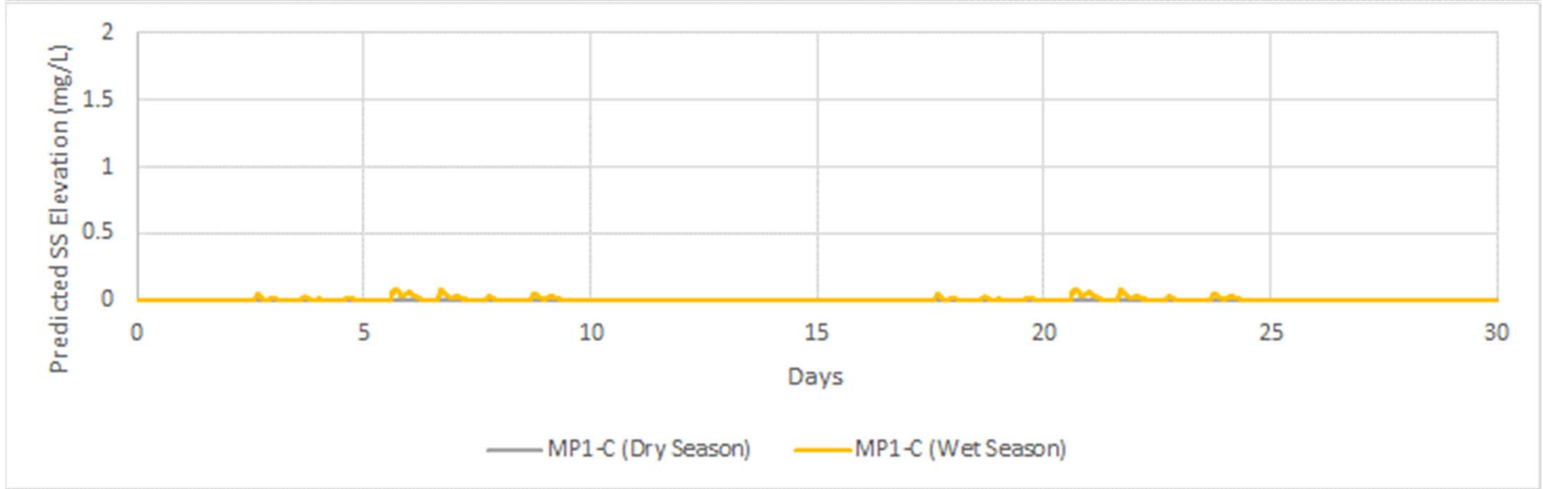
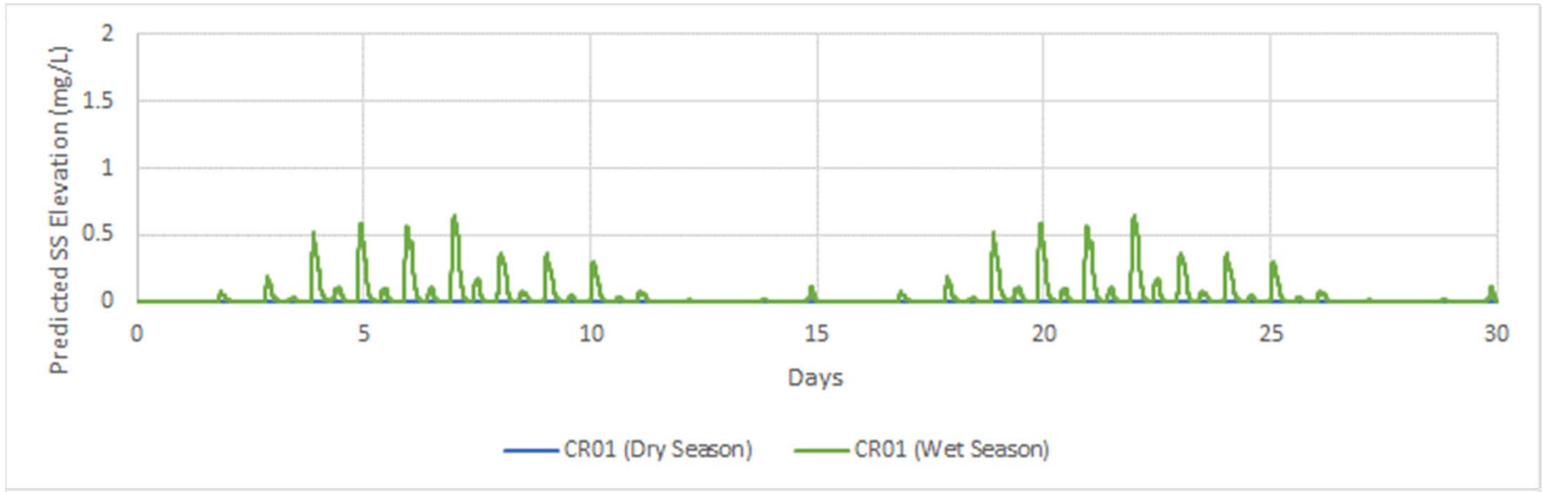
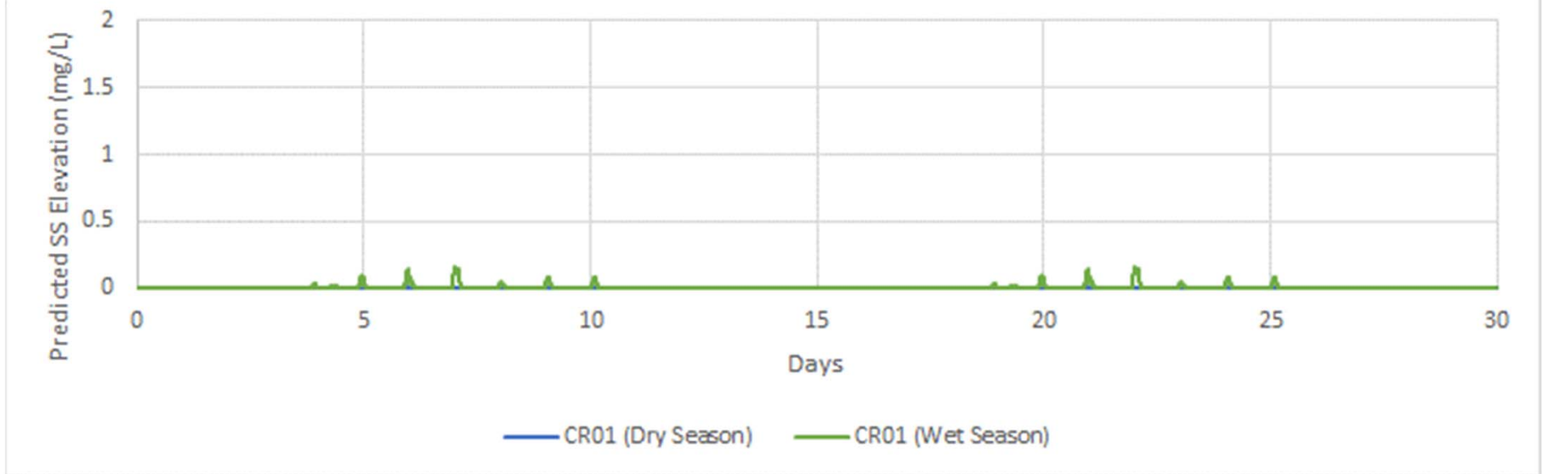


Figure 3E.11 **Time Series of Predicted SS Elevation at MP1-C Scenario C2A**

Scenario C2A Depth-averaged



Scenario C2A Surface



Scenario C2A Bottom

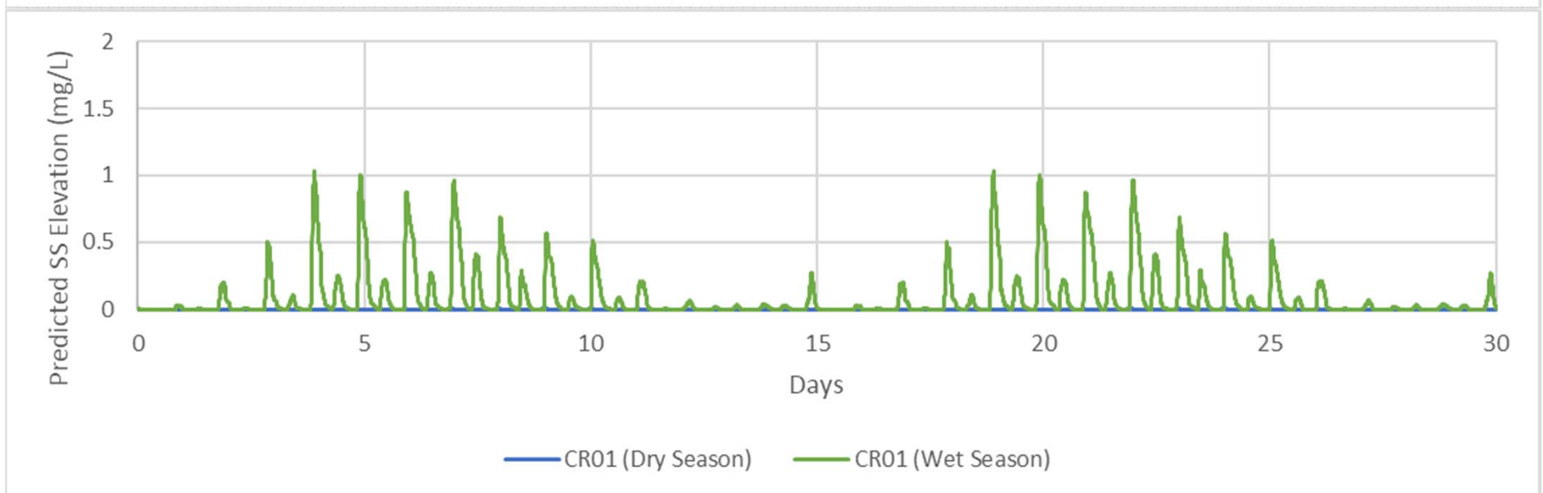
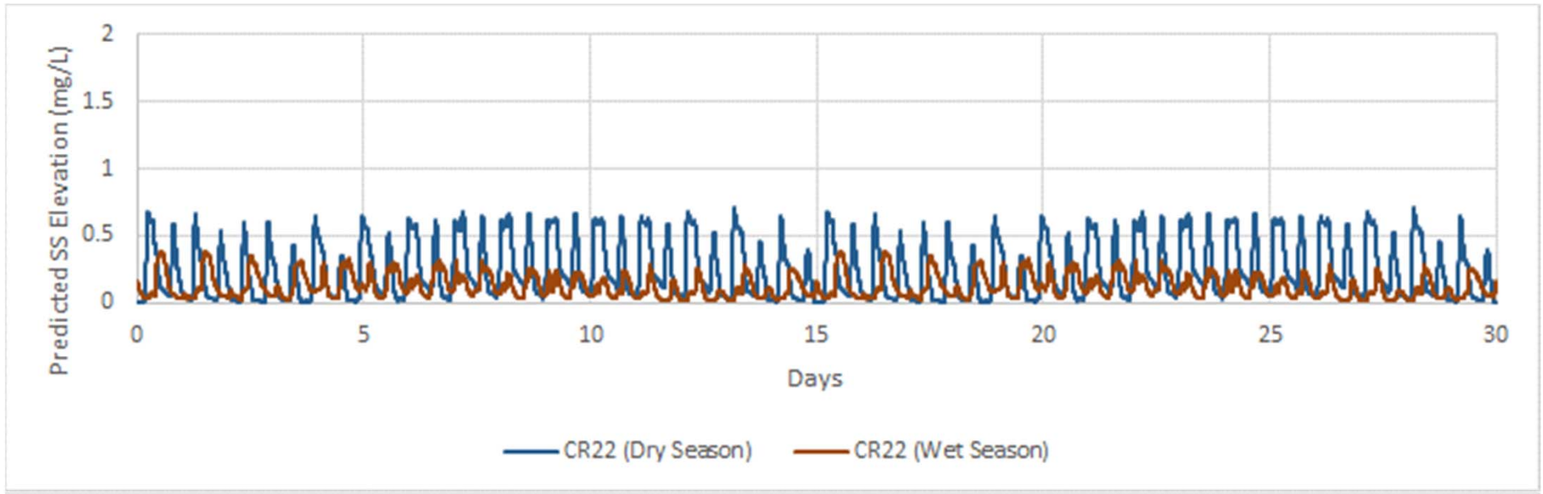
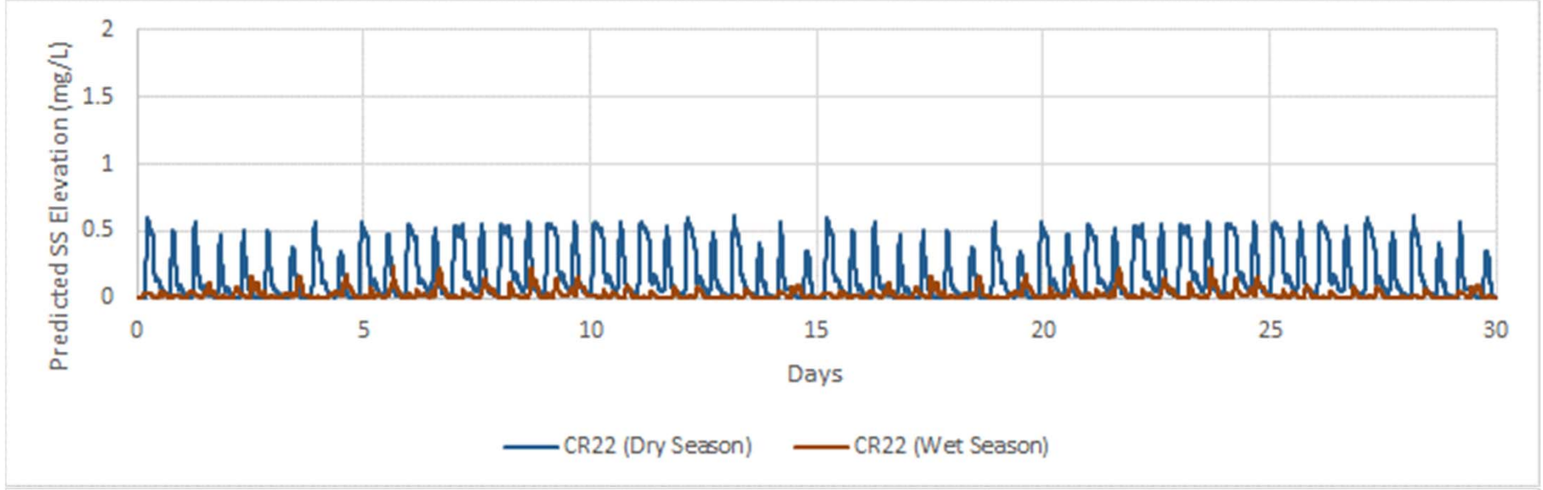


Figure 3E.12 **Time Series of Predicted SS Elevation at CR01 Scenario C2A**

Scenario C2A Depth-averaged



Scenario C2A Surface



Scenario C2A Bottom

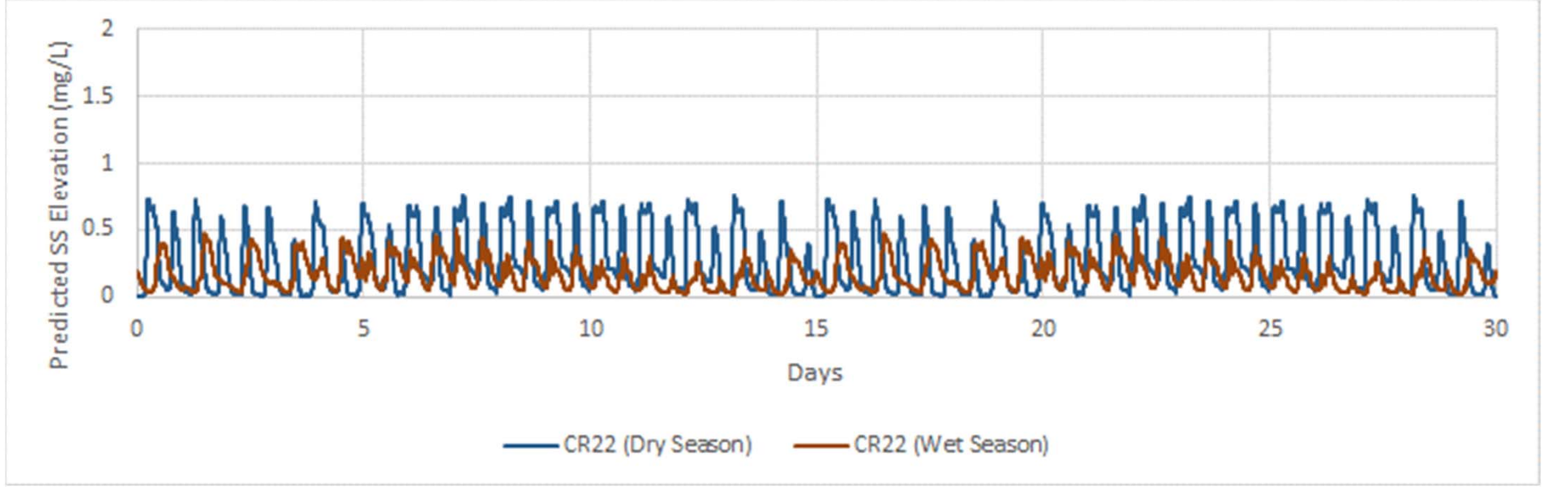
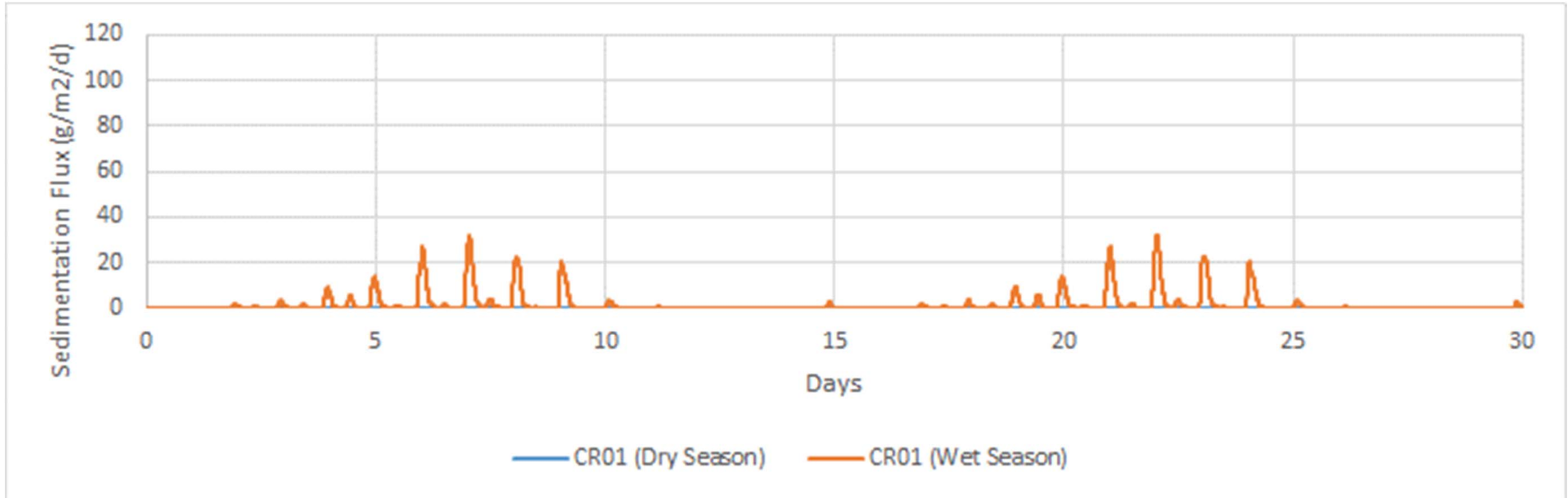


Figure 3E.13 **Time Series of Predicted SS Elevation at CR22 Scenario C2A**

Scenario C1A
Sedimentation Flux



Scenario C2A
Sedimentation Flux

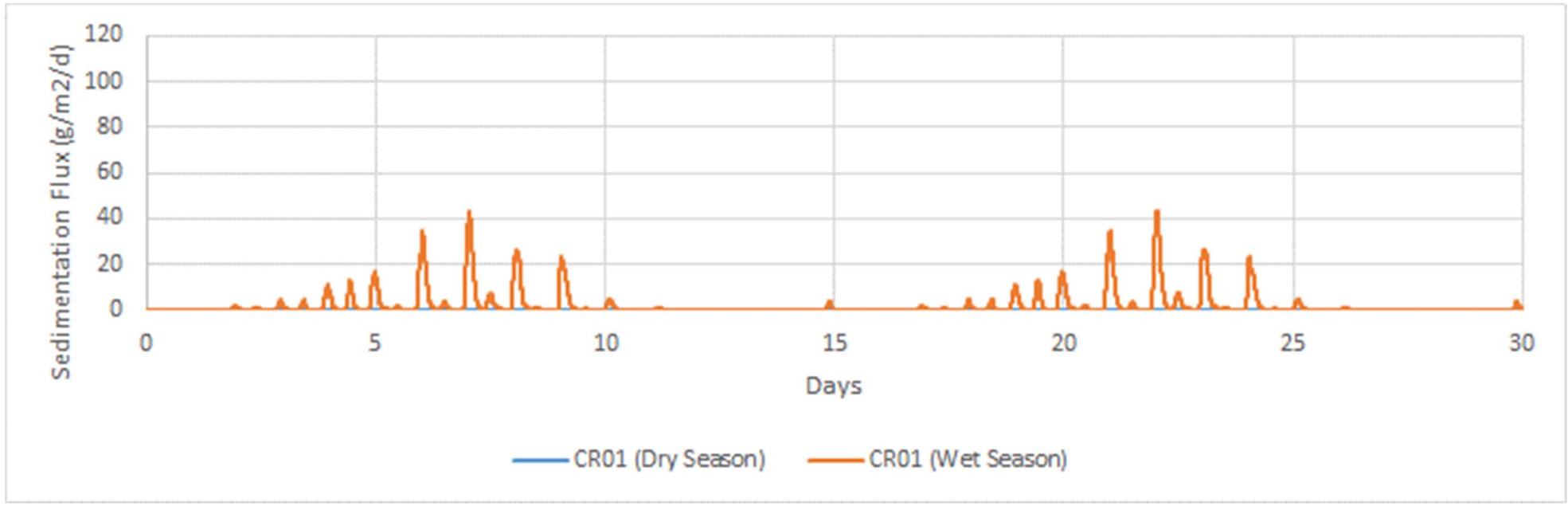
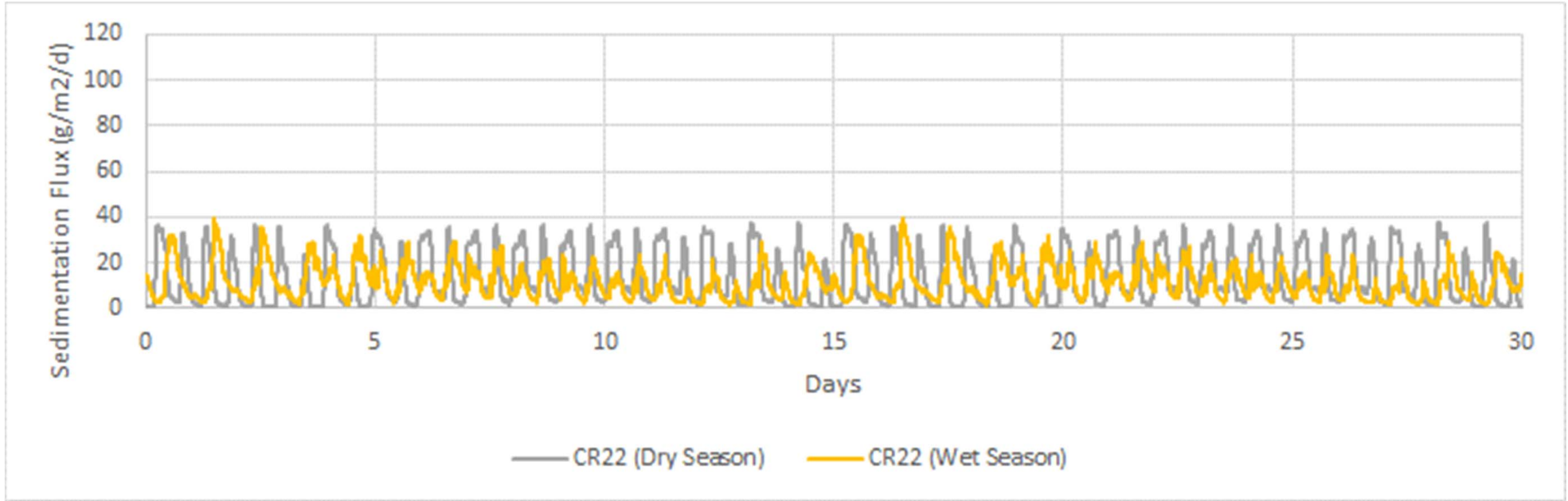


Figure 3E.14 **Time Series of Predicted Sedimentation Flux at CR01**

Scenario C1A
Sedimentation Flux



Scenario C2A
Sedimentation Flux

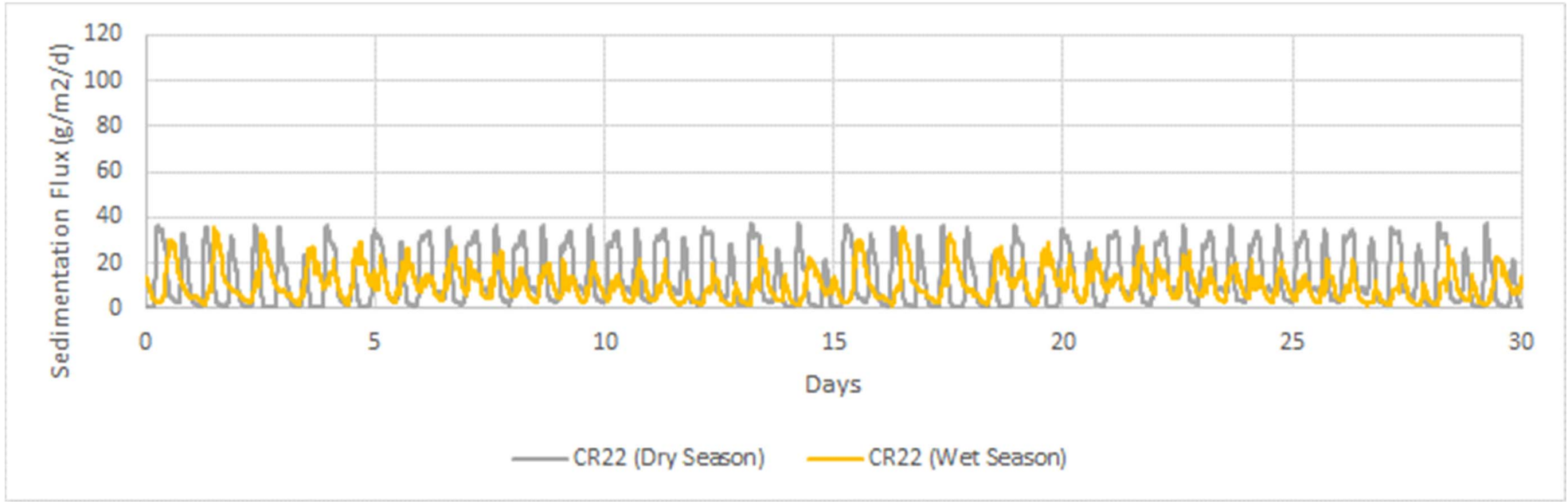


Figure 3E.15 **Time Series of Predicted Sedimentation Flux at CR22**

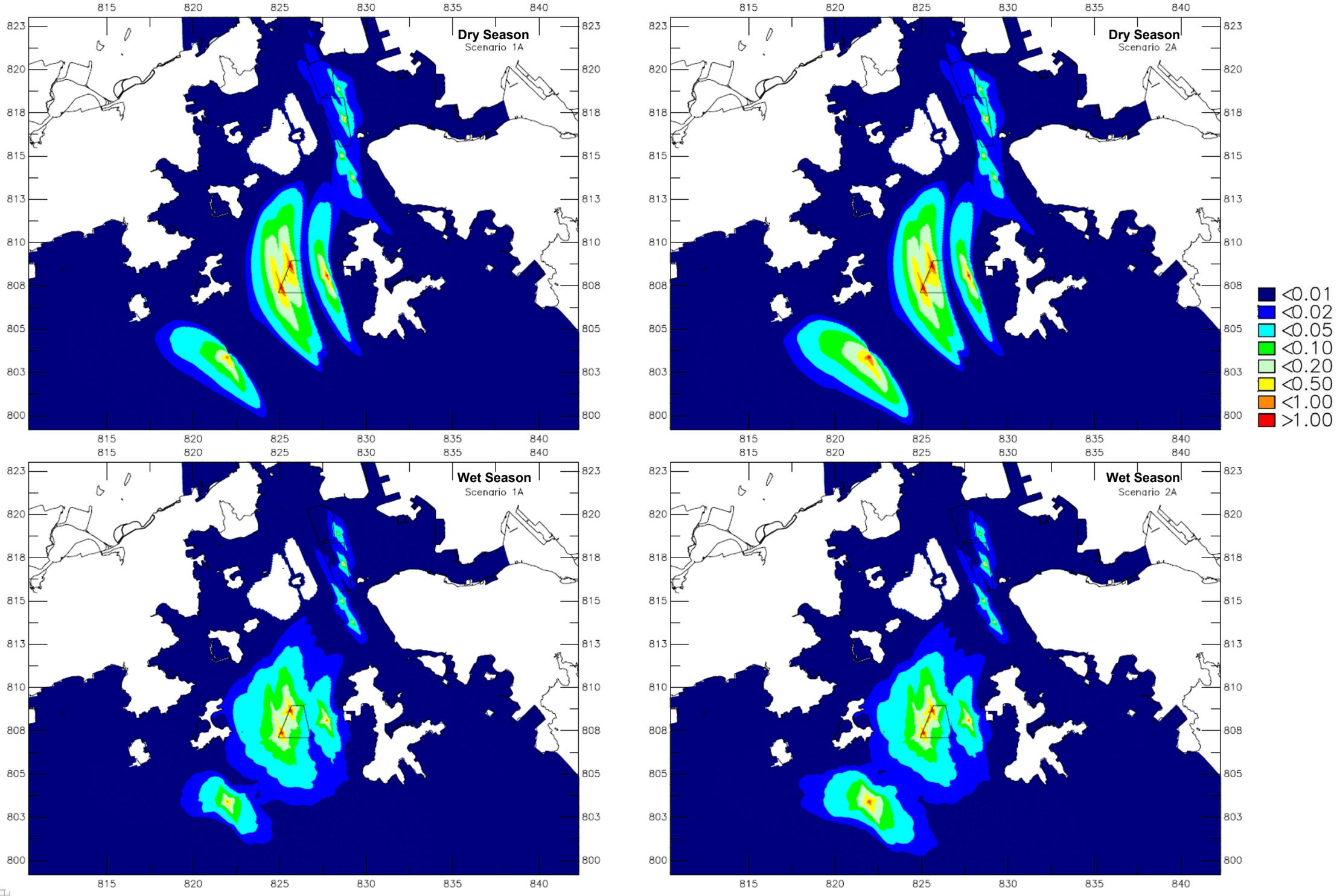


Figure 3E.16 **Predicted Maximum Dissolved Oxygen (DO) Depletion (mg/L) from Marine Works Scenario C1A and Scenario C2A (Dry and Wet Seasons)**

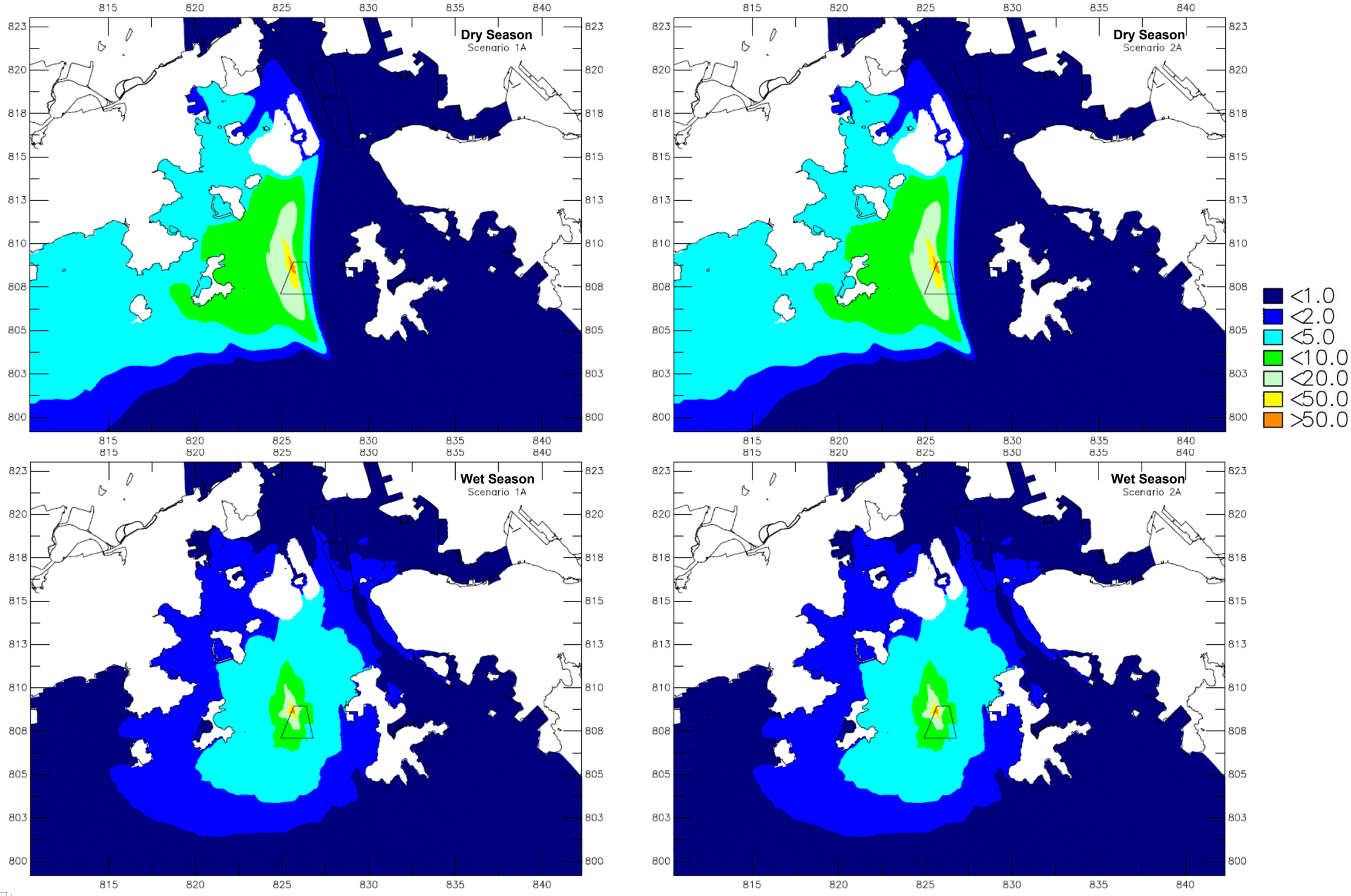


Figure 3E.17 **Predicted Maximum Depth-averaged Conservative Tracer Concentration (mg/L) from Backfilling Scenario C1A and Scenario C2A (Dry and Wet Seasons)**

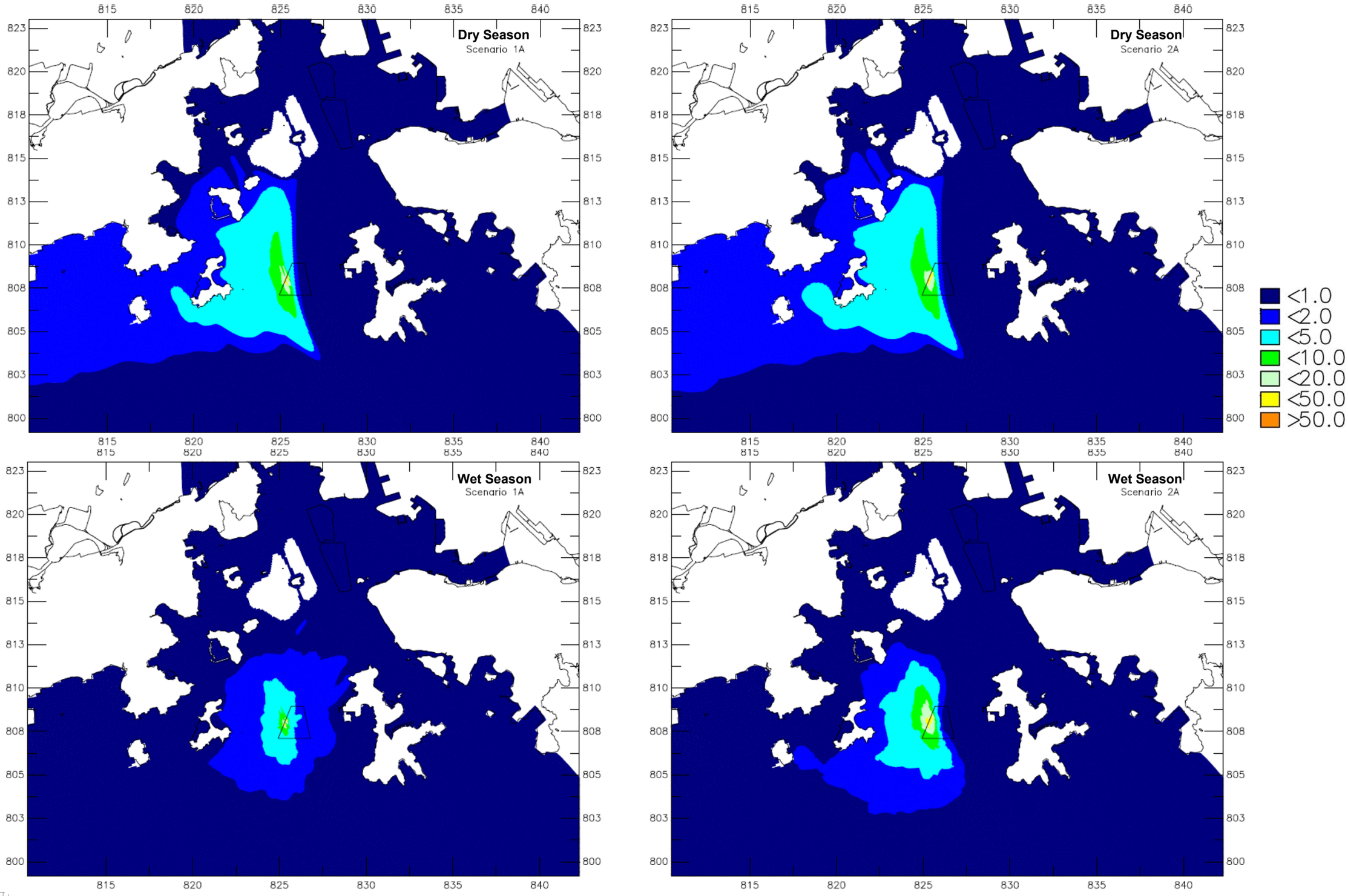


Figure 3E.18 **Predicted Maximum Depth-averaged Conservative Tracer Concentration (mg/L) from Dredging Scenario C1A and Scenario C2A (Dry and Wet Seasons)**

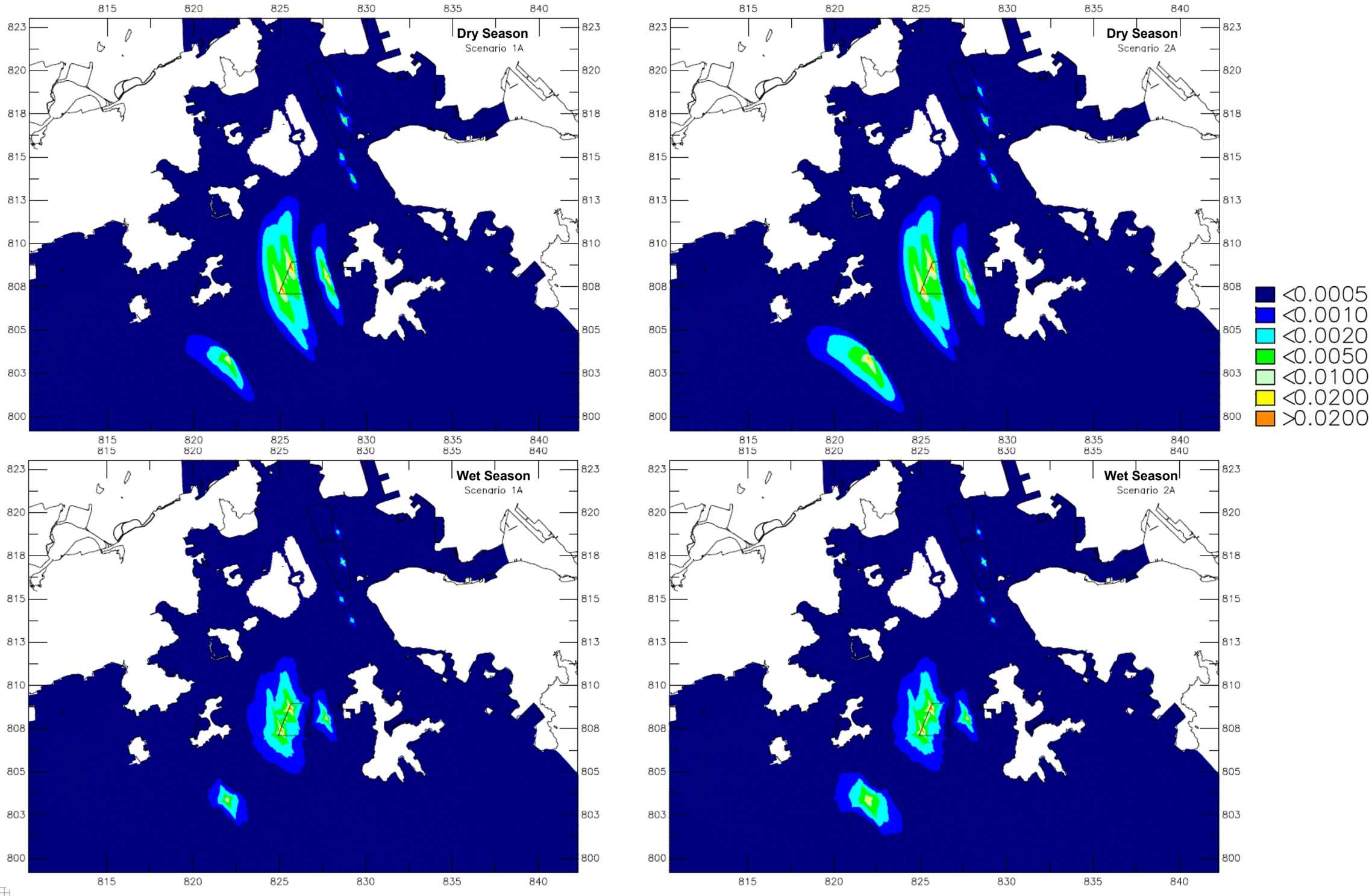


Figure 3E.19 **Predicted Maximum Total Inorganic Nitrogen (TIN) Elevation (mg/L) from Marine Works Scenario C1A and Scenario C2A (Dry and Wet Seasons)**

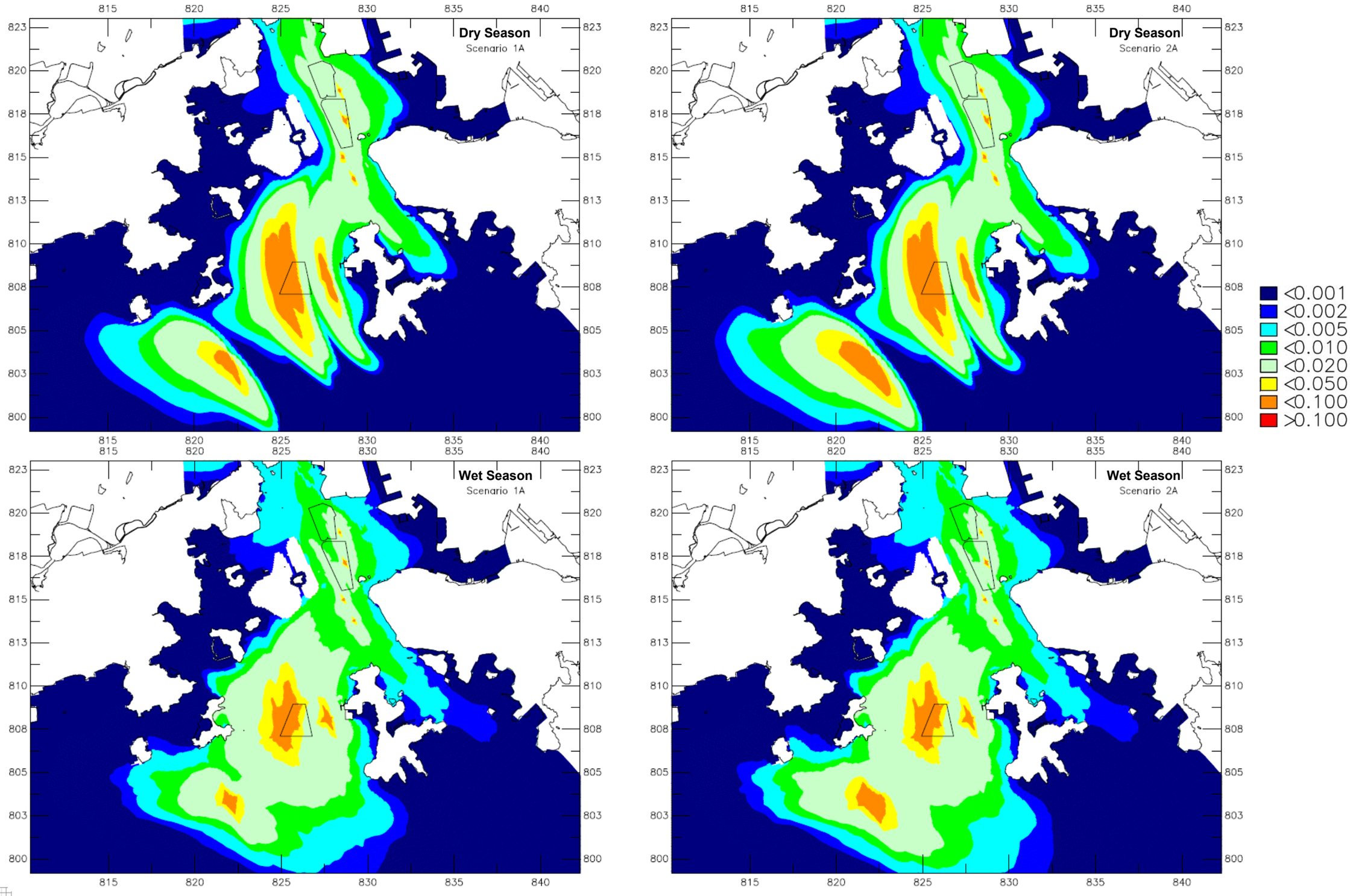


Figure 3E.20 **Predicted Maximum Unionized Ammonia (UIA) Elevation (µg/L) from Marine Works Scenario C1A and Scenario C2A (Dry and Wet Seasons)**