6 WATER QUALITY IMPACT

6.1 Introduction

This Section describes the baseline conditions and potential impacts on marine water quality from the construction and operation of the Project at Tseung Kwan O (TKO). Mathematical modelling was used to predict potential impacts to water quality, and the predictions were assessed with reference to the relevant environmental legislation, standards and tolerance criteria.

6.2 Legislation Requirement & Guidelines

The following relevant legislation and associated guidance are applicable to the evaluation of water quality impacts associated with the Project:

a) *Water Pollution Control Ordinance (WPCO);*

b) *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM- ICW);*

c) *Environmental Impact Assessment Ordinance (Cap. 499. S.16) and the Technical Memorandum on EIA Process (EIAO-TM), Annexes 6 and 14; and*

d) *Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN1/94).*

6.2.1 Water Pollution Control Ordinance

The *Water Pollution Control Ordinance* (WPCO) is the primary legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs).

The Study Area will cover Junk Bay, Eastern Buffer, Port Shelter, Mirs Bay and Southern WCZs. The applicable WQOs for the WCZs are presented in ***Table 6.1*** to

Table 6.5 and used in the following water quality impact assessment.

Table 6.1 Water Quality Objectives Applicable to the Junk Bay WCZ

	Water Quality Objective	**Applicable Area**
A	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone
d)	There should be no recognisable sewage-derived debris	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone

	Water Quality Objective	**Applicable Area**
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B	BACTERIA	
a)	The level of *Escherichia coli* should not exceed 610 per 100 milligrams per litre, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone & Fish Culture Zones
b)	The level of *Escherichia coli* should not exceed 1000 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Inland waters
C	COLOUR	
	Waste discharges shall not cause the colour of water to exceed 50 Hazen units.	Inland waters
D	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones
c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.	Inland waters of the Zone
E	pH	
a)	The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters
b)	The pH of the water should be within the range of 6.0 - 9.0 units.	Inland waters
F	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
G	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
H	SUSPENDED SOLIDS	
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 25 milligrams per litre.	Inland waters
I	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean), as unionized form.	Whole zone

J	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Whole zone
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	Whole zone
K	5-DAY BIOCHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Inland waters
L	CHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Inland waters
M	DANGEROUS SUBSTANCES	
a)	Waste discharges shall not cause the dangerous substances in marine waters to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone

Note:
(a) Reference: Junk Bay Water Control Zone Statement of Water Quality Objectives

Table 6.2 Water Quality Objectives Applicable to the Eastern Buffer WCZ

	Water Quality Objective	**Applicable Area**
A	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone
d)	There should be no recognisable sewage-derived debris	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone

B	BACTERIA	
a)	The level of *Escherichia coli* should not exceed 610 per 100 milligrams per litre, calculated as the geometric mean of all samples collected in one calendar year.	Fish Culture Zones
b)	The level of Escherichia coli should be less than 1 per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Water Gathering Ground Subzones
c)	The level of Escherichia coli should not exceed 1000 per 100 mL, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Other inland waters
C	COLOUR	
a)	Human activity should not cause the colour of water to exceed 30 Hazen units.	Water Gathering Ground Subzones
b)	Human activity should not cause the colour of water to exceed 50 Hazen units.	Other inland waters
D	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones
c)	The level of dissolved oxygen should not be less than 4 mg per litre.	Water Gathering Ground Subzones and other inland waters
E	pH	
a)	The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters
b)	Human activity should not cause the pH of the water to exceed the range of 6.5-8.5 units.	Water Gathering Ground Subzones
c)	Human activity should not cause the pH of the water to exceed the range of 6.0-9.0 units.	Other inland waters
F	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
G	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone

H	SUSPENDED SOLIDS	
a)	Human activity should neither cause the natural ambient level to be raise by more than 30 % nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
b)	Human activity should not cause the annual median of suspended solids to exceed 20 mg per litre.	Water Gathering Ground Subzones
c)	Human activity should not cause the annual median of suspended solids to exceed 25 mg per litre.	Other inland waters
I	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean).	Whole zone
J	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Whole zone
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.4 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	Whole zone
K	5-DAY BIOCHEMICAL OXYGEN DEMAND	
a)	The 5-day biochemical oxygen demand should not exceed 3 mg per litre.	Water Gathering Ground Subzones
b)	The 5-day biochemical oxygen demand should not exceed 5 mg per litre.	Other inland waters
L	CHEMICAL OXYGEN DEMAND	
a)	The chemical oxygen demand should not exceed 15 mg per litre.	Water Gathering Ground Subzones
b)	The chemical oxygen demand should not exceed 30 mg per litre.	Other inland waters
M	DANGEROUS SUBSTANCES	
a)	Waste discharges shall not cause the dangerous substances in marine waters to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone

Note:
(a) Reference: Statement of Water Quality Objectives (Eastern Buffer Water Control Zone)

Table 6.3 Water Quality Objectives Applicable to the Port Shelter WCZ

	Water Quality Objective	Applicable Area
A	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone
d)	There should be no recognisable sewage-derived debris	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B	BACTERIA	
a)	The level of *Escherichia coli* should not exceed 610 per 100 milligrams per litre, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone & Fish Culture Zones
b)	The level of *Escherichia coli* should not exceed 180 per 100 milligrams per litre, calculated as the geometric mean of all samples collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	Bathing Beach Subzones
C	COLOUR	
	Human activity should not cause the colour of water to exceed 50 Hazen units.	Inland waters
D	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones
c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.	Inland waters of the Zone

E	pH	
a)	The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters excepting Bathing Beach Subzones
b)	The pH of the water should be within the range of 6.0 - 9.0 units for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	Bathing Beach Subzones
c)	Waste discharges shall not cause the pH of the water to exceed the range of 6.5-8.5 units.	Ho Chung (A) Subzone
d)	The pH of the water should be within the range of 6.0 - 9.0 units.	Other inland waters
F	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
G	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
H	SUSPENDED SOLIDS	
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 25 milligrams per litre.	Inland waters
I	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean).	Whole zone
J	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.1 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	Marine waters
K	5-DAY BIOCHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Inland waters
L	CHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Inland waters
M	DANGEROUS SUBSTANCES	
a)	Waste discharges shall not cause the dangerous substances in marine waters to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone

Note:
(a) Reference: Port Shelter Water Control Zone Statement of Water Quality Objectives

Table 6.4 Water Quality Objectives Applicable to the Mirs Bay WCZ

	Water Quality Objective	Applicable Area
A	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone
d)	There should be no recognisable sewage-derived debris	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B	BACTERIA	
a)	The level of *Escherichia coli* should not exceed 610 per 100 milligrams per litre, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone & Fish Culture Zones
b)	The level of Escherichia coli should be zero per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Water Gathering Ground Subzones
(c)	The level of Escherichia coli should not exceed 1000 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Other inland waters of the Zone
C	COLOUR	
a)	Waste discharges shall not cause the colour of water to exceed 30 Hazen units.	Water Gathering Ground Subzones
b)	Waste discharges shall not cause the colour of water to exceed 50 Hazen units.	Other inland waters of the Zone
D	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones
c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.	Inland waters of the Zone

E	pH	
a)	The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters
b)	Waste discharges shall not cause the pH of the water to exceed the range of 6.5-8.5 units.	Water Gathering Ground Subzones
c)	The pH of the water should be within the range of 6.0 - 9.0 units.	Other inland waters of the Zone
F	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
G	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
H	SUSPENDED SOLIDS	
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 20 milligrams per litre.	Water Gathering Ground Subzones and Other inland waters of the Zone
I	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean).	Whole zone
J	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Whole zone
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	
K	5-DAY BIOCHEMICAL OXYGEN DEMAND	
a)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 milligrams per litre.	Water Gathering Ground Subzones
b)	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Other inland waters of the Zone
L	CHEMICAL OXYGEN DEMAND	
a)	Waste discharges shall not cause the chemical oxygen demand to exceed 15 milligrams per litre.	Water Gathering Ground Subzones
b)	Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Other inland waters of the Zone
M	DANGEROUS SUBSTANCES	
a)	Waste discharges shall not cause the dangerous substances in marine waters to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone

Note:
(a) Reference: Statement of Water Quality Objectives (Mirs Bay Water Control Zone)

Table 6.5 Water Quality Objectives Applicable to the Southern WCZ

	Water Quality Objective	Applicable Area
A	AESTHETIC APPEARANCE	
a)	Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam.	Whole zone
d)	There should be no recognisable sewage-derived debris	Whole zone
e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B	BACTERIA	
a)	The level of *Escherichia coli* should not exceed 610 per 100 milligrams per litre, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone & Fish Culture Zones
b)	The level of *Escherichia coli* should not exceed 180 per 100 milligrams per litre, calculated as the geometric mean of all samples collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	Bathing Beach Subzones
C	DISSOLVED OXYGEN	
a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones
b)	The dissolved oxygen level should not be less than 5 milligrams per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 milligrams per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Fish Culture Subzones
c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 milligrams per litre.	Inland waters of the Zone

D	pH	
a)	The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters excepting Bathing Beach Subzones; Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones.
b)	The pH of the water should be within the range of 6.0 - 9.0 units.	Mui Wo (D) Sub-zone and other inland waters.
c)	The pH of the water should be within the range of 6.0 - 9.0 units for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	Bathing Beach Subzones
E	TEMPERATURE	
	Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone
F	SALINITY	
	Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
G	SUSPENDED SOLIDS	
a)	Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters of the whole zone
b)	Waste discharges shall not cause the annual median of suspended solids to exceed 20 milligrams per litre.	Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones.
c)	Waste discharges shall not cause the annual median of suspended solids to exceed 25 milligrams per litre.	Mui Wo (D) Sub-zone and other inland waters.
H	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 milligram per litre, calculated as the annual average (arithmetic mean).	Whole zone
I	NUTRIENTS	
a)	Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Whole zone
b)	Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.1 milligram per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	
J	5-DAY BIOCHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 milligrams per litre.	Inland waters of the zone
K	CHEMICAL OXYGEN DEMAND	
	Waste discharges shall not cause the chemical oxygen demand to exceed 30 milligrams per litre.	Inland waters of the zone

L	DANGEROUS SUBSTANCES	
a)	Waste discharges shall not cause the dangerous substances in marine waters to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b)	Waste discharges of dangerous substances shall not put a risk to any beneficial uses of the aquatic environment.	Whole zone

Note:
(b) Reference: Statement of Water Quality Objectives (Southern Water Control Zone)

6.2.2 Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ICW)

All discharges during both the construction and operation phases of the Project are required to comply with the *TM-ICW* issued under Section 21 of the *WPCO*.

The *TM-ICW* defines acceptable discharge limits to different types of receiving waters. Under the *TM-ICW*, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for specified discharge volumes. These are defined by the Environmental Protection Department (EPD) and are specified in licence conditions for any new discharge within a WCZ.

The *TM-ICW* also prohibits new effluent (1) within 100m of the boundaries of a gazetted beach in any direction, including rivers, streams and storm water drains, (2) within 200m of the seaward boundaries of a marine fish culture zone or a site of special scientific interest, and within 100m of the landward boundaries (3) in any typhoon shelter, (4) in any marina and (5) within 100m of a seawater intake point. As shown in ***Figure 6.1***, there is no gazetted beach, site of special scientific interest, typhoon shelter, marina and existing seawater intake within 100m from the proposed submarine outfall. The nearest fish culture zone at Tung Lung Chau is more than 500 m away. The proposed seawater intake under this project would also be over 150 m away from the proposed submarine outfall.

6.2.3 Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM)

Annexes 6 and *14* of the *EIAO-TM* provide general guidelines and criteria to be used in assessing water quality impacts.

The *EIAO-TM* recognizes that, in the application of the above water quality criteria, it may not be possible to achieve the WQO at the point of discharge as there are areas which are subjected to greater impacts (which are termed by the EPD as the mixing zones) where the initial dilution of the discharge takes place. The definition of this area is determined on a case-by-case basis. In general, the criteria for acceptance of the mixing zone are that it must not impair the integrity of the water body as a whole and must not damage the ecosystems.

6.2.4 Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94)

Apart from the above statutory requirements, the ProPECC PN 1/94, issued by EPD in 1994, also provide useful guidelines on water pollution associated with construction activities.

6.3 Baseline Condition

6.3.1 Overview

The Study Area for water quality, which consists of marine waters within 7 km from the boundary of the proposed TKO Desalination Plant and the associated marine intake and outfall, covers the Junk Bay WCZ, Eastern Buffer WCZ, Port Shelter WCZ, Mirs Bay WCZ and Southern WCZ. The Study Area is located at the eastern end of the Victoria Harbour and is less affected seasonally by the Pearl River flow when compared with the Western and Central Waters. Water depth varies widely over the Study Area, from relatively shallow waters in Tai Miu Wan and Junk Bay WCZ to the deeper Mirs Bay and Southern Waters.

6.3.2 Marine Water Quality

Baseline marine water quality of the Study Area has been determined through a review of EPD routine monthly water quality monitoring data collected in 2009 to 2013. Six EPD monitoring stations are identified within the Study Area and the locations of these stations are presented in ***Figure 6.1***.

Water quality monitoring data from stations JM3, JM4, EM1, EM2, EM3 and MM19 were used to provide the baseline water quality condition in the vicinity of the Project Site. The monitoring results in 2009 to 2013 at the selected monitoring stations are summarized in ***Table 6.6***. According to the EPD's Marine Water Quality in Hong Kong in 2013, full compliance at all monitoring stations in both the Eastern Buffer and Junk Bay WCZs was achieved since the implementation of HATS Stage 1 in end 2011. The overall WQO compliance rate of the Mirs Bay WCZ was 100% in 2013. The water quality of the Mirs Bay WCZ was good in 2013 with high DO and low TIN levels. Moreover, the Mirs Bay WCZ also complied with the bacteriological WQO of ≤ 610 *E. coli* cfu / 100 mL (annual geometric mean) for secondary contact recreation. For Port Shelter, the 2013 the water quality of the Port Shelter WCZ was good and the overall WQO compliance rate was 100%, with full compliance with the WQOs for DO, *E. coli*, TIN and NH_3-N. Although the TIN level in the Port Shelter WCZ complied with the WQO in 2013, long term data still showed an increasing trend during the period from 2009 to 2013. Because a similar pattern of TIN elevation was also noted at both the inner and outer parts of the Port Shelter WCZ as well as the Mirs Bay and Eastern Buffer WCZs, it is observed that the elevated TIN level in recent years is a regional phenomenon which could be related to a higher background TIN level in the eastern waters of Hong Kong brought about by an increase in shipping and port activities in the region.

6.3.3 Sediment Quality

Baseline marine sediment quality in the Study Area has been determined through a review of EPD routine biannual sediment quality monitoring data collected between 2009 and 2013. Locations of EPD sediment monitoring stations within the Study Area are presented in ***Figure 6.1***.

Sediment monitoring data from stations JS2, ES1, ES2 and ES4 were reviewed to represent the sediment quality adjacent to the Project Site (***Table 6.7***). The levels for metals, Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) were compared to the relevant sediment quality criteria specified in ETWB TC(W) No. 34/2002 Management of Dredged/Excavated Sediment.

The EPD routine monitoring data indicate that mild level of sediment contamination is identified in the vicinity of the Project Site. Exceedance of the Lower Chemical Exceedance Level (LCEL) of copper and silver are identified at Sediment Station JS2. Exceedance of the Upper Chemical Exceedance Level (UCEL) for silver and exceedance of LCEL for copper, zinc and high molecular weight polycyclic aromatic hydrocarbon are identified at Sediment Station ES4.

Sediment sampling and testing was conducted under this Study to identify the level of sediment contamination within the marine construction works area. Sediment sampling locations are shown in ***Figure 6.3***. The testing results are compared against the LCEL and UCEL below in ***Table 6.8****. S*ediment testing and the associated elutriate testing results from the laboratory are enclosed in *Annex 6H*. As shown, no exceedance in LCEL is identified for all sediment samples for all parameters. Furthermore, sediment elutriate test was conducted using sediment samples from these sampling stations to identify the potential of dissolution of sediment-bounded nutrients, heavy metals and trace organic pollutants due to disturbance from marine works under this Project. The sediment elutriate test results are shown in ***Table 6.9*** below.

Table 6.6 Summary of EPD Routine Water Quality Monitoring Data from Selected Stations of the Junk Bay, Eastern Buffer and Mirs Bay Water Control Zones from 2009 to 2013

Parameter	JM3	JM4	EM1	EM2	EM3	MM19
Temperature (°C)	23.1 (15.0-29.1)	22.9 (14.8-29.1)	22.9 (15.0-29.2)	22.9 (14.9-29.0)	22.8 (14.9-28.9)	22.7 (15.0-29.1)
Salinity (psu)	32.1 (27.7-33.8)	32.3 (29.5-33.9)	32.3 (29.7-33.9)	32.3 (25.7-33.9)	32.6 (30.1-33.9)	32.8 (31.2-34.0)
Dissolved Oxygen (mg/L) - Depth Averaged	6.5 (4.1-9.6)	6.3 (3.9-9.7)	6.2 (3.7-9.7)	6.4 (4.2-9.7)	6.5 (4.1-9.7)	6.5 (3.6-8.3)
Dissolved Oxygen (mg/L) - Bottom	6.1 (2.9-9.7)	6.0 (2.7-9.7)	6.0 (2.6-9.6)	6.0 (3.1-9.7)	6.1 (2.5-9.7)	5.9 (2.2-8)
Suspended Solids (mg/L)	2.9 (0.8-7.9)	3.3 (0.8-8.6)	3.4 (0.6-7.5)	3.4 (0.7-10.2)	3.4 (0.6-11.2)	2.7 (0.8-7.5)
5-day Biochemical Oxygen Demand (mg/L)	0.8 (0.2-3.6)	0.8 (0.1-4.0)	0.7 (0.2-2.1)	0.7 (0.1-4.9)	0.7 (0.1-4.9)	0.6 (0.1-1.5)
Unionised Ammonia (mg/L)	0.002 (0.001-0.009)	0.002 (0.001-0.008)	0.003 (0.001-0.047)	0.002 (0.001-0.005)	0.002 (0.001-0.005)	0.001 (0.001-0.005)
Total Inorganic Nitrogen (mg/L)	0.18 (0.05-0.34)	0.16 (0.04-0.33)	0.17 (0.04-0.45)	0.14 (0.02-0.47)	0.11 (0.01-0.28)	0.09 (0.01-0.27)
Orthophosphate Phosphorus (mg/L)	0.014 (0.003-0.035)	0.013 (0.004-0.029)	0.014 (0.003-0.029)	0.012 (0.004-0.027)	0.011 (0.002-0.030)	0.009 (0.003-0.026)
Total Phosphorus (mg/L)	0.032 (0.020-0.047)	0.031 (0.020-0.047)	0.032 (0.020-0.100)	0.030 (0.020-0.047)	0.029 (0.020-0.047)	0.027 (0.020-0.045)
Chlorophyll-*a* (µg/L)	4.0 (0.2-29.7)	3.3 (0.5-20.9)	3.2 (0.2-24.3)	2.7 (0.5-21.6)	2.2 (0.4-12.8)	1.8 (0.5-11.1)
Escherichia coli (cfu/100ml)	59 (4-817)	56 (1-697)	60 (1-1563)	26 (1-1000)	6 (1-474)	2 (1-5)

Notes:

(a) Data presented are depth-averaged values calculated by taking the means of three depths, i.e. surface (S), mid-depth (M) and bottom (B), except as specified.

(b) Data presented are annual arithmetic means except for *E. coli*, which are geometric means.

(c) Data enclosed in brackets indicate the ranges regardless of the depths.

(d) Bold and underlined figures indicate non-compliance with the WQOs: TIN = 0.1 mg/L for South WCZ; TIN = 0.4 mg/L for Western Buffer WCZ.

Table 6.7 Summary of EPD Routine Marine Sediment Quality Monitoring Data from Selected Station of for the Junk Bay and Eastern Buffer Water Control Zone (2009-2013)

Parameter	ETWB TC(W) No. 34/2002 Guideline		Junk Bay WCZ	Eastern Buffer WCZ		
	LCEL	UCEL	JS2	ES1	ES2	ES4
Arsenic (mg/kg)	12	42	7.8 (6.8-8.6)	5.5 (4.4-6.2)	5.5 (4.4-7.3)	5.5 (3.4-7.0)
Cadmium (mg/kg)	1.5	4	0.1 (0.1-0.2)	<0.1 (<0.1-<0.1)	0.1 (<0.1-0.2)	0.1 (<0.1-0.4)
Chromium (mg/kg)	80	160	43 (29-48)	24 (18-30)	22 (17-30)	30 (24-39)
Copper (mg/kg)	65	110	78 (55-92)	27 (18-36)	16 (9-54)	52 (32-100)
Lead (mg/kg)	75	110	48 (35-55)	28 (21-35)	24 (18-38)	35 (26-61)
Mercury (mg/kg)	0.5	1	0.22 (0.17-0.29)	0.12 (0.08-0.21)	0.07 (<0.05-0.17)	0.21 (0.12-0.50)
Nickel (mg/kg)	40	40	21 (15-23)	14 (11-18)	14 (12-19)	16 (13-21)
Silver (mg/kg)	1	2	1.6 (0.9-2.0)	0.5 (0.3-0.6)	0.2 (<0.2-0.4)	1.3 (0.7-4.2)
Zinc (mg/kg)	200	270	130 (97-150)	69 (56-87)	61 (40-120)	110 (69-260)
Total Polychlorinated Biphenyls (PCBs) (μg / kg)	23	180	18 (18-18)	18 (18-18)	18 (18-18)	18 (18-19)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)	550	3,160	120 (93-250)	120 (90-210)	96 (90-120)	110 (90-140)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg)	1,700	9,600	300 (130-430)	220 (68-840)	84 (25-300)	400 (110-1800)
Chemical Oxygen Demand (mg/kg)	--	--	13700 (11000-16000)	10800 (9100-14000)	8790 (6700-13000)	12400 (9300-24000)

Parameter	ETWB TC(W) No. 34/2002 Guideline		Junk Bay WCZ	Eastern Buffer WCZ		
	LCEL	UCEL	JS2	ES1	ES2	ES4
Total Kjeldahl Nitrogen (mg/kg)	--	--	500 (320-600)	380 (220-460)	390 (280-490)	440 (290-530)
Ammonia Nitrogen (mg/kg)	--	--	4.5 (0.10-8.20)	4.6 (0.30-14.00)	4.6 (0.10-19.00)	5 (0.80-12.00)
Total Phosphorus (mg/kg)	--	--	200 (150-230)	190 (110-230)	200 (170-240)	190 (120-230)

Table 6.8 Summary of Marine Sediment Quality at Geophysical Survey Stations conducted under this Study

Parameter (Unit)	**LOR**	**LCEL**	**UCEL**	**SD5-1 0.0-0.9m**	**SD5-2 0.9-1.9m**	**SD5-3 1.9-2.9m**	**SD5-4 4.9-5.9m**	**SD5-5 7.9-8.9m**	**SD5-6 10.9-11.9m**	**GS5**	**GS6**	**GS7**	**Reference Sample**
Silver (mg/kg)	0.1	1	2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.5	0.4	0.5	0.2
Arsenic (mg/kg)	1	12	42	4	3	4	5	8	8	7	6	7	9
Cadmium (mg/kg)	0.2	1.5	4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.4
Chromium (mg/kg)	1	80	160	6	27	33	29	38	43	43	38	40	14
Copper (mg/kg)	1	65	110	7	8	8	8	12	15	44	37	38	16
Nickel (mg/kg)	1	40	40	4	20	26	21	28	32	25	23	24	10
Lead (mg/kg)	1	75	110	6	19	16	17	24	26	37	33	36	14
Zinc (mg/kg)	1	200	270	30	61	73	60	72	79	106	96	101	72
Mercury (mg/kg)	0.05	0.5	1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.13	0.16	<0.05
Total PCBs (µg/kg)	18	123	180	<18	<18	<18	<18	<18	<18	<18	<18	<18	<18
LMW PAHs (µg/kg)	550	550	3160	<550	<550	<550	<550	<550	<550	<550	<550	<550	<550
HMW PAHs (µg/kg)	1700	1700	9600	<1700	<1700	<1700	<1700	<1700	<1700	<1700	<1700	<1700	<1700
TBT (µg/kg)	0.015	0.15	0.15	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	IS
Ammonia (mg/kg)	0.1	-	-	4	3.6	4.6	12.8	25.7	30.3	11.2	8.6	9.2	26.7
Reactive Phosphorous (mg/kg)	0.1	-	-	0.5	0.2	0.2	0.2	0.6	1.3	1.1	1.1	1.2	1.3
Total Kjeldahl Nitrogen (mg/kg)	50	-	-	980	760	870	860	670	740	1330	1410	1480	1520
Total Phosphorous (mg/kg)	10	-	-	492	414	488	544	332	419	573	551	566	611
Nitrate (mg/kg)	1	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nitrite (mg/kg)	1	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

(a) LOR: Limit of Reporting; LCEL: Lower Chemical Exceedance Level; UCEL: Upper Chemical Exceedance Level

Table 6.9 Summary of Sediment Elutriate Test Results at Geophysical Survey Stations conducted under this Study

Parameter (Unit)	**WQC**	**LOR**	**SD5-1 0.0-0.9m**	**SD5-2 0.9-1.9m**	**SD5-3 1.9-2.9m**	**SD5-4 4.9-5.9m**	**SD5-5 7.9-8.9m**	**SD5-6 10.9-11.9m**	**SD5-6 Water Blank**	**GS5**	**GS6**	**GS7**	**GS5 Water Blank**	**GS6 Water Blank**	**GS7 Water Blank**	**Reference Sample**	**Reference Sample Water Blank**
Mercury (μg/L)	0.3	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Arsenic (μg/L)	25	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cadmium (μg/L)	2.5	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chromium (μg/L)	15	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Copper (μg/L)	5	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lead (μg/L)	25	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel (μg/L)	30	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver (μg/L)	1.9	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc (μg/L)	40	25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Total PCBs (μg/L)	0.03	0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18	<0.18
Total PAHs (μg/L)	3	0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16	<0.16
TBT (μg/L)	0.1	0.015	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15
Ammonia (mg/L)	-	0.01	0.47	0.54	0.31	1.82	3.29	2.93	0.01	0.62	0.83	0.75	<0.01	<0.01	<0.01	1	0.04
Reactive Phosphorous (μg/L)	-	10	130	100	40	110	110	60	<10	70	120	70	<10	<10	<10	70	<10
Total Kjeldahl Nitrogen (mg/L)	-	0.1	0.9	0.9	0.7	1.9	4.2	3.6	0.3	0.9	1.2	1.1	0.3	0.2	0.3	1.4	0.3
Total Phosphorous (mg/L)	-	0.1	0.1	0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Nitrate (mg/L)	-	0.01	<0.01	0.06	0.02	0.02	0.02	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Nitrite (mg/L)	-	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

(a) WQC: Water quality assessment criteria (stipulated under *Section 6.5.6*); LOR: Limit of Reporting

6.4 Water Quality Sensitive Receivers

The water quality sensitive receivers (WSRs) have been identified in accordance with *Annex 14* of the *EIAO-TM* as well as Clause 3.4.4.2 of the Environmental Impact Assessment Study Brief for Desalination Plant at Tseung Kwan O (No. ESB-266/2013). These WSRs are illustrated in ***Figure 6.1*** and listed in ***Table 6.10***. The representative WSRs as discrete modelling output points are shown in ***Figure 6.2***.

Table 6.10 Water Quality Sensitive Receivers (WSRs) in the Vicinity of the Project Site

Description	Location	Model Output Location	Distance from Seawater Intake	Distance from Submarine Outfall
Fisheries Sensitive Receivers				
Fish Culture Zones	Tung Lung Chau	SR2	1371	1147
	Po Toi O	SR27	1776	2124
Ecological Sensitive Receivers				
Coral Communities	Junk Bay	SR20	4161	4220
	Junk Bay	SR21	3659	3692
	Junk Bay	SR22	4109	4114
	Fat Tong Chau	SR16	2084	2097
	Tai Miu Wan	SR4	915	1233
	Cape Collinson	SR10	2089	2000
	Cape Collinson	SR11	2446	2320
	Cape Collinson	SR12	3036	2808
	Tung Lung Chau	SR1	2047	1597
	Tung Lung Chau	SR3	1353	1321
	Tung Lung Chau	SR6	1876	1973
	Tung Lung Chau	SR7	2396	2301
	Tung Lung Chau	SR8	2843	2641
	Tung Lung Chau	SR9	3298	2863
	Tai Long Pai	SR32	3727	3309
	Coral Survey Locations D-W	SR33	400	723
	Coral Survey Locations D-T	SR34	784	1134
	Coral Survey Locations D-L	SR35	1231	946
	Kwun Tsai	SR36	90	246
	Tit Cham Chau	SR37	256	75
Water Quality Sensitive Receivers				
Gazetted Bathing Beaches	Big Wave Bay	SR12	3036	2808
	Clear Water Bay	SR29	2506	2780
	Clear Water Bay	SR30	2738	3017
	Shek O	SR15	4979	4620
	Rocky Bay	SR14	4350	4007
Coastal Protection Areas	Clear Water Bay	SR28	2430	2780
	Clear Water Bay	SR29	2506	2780
	Clear Water Bay	SR30	2738	3017
	Clear Water Bay	SR31	2863	3178
	Po Toi O	SR27	1776	2124
	Tai Miu Wan	SR4	915	1233
	Tai Miu Wan	SR5	1466	1749
	Cape Collinson	SR10	2089	2000

Description	Location	Model Output Location	Distance from Seawater Intake	Distance from Submarine Outfall
Seawater Intakes	Cape Collinson	SR11	2446	2320
	Big Wave Bay	SR13	3785	3554
	Tai Tam	SR25	2704	2983
	Tai Tam	SR26	2041	2317
	Tseung Kwan O New Town	SR19	3539	3617
	Siu Sai Wan	SR16	2084	2097
	Siu Sai Wan	SR17	3001	2955
	Heng Fa Chuen	SR23	4472	4456
	Heng Fa Chuen	SR24	3957	3928

Noted: There are seven coral sites identified and surveyed in the coral survey conducted under this Study. Two of them (D-O and D-I) are located at Tit Cham Chau and Kwun Tsai and would be assessed as SR36 and SR37 respectively. Two of them (D-F and D-E) are previously known coral sites and are already represented as SR16 and SR4 respectively. The remaining three coral sites are included as SR33-SR35.

6.5 Assessment Criteria

6.5.1 Water Quality Objectives

Suspended Solids

Specific water quality criteria for SS level allowed at fish culture zones and Water Supplies Department (WSD) Flushing Water Intakes are stipulated below. For all other WSRs with no specific water quality criteria, elevation in SS concentrations resulting from the Project's construction and operational activities were assessed against the WQO. The WQO for SS is defined as not to raise the natural ambient level by 30%, nor cause the accumulation of SS which may adversely affect aquatic communities. The assessment criterion is hence defined as the WQO allowable increase in SS concentrations within the corresponding WCZs.

SS data from EPD's routine water quality monitoring programme in 2009-2013 have been analyzed to determine the WQO allowable increase at the WSRs. This is calculated as 30% of the ambient level (90th percentile value) from the 2009-2013 baseline marine water quality data. For each WSR, ambient level was derived from the closest EPD water quality monitoring station. The assessment criterion for SS at each WSR is summarized in ***Table 6.11***.

Dissolved Oxygen

Oxygen depletion resulting from the Project's construction and operational activities were assessed against the WQO. The assessment criterion is defined as the WQO allowable depletion in DO levels at the WSRs.

DO data from EPD's routine water quality monitoring programme from 2009-2013 have been analyzed to determine WQO allowable depletion at the WSRs. Allowable DO depletion is calculated as the ambient DO level minus the WQO, i.e. 4 mg/L for depth-averaged, surface and middle layers, and 2 mg/L for bottom layer. Ambient level is calculated as the 10^{th}-percentile value from the 2009-2013 marine water quality data. For each WSR, ambient level was derived from the closest EPD water quality monitoring station. The assessment criterion for DO at each WSR is summarized in ***Table 6.12***.

Table 6.11 Water Quality Assessment Criteria for Suspended Solids (mg/L) at WSRs

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable Change	Ambient Level (a)	WQO Allowable Change
Fisheries Sensitive Receivers								
Fish Culture Zones	Tung Lung Chau	SR2	EM2	Depth-averaged	7.27	42.73(AFCD)	5.13	44.87(AFCD)
	Po Toi O	SR27	MM19	Depth-averaged	5.37	44.63(AFCD)	3.69	46.31(AFCD)
Ecological Sensitive Receivers								
Coral Communities	Junk Bay	SR20	JM3	Bottom	8.70	2.61	5.80	1.74
		SR21	JM4	Bottom	8.28	2.48	9.24	2.77
		SR22	JM4	Bottom	8.28	2.48	9.24	2.77
	Fat Tong Chau	SR16	EM1	Bottom	7.34	2.20	6.85	2.06
	Tai Miu Wan	SR4	EM2	Bottom	12.60	3.78	8.20	2.46
	Cape Collinson	SR10	EM2	Bottom	12.60	3.78	8.20	2.46
		SR11	EM2	Bottom	12.60	3.78	8.20	2.46
		SR12	EM2	Bottom	12.60	3.78	8.20	2.46
	Tung Lung Chau	SR1	EM3	Bottom	11.80	3.54	6.92	2.08
		SR3	EM2	Bottom	12.60	3.78	8.20	2.46
		SR6	MM19	Bottom	9.84	2.95	6.76	2.03
		SR7	MM19	Bottom	9.84	2.95	6.76	2.03
		SR8	MM19	Bottom	9.84	2.95	6.76	2.03
		SR9	EM3	Bottom	11.80	3.54	6.92	2.08
	Tai Long Pai	SR32	EM3	Bottom	11.80	3.54	6.92	2.08
	D-W	SR33	EM2	Bottom	12.60	3.78	8.20	2.46
	D-T	SR34	EM2	Bottom	12.60	3.78	8.20	2.46

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable Change	Ambient Level (a)	WQO Allowable Change
	D-L	SR35	EM2	Bottom	12.60	3.78	8.20	2.46
	Kwun Tsai	SR36	EM2	Bottom	12.60	3.78	8.20	2.46
	Tit Cham Chau	SR37	EM2	Bottom	12.60	3.78	8.20	2.46
Water Quality Sensitive Receivers								
Gazetted Bathing Beaches	Big Wave Bay	SR12	EM2	Depth-averaged	7.27	2.18	5.13	1.54
	Clear Water Bay	SR29	MM19	Depth-averaged	5.37	1.61	3.69	1.11
		SR30	MM19	Depth-averaged	5.37	1.61	3.69	1.11
	Shek O	SR15	EM3	Depth-averaged	7.17	2.15	5.54	1.66
	Rocky Bay	SR14	EM3	Depth-averaged	7.17	2.15	5.54	1.66
Coastal Protection Areas	Clear Water Bay	SR28	MM19	Depth-averaged	5.37	1.61	3.69	1.11
		SR29	MM19	Depth-averaged	5.37	1.61	3.69	1.11
		SR30	MM19	Depth-averaged	5.37	1.61	3.69	1.11
		SR31	MM19	Depth-averaged	5.37	1.61	3.69	1.11
	Po Toi O	SR27	MM19	Depth-averaged	5.37	1.61	3.69	1.11
	Tai Miu Wan	SR4	EM2	Depth-averaged	7.27	2.18	5.13	1.54
		SR5	EM2	Depth-averaged	7.27	2.18	5.13	1.54
	Cape Collinson	SR10	EM2	Depth-averaged	7.27	2.18	5.13	1.54
		SR11	EM2	Depth-averaged	7.27	2.18	5.13	1.54
	Big Wave Bay	SR13	EM3	Depth-averaged	7.17	2.15	5.54	1.66
	Tai Tam	SR25	MM19	Depth-averaged	5.37	1.61	3.69	1.11
		SR26	MM19	Depth-averaged	5.37	1.61	3.69	1.11

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable Change	Ambient Level (a)	WQO Allowable Change
WSD Flushing Intake	Tseung Kwan O New Town	SR19	JM3	Mid-depth	4.50	5.50 (WSD)	4.78	5.22 (WSD)
	Siu Sai Wan	SR17	EM1	Mid-depth	4.10	5.90 (WSD)	5.24	4.76 (WSD)
	Heng Fa Chuen	SR23	EM1	Mid-depth	4.10	5.90 (WSD)	5.24	4.76 (WSD)
Cooling Water Intake	Chai Wan Godown	SR16	EM1	Mid-depth	4.10	1.23	5.24	1.57
	Pamela Youde Nethersole Eastern Hospital	SR24	EM1	Mid-depth	4.10	1.23	5.24	1.57

Notes:

(a) Ambient level is calculated as 90th percentile of the EPD routine monitoring data of 2009-2013 at respective EPD station close to the WSRs;

(b) This table is applicable for those WSRs which were assessed against the WQO. Assessment of some WSRs should also refer to the specific assessment criterion of SS for this type of WSR. The allowable elevation of SS for Fish Culture Zones is 50 mg/L minus ambient level;

(c) There is a specific requirement for the seawater intake and the SS should be maintained at below 10 mg/L. Allowable SS increase is calculated as 10 mg/L minus 90th percentile of the ambient SS level.

Table 6.12 Water Quality Objectives for Dissolved Oxygen (mg/L) at WSRs

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable DO Depletion	Ambient Level (a)	WQO Allowable DO Depletion
Fisheries Sensitive Receivers								
Fish Culture Zones	Tung Lung Chau	SR2	EM2	Depth-averaged	6.25	1.25	4.63	-
	Po Toi O	SR27	MM19	Depth-averaged	6.40	1.40	4.68	-
Ecological Sensitive Receivers								
Coral Communities	Junk Bay	SR20	JM3	Bottom	6.08	4.08	3.90	1.90
		SR21	JM4	Bottom	6.14	4.14	3.24	1.24
		SR22	JM4	Bottom	6.14	4.14	3.24	1.24
	Fat Tong Chau	SR16	EM1	Bottom	6.14	4.14	3.22	1.22
	Tai Miu Wan	SR4	EM2	Bottom	6.34	4.34	3.32	1.32
	Cape Collinson	SR10	EM2	Bottom	6.34	4.34	3.32	1.32
		SR11	EM2	Bottom	6.34	4.34	3.32	1.32
		SR12	EM2	Bottom	6.34	4.34	3.32	1.32
	Tung Lung Chau	SR1	EM3	Bottom	6.38	4.38	3.32	1.32
		SR3	EM2	Bottom	6.34	4.34	3.32	1.32
		SR6	MM19	Bottom	6.24	4.24	3.20	1.20
		SR7	MM19	Bottom	6.24	4.24	3.20	1.20
		SR8	MM19	Bottom	6.24	4.24	3.20	1.20
		SR9	EM3	Bottom	6.38	4.38	3.32	1.32
	Tai Long Pai	SR32	EM3	Bottom	6.38	4.38	3.32	1.32
	D-W	SR33	EM2	Bottom	6.34	4.34	3.32	1.32
	D-T	SR34	EM2	Bottom	6.34	4.34	3.32	1.32

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable DO Depletion	Ambient Level (a)	WQO Allowable DO Depletion
	D-L	SR35	EM2	Bottom	6.34	4.34	3.32	1.32
	Kwun Tsai	SR36	EM2	Bottom	6.34	4.34	3.32	1.32
	Tit Cham Chau	SR37	EM2	Bottom	6.34	4.34	3.32	1.32
Water Quality Sensitive Receivers								
Gazetted Bathing Beaches	Big Wave Bay	SR12	EM2	Depth-averaged	6.25	2.25	4.63	0.63
	Clear Water Bay	SR29	MM19	Depth-averaged	6.40	2.40	4.68	0.68
		SR30	MM19	Depth-averaged	6.40	2.40	4.68	0.68
	Shek O	SR15	EM3	Depth-averaged	6.34	2.34	4.56	0.56
	Rocky Bay	SR14	EM3	Depth-averaged	6.34	2.34	4.56	0.56
Coastal Protection Areas	Clear Water Bay	SR28	MM19	Depth-averaged	6.40	2.40	4.68	0.68
		SR29	MM19	Depth-averaged	6.40	2.40	4.68	0.68
		SR30	MM19	Depth-averaged	6.40	2.40	4.68	0.68
		SR31	MM19	Depth-averaged	6.40	2.40	4.68	0.68
	Po Toi O	SR27	MM19	Depth-averaged	6.40	2.40	4.68	0.68
	Tai Miu Wan	SR4	EM2	Depth-averaged	6.25	2.25	4.63	0.63
		SR5	EM2	Depth-averaged	6.25	2.25	4.63	0.63
	Cape Collinson	SR10	EM2	Depth-averaged	6.25	2.25	4.63	0.63
		SR11	EM2	Depth-averaged	6.25	2.25	4.63	0.63
	Big Wave Bay	SR13	EM3	Depth-averaged	6.34	2.34	4.56	0.56
	Tai Tam	SR25	MM19	Depth-averaged	6.40	2.40	4.68	0.68
		SR26	MM19	Depth-averaged	6.40	2.40	4.68	0.68

Sensitive Receivers	Name	Model Output Location	EPD Station	Relevant Depth for Assessment	Dry Season		Wet Season	
					Ambient Level (a)	WQO Allowable DO Depletion	Ambient Level (a)	WQO Allowable DO Depletion
WSD Flushing Intake	Tseung Kwan O New Town	SR19	JM3	Mid-depth	5.98	3.98	4.58	2.58
	Siu Sai Wan	SR17	EM1	Mid-depth	6.08	4.08	3.80	1.80
	Heng Fa Chuen	SR23	EM1	Mid-depth	6.08	4.08	3.80	1.80
Cooling Water Intake	Chai Wan Godown	SR16	EM1	Mid-depth	6.08	-	3.80	-
	Pamela Youde Nethersole Eastern Hospital	SR24	EM1	Mid-depth	6.08	-	3.80	-

Notes:

(a) Ambient level is calculated as 10th percentile of the EPD routine monitoring data of 2009-2013 at respective EPD station close to WSRs;

(b) This table is applicable for those WSRs which were assessed against the WQO. WQO may not be applicable for the assessment all the WSRs and it should refer to the specific assessment criterion of DO for this type of WSR. The value for Fish Culture Zones is 5.0 mg/L;

(c) There is a specific requirement for the seawater intake and the DO should be maintained at above 2 mg/L. Allowable DO depletion is calculated as average of the ambient DO level minus 2 mg/L.

(d) EPD water quality monitoring data indicated that 10th percentile DO level of fish culture zone at Tung Lung Chau and Po Toi O is below the corresponding WQO criteria of 5 mg/L in wet season.

Criteria for Nutrients for Project Construction

Elevation in the levels of nutrients, if any, as a result of the Project's construction activities were assessed in accordance with the respective WQO and WSD criteria summarized in ***Table 6.13*** *and* ***Table 6.14***. Other water quality criteria for the Project operation are provided below in *Section 6.5.6*.

Table 6.13 Other Relevant WQO Criteria for Construction Phase

Parameters (unit: mg/L)	Assessment Criteria				
	Junk Bay	Eastern Buffer	Port Shelter	Mirs Bay	Southern
Total Inorganic Nitrogen	< 0.3	< 0.4	< 0.1	< 0.3	< 0.1
Unionized Ammonia	< 0.021 mg/L for all WCZs				

6.5.2 Water Quality Criteria from Water Supplies Department

The WSD has a set of standards for the quality of abstracted seawater (***Table 6.14***). Water quality of WSD's seawater intakes have been assessed against an SS criterion of < 10 mg/L. The maximum allowable SS elevation and DO depletion is provided in ***Table 6.11*** *and* ***Table 6.12*** above.

Table 6.14 WSD Water Quality Criteria for Flushing Water Intakes

Parameter	Criterion
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour No.	< 100
Ammoniacal Nitrogen (mg/L)	< 1
Suspended Solids (mg/L)	< 10
Dissolved Oxygen (mg/L)	> 2
5-day Biochemical Oxygen Demand (mg/L)	< 10
Synthetic Detergents (mg/L)	< 5
E. coli (cfu/100mL)	< 20,000

6.5.3 Sediment Deposition Rate and Suspended Solids Criteria for Corals

Impacts to coral communities, if any, have been assessed with regard to sediment deposition. The assessment criterion of 100 $g/m^2/day$, which represents an indicative level above which sustained deposition could harm sediment sensitive hermatypic corals, has been used in approved EIA Reports (1) (2) and was adopted here.

(1) ERM – Hong Kong, Ltd (2007) EIA for Development of a Bathing Beach at Lung Mei, Tai Po. For Civil Engineering Department, Hong Kong SAR Government.
(2) ERM - HK Ltd (2010). Development of an Offshore Wind Farm in Hong Kong. Final Environmental Impact Assessment. For the Hong Kong Electric Company

Coral communities have been identified along the coastline of Tung Lung Chau, Fat Tong Chau, Tai Miu Wan, Junk Bay and Cape Collinson. There are no established legislative criteria for water quality at coral communities; however, information on hard coral tolerances to SS indicates that a 20% reduction in annual growth rate corresponds to a 30% increase in average long-term background SS levels (2). WQOs of SS (30% increase) at the identified coral communities are presented in ***Table 6.11*** and have been utilized for determining the acceptability of impacts on corals (1) in this EIA.

6.5.4 Criteria for Fish Culture Zones

The Agriculture, Fisheries and Conservation Department (AFCD) have identified a guideline for the protection of water quality at Fish Culture Zones (FCZs) and a maximum SS value of 50 mg/L is recommended. This criterion has been adopted in previous approved EIA Reports (2) (3) (4). Thus, for the purposes of assessment, the AFCD criterion is considered to be applicable for the Tung Lung Chau and Po Toi O FCZs.

For FCZs, in accordance with the WQO, the DO criterion is set at > 5 mg/L measured as water column average. The maximum allowable SS elevation and DO depletion is provided in ***Table 6.11*** and ***Table 6.12*** above. As shown in ***Table 6.12***, the 10^{th}-percentile ambient DO level at FCZs of Tung Lung Chau and Po Toi O are both below the proposed criteria of 5 mg/L in wet season.

6.5.5 Criteria for Dissolved Metals and Organic Compounds

There are no existing regulatory standards or guidelines for dissolved metals and organic contaminants in the marine waters of Hong Kong. It is thus proposed to make reference to relevant international standards and this approach has been adopted in previous approved EIAs, i.e., EIA for Decommissioning of Cheoy Lee Shipyard at Penny's Bay (5), EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit (6), EIA for Wanchai Development Phase II *(7)*, EIA for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities (8), and EIA for Hong Kong Offshore Wind Farm in Southeastern Waters (9). ***Table 6.15*** shows the assessment criteria for dissolved metals and organic compounds for this Study.

(1) Maunsell Consultant Asia Ltd, (2007). Wan Chai Development Phase II and Central-Wan Chai Bypass. EIA-141/2007.
(2) ERM – Hong Kong, Ltd (2002) EIA for the Proposed Submarine Gas Pipeline from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plank, Hong Kong. Final EIA Report. For the Hong Kong and China Gas Co., Ltd.
(3) Maunsell (2001) EIA for Tai Po Sewage Treatment Works - Stage V. Final EIA Report. For Drainage Services Department, Hong Kong SAR Government.
(4) ERM - Hong Kong, Ltd (2007) Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities. For CAPCO. Final EIA Report. December 2006
(5) Maunsell (2002). EIA for Decommissioning of Cheoy Lee Shipyard at Penny's Bay. For Civil Engineering Department, Hong Kong SAR Government.
(6) ERM – Hong Kong (1997). EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit. For Civil Engineering Department, Hong Kong SAR Government.
(7) Maunsell (2001). EIA for Wanchai Development Phase II - Comprehensive Feasibility Study. For Territory Development Department, Hong Kong SAR Government.
(8) ERM - Hong Kong, Ltd (2006) Op Cit
(9) BMT Asia Pacific Ltd (2009). EIA for Hong Kong Offshore Wind Farm in Southeastern Waters. For HK Offshore Wind Limited

Table 6.15 Summary of Assessment Criteria for Dissolved Metals and Organic Compounds

Parameter	Unit	Assessment Criteria for this Study
Metals		
Cadmium (Cd)	μg/L	2.5 (a) (b)
Chromium (Cr)	μg/L	15 (a) (b)
Copper (Cu)	μg/L	5 (a) (b)
Nickel (Ni)	μg/L	30 (a) (b)
Lead (Pb)	μg/L	25 (a) (b)
Zinc (Zn)	μg/L	40 (a) (c)
Mercury (Hg)	μg/L	0.3 (b)
Arsenic (As)	μg/L	25 (a) (b)
Silver (Ag)	μg/L	1.9 (d)
Total PAHs	μg/L	3.0 (f)
PCBs		
Total PCBs	μg/L	0.03 (d)
Organotins		
Tributyltin (TBT)	μg/L	0.1 (e)

Notes:

(a) UK Environment Agency, Environmental Quality Standards (EQS) for List 1 & 2 dangerous substances, EC Dangerous Substances Directive (76/464/EEC) (http://www.ukmarinesac.org.uk/activities/water-quality/wq4_1.htm).

(b) Annual average dissolved concentration (i.e. usually involving filtration a 0.45-um membrane filter before analysis).

(c) Annual average total concentration (i.e. without filtration).

(d) U.S. Environmental Protection Agency, National Recommended Water Quality Criteria, 2009. (http://www.epa.gov/waterscience/criteria/wqctable). The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water (i.e. saltwater) to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. CMC is used as the criterion of the respective compounds in this study.

(e) Salazar MH, Salazar SM (1996) Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions. In Organotin, edited by M.A. Champ and P.F. Seligman. Chapman & Hall, London.

(f) Australian and New Zealand Environment and Conservation Council (ANZECC), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (1992)

There are no existing regulatory standards or guidelines for total PCBs, total PAHs and tributyltin (TBT) in water and hence reference has been made to the United States Environmental Protection Agency (USEPA) water quality criteria, Australian water quality guidelines, and international literature, respectively. The assessment criteria for total PCBs, total PAHs and TBT are 0.03 μg/L, 3.0 μg/L and 0.1 μg/L respectively.

6.5.6 Criteria for Saline Water Discharges

During Project operation, reverse osmosis (RO) concentrate from desalination plant would be discharged into marine water via a submarine outfall. RO concentrate would be high in salinity and other constituents which are originally present in marine water (such as suspended solid). Some chemicals would also be added to desalination system and be discharged together with the RO concentrate during normal operation and bio-growth control works. Notable constituents and the corresponding proposed assessment criteria for water quality assessment are given in ***Table 6.16*** below.

Given that non-metal and corrosion resistance materials, such as super-duplex stainless steel or equivalent corrosive resistance material, would be adopted in the proposed desalination plant, leaching of corrosion products into the RO stream, namely copper and nickel, is not anticipated and hence further assessment on corrosion products is not necessary.

Table 6.16 Assessment Criteria for Constituents of Reverse Osmosis Concentrate

Parameters (unit: mg/L)	Assessment Criteria				
	Junk Bay	Eastern Buffer	Port Shelter	Mirs Bay	Southern
Salinity	Change not to exceed 10% for all WCZs				
Iron	< 0.3 mg/L (a)				
pH	6.5-8.5				
Total Inorganic Nitrogen	< 0.3	< 0.4	< 0.1	< 0.3	< 0.1
Suspended Solids	Not to raise the natural ambient level by 30%				
Sodium Metabisulphite	Oxygen depletion due to sodium metabisulphite not to exceed WQO criterion (5 mg/L for fish culture zones, 4 mg/L for other WSRs)				
Total Residual Chlorine	0.02 mg/L (b)				
Anti-scalant	0.362 mg/L (One thousandth of the levels indicated by the available EC50 data (c))				

Notes:

(a) Australian and New Zealand Environment and Conservation Council (ANZECC), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) – Interim indicative working level. (http://www.mincos.gov.au/publications/australian_and_new_zealand_guidelines_for_fresh_and_marine_water_quality).

(b) Tender Ref. WP 98-567 Provision of Service for Ecotoxicity Testing of Marine Antifoulant – Chlorine in Hong Kong Final Report January 2000. Submitted to Environmental Protection Department by the Centre for Coastal Pollution and Conservation, City University of Hong Kong.

(c) Technical Guidance Document on Risk Assessment. European Chemical Bureau, Institute for Health and Consumer Protection, European Commission. (https://echa.europa.eu/documents/10162/16960216/tgdpart2_2ed_en.pdf)

6.6 Assessment Methodology

6.6.1 General Methodology

The methodology employed to assess potential water quality impacts associated with the construction and operation of the Project is presented in the Water Quality Method Statement (*Annex 6A*) and has been based on the information presented in the Project Description (*Section 3*). Full details of the scenarios examined in the modelling works are provided in *Annex 6A*. As discussed previously, the WSRs as well as the water quality modelling output points in the vicinity of the Project are presented in ***Figure 6.1*** *and* ***Figure 6.2*** respectively.

6.6.2 Construction Phase

Impacts due to the dispersion of fine sediment in suspension and the subsequent sedimentation during the construction of the proposed submarine outfall and seawater intake have been simulated using Delft3D PART module. Mitigation measures, as proposed in

Section 6.8.1 such as the use of silt curtain, were assumed to be absent for modelling of the unmitigated scenario.

The depletion of DO and the elevation in nutrient levels associated with the release of SS are calculated using the modelled maximum SS concentrations.

Dissolved Oxygen Depletion

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. The impact of the sediment oxygen demand on DO concentrations has been calculated based on the following equation (1):

DO (mg O_2/L) = DO (g O_2/m^3) = SS (g DW/m^3) × fraction of organic matter in sediment (g C/g DW) × 2.67 (g O_2/gC)

The assumption behind this equation is that all the released organic matter is eventually re-mineralized within the water column. This leads to an estimated depletion with respect to the background DO concentrations. This DO depletion depends on the quality of the released sediments, i.e. on the percentage of organic matter in the sediment. The fraction of organic matter in sediment (Chemical oxygen demand in ***Table 6.7***) was taken as 14,000 mg/kg based on maximum data from EPD Sediment Monitoring Stations ES1 located near the Project Site from 2009-2013. It should be noted that other EPD Sediment Monitoring Stations are much further away from the dredging site (>1 km) and therefore the adoption of EPD Sediment Monitoring Station ES1 is deemed the most appropriate.

This is a conservative prediction of DO depletion since oxygen depletion is not instantaneous and will depend on tidally averaged suspended sediment concentrations. It is worth noting that the above equation does not account for re-aeration which would tend to reduce impacts of the SS on DO concentrations in the water column. The proposed analysis, which is on the conservative side, will not, therefore, underestimate the DO depletion. Further, it should be noted that, for sediment in suspension to exert any oxygen demand in the water column will take time and, at the same time, the sediment will be transported and mixed or dispersed with oxygenated water. As a result, the oxygen demand and the impact on DO concentrations will diminish as the suspended sediment concentrations decrease.

Nutrients

An assessment of nutrient release during marine dredging for submarine outfall and seawater intake has been carried out based on the predicted SS elevation and the testing results of EPD sediment monitoring station. In the calculation it is assumed that all total kjeldahl nitrogen (TKN) concentrations in the sediments are released to the water. This is a highly conservative assumption and will result in the overestimation of the potential impacts.

(1) ERM - HK Ltd (2010). Development of an Offshore Wind Farm in Hong Kong. Final Environmental Impact Assessment. For the Hong Kong Electric Company

Ammonia nitrogen is the sum of ionized ammonia and unionized ammonia (UIA). Under normal conditions of Hong Kong waters, more than 90% of the ammonia nitrogen would be in the ionized form. EPD marine water quality monitoring data at EM2 from 1986 to 2013 indicated that on average 5.7% of ammonia nitrogen exists as UIA. For the purpose of assessment, this average value would be adopted for estimation of UIA from disturbance of marine sediment due to marine construction. In view that the mineralization of the organic nitrogen will also contribute to ammonia, the calculations of NH_3-N are based on maximum total TKN concentrations from the sediment sampling and testing exercise conducted under this Study (1480 mg/kg at station GS7 under ***Table 6.8***), which is higher than the maximum level of TKN in the sediment at EPD station ES1 from 2009-2013. TKN is the total of ammonia nitrogen and organic nitrogen. Note that it is a highly conservative approach since it is assumed that 100% of organic nitrogen will be mineralized to ammonia but this is unlikely to occur in reality.

The maximum SS concentration at each WSR is multiplied by the following factors to predict the maximum UIA elevations:
Max UIA (mg/L) = Max SS (mg DW/L) $\times$ Max TKN (mg N/ kg DW) $\times 10^{-6} \times$ 5.7%

The maximum predicted SS concentration at each WSR is multiplied by the maximum concentration of TKN in sediment (mg/kg) at sediment sampling station GS7 conducted under this Study to give the maximum elevation in TIN (mg/L). In accordance with sediment test results conducted under this Study (TKN, assume 100% of organic nitrogen will be mineralized to ammonia), maximum TKN concentrations in the sediment is 1480 mg/kg. While nitrate and nitrite may also be constituent of TIN in marine water, they are generally in negligible concentration in view of low electrochemical potential of marine sediment. Under low electrochemical potential (i.e. reducing environment), oxidized forms of nitrogen (e.g. nitrate and nitrite) tend to be reduced to their reduced form (e.g. ammonia), and thus is considered as part of TKN. The concentration these two oxidized nitrogen species are both found to be below the detection limit of 1 mg/kg, making them negligible when compared with the contribution by TKN. The calculations of maximum elevation in TIN (from TKN) at WSRs are shown below:
Max TIN (mg/L) = Max SS (mg DW/L) $\times$ Max TKN (mg N/ kg DW) $\times 10^{-6}$

Heavy Metals and Micro-Organic Pollutants

Sediment elutriate test was conducted under this Study to determine the level of potential leaching of sediment-bounded pollutants during the construction of submarine outfall and seawater intake. The level of pollutant presence in elutriate would be compared against the water quality assessment criteria stipulated under *Section 6.5.6*. In case the level pollutants presence in the elutriate exceeds the proposed water quality assessment criteria, the level of pollutants would be estimated based on the maximum predicted level of suspended solid at the most impacted WSR and the maximum level of pollutants identified in the geophysical survey conducted under this Study. The appropriate adopted method for the estimation of TIN from maximum TKN level would be followed, assuming 100% release of sediment-bounded pollutants.

6.6.3 Operation Phase

The simulation of operational impacts on hydrodynamic regimes and water quality due to the discharge of RO concentrate and other associated chemicals from the Project have also been studied by means of computational modelling.

Hydrodynamic Change

Delft3D-FLOW was first carried out to simulate the hydrodynamic conditions without Project to provide ambient conditions for near field dispersion modelling using the CORMIX suite of model. The CORMIX model predicted the typical vertical profile of the effluent plume of the RO concentrate in the water column. The predicted vertical profile of the effluent plume was then used to carry out the second iteration of the Delft3D-FLOW modelling to provide ambient conditions for second iteration of CORMIX near field modelling. This ensures the potential change in hydrodynamic due to the saline discharge would be taken into account in both the far field and near field model. To ensure the robustness of the hydrodynamic simulation, the vertical profile of effluent plume predicted by CORMIX in the first and second iteration was compared to see if convergence has been reached. It was observed that the predicted vertical profile of effluent plume in the first iteration is similar to the second iteration in both seasons under the conservative 10^{th} percentile flow scenario. The Delft3D FLOW simulations (second iteration for both seasons) were then used for the water quality modelling assessment of RO concentrate discharge.

Water Quality Impacts

Delft3D PART was used for simulation of discharge of various constituents in RO concentrate from the Project. Three kinds of tracers, namely conservative tracer, decayable tracer and sediment, were used for simulation of various constituents in the RO concentrate. The use of these three kinds of tracers is stipulated below in ***Table 6.17***.

Table 6.17 Use of Delft3D PART Tracers for Various RO Concentrate Constituents

Type of Tracer	Properties	Constituents Represented
Conservative Tracer	Non-decayable and non-settling	Iron, sodium metabisulphite, TIN, Anti-scalant
Decayable Tracer	Decayable (T90 = 8289s) but non-settling	Total residual chlorine
Sediment	Non-decayable but settling	Suspended solid

In the modelling process, it is assumed that iron (Fe), sodium metabisulphite (SMBS), TIN and anti-scalant are conservative substance and no adsorption / absorption process occurs. This is a rather conservative method to assess the impacts from Fe and SMBS. For SMBS, the maximum oxygen depletion due to the presence of SMBS would be compared against the allowed level by WQO. For total residual chlorine (TRC), the chlorine decay value (T90 = 8289s), which were adopted in both EIAs of HATS 2A [(1)] and Express Rail Link [(1)], would be

(1) ENSR Asia (HK) Ltd (2008). *Harbour Area Treatment Scheme Stage 2A EIA Study – Investigation. Environmental Impact Assessment Report.*

used under this Study. This T90 factor is the most conservative value upon our review of relevant past EIA studies.

6.6.4 Uncertainties in Assessment Methodology

Uncertainties in Sediment Transport Assessment

Uncertainties in the assessment of the impacts from sediment plumes will be considered when drawing conclusions from the assessment. In carrying out the assessment, the worst case assumptions have been made in order to provide a conservative assessment of environmental impacts. These assumptions are as follows:

- The calculations of loss rates of sediment to suspension are based on conservative estimates for the methods of working;
- The modelled dredging period covers a whole tidal spring-neap cycle (15 days) for both dredging at submarine outfall and seawater intake, which is much longer than the required actual dredging period. This ensures the worst case tidal condition within a spring-neap cycle could be captured in the modelling exercise; and
- The assessment is based on peak dredging rate for submarine outfall and seawater intake construction. In reality these will only occur for a short period of time.

Uncertainties arising from Operations

To ensure robustness of modelling assessment, conservative assumptions have been made to address the uncertainties from future operation. These assumptions include:

- Constituents in the RO concentrate, including salinity, SS, anti-scalant, TIN and Fe under normal operation as well as TRC and SMBS under bio-growth control works period, were assumed to be released at their maximum level from the plant. This ensures any fluctuation in effluent quality of RO concentrate within specified limit will not result in water quality impact beyond the modelled worst case;
- Continuous release was assumed for modelling all constituents, including TRC and SMBS which would only be released at specific time period when bio-growth control works is being conducted. This ensures any fluctuation in effluent discharge time period will not result in water quality impact beyond the modelled worst case; and
- Model spin up was conducted for multiple tidal spring-neap cycles to ensure sufficient background build-up of constituents, if any, could be captured in the modelling.

(1) AECOM Asia Co. Ltd (2009). *Environmental Impact Assessment of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link. Environmental Impact Assessment Report.*

6.7 Potential Sources of Impact

Potential sources of impacts to water quality arising from the Project may occur during both the construction and operation phases. Each is discussed in turn below.

6.7.1 Construction Phases

Marine-based and land-based construction activities of the Project have the potential to affect water quality through:

- Changes in water quality, including suspended sediment dispersion, sediment deposition, DO depletion, and elevated concentrations of nutrients, heavy metals and micro-organic pollutants, due to marine dredging at submarine outfall and seawater intake;
- Other marine construction which would not involve significant sediment disturbance;
- Vessel discharges;
- Land-based site runoff from construction workforce; and
- Water from cleaning and sterilization of the new fresh water main.

6.7.2 Operation Phase

The potential impacts to water quality arising from the operation of the proposed desalination have been identified as follows:

- Changes in the hydrodynamic regime and water quality due to the discharge of RO concentrate from the Project; and
- Generation of sewage effluent.

6.8 Impact Assessment

6.8.1 Construction Phase

Elevation of Suspended Solids and Sedimentation

Based on the latest design information, it is understood that the intake structures and outfall diffusers of the proposed desalination plant will be installed by trenchless method. As such dredging is limited to an area of the seabed for the installation of the above-seabed portion of the outfalls and intake structures. The estimated dredged volumes are about 1,740 m^3 (seawater intake) and 4,590 m^3 (submarine outfall). Working hours are assumed to be 12 hours per day with a maximum dredging rate of 3,500 m^3/day (i.e. 0.081 m^3/s). It is assumed that dredging for seawater intake and submarine outfall would not be conducted concurrently and the same dredging rate applies to dredging at both locations. Only one closed grab dredger would be working and spillage of mud from closed grab dredgers is assumed to take place uniformly over the water column.

Loss rates have been taken from previously accepted EIAs in Hong Kong (1)(2)(3) and have been based on a review of worldwide data on loss rates from dredging operations undertaken as part of assessing the impacts of dredging areas of Kellett Bank for mooring buoys (4). The assessment concluded that for 8 m^3 (minimum) grab dredgers working in areas with significant amounts of debris on the seabed (such as in the vicinity of existing mooring buoys) that the loss rates would be 25 kg per cubic metre dredged, while the grab dredger bucket size in areas where debris is less likely to hinder operations could be 12 or 16 m^3, with a loss rate of 17 kg/ m^3. It is assumed there is little debris based on the fact the area is away from marine works and heavy marine traffic / industry. The value of 17 kg/ m^3, for dredgers with grab size of 12 or 16 m^3, will therefore be used for this Study. The maximum sediment loss rate is calculated from the maximum dredging rate (0.081 m^3/s) and the unit loss rate of sediment (17 kg/m^3):

Loss Rate (kg /s)

= *Dredging Rate (m^3/ s) * Loss Rate (kg/ m^3)*

= *0.081 m3 /s * 17 kg /m^3*

= ***1.3773 kg/ s***

Therefore a continuous release rate of 1.3773 kg/s for one dredger will be adopted in the model for release throughout the whole water column. Given the small extent of marine dredging area, one stationary source at the outfall discharge point is assumed in the model to represent the grab dredger. It should be noted that while the whole dredging would last for only 2 days at the assessed peak dredging rate (6,330 m^3 ÷ 3,500 m^3/day = 1.81 day), the modelled sediment release would last for a whole 15-day spring-neap cycle to ensure all possible worst-case tidal conditions are included in the simulation. The sediment plume modelling period would last for one more spring-neap cycle (total simulation period: 30 days) to allow sufficient time for any suspended solids (SS) release to reach the potential WSRs. Other detail settings for the sediment plume modelling are provided in *Annex 6A* and would not be provided in detail below.

Suspended Solids Dispersion

Simulation results of SS elevation arising from the marine dredging at seawater intake and submarine outfall in both the dry and wet seasons are presented below in ***Table 6.18***. It should be noted that the values presented in ***Table 6.18*** are the maximum levels predicted at the specific WSRs during the specified season (dry / wet season) with the results of both

(1) ERM - Hong Kong, Ltd (2006) *EIA Study for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities*. For CAPCO. Register No.: AEIAR-106/2007, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1252006/html/index.htm

(2) ERM (2005). *Detailed Site Selection Study for a Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. EIA and Final Site Selection Report*. For CEDD. Approved on 1 September 2005. Register No.: AEIAR-089/2005, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1062005/index.htm

(3) ERM (2000). *Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures – Final EIA Report*. For CEDD. Approved on 28 April 2000. Register No.: AEIAR-032/2000 http://www.epd.gov.hk/eia/register/report/eiareport/eia_0412000/index.html

(4) ERM (1997). *EIA: Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Bays. Working Paper on Design Scenarios*. For CEDD.

dredging at seawater intake and submarine outfall. It should be highlighted that the values presented in ***Table 6.18*** is the instantaneous maximum [1] of SS elevation at the specified water depth for assessment at the WSRs throughout the simulation period. The predicted SS elevation is compared to the proposed assessment criteria stipulated under *Section 6.5.1* and ***Table 6.11***. The predicted percentage time of compliance to assessment criteria for SS elevation is also shown in *Table 6.18* for each WSR. Contour plots of instantaneous SS elevation at surface, middle and bottom layer of the water column on typical working day for dredging at submarine outfall and seawater intake are also provided in *Annex 6B* for both seasons. Please refer to *Annex 6B-1* to *Annex 6B-34* for contour plots showing the instantaneous SS elevation of unmitigated scenario for wet season and *Annex 6B-69 to Annex 6B-102* for contour plots showing the same of unmitigated scenario for dry season. Maximum SS elevation throughout the whole tidal cycle of SS elevation for dredging at seawater intake and submarine outfall are shown in *Annex 6B-137, 138, 149* and *150*. Tidal average of sedimentation flux for dredging at seawater intake and submarine outfall are shown in *Annex 6B-145, 146, 157* and *158*. Maximum sedimentation flux for dredging at seawater intake and submarine outfall throughout the modelled tidal period are shown in *Annex 6B-147, 148, 159* and *160*.

The results presented in ***Table 6.18*** indicate that elevation in SS is generally confined within a short distance from the sediment sources. Elevation in SS is limited in most WSRs and compliance to the corresponding assessment criteria is expected. As shown in both *Table 6.18* and *Annex 6B-1* to *34* and *69* to *102*, the sediment plume is highly localized and is bounded within Tai Miu Wan and southern corner of Junk Bay by the fast-moving current in the Tathong Channel. Elevation of SS and sedimentation experienced on the other side of the channel (i.e. near Hong Kong Island) is negligible. The SS plume tends to drift towards the Junk Bay during flood tide and drift toward Tung Lung Chau during ebb tide.

Elevation in SS is predicted to be above the corresponding assessment criteria for coral communities at Fat Tong Chau (SR16) and Tai Miu Wan (SR4) for dredging at submarine outfall and at Kwun Tsai (SR36) and Tit Cham Chau (SR37) for dredging at seawater intake under unmitigated scenario of wet season (***Figures 6.6 & 6.7***). SS elevation predicted at SR16 and SR4 would be in compliance to the WQO criteria for over 99% of the simulation time. The predicted maximum SS elevation at SR16 is 3.42 mg/L in wet season and 2.89 mg/L in dry season. Exceedance in WQO SS criteria is only predicted at SR4 in wet season, with maximum SS elevation predicted to be 4.42 mg/L. For coral identified at SR36 and SR37, the predicted maximum level of SS elevation as well as the sedimentation flux would be higher than the corresponding assessment criteria in both seasons. As shown in ***Table 6.18*** and *Annex 6B*, marine dredging at the proposed seawater intake (*Annex 6B-1* to *17* and *69* to *85*) is the source which contributes to the exceedance of SS level at the most impacted SR36 and SR37. The sediment plume from dredging (shown in *Annex 6B-18* to *34* and *86* to *103*) at the proposed submarine outfall would not encroach to SR36 and SR37. For other coral communities identified under this Study, it is predicted that the sediment deposition would

[1] Since the actual dredging operation would be completed in a few day (i.e. shorter than a spring-neap cycle), mean values of SS elevation are cannot provide representative indication of overall SS impact at the WSRs.

be in compliance with the proposed sedimentation criteria (100 g/m²/day) under both dredging at submarine outfall and seawater intake in both seasons.

Table 6.18 Predicted Maximum Elevation in Suspended Solid and Sediment Deposition at WSRs from Marine Dredging at Seawater Intake and Submarine Outfall – Unmitigated Scenario

WSR (ID)	SS Elevation (mg/L)						Sediment Deposition (g/m²/day)		
	Wet Season			Dry Season			Criteria	Wet Season	Dry Season
	Criteria	Max	Compliance Time %	**Criteria**	Max	Compliance Time %		Max	Max
Dredging at Seawater Intake									
Fish Culture Zone (Depth-averaged)									
Tung Lung Chau (SR2)	44.87	0.03	100.00%	42.73	0.05	100.00%	-	-	-
Po Toi O (SR27)	46.31	0.00	100.00%	44.63	0.00	100.00%	-	-	-
Coral Communities (Bottom)									
Junk Bay (SR20)	1.74	0.05	100.00%	2.61	0.00	100.00%	100	0.13	0.00
Junk Bay (SR21)	2.77	0.49	100.00%	2.48	0.01	100.00%	100	3.48	0.87
Junk Bay (SR22)	2.77	0.10	100.00%	2.48	0.00	100.00%	100	0.66	0.43
Fat Tong Chau (SR16)	2.06	1.25	100.00%	2.20	0.01	100.00%	100	3.69	6.03
Tai Miu Wan (SR4)	2.46	0.52	100.00%	3.78	0.01	100.00%	100	1.19	0.22
Cape Collinson (SR10)	2.46	0.02	100.00%	3.78	0.00	100.00%	100	0.05	0.05
Cape Collinson (SR11)	2.46	0.01	100.00%	3.78	0.00	100.00%	100	0.03	0.00
Cape Collinson (SR12)	2.46	0.01	100.00%	3.78	0.00	100.00%	100	0.03	0.00
Tung Lung Chau (SR1)	2.08	0.00	100.00%	3.54	0.00	100.00%	100	0.00	1.11
Tung Lung Chau (SR3)	2.46	0.32	100.00%	3.78	0.00	100.00%	100	0.95	2.44
Tung Lung Chau (SR6)	2.03	0.28	100.00%	2.95	0.00	100.00%	100	0.24	0.67
Tung Lung Chau (SR7)	2.03	0.00	100.00%	2.95	0.00	100.00%	100	0.00	0.00
Tung Lung Chau (SR8)	2.03	0.00	100.00%	2.95	0.00	100.00%	100	0.00	0.00
Tung Lung Chau (SR9)	2.08	0.02	100.00%	3.54	0.00	100.00%	100	0.03	0.05
Tai Long Pai (SR32)	2.08	0.01	100.00%	3.54	0.00	100.00%	100	0.03	0.09
D-W (SR33)	2.46	0.00	100.00%	3.78	0.00	100.00%	100	0.00	0.00
D-T (SR34)	2.46	0.00	100.00%	3.78	0.00	100.00%	100	0.00	0.00
D-L (SR35)	2.46	0.12	100.00%	3.78	0.00	100.00%	100	0.47	0.67
Kwun Tsai (SR36)	2.46	**14.42**	**90.98%**	3.78	**13.62**	**91.96%**	100	**168.30**	**115.10**
Tit Cham Chau (SR37)	2.46	**58.74**	**88.63%**	3.78	**86.74**	**92.93%**	100	**382.12**	**309.78**
Gazetted Bathing Beaches (Depth-averaged)									
Big Wave Bay (SR12)	1.54	0.00	100.00%	2.18	0.00	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Shek O (SR15)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-
Rocky Bay (SR14)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-

Coastal Protection Areas (Depth-averaged)									
Clear Water Bay (SR28)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR31)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Po Toi O (SR27)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Tai Miu Wan (SR4)	1.54	0.10	100.00%	2.18	0.02	100.00%	-	-	-
Tai Miu Wan (SR5)	1.54	0.00	100.00%	2.18	0.00	100.00%	-	-	-
Cape Collinson (SR10)	1.54	0.00	100.00%	2.18	0.01	100.00%	-	-	-
Cape Collinson (SR11)	1.54	0.00	100.00%	2.18	0.00	100.00%	-	-	-
Big Wave Bay (SR13)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-
Tai Tam (SR25)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Tai Tam (SR26)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Seawater Intakes (Mid-depth)									
Tseung Kwan O New Town (SR19)	5.22	0.00	100.00%	5.50	0.00	100.00%	-	-	-
Siu Sai Wan (SR17)	4.76	0.02	100.00%	5.90	0.01	100.00%	-	-	-
Heng Fa Chuen (SR23)	4.76	0.00	100.00%	5.90	0.00	100.00%	-	-	-
Chai Wan Godown (SR16)	1.57	0.03	100.00%	1.23	0.01	100.00%	-	-	-
Pamela Youde Nethersole Eastern Hospital (SR24)	1.57	0.01	100.00%	1.23	0.02	100.00%	-	-	-
Dredging at Submarine Outfall									
Fish Culture Zone (Depth-averaged)									
Tung Lung Chau (SR2)	44.87	0.10	100.00%	42.73	0.45	100.00%	-	-	-
Po Toi O (SR27)	46.31	0.00	100.00%	44.63	0.00	100.00%	-	-	-
Coral Communities (Bottom)									
Junk Bay (SR20)	1.74	0.22	100.00%	2.61	0.00	100.00%	100	0.53	0.00
Junk Bay (SR21)	2.77	1.89	100.00%	2.48	0.43	100.00%	100	9.39	6.50
Junk Bay (SR22)	2.77	0.83	100.00%	2.48	0.09	100.00%	100	4.69	1.62
Fat Tong Chau (SR16)	2.06	**3.42**	**99.17%**	2.20	**2.89**	**99.45%**	100	30.84	18.62
Tai Miu Wan (SR4)	2.46	**4.42**	**99.72%**	3.78	0.12	100.00%	100	15.17	0.67
Cape Collinson (SR10)	2.46	0.03	100.00%	3.78	0.01	100.00%	100	0.08	0.10
Cape Collinson (SR11)	2.46	0.01	100.00%	3.78	0.01	100.00%	100	0.03	0.09
Cape Collinson (SR12)	2.46	0.01	100.00%	3.78	0.02	100.00%	100	0.03	0.08
Tung Lung Chau (SR1)	2.08	0.28	100.00%	3.54	0.86	100.00%	100	0.71	6.67
Tung Lung Chau (SR3)	2.46	0.43	100.00%	3.78	0.90	100.00%	100	1.90	14.89
Tung Lung Chau (SR6)	2.03	1.43	100.00%	2.95	0.14	100.00%	100	3.79	1.33
Tung Lung Chau (SR7)	2.03	0.00	100.00%	2.95	0.05	100.00%	100	0.00	0.22
Tung Lung Chau (SR8)	2.03	0.15	100.00%	2.95	0.00	100.00%	100	0.24	0.00
Tung Lung Chau (SR9)	2.08	0.12	100.00%	3.54	0.12	100.00%	100	0.23	0.30
Tai Long Pai (SR32)	2.08	0.04	100.00%	3.54	0.25	100.00%	100	2.63	0.15
D-W (SR33)	2.46	0.00	100.00%	3.78	0.00	100.00%	100	0.00	0.00
D-T (SR34)	2.46	0.00	100.00%	3.78	0.00	100.00%	100	0.00	0.00
D-L (SR35)	2.46	0.38	100.00%	3.78	0.88	100.00%	100	0.71	2.44

Kwun Tsai (SR36)	2.46	0.58	100.00%	3.78	0.24	100.00%	100	9.96	2.67
Tit Cham Chau (SR37)	2.46	0.08	100.00%	3.78	0.00	100.00%	100	0.00	0.00
Gazetted Bathing Beaches (Depth-averaged)									
Big Wave Bay (SR12)	1.54	0.00	100.00%	2.18	0.01	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Shek O (SR15)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-
Rocky Bay (SR14)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-
Coastal Protection Areas (Depth-averaged)									
Clear Water Bay (SR28)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Clear Water Bay (SR31)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Po Toi O (SR27)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Tai Miu Wan (SR4)	1.54	0.93	100.00%	2.18	0.05	100.00%	-	-	-
Tai Miu Wan (SR5)	1.54	0.00	100.00%	2.18	0.04	100.00%	-	-	-
Cape Collinson (SR10)	1.54	0.01	100.00%	2.18	0.01	100.00%	-	-	-
Cape Collinson (SR11)	1.54	0.00	100.00%	2.18	0.01	100.00%	-	-	-
Big Wave Bay (SR13)	1.66	0.00	100.00%	2.15	0.00	100.00%	-	-	-
Tai Tam (SR25)	1.11	0.00	100.00%	1.61	0.00	100.00%	-	-	-
Tai Tam (SR26)	1.11	0.01	100.00%	1.61	0.00	100.00%	-	-	-
Seawater Intakes (Mid-depth)									
Tseung Kwan O New Town (SR19)	5.22	0.00	100.00%	5.50	0.00	100.00%	-	-	-
Siu Sai Wan (SR17)	4.76	0.04	100.00%	5.90	0.02	100.00%	-	-	-
Heng Fa Chuen (SR23)	4.76	0.23	100.00%	5.90	0.05	100.00%	-	-	-
Chai Wan Godown (SR16)	1.57	0.02	100.00%	1.23	0.01	100.00%	-	-	-
Pamela Youde Nethersole Eastern Hospital (SR24)	1.57	0.02	100.00%	1.23	0.02	100.00%	-	-	-

Note:
Bold and underlined figures indicate exceedance of WQO.

To minimize potential water quality impacts from elevation of SS due to the proposed dredging works at submarine outfall and seawater intake, mitigation measure in form of silt curtain around grab dredger would be adopted for the dredging at both the proposed submarine outfall and seawater intake. As discussed in the previous section, the contribution of SS elevation from dredging at seawater intake would be much higher than that of dredging at submarine outfall for the nearby SR36 and SR37 Furthermore, the rate of dredging at the seawater intake would also be reduced from 3,500 m^3/day (in the unmitigated scenario) to 750 m^3/day. Silt curtains would be highly effective in areas where current speeds are low, as the effectiveness of the silt curtains will be reduced in areas of high current speeds. Hydrodynamic simulation by Delft3D indicated that tidal current near the proposed submarine outfall and seawater intake would be in general below 0.2 m/s, which is deemed appropriate for the application of silt curtain. According to the Contaminated Spoil

Management Study [1], the implementation of silt curtain around the closed grab dredgers will reduce the dispersion of SS by a factor of 4 (or about 75%). This SS reduction factors have been adopted in a number of past studies involved in release of marine sediment from marine works, including the approved SCL Hung Hom to Admiralty Section, IWMF, WDII & CWB EIA, CT Dredging EIA as well as the Western Coast Road EIA study. The combined use of different types of silt curtain can further reduce SS dispersion. The combined use of a floating type silt curtain (described above with 75% sediment dispersion reduction) and a cage type silt curtain is known to reduce sediment dispersion by 95% according to the approved EIAs of Tuen Mun – Chek Lap Kok Link, Hong Kong – Zhuhai – Macau Bridge Boundary Crossing Facilities and Hong Kong Link Road. Under the mitigated scenario of this Project, a single layer of floating type silt curtain would be used for dredging at marine outfall and the combined used of one floating type and one cage type silt curtain would be adopted at the seawater intake to ensure protection of nearby WSRs. The layout for the proposed use of silt curtain is indicatively shown in ***Figures 6.4 and* 6.5**. The combined use of two types of silt curtain and reduction of dredging rate would mainly reduce the level of SS elevation at SR16, SR36 and SR37 since the maximum SS elevations at these receivers are all contributed by the dredging at seawater intake. For SR4, the effect of mitigation measure would be less significant, as only single layer of silt curtain would be used for dredging at submarine outfall. The predicted SS elevations with the implementation of silt curtain are presented in ***Table 6.19***. The corresponding instantaneous SS elevation at surface, middle and bottom layer of the water column on typical working day for dredging at submarine outfall and seawater intake for mitigated scenario are also provided in *Annex 6B* for both seasons. Please refer to *Annex 6B-35 to Annex 6B-68* for contour plots of mitigated scenario for wet season and *Annex* 6B-*103 to Annex 6B-136* for contour plots of mitigated scenario for dry season. Contour plots for maximum instantaneous SS elevation under mitigated scenarios for dredging at seawater intake and submarine outfall are shown in *Annex 6B-139*, *140* for wet season and *Annex 6B-151*, *152* for dry season.

Table 6.19 Predicted Maximum Elevation in Suspended Solid and Sediment Deposition at Coral Communities (SR4, SR16, SR36 and SR37) from Marine Dredging at Seawater Intake and Submarine Outfall – Mitigated Scenario

WSRs	**Criteria**	**Maximum SS Elevation (mg/L)**	**Compliance Time %**	**Maximum Sediment Deposition (g/m^2/day)**	**Compliance Time %**
Dredging at Seawater Intake (Dredging at 750 m^3day, with combined use of floating type and cage type silt curtain)					
Wet Season					
SR4 (B)	2.46	0.01	100.00%	0.01	100.00%
SR16 (B)	2.06	0.01	100.00%	0.04	100.00%
SR36 (B)	2.46	0.15	100.00%	1.80	100.00%
SR37 (B)	2.46	0.63	100.00%	4.09	100.00%
Dry Season					
SR4 (B)	3.78	0.00	100.00%	0.00	100.00%
SR16 (B)	2.20	0.00	100.00%	0.06	100.00%

(1) Mott MacDonald (1991). Contaminated Spoil Management Study, Final Report, Volume 1, for EPD, October 1991.

WSRs	Criteria	Maximum SS Elevation (mg/L)	Compliance Time %	Maximum Sediment Deposition (g/m²/day)	Compliance Time %
SR36 (B)	3.78	0.15	100.00%	1.23	100.00%
SR37 (B)	3.78	0.93	100.00%	3.32	100.00%
Dredging at Submarine Outfall (Dredging at 3,500 m³day, with floating type silt curtain)					
Wet Season					
SR4 (B)	2.46	1.11	100.00%	3.79	100.00%
SR16 (B)	2.06	0.85	100.00%	7.71	100.00%
SR36 (B)	2.46	0.15	100.00%	2.49	100.00%
SR37 (B)	2.46	0.02	100.00%	0.00	100.00%
Dry Season					
SR4 (B)	3.78	0.03	100.00%	0.17	100.00%
SR16 (B)	2.20	0.72	100.00%	4.65	100.00%
SR36 (B)	3.78	0.06	100.00%	0.67	100.00%
SR37 (B)	3.78	0.00	100.00%	0.00	100.00%

Note:

(B): Bottom SS level, which is the relevant water depth for assessment

As shown in ***Table 6.19***, full compliance to assessment criteria is predicted at SR4, SR16, SR36 and SR37 with the implementation of silt curtain around grab dredger (***Figures 6.6 & 6.7***). It is also shown in *Annex 6B* that the extent of the SS plume would be reduced significantly with the implementation of silt curtain(s) around the grab dredger and reduction of dredging rate for dredging at the proposed seawater intake. No adverse water quality impact from SS elevation due to marine dredging at submarine outfall and seawater intake is anticipated.

DO Depletion

Dispersion of SS may release sediment-bounded pollutant into the water column. Readily-biodegradable organic compounds could be taken up by micro-organism and result in depletion of dissolved oxygen (DO). An assessment of DO depletion during dredging is made in relation to the results of the sediment plume modelling of dredging activities and the sediment quality data near the Study Area. The predicted maximum elevations in SS concentrations at various WSRs under unmitigated scenario (given in ***Table 6.18*** above) were used to estimate the effects of increased SS concentrations on DO based on the methodology stipulated under *Section 6.6.2* above. The allowed level of DO depletion is provided in ***Table 6.12*** above. The predicted maximum DO depletion from marine dredging under this Project is presented in ***Table 6.20*** below.

Table 6.20 Predicted Maximum Depletion in Dissolved Oxygen at WSRs from Marine Dredging at Seawater Intake and Submarine Outfall – Unmitigated Scenario

WSR (ID)	Wet Season			Dry Season		
	Max SS Elevation (mg/L)	Max DO Depletion (mg/L)	Allowed DO Depletion (mg/L)	Max SS Elevation (mg/L)	Max DO Depletion (mg/L)	Allowed DO Depletion (mg/L)
Fish Culture Zone (Depth-averaged)						
Tung Lung Chau (SR2)	0.10	0.0013	-	0.45	0.0064	1.25
Po Toi O (SR27) [(a)]	0.00	0.0000	-	0.00	0.0000	1.40
Coral Communities (Bottom)						
Junk Bay (SR20)	0.22	0.0030	1.90	0.00	0.0000	4.08
Junk Bay (SR21)	1.89	0.0265	1.24	0.43	0.0060	4.14
Junk Bay (SR22)	0.83	0.0116	1.24	0.09	0.0013	4.14
Fat Tong Chau (SR16)	**3.42**	0.0478	1.22	**2.89**	0.0405	4.14
Tai Miu Wan (SR4)	**4.42**	0.0619	1.32	0.12	0.0017	4.34
Cape Collinson (SR10)	0.03	0.0004	1.32	0.01	0.0002	4.34
Cape Collinson (SR11)	0.01	0.0002	1.32	0.01	0.0002	4.34
Cape Collinson (SR12)	0.01	0.0001	1.32	0.02	0.0003	4.34
Tung Lung Chau (SR1)	0.28	0.0039	1.32	0.86	0.0121	4.38
Tung Lung Chau (SR3)	0.43	0.0061	1.32	0.90	0.0125	4.34
Tung Lung Chau (SR6)	1.43	0.0200	1.20	0.14	0.0019	4.24
Tung Lung Chau (SR7)	0.00	0.0000	1.20	0.05	0.0007	4.24
Tung Lung Chau (SR8)	0.15	0.0021	1.20	0.00	0.0000	4.24
Tung Lung Chau (SR9)	0.12	0.0017	1.32	0.12	0.0017	4.38
Tai Long Pai (SR32)	0.04	0.0006	1.32	0.25	0.0035	4.38
D-W (SR33)	0.00	0.0000	1.32	0.00	0.0000	4.34
D-T (SR34)	0.00	0.0000	1.32	0.00	0.0000	4.34
D-L (SR35)	0.38	0.0054	1.32	0.88	0.0123	4.34
Kwun Tsai (SR36)	**14.42**	0.2019	1.32	**13.62**	0.1907	4.34
Tit Cham Chau (SR37)	**58.74**	0.8223	1.32	**86.74**	1.2144	4.34
Gazetted Bathing Beaches (Depth-averaged)						
Big Wave Bay (SR12)	0.00	0.0000	0.63	0.01	0.0001	2.25
Clear Water Bay (SR29)	0.00	0.0000	0.68	0.00	0.0000	2.40
Clear Water Bay (SR30)	0.00	0.0000	0.68	0.00	0.0000	2.40
Shek O (SR15)	0.00	0.0000	0.56	0.00	0.0000	2.34
Rocky Bay (SR14)	0.00	0.0000	0.56	0.00	0.0000	2.34
Coastal Protection Areas (Depth-averaged)						
Clear Water Bay (SR28)	0.00	0.0000	0.68	0.00	0.0000	2.40
Clear Water Bay (SR29)	0.00	0.0000	0.68	0.00	0.0000	2.40
Clear Water Bay (SR30)	0.00	0.0000	0.68	0.00	0.0000	2.40
Clear Water Bay (SR31)	0.00	0.0000	0.68	0.00	0.0000	2.40
Po Toi O (SR27) [(a)]	0.00	0.0000	0.68	0.00	0.0000	2.40

WSR (ID)	Wet Season			Dry Season		
	Max SS Elevation (mg/L)	Max DO Depletion (mg/L)	Allowed DO Depletion (mg/L)	Max SS Elevation (mg/L)	Max DO Depletion (mg/L)	Allowed DO Depletion (mg/L)
Tai Miu Wan (SR4)	0.93	0.0130	0.63	0.05	0.0007	2.25
Tai Miu Wan (SR5)	0.00	0.0000	0.63	0.04	0.0006	2.25
Cape Collinson (SR10)	0.01	0.0002	0.63	0.01	0.0001	2.25
Cape Collinson (SR11)	0.00	0.0000	0.63	0.01	0.0001	2.25
Big Wave Bay (SR13)	0.00	0.0000	0.56	0.00 (b)	0.0001 (b)	2.34
Tai Tam (SR25)	0.00	0.0001	0.68	0.00	0.0000	2.40
Tai Tam (SR26)	0.01	0.0002	0.68	0.00	0.0000	2.40
Seawater Intakes (Mid-depth)						
Tseung Kwan O New Town (SR19)	0.00	0.0000	2.58	0.00	0.0000	3.98
Siu Sai Wan (SR17)	0.04	0.0006	1.80	0.02	0.0003	4.08
Heng Fa Chuen (SR23)	0.23	0.0032	1.80	0.05	0.0007	4.08
Chai Wan Godown (SR16) (c)	0.02	0.0003	-	0.01	0.0001	-
Pamela Youde Nethersole Eastern Hospital (SR24) (c)	0.02	0.0003	-	0.02	0.0003	-

Note:

(a) EPD water quality monitoring data indicated that 10th percentile DO level of fish culture zone at Po Toi O is below the corresponding WQO criteria of 5 mg/L in wet season.

(b) Maximum SS elevation at SR13 is 0.0042 mg/L (i.e. below level of significant of two decimal places). The corresponding maximum DO depletion is predicted to be 0.000059 mg/L.

(c) Cooling water intakes for Chai Wan Godown and Pamela Youde Nethersole Eastern Hospital are not sensitive to DO depletion. The predict values of DO depletion are for reference only and there is no corresponding assessment criteria.

As discussed previously under *section 6.5.1*, the baseline 10%-percentile DO level is already below the WQO criteria (5 mg/L) at the two fish culture zones (SR2 and SR27) in wet season. The maximum potential DO depletion at the Tung Lung Chau Fish Culture Zone (SR2) due to marine dredging is predicted to be only 0.0013 mg/L in wet season, which is already negligible. Review of EPD water quality monitoring data indicated under baseline condition, DO level at SR2 would be equal to or above 5 mg/L for 83.8240% of time in wet season. With the 0.0013 mg/L DO depletion, the time for DO compliance is reduced to 83.7948% (i.e. reduction by 0.0292%). It should be highlighted that WQO requires the level of DO be above 5 mg/L for 90% of sampling incidents within a year, regardless of the season of the sampling event. Since baseline DO in general is lower in wet season (refer to ***Table 6.12***) while SS elevation (also DO depletion) at WSRs is also generally higher in wet season as well, the above predicted of DO depletion would be too conservative for WSRs with low DO level in wet season. Routine EPD monitoring data from 2009 – 2013 indicated that annual depth-average 10th-percentile DO at EM2 is 5.05 mg/L (without considering the seasons). As the predicted maximum DO at the Tung Lung Chau FCZ is only 0.0013 mg/L, the marine construction works would not reduce the 10th-percentile DO at SR2 to below 5 mg/L. It should also be highlighted that the above calculation based on continuous DO depletion resulted by maximum SS elevation from the dredging operation. In fact the actual time required for the dredging works would be very short based on the recommended working rate (2 days for dredging at submarine outfall, 3 days for dredging at seawater intake). Also, the predicted maximum SS elevation occurs at WSRs for short period of time (one hour) out of the whole dredging period. This means the maximum DO depletion presented above is very transient. As such, the change in absolute level of DO (0.0013 mg/L) and the induced reduction of time of DO above 5mg/L in wet season are both minimal and not significant. Also, there will be no non-compliance in DO expected on an annual basis, it is therefore considered no unacceptable adverse water quality impact from the potential change in DO level is expected from the proposed dredging works under this Project. It should also be highlighted that the WQO criteria for DO requires DO level at fish culture zone be above 5 mg/L for 90% of the samples without making reference on the seasons. The 10th-percentile DO level at EM2 within the same baseline period (all samples from 2009 to 2013) is 5.05 mg/L which is slightly above the criteria and thus complies with the WQO DO criteria in annual basis. Taken into account the above, the 0.0013 mg/L maximum DO depletion would not results in exceedance in WQO criteria.

It should be highlighted that the Po Toi O Fish Culture Zone (SR27) is far away from the Project and is beyond the envelope of impact from this Project. The DO condition at SR27 would not be adversely affected by this Project. No significant DO depletion at all other non-fish culture zone WSRs is identified under the unmitigated scenario. No additional mitigation measure is required for DO depletion. No adverse water quality impact from DO depletion due to marine dredging at submarine outfall and seawater intake is anticipated.

Elevation of Nutrients

Other than readily-biodegradable organic compounds (which are assessed in the previous section), sediment-bounded nitrogenous compounds could also be released into the water column and result in an increase of total inorganic nitrogen (TIN) and UIA. Review of sediment quality data (provided in *Table 6.7* above) indicated that level of TKN is low near the Project site (represented by EPD sediment monitoring station ES1) when compared to the level at other EPD sediment quality monitoring stations in the Victoria Harbour. Nevertheless, sediment elutriate test results (provided in *Table 6.9* above) indicated that there will be dissolution of ammonia nitrogen as well as organic nitrogen from sediment disturbance, which could results in change in water quality. Maximum elutriate level of ammonia (ionized + unionized) is 3.29 mg/L while the seawater blank ammonia level is 0.01 mg/L. As discussed in *Section 6.6.2*, EPD marine water quality monitoring data at EM2 from 1986 to 2013 indicated that on average 5.7% of ammonia nitrogen exists as UIA. This means for the area of initial disturbance of sediment (which can be very small though), the maximum level of UIA could potentially be (3.29 mg/L $\times$ 5.7%) = 0.18753 mg/L, which is higher than the corresponding WQO criteria. For TKN, the maximum elutriate level and seawater blank level are 4.2 and 0.3 mg/L respectively. Assuming all TKN turns into TIN upon release into the water column (which is a very conservative assumption), there would be a potential increase in TIN over the corresponding WQO at the area of initial disturbance of sediment. Further detailed assessment of potential elevation of TIN and UIA at WSR is therefore conducted based on the method stipulated in *Section 6.6.2* above. Based on the conservative prediction of TIN and UIA using the maximum predicted SS elevation at SR4

(1.11 mg/L for dredging at submarine outfall in wet season, mitigated) and the maximum TKN level in sediment sampled under this Study, the predicted maximum elevation in TIN and UIA is calculated as follow:

Max TIN (mg/L) = Max SS (mg DW/L) × Max TKN (mg N/ kg DW) × 10^{-6}

= 1.11 × 1480 × 10^{-6} mg/L = 0.001643 mg/L

Max UIA (mg/L) = Max SS (mg DW/L) × Max TKN (mg N/ kg DW) × 10^{-6} × 5.7%

= 1.11 × 1480 × 10^{-6} × 5.7% mg/L

= 0.0000941 mg/L = 0.0941 µg/L

As shown in the calculation above, only minimal elevation of TIN and UIA is expected at the SR4, which is the most adversely impacted by the proposed marine dredging. The predicted maximum elevation of TIN and UIA is below 3% of the allowed level of elevation (i.e. WQO criteria minus background level) as shown in *Table 6.21* below. Potential elevation of TIN and UIA at other WSRs are expected to be even lower. No exceedance of WQO TIN and UIA criteria is expected at SR4 and any other WSRs from the proposed dredging operation. No adverse water quality impact from the release of nutrient due to marine dredging at submarine outfall and seawater intake is anticipated.

Table 6.21 Predicted Worst Case Elevation of TIN and UIA and its comparison with the corresponding WQO Criteria

Unit: mg/L	**TIN (mg/L)**			**UIA (µg/L)**		
WQO Criteria						
	Total	**Background Level**	**Allowed Elevation**	**Total**	**Background Level**	**Allowed Elevation**
EM1	0.4	0.23	0.17	21	2	19
EM2	0.4	0.19	0.21	21	2	19
EM3	0.4	0.17	0.23	21	1	20
JM3	0.3	0.24	0.06	21	2	19
JM4	0.3	0.22	0.08	21	2	19
MM19	0.3	0.12	0.18	21	1	20
Predicted Elevation at Most Adversely Impacted Receivers						
Tai Miu Wan (SR4)		0.001643			0.0941	

Note:
Annual mean of TIN and UIA given in *Table 6.6* were taken as the background level at each EPD monitoring stations.

Elevation of Heavy Metals and Micro-organic Pollutants

The proposed dredging operation may disturb bottom sediment and results in release of sediment-bounded pollutants, namely heavy metals, metalloid (arsenic) and trace organic compounds (PAHs, PCBs and TBT). As shown in ***Table 6.9***, the sediment elutriate test results indicated that the levels of all heavy metals, metalloid and trace organic compounds in sediment samples analyzed under this Study are below the corresponding limit of reporting (LOR) adopted for the laboratory tests. With the exception of mercury and total PCB, the limit of reporting adopted for the laboratory tests are all below the proposed water quality assessment criteria for heavy metals, metalloid and trace organic compounds. This means there will not be any mixing zone for heavy metals, metalloid and trace organic compounds, except mercury and total PCB. To assess the potential water quality impacts from the release of mercury and total PCB from disturbed sediment, further estimation would be required according to the methodology stipulated in *Section 6.6.2*. Based on the conservative prediction of released bounded using the maximum predicted SS elevation at SR4 (1.11 mg/L in wet season, mitigated) and the maximum pollutant level in sediment, the predicted maximum elevation of mercury and total PCB is calculated and presented in ***Table 6.22*** below.

Table 6.22 Predicted Worst Case Elevation of Pollutants and its comparison with the corresponding Assessment Criteria

Parameter	Assessment Criteria (μg/L)	Maximum Sediment Pollutant Level from Geophysical Survey (mg/kg)	Predicted Maximum SS Elevation (mg/L)	Predicted Maximum Pollutant Elevation (μg/L)
Metals				
Mercury (Hg)	0.3	0.16	1.11	0.177
Total PCBs	0.03	0.018	1.11	0.019890

As shown, only minimal elevation of mercury and total PCB is expected at SR4, which is the most adversely impacted by the proposed marine dredging. The predicted maximum elevation of pollutants is below the proposed assessment criteria as shown in ***Table 6.22*** above below. Potential elevation of mercury and total PCB at other WSRs are expected to be even lower. No exceedance of the proposed assessment criteria for pollutants is expected at SR4 and any other WSRs from the proposed dredging operation. No adverse water quality impact from the release of pollutants due to marine dredging at submarine outfall and seawater intake is anticipated.

Other Marine Construction Works

As discussed in *Section 3*, marine construction works (other than sediment dredging assessed in the previous sections) would be required for the construction of the proposed submarine outfall and seawater intake. These marine construction works includes:

- Construction of submarine outfall diffuser and submerged intake using prefabricated structures;
- Backfilling using rock fill with low fines content.

These marine construction works would be conducted at the seabed level of the outfall and intake site and is expected to result in limited disturbance to the seabed. The adoption of prefabricated structure for the construction of submarine outfall and seawater intake would avoid any concreting works and also shorten the duration required for marine construction, thus limiting the potential water quality impact. The use of rock fill with low fines content would also minimize any loss of fine to the water column during the backfill works. In view of the above, no unacceptable water quality impact is expected from these non-dredging marine construction works.

It should be noted that horizontal directional drilling (HDD) would be used to construct the pipeline from the outfall diffuser and seawater intake to the desalination plant. Drilling would be starting on the landside of the Project site and proceed outward to the locations of the proposed outfall diffuser and seawater intake. As the HDD works would be conducted within the bedrock, disturbance of marine sediment is not expected. Generally, marine dredging at the submarine outfall and seawater intake would only be conducted after the completion of HDD so drilling fluid would not be exposed to seawater. Used drilling fluid and other wastewater from HDD would only be collected on the landside works area. Rock debris contained in the drilling fluid from the HDD would be removed from the fluid and be collected as fill material onsite. The drilling fluid would then be reconditioned (if necessary) and be reused as much as practicable. When the drilling fluid is no longer suitable for reuse or after the completion of the HDD process, the drilling fluid would be dewatered and disposed to the landfill accordingly. Any wastewater generated from the drilling process would be collected in the landside works area and treated properly before disposal.

General Construction Activities

Discharges and runoff from the site during the construction phase, particularly during site formation, excavation and backfilling works, will contain SS which could be a source of water pollution. Uncontrolled disposal of debris and rubbish such as packaging, construction materials and refuse and spillages of chemicals stored on-site, such as oil, diesel and solvents would also result in contamination of construction site runoff. However, it is anticipated that no unacceptable water quality impacts would arise from the land-based works if standard site practices and mitigation measures, described in *Section 6.9.1*, are in place and properly implemented.

Sewage Effluents from Construction Workforce

Appropriate numbers of portable toilets shall be provided by a licensed contractor to serve the construction workers over the construction site to prevent direct disposal of sewage into the water environment. The Contractor shall also be responsible for waste disposal and maintenance practices.

Sterilization of Water Mains Prior to Commissioning

The proposed fresh water mains would be cleaned and sterilized prior to commissioning. Typically, water mains are sterilized by chlorination. The purpose of chlorination is to eliminate potential pathogens and maintain a sterile / aseptic condition for potable water transfer.

The cleaning and sterilization procedures of fresh water mains would be carried out according to the latest version of *WSD Departmental Instruction No. 805: Mainlaying - Cleaning and Sterilization of Fresh Water Mains (Section 3.11).* General procedures for cleaning and sterilization of potable water mains are outlined below:

- The internal of the pipeline should be cleaned as thoroughly as possible to ensure that no foreign matter remains inside the water mains. For 1200 mm diameter mains, a CCTV survey should be carried out to inspect and assess the internal conditions of the pipeline.

- After cleaning, the pipeline should be disinfected by completely filling with water that has been dosed with a homogeneous solution of chloride of lime (or sodium hypochlorite solution) such that the final concentration of free chorine in the water is at least 30 ppm. The water shall be left in the pipeline for at least 24 hours. The pipeline should be drained down and flushed thoroughly with potable water, until the concentration of the remaining chlorine is less than 1 ppm.

- Water samples will then be taken for bacteriological and chemical analyses. The pipeline can only be put into service after the test results are found to be satisfactory.

Based on the preliminary design, a total of 11,000 m^3 of chlorinated water would be required for sterilization of the new fresh water main and an additional 22,000 m^3 of potable water would be used for cleaning and flushing. The sterilization water would be dechlorinated with TRC level below 1 mg/L before discharge. The cleaning and flushing water would also be treated and desilted to the relevant discharge requirement stipulated in TM-DSS before discharging into public sewer. With the implementation of appropriate treatment processes and facilities to control water discharge from sterilized water mains, adverse impact on water quality is not expected. To ensure sterilization water is sufficiently dechlorinated, monitoring of the TRC concentration before discharge is recommended.

Spillage of Chemicals

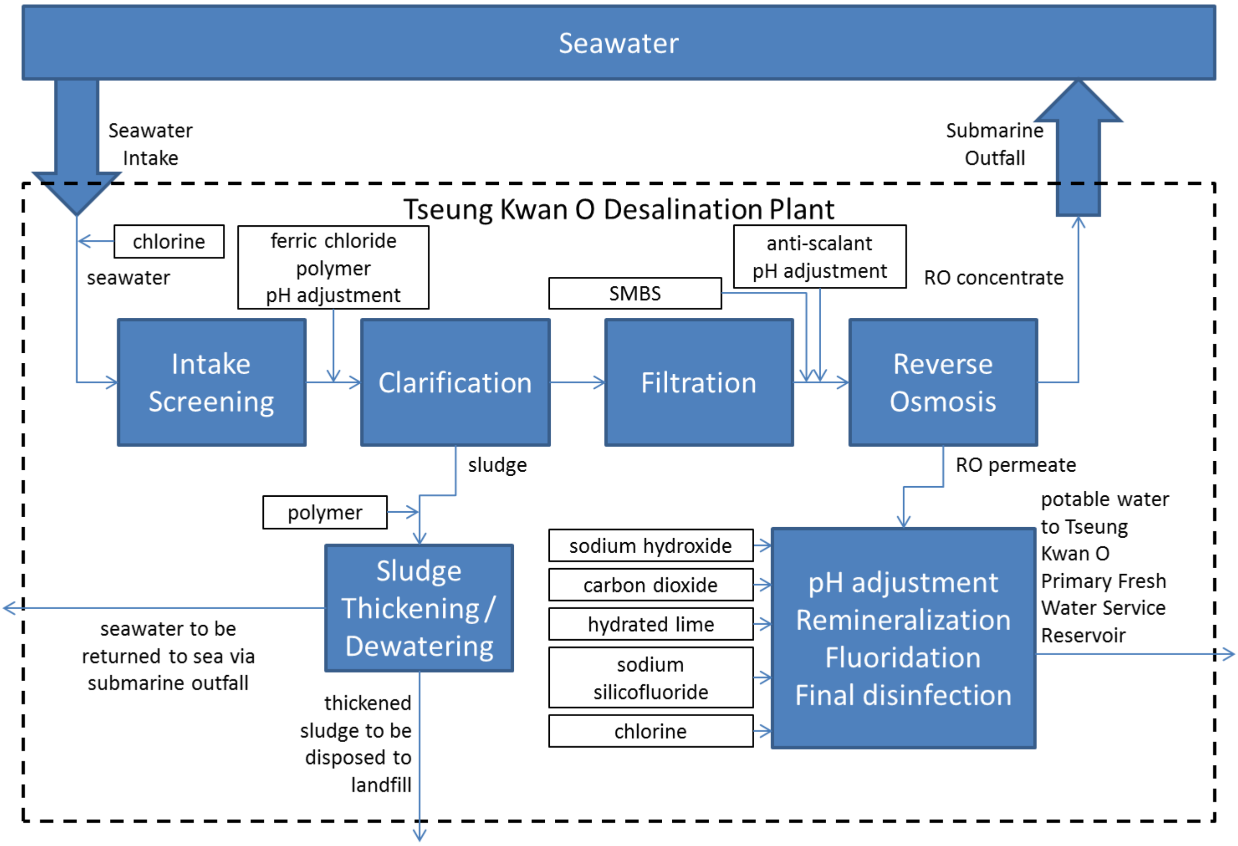
Site drainage should be well maintained and good construction practices should be observed to ensure that oil, fuels, solvents, drilling fluid and other chemicals are managed, stored and handled properly and do not enter the nearby water streams. No adverse water quality impacts are expected with proper implementation of the recommended mitigation measures.

Plant Testing and Commissioning

A brief period of plant testing and commissioning would be required before the actual operation of the Project. Works involved would be similar to that of normal operation (which would be assessed in the following sections) but would be conducted at smaller scale. In view of the similar nature and smaller scale, the assessment of potential water quality impact from plant testing and commissioning would be covered under the operation assessment provided below.

6.8.2 Operation Phase

The design capacity (after expansion) of the Project is 270 Mld (about 250,000 m^3/day), with maximum saline discharge of 464,000 m^3/day. The normal operation of the proposed desalination plant is outlined below. A number of chemicals would be added during the desalination process to improve the quality of potable water from RO permeate.



Chemicals present in the RO concentrate may include most types of chemicals which are dosed upstream to the RO process, together with the concentrated constituents of marine water. Based on the preliminary design of the Desalination Plant, the proposed effluent standards upon commissioning of the Project are summarized in ***Table 6.23***. Since no heating is involved in the desalination process, the temperature of the RO concentrate would be similar to the ambient water temperature. There would also be no cooling water discharge in the proposed desalination plant. The effluent will also have DO level that is similar to ambient DO level in the seawater. Chemicals added for coagulation (ferric chloride), flocculation (polymer) and pH adjustment (sulphuric acid and hydrochloric acid) would be removed during the pre-treatment process or neutralized and would not present in the RO concentrate at significant level. Polymer, which is a high molecular weight compound (up to 200,000 atomic mass unit per molecule) and carries multiple charges, tends to adsorb onto particle surfaces. Through interparticle bridging coalesce with other particles to form floc, polymer enhances the removal of suspended solids from the treated stream. Most of the polymer dosed would be removed in the pretreatment process together with the floc and would not be present in the RO concentrate at notable level. Residual polymer in the RO concentrate, if any, would also be adsorbed to suspended solids in the water column and be removed from the water column quickly. Therefore, assessment on the use of polymer is not required.

Anti-scalant would also be added during the desalination process and is expected to present in the RO concentrate. Based on the material safety data sheet (MSDS) of typical anti-scalant products (provide in *Annex 6F*), anti-scalant is known to be low in toxicity to aquatic fish and human. Toxicity studies indicated that EC_{50} for most test organisms would be in the order of hundreds or thousands of mg/L, which would be well above the expected discharge concentration and is not considered a major concern on water quality. As such, there is no commonly used water quality standard for anti-scalant. For the purpose of deriving a Predicted No-Effect Concentration (PNEC) from the toxicology data of the anti-scalant, reference would be made to the method proposed under the *Technical Guidance Document on Risk Assessment by the European Chemical Bureau of the Institute for Health and Consumer Protection under the European Commission*. An assessment factor of 1000 would be applied to the available EC_{50} data of the proposed anti-scalant, i.e. the proposed assessment criteria for the anti-scalant would be one thousandth of the EC_{50} data available, for conservative assessment. The lowest EC_{50} value (362 mg/L for algae) from the MSDSs of the potential anti-scalant candidates would be used for the calculation and the assessment criteria for anti-scalant under this Study would be 0.362 mg/L.

With reference to the characteristics of effluent from the desalination plant (see ***Table 6.23***), the operation phase modelling for normal operation will consider five key parameters, namely salinity, Fe, anti-scalant, TIN and SS, for a focused assessment. The addition of other chemicals during routine maintenance such as bio-growth control and chemical cleaning of RO unit is also assessed in detail in the following sections.

Table 6.23 Proposed Effluent Discharge Standards of TKO Desalination Plant upon Commissioning

Parameters	Upper Limit
Discharge to Marine Water from Normal Operation	
Discharge Flow Rate	464,000 m^3/day (5.3704 m^3/s)
Fe	0.6 mg/L
Total Phosphorus	1 mg/L
Total Inorganic Nitrogen	2 mg/L
Salinity	65,000 mg/L
pH	6-9
SS	13 mg/L
Anti-scalant	8 mg/L
Discharge to Marine Water during Bio-growth control	
pH	6-9
Sodium Metabisulphite (SMBS)	0.5 mg/L
Total Residual Chlorine (TRC)	0.1 mg/L
Discharge to Public Sewer during Chemical Cleaning	
Maximum Amount Discharged per Event	514.8 m^3
Fe	0.6 mg/L
pH	6-9
SS	13 mg/L
Citric acid	10-30 mg/L
Sodium lauryl sulphate	10-30 mg/L

Change in Hydrodynamic due to Discharge of RO Concentrate

The discharge of RO concentrate, which is high in salinity, may alter the flow regime near the submarine outfall. Salinity is also a water quality criterion stipulated under the WQO and any change due to discharge should not exceed 10% of natural ambient level. To assess the potential change in flow regime, computation modelling has been conducted using a combination of CORMIX suite of model (for near field dispersion modelling) and Delft3D suite of model (for far field dispersion modelling). The detailed approach is summarized in *Annex 6A and Section 6.6.3* above. The assessment criteria stipulated under *Section 6.5.6* would be followed.

As stated in *Section 6.6.3* above, continuous discharge of RO concentrate is simulated using CORMIX suite of model (using ambient conditions provided by Delft3D FLOW base case scenario) to determine the near field behaviour of the discharge plume. Detailed predictions from CORMIX simulation are presented in *Annex 6C*.

Contour plots showing the mixing zone of relative salinity elevation [1] at surface, middle and bottom level of the water column at selected tidal condition (mid-flood, high water, mid-ebb and low water for both spring tide and neap tide) near the outfall in both seasons are presented in *Annex 6D*. As shown in *Annex 6D*, the effluent plume of RO concentrate discharge is confined closely to submarine outfall in both seasons. A small mixing zone where relative salinity elevation >0.1 (i.e. salinity elevation by 10% as stated in the WQO) could be observed at the bottom level. Localized plume of minor elevation relative salinity elevation >0.05 (i.e. salinity elevation by 5%) is observed near the outfall for some of the tidal conditions at bottom level. The maximum percentage increase in salinity at the outfall is predicted under low water condition in spring tide of dry season, where a 13.4% increase of salinity above ambient is predicted at the bottom level. Maximum percentage increase in salinity at other occasions (i.e. wet season, neap tide, etc), other locations further away from the outfall or other level of the water column (surface or middle) would be lower. Yet the mixing zone predicted under all occasion is very small (less than 30 m × 30 m), highly localized and away from any WSRs identified (***Figures 6.8a to 6.8d***). No unacceptable change in flow regime from the elevation in salinity due to the discharge of RO concentrate is expected. The predicted elevation in salinity at the nearest WSR at Tit Cham Chau (SR37) would be the highest in low water condition (i.e. slack water after ebb tide) in both seasons. The predicted percentage increase in salinity at SR37 would be about 1.65% and 1.36% respectively in low water condition in dry and wet season respectively. The predicted increase at other WSRs would be even lower. Compliance to the WQO criteria for salinity is expected at all WSRs identified under this Study.

Change in Water Quality due to Discharge of RO Concentrate during Normal Operation

As discussed in the previous section, a number of chemicals would be continuously dosed to the seawater extracted during the normal operation. Extracted seawater would be first screened to remove large objects. The screened seawater would then be dosed with ferric chloride (to enhance coagulation), polymer (to enhance flocculation) and sulphuric acid (to adjust pH to allow optimum coagulation and flocculation) and then subjected to clarification. Large particles would be removed through this process.

[1] Relative salinity elevation is calculated by: (Salinity with discharge – Salinity without discharge) / Salinity without discharge. The corresponding WQO salinity criteria would be 0.1.

The clarified water would then be filtered to remove suspended particles of smaller size. Anti-scalant would be added to inhibit scaling of the RO membrane. pH adjustment in form of sodium hydroxide may be needed to optimize the working pH of anti-scalant. The RO permeate (water which passes through the RO membrane) would be diverted for further downstream treatment and the RO concentrate would be neutralized to pH 6-9 and then discharged via the submarine outfall.

The discharge of Fe, anti-scalant, TIN and SS is modelled using the Delft3D PART suite of model. Inert, non-settling tracer (i.e. conservative tracer) was assumed for Fe, anti-scalant and TIN, while inert, settling tracer (i.e. sediment) was assumed for SS. The release is assumed to be continuous and located at the vertical layers predicted by the CORMIX near field simulation (the second iteration for both seasons given in *Annex 6C*). Assessment criteria stipulated in ***Table 6.16*** are adopted. Based on the field survey conducted under this Project, the level of Fe in ambient seawater is around 0.19 mg/L. The allowed elevation for Fe at WRSs is therefore 0.3 mg/L – 0.19 mg/L = 0.11 mg/L. Similarly, allowed elevation of TIN is [0.4 mg/L (WQO for TIN at Eastern Buffer WCZ) – 0.17 mg/L (long term average TIN from 1986-2013 at EPD Water Quality Monitoring Station EM2)] = 0.23 mg/L.

The predicted maximum depth-averaged elevation of Fe, anti-scalant, TIN and SS from RO concentrate discharge over a spring-neap tidal cycle for dry and wet season are presented in *Annex 6E-1 to Annex 6E-4*. The corresponding plots for bottom level of these parameters are provided in *Annex 6E-1a to Annex 6E-4a* for assessment of impact to coral sites. Based on the results of the near field dispersion modelling presented in *Annex 6C*, the effluent plume of the RO concentrate would be mostly concentrated at the bottom level of the water column, thus the elevation and plume extent of these parameters would be bigger than that of the depth-averaged plots. It should be highlighted the predicted values and plots are the elevation above baseline level. For water quality parameters including TRC and SMBS, their corresponding baseline level in marine water should be negligible due to their tendency to decay and the lack of nearby source, the predicted elevation should be similar or equal the absolute level.

Iron

As shown in *Annex 6E-1*, no mixing zone of exceedance of the allowed elevation of 0.11 mg/L of Fe is predicted in both seasons for depth-averaged results. Small effluent plumes, highly localized and confined near the submarine outfall, are observed in both seasons at a level 10% of the proposed assessment criteria of 0.3 mg/L. The predicted bottom level of iron is higher since the RO concentrate stay low in the water column. As shown a mixing zone with iron level above allowed elevation of 0.11 mg/L is predicted near the outfall without encroaching into nearby coral sites. The predicted maximum iron elevation level at the bottom level of the nearest WSR at Tit Cham Chau (SR37) is 0.0066 mg/L in dry season and 0.0152 mg/L in wet season, which is lower than the assessment criteria. The predicted iron elevation level would be even lower at other WSRs.

Anti-scalant

As shown in *Annex 6E-2* and *2a*, small mixing zone with maximum anti-scalant concentration higher than the proposed assessment criteria of 0.362 mg/L is predicted near the proposed submarine outfall under wet season for the depth-averaged and bottom level results. Yet the depth-averaged mixing zone is highly localized and does not encroach to any WSR identified under this Project (as shown in ***Figure 6.8f***). Whilst the mixing zone predicted at bottom level is bigger, it is not predicted to encroach into the nearby coral sites SR36 and 37 (***Figure 6.8f***). It should be noted that the predicted level shown in *Annex 6E-2* and *2a* is the instantaneous maximum predicted throughout the 15-day spring-neap cycle and does not reflect the actual extent of effluent plume at any incident. The prediction is made based on conservative assumptions that (1) the RO concentration would be continuously discharged at the maximum capacity of proposed plant and (2) the concentration of anti-scalant would be maintained at the proposed maximum level. These multiple levels of conservative assumptions would result in overestimation of impacts. The predicted maximum level of anti-scalant at the bottom level of the nearest WSR at Tit Cham Chau (SR37) is 0.1939 mg/L in dry season and 0.3486 mg/L in wet season, which is lower than the assessment criteria. The predicted maximum level of anti-scalant at the bottom level of the nearest WSR at Kwun Tsai (SR36) is 0.0648 mg/L in dry season and 0.1539 mg/L in wet season, which is also lower than the assessment criteria. The predicted level of anti-scalant would be lower at other WSRs. For example, maximum anti-scalant level predicted at the nearby Tung Lung Chau Fish Culture Zone (SR2) is 0.0416 mg/L in wet season and 0.1399 in dry season while mean anti-scalant level at SR2 is predicted to be 0.0089 mg/L in wet season and 0.0271 mg/L in dry season.

Anti-scalant is in general a mixture of polymers of different molecular size and biodegradation is expected as stated in the corresponding MSDSs (provided in *Annex 6F*). The degradation of these polymers is slow and the degradation product would unlikely be present in significant concentration in view of the significant flushing at the submarine outfall and the nearby waters. Degradation products of the anti-scalant are therefore not considered a water quality concern. It is, however, understood that certain type of anti-scalant may contain phosphorus. As stated in *Annex 6F*, degradation of anti-scalant is only about 23% in 28 day, which means about 0.929% [(1)] of anti-scalant degrade every day. As given in *Table 6.23*, the percentage of mass of phosphorus in anti-scalant would be below 12.5%. This means phosphate of mass less than (0.929% × 12.5% =) 0.12% of anti-scalant would be released each day, which is unlikely to be of concern considering the low level of anti-scalant presented in the marine water (0.0881 mg/L in dry season and 0.2032 mg/L in wet season at the most impacted WSR as stated in the previous section). It is therefore considered the discharge of anti-scalant would not contribute to significant level of biologically available phosphorus before leaving the HK waters in view of the slow degradation rate and relatively high flushing near the outfall. No secondary impact, such as eutrophication or algal bloom, is therefore expected.

(1) Assuming first order decay (according to OCED Guideline 302b). Decay rate = $1-(1-23\%)^{(1/28)} = 0.9291\%$

Total Inorganic Nitrogen

Contour plot of predicted maximum elevation of TIN from the RO discharge is provided in *Annex 6E-3* and *3a*. As shown, there is no mixing zone with TIN elevation higher than the 0.23 mg/L assessment criterion predicted in both seasons for depth-averaged results. Very small effluent plume of 0.13 mg/L is predicted close to the proposed submarine outfall, but that neither exceeds the proposed TIN assessment criterion nor encroaches to any WSRs nearby. For bottom level of TIN, predicted level is higher and a localized mixing zone is predicted in wet season around the proposed submarine outfall. The predicted maximum TIN level at the bottom level of the nearest WSR at Tit Cham Chau (SR37) is 0.0485 mg/L in dry season and 0.0872 mg/L in wet season, which is lower than the assessment criteria. The predicted TIN level would be even lower at other WSRs.

It should be highlighted that there will not be addition of nitrogen loading to seawater during the desalination process. The TIN level is predicted to be in compliance with the relevant WQO level at the nearby WSRs and mixing zone is small and confined near the outfall. No secondary impact, such as eutrophication or algal bloom, is therefore expected.

Suspended Solids and Sedimentation

For SS, no mixing zone with exceedance of the WQO criteria of 30% elevation above ambient level is predicted in dry season for both depth-averaged and bottom results. Maximum depth-averaged SS elevation is predicted to be higher in wet season, reaching 1.70 mg/L near the submarine outfall, as shown in *Annex 6E-4*. The predicted maximum SS level in wet season is slightly above the 30% elevation above ambient level of the nearby EPD marine water monitoring station of EM3. Yet the mixing zone is very small, confined near the submarine outfall and does not reach any identified WSRs under this Study. Slightly bigger zone of mixing is predicted for bottom SS level. Yet the predicted maximum mixing zone of bottom SS is still away from the nearby receivers. The predicted maximum bottom SS level at the bottom level of the nearest WSR at Tit Cham Chau (SR37) is 0.15204 mg/L in dry season and 0.32677 mg/L in wet season, which is lower than the assessment criteria of 30% above ambient level. The predicted SS level would be even lower at other WSRs.

It is observed that the maximum sediment plume predicted is not located right at the proposed submarine outfall as shown in *Annex 6E-4*. It is because the sediment release rate is very low [(1)] that any increase in SS near the outfall would be below the assessment criteria of 30% increase above the ambient level. On the other hand, sediment released from the outfall would settle around the outfall (as shown in *Annex 6E-5*), and be re-suspended (together with the existing sediment) when the tide condition becomes favourable (i.e. high current velocity during spring tide). Such re-suspension event would occur in short period of time in a tidal-cycle and the effect would be very localized depending on the ambient flow condition. It should be highlighted that such re-suspension event would be naturally occurring (if the sediment conditions are suitable) and is not a result of this Project.

[1] Maximum release rate for SS = 464000 m^3/day ÷ 24 hr/day ÷ 3600 s/hr ×13 g/m^3 = 69.8 g/s. For comparison, the sediment loss rate assumed under the unmitigated scenario for dredging operation is 3500 m^3/day × 17 kg/m^3 ÷ 12hr/day ÷ 3600 s/hr = 1.3773 kg/s = 13773 g/s., which is nearly 20 times of the loading from operation.

The maximum sedimentation flux from the RO concentrate discharge is shown in *Annex 6E-5*. A small area where maximum sedimentation rate exceeds the 100 g/m^2/day assessment criteria for coral is predicted. Yet the area is predicted to be confined close to the submarine outfall and would not encroach to any of the coral WSRs identified under this Study. It should be highlighted that the extent of maximum sedimentation flux is predicted based on continuous discharge at the maximum design capacity of the plant with maximum SS concentration in RO concentrate, which represents a significant overestimation of sedimentation rate. No adverse impact from sedimentation would be expected. Also, no maintenance dredging near submarine outfall would be expected. The predicted maximum seabed (i.e. bottom) sedimentation flux at the nearest WSR at Tit Cham Chau (SR37) is 30.94 g/m^2/day in dry season and 46.10 g/m^2/day in wet season, which is lower than the assessment criteria. The predicted sedimentation flux would be even lower at other WSRs.

In view of the above, no adverse water quality impact from the elevation of Fe, anti-scalant, TIN, SS and sedimentation flux due to the discharge of RO concentrate would be expected.

Change in Water Quality due to Discharge of RO Concentrate during Bio-growth Control Works

Control of bio-growth at seawater inlet as well as the pre-treatment unit (clarification and filtration) would be conducted on a regular basis. Base on the latest design information available, bio-growth control works would be conducted for every 5 days. Chlorine at a level of 15 mg/L would be dosed to the system for a period of 6 hours. For the pre-treatment unit, bio-growth control would be conducted every 24 hours using chlorine at 5 – 10 mg/L level for 30 minutes. No other biocide is required based on the latest design information available. As a measure to avoid damage to the membrane of the RO unit, SMBS would be dosed to the extracted water before reaching the RO unit for dechlorination. The level of total residual chlorine (TRC) and SMBS is expected to be minimal in the RO concentrate. For conservative reason, computational modelling using Delft3D PART model was conducted to study the dispersion of TRC and SMBS from the submarine outfall at a maximum discharge level of 0.1 mg/L and 0.5 mg/L respectively. Inert, non-settling tracer (i.e. conservative tracer) was assumed for SMBS, while decayable, non-settling tracer was assumed for TRC. Similar to the modelling assessment for Fe and SS, the release is assumed to be continuous and located at the vertical layers predicted by the CORMIX near field simulation (the second iteration for both seasons given in *Annex 6C*). It should be noted that this is a very conservative approach to assume continuous release of TRC and SMBS. In fact the release of TRC and SMBS would only last for a brief period (30 minutes for bio-growth control at pre-treatment unit and 6 hours for bio-growth control at inlet) when the bio-growth control works is being conducted. By assuming continuous release, the modelling simulation takes into account the worst case scenario that may arise from different tide condition as well as the potential for background buildup, thus ensuring conservative assessment. Assessment criteria stipulated in *Table 6.16* are adopted.

The predicted maximum depth-averaged concentration of TRC and SMBS from RO concentrate discharge over a spring-neap tidal cycle for dry and wet season is presented in *Annex 6E-6 and Annex 6E-7*.

Total Residual Chlorine

As shown in *Annex 6E-6*, no mixing zone with exceedance of the proposed assessment criteria of 0.02 mg/L of TRC is predicted in both seasons. Effluent plumes are observed within the Tai Miu Wan and Tathong Channel in both seasons at a level one-tenth of the proposed assessment criteria. The predicted level of TRC at the bottom level is slightly higher and small and localized mixing zone with TRC level above 0.02mg/L is predicted within the Tai Miu Wan in wet season. Yet the bottom mixing zone does not encroach into the nearby coral sites. The predicted maximum TRC level at the nearest WSR at Tit Cham Chau (SR37) is 0.00160 mg/L in dry season and 0.00398 mg/L in wet season, which is lower than the assessment criteria. The predicted TRC level would be even lower at other WSRs.

Sodium Metabisulphite and associated Oxygen Depletion

No criterion is proposed to directly assess the acceptable level for SMBS in view of lack of / nil in toxicity to human and aquatic animals at the maximum discharge concentration given in ***Table 6.23***. Yet as a reducing dechlorination agent, the presence of SMBS would contribute to an increase in chemical oxygen demand in the water column. The product of hydrolysis of SMBS, sulphite ion, may also be present in the RO concentrate. Sulphite, which is slightly reducing, acts similar to SMBS and reacts with DO. Since the amount of DO being consumed by each mole of SMBS would be the same as that consumed by the amount of sulphite produced by the one mole of SMBS, the potential water quality impact (DO depletion) would be assessed together in this section for simplicity [(1)]. The maximum potential DO depletion from SMBS is calculated from the predicted maximum SMBS level from RO concentrate discharge. This approach is considered appropriate and is the same as the approach adopted for calculating DO depletion from release of sediment-bounded pollutant from construction phase marine dredging under *Section 6.8.1*.

SMBS reacts with DO according to the following stoichiometric equation:

$Na_2S_2O_5$ (aq) + O_2 (aq) + H_2O (l) $\rightarrow$ 2 $NaHSO_4$ (aq)

One molecule of SMBS reacts with one molecule of DO. Taken into account the molecular mass of SMBS and oxygen, 1 mg/L of SMBS would react with 0.16832 mg/L of DO (assuming complete reaction). The level of maximum potential DO depletion is calculated from the maximum predicted SMBS level accordingly.

Contour plots of SMBS and the corresponding plots for depth-averaged DO depletion are provided in *Annex 6E-7 and Annex 6E-8*. As shown in the contour plots for DO depletion (*Annex 6E-8*), DO depletion would be below 0.016832 mg/L (corresponds to 0.1 mg of SMBS). As discussed under *section 6.8.1,* the 10^{th}-percentile DO at EM2 is 5.05 mg/L (all samples without dividing into two seasons). This means the allowed DO depletion would be 0.05 mg/L. The predicted maximum bottom DO depletion at the nearest WSR at Tit Cham Chau (SR37) is 0.0020 mg/L in dry season and 0.0037 mg/L in wet season. The level of DO depletion is also predicted to be below 0.01 mg/L at the nearby Tung Lung Chau Fish Culture

(1) The concentration of residual SMBS in RO concentrate estimated based on mass-balance method

Zone (SR2), which indicates compliance to the assessment criteria for DO. It is therefore expected that any depletion of DO due to the discharge of SMBS from RO concentrate would not result in exceedance of the relevant WQO criteria.

It is also known that SMBS releases odorous sulphur dioxide gas when it first dissolves in water. Such emission of sulphur dioxide would only be at notable level near its saturation concentration (SMBS saturates in water at 540 g/L at room temperature, which is 10^6 times of the maximum residual level in RO concentrate). Yet the level of SMBS present in the RO concentrate would only be 0.5 mg/L or below, which is well below the concentration of SMBS dosing solution when it is first prepared. Therefore, significant release of sulphur dioxide gas from RO concentrate is not expected.

Chlorination By-products

With the use of chlorination as a measure for bio-growth control, the generation of chlorination by-products may potentially be a concern. A review of nearby water quality data indicated that the level of organics in marine water near the Project (indicated by the average 5-day biochemical oxygen demand at EPD monitoring station EM2) is quite low (below 1.1 mg/L in 2013). For comparison, such level of organics is about 1/80 of the effluent from Stonecutters Sewage Treatment Works (as given in Figure 4.6 of the approved EIA of HATS Stage 2A) and about 1/4 of the raw water from Dongjiang in 2013 [(1)]. The amount of organics available from seawater for reaction with chlorine from bio-growth control would be limited and the generation of chlorination by-products is expected to be limited as well.

Polymer, also known as polyelectrolyte, is a class of high molecular mass (inorganic and organic) compounds which generally carry multiple (positive and / or negative) charges. Based on the preliminary design information, polymer would be dosed to the seawater drawn into the desalination plant after the preliminary filtration on an as-needed basis with dosing level at maximum 1 mg/L. As a precautionary measure, the dosing of polymer will be controlled to avoid any concurrent dosing during chlorination for bio-growth control. This precautionary measure will be incorporated in the operation manual of the plant. As such, no formation of chlorination by-products would be expected from the use of polymer for pre-treatment.

The addition of anti-scalant, which is organic in nature, would be conducted after the removal of chlorine from the bio-growth control exercise. Monitoring of TRC level of the dechlorinated bio-growth control effluent would be routinely conducted for every bio-growth control exercise to ensure sufficient dechlorination. The risk of formation of chlorination by-products would also be low. No unacceptable water quality impact from chlorination by-products is expected.

In view of the above, no adverse water quality impact from the potential discharge of TRC, SMBS and chlorination by-products due to the bio-growth control works would be expected.

[(1)] Water Supplies Department, Dongjiang Raw Water (http://www.wsd.gov.hk/en/water_resources/raw_water_sources/dongjiang_raw_water/index.html). Latest revision date: 25 Sep 2014.

Change in Water Quality due to Discharge of RO Concentrate during Chemical Cleaning

Chemical cleaning is a process of removal of mineral scale, biological matter, colloidal particles and insoluble organic constituents deposited on the RO membrane by chemical method. The deposited substance, which deposited on the RO membrane due to the local increase of solute concentration during the RO process, would be dissolved, detach or re-suspended in the cleaning solution in response to the change in pH, allowing easy removal. Chemical cleaning would be conducted once a month for the RO membrane. Based on the latest design information, acids (hydrochloric acid and citric acid, both are commonly used acids in household cleaning products), base (sodium hydroxide, commonly used as drain cleaner) and surfactant (sodium lauryl sulphate, used in liquid soap and detergent) would be used to remobilize the deposited substance from the RO unit. These chemicals are common and non-hazardous at the proposed discharge concentration. The amount of wash water is expected to be about 514.8 m^3 for each cleaning event, which would last for 4 to 8 hours. After the cleaning event, the wash water would be neutralized to pH of 6-9 and treated to appropriate quality stipulated in Table 1 of *Cap 358AK Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* before disposal to public sewer which leads to the Tseung Kwan O Preliminary Treatment Works. No adverse water quality impact from the discharge of effluent from chemical cleaning to public sewer would be expected.

Desalination Plant Failure, Power Failure and Other Contingency

In case of plant failure or power failure, water extraction and the desalination process would be discontinued. Limited discharge of RO concentrate, which is generated before the plant / power failure would be expected, with effluent quality similar to that stipulated in ***Table 6.23***. No emergency discharge from the submarine outfall is expected. No adverse water quality impact would be expected from plant failure or power failure. Also, there will not be any discharge from the plant when it is put into its standby / dormant mode.

Maintenance Dredging

Based on the current design information, there is no need for maintenance dredging at the submarine outfall. While *Annex 6E-5* shows that sedimentation near the proposed outfall is predicted, it should be highlighted that the extent of maximum sedimentation flux is predicted based on continuous discharge at the maximum design capacity of the plant with maximum SS concentration in RO concentrate, which represents a significant overestimation of sedimentation rate. Any need for maintenance dredging would be reviewed and confirmed upon commencement of the Project, subject to field measurement after the commencement of the Project. Should there be a need for maintenance dredging at the proposed submarine outfall, the potential water quality impact should be assessed in a separate environmental study.

Generation of Sewage Effluent

The sewage generated from human activities of the Project would include the sewage from the operation staff and visitors. Sewage effluent and neutralized chemical cleaning water from the Reverse Osmosis (RO) system would be disposed to Tseung Kwan O Preliminary

Treatment Works for this Project. No adverse water quality impact from the generation of sewage effluent from Project operation is expected (see *Section 7*).

Accidental Spillage of Chemicals

A number of chemicals would be stored onsite and be used during the desalination process. Based on the latest design information available, chemicals would be stored on site at bunded area and separate drainage system will be provided as appropriate to avoid any spilled chemicals from entering the storm drain in case of an accidental spillage. Adequate tools for cleanup of spilled chemicals should be stored on site. Appropriate training shall also be provided to staff. No adverse water quality impacts are expected with proper implementation of the recommended mitigation measures.

6.9 Mitigation Measures

6.9.1 Construction Phase

Marine Construction

To minimize potential water quality impacts from elevated SS due to the proposed dredging works at submarine outfall and seawater intake, mitigation measure in form of (1) floating type silt curtain around grab dredger would be adopted for dredging at the proposed submarine outfall and (2) combine used of one floating type silt curtain and one cage type silt curtain for dredging at seawater intake. Silt curtains shall be formed from tough, abrasion resistant, permeable membranes, suitable for the purpose, supported on floating booms in such a way as to ensure that the sediment plume shall be restricted to within the limit of the works area. The silt curtain shall be formed and installed in such a way that tidal rise and fall are accommodated, with the silt curtains always extending from the surface to the bottom of the water column and held with anchor blocks. Based on the results of construction phase water quality modelling assessment, the maximum allowed dredging rate at the seawater intake should be limited to 750 m^3/day while the maximum allowed dredging rate at the submarine outfall is 3,500 m^3/day. The contractor shall regularly inspect the silt curtains and check that they are moored and marked to avoid danger to marine traffic. Regular inspection on the integrity of the silt curtain should be carried out by the contractor and any damage to the silt curtain shall be repaired by the contractor promptly. Relevant marine works shall be stopped until the repair is fixed to the satisfaction of the engineer.

To ensure the maximum allowed dredging rate of 750 m^3/day is implemented properly for dredging at seawater intake, specific measures stipulated below will be followed:

- Closed grab of 3 to 6 m^3 will be used for dredging at seawater intake;
- Number of cycle shall be limited to (750 $m^3 \div 3$ m^3/grab $\div$ 12 hours) = 20.83, i.e. 20 to 21 grabs per hour for 3 m^3 closed grab;
- Number of cycle shall be limited to (750 $m^3 \div 6$ m^3/grab $\div$ 12 hours) = 10.42, i.e. 10 to 11 grabs per hour for 6 m^3 closed grab;

- Specific work staff will be assigned the responsibility for monitoring the number of grab dredged per hour; and

- The grab should be operated in slow and controlled manner such that the impact to seabed by the grab when being lowered could be minimized. Also, the operator should ensure the grab be properly closed before lifting the grab.

Furthermore, a number of standard measures and good site practices should be implemented to avoid / minimize the potential impacts from marine construction. These measures include:

- All vessels should be well maintained and inspected before use to limit any potential discharges to the marine environment;

- All vessels must have a clean ballast system;

- No discharge of sewage/grey wastewater should be allowed. Wastewater from potentially contaminated area on working vessels should be minimized and collected. These kinds of wastewater should be brought back to port and discharged at appropriate collection and treatment system; and

- No soil waste is allowed to be disposed overboard.

General Construction Activities

Standard site practices outlined in ProPECC PN 1/94 "Construction Site Drainage" will be followed as far as practicable in order to reduce surface runoff, minimize erosion, and also to retain and reduce any SS prior to discharge. These practices include the following:

- Silt removal facilities such as silt traps or sedimentation facilities will be provided to remove silt particles from runoff to meet the requirements of the TM standard under the WPCO. The design of silt removal facilities will be based on the guidelines provided in ProPECC PN 1/94. All drainage facilities and erosion and sediment control structures will be inspected on a regular basis and maintained to confirm proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit will be removed regularly.

- Earthworks to form the final surfaces will be followed up with surface protection and drainage works to prevent erosion caused by rainstorms.

- Appropriate surface drainage will be designed and provided where necessary.

- The precautions to be taken at any time of year when rainstorms are likely together with the actions to be taken when a rainstorm is imminent or forecasted and actions to be taken during or after rainstorms are summarised in Appendix A2 of ProPECC PN 1/94.

- Oil interceptors will be provided in the drainage system where necessary and regularly emptied to prevent the release of oil and grease into the storm water drainage system after accidental spillages.

- Temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge, if any, will be adequately designed for the controlled release of storm flows.

- The temporary diverted drainage, if any, will be reinstated to the original condition when the construction work has finished or when the temporary diversion is no longer required.

As the Project site is next to the shoreline, infiltration of seawater during excavation is anticipated. Appropriate infiltration control, such as cofferdam wall, should be adopted to limit groundwater inflow to the excavation works areas in the Project site. Groundwater pumped out from excavation area should be discharged into the storm system via silt removal facilities.

Appropriate numbers of portable toilets shall be provided by a licensed contractor to serve the construction workers over the construction site to prevent direct disposal of sewage into the water environment.

Sterilization of Water Mains Prior to Commissioning

The sterilization water should be dechlorinated with TRC level below 1 mg/L before discharge to public sewer. In situ testing of TRC should also be conducted for the discharge of chlorinated water for pipeline disinfection to ensure sufficient dechlorination before discharge to public sewer. The cleaning and flushing water should also be treated and desilted to the relevant discharge requirement stipulated in TM-DSS before discharging.

Spillage of Chemicals

Site drainage should be well maintained and good construction practices should be observed to ensure that oil, fuels, solvents and other chemicals are managed, stored and handled properly and do not enter the nearby water streams.

6.9.2 Operation Phase

Modelling assessment for operation phase effluent discharge indicated that no adverse water quality impact from the RO concentrate discharge and other relevant discharge. To ensure compliance to the effluent discharge standards stipulated in ***Table 6.23***, effluent quality monitoring is recommended. Furthermore, regular water quality monitoring at nearby WSRs is recommended for operation phase environmental monitoring and audit. Details are provided in the standalone EM&A Manual.

6.10 Residual Impacts

6.10.1 Construction Phase

Elevation of Suspended Solids and Sedimentation

It is predicted that the maximum SS elevation at all WSRs would be in compliance with the corresponding WQO SS criteria with the implementation of silt curtain around the dredging area. No unacceptable residual water quality impact from SS elevation due to marine dredging at submarine outfall and seawater intake is expected.

No exceedance of the proposed sedimentation criteria is predicted at all coral communities in the mitigated scenario. No adverse water quality impact from the elevation in sedimentation due to marine dredging at submarine outfall and seawater intake is expected.

Depletion of Dissolved Oxygen

No exceedance of the WQO and WSD DO criteria is predicted at all WSRs in the unmitigated scenario. No adverse water quality impact from the potential oxygen depletion due to marine dredging at submarine outfall and seawater intake is expected.

Release of Nutrients, Heavy Metals and Micro-organic Pollutants

No exceedance of the proposed assessment criteria for nutrients, heavy metals and micro-organic pollutants is predicted at all WSRs in the unmitigated scenario. No adverse water quality impact from the potential elevation in nutrients, heavy metals and micro-organic pollutants due to marine dredging at submarine outfall and seawater intake is expected.

6.10.2 Operation Phase

Modelling assessment for operation phase effluent discharge indicated that no unacceptable adverse water quality impact from the RO concentrate discharge and other relevant discharge. Wastewater from chemical cleaning of RO membrane would be disposed to public sewer.

Chemicals would be stored on site at bunded area and separate drainage system will be provided as appropriate to avoid any spilled chemicals from entering the storm drain in case of an accidental spillage. Adequate tools for cleanup of spilled chemicals should be stored on site. Appropriate training shall also be provided to staff.

6.11 Cumulative Impacts

6.11.1 Consideration of Concurrent Projects

Based on the latest design information available, the construction of submarine outfall and seawater intake under this Project would be conducted from early 2018 to mid-2019. As discussed in the previous section, the duration of marine dredging required under this Project would be quite short (around 2 days for submarine outfall at 3,500 m^3/day and around 3 days for seawater intake at 750 m^3/day) and the extent of potential water quality impact is very limited. Significant overlap in impacted area with other projects nearby is not expected. Nevertheless, review of publicly available information was conducted and a number of projects are identified with the Study Area. These projects are summarized below in ***Table 6.24***:

Table 6.24 Nearby Projects Identified

Project	Duration	Location	Major Marine Activity
Project Asia Pacific Gateway – Tseung Kwan O	2014 Q1-Q3	Junk Bay, Eastern Buffer, Southern and Mirs Bay WCZ	Submarine cable installation
Truck Road T2	Late 2015 - Late 2020	Kwun Tong Typhoon Shelter	Construction of submarine tunnel
Backfilling Marine Borrow Areas at East Tung Lung Chau	Oct - Dec 2014	Marine Waters east of Tung Lung Chau	Marine dumping
Cross Bay Link	Jan 2017 - Jul 2020	Junk Bay	Construction of bridge piers
Tseung Kwan O – Lam Tin Tunnel and Associated Works	Feb 2016 - Apr 2020	Junk Bay	Reclamation

PROJECT ASIA PACIFIC GATEWAY – TSEUNG KWAN O

According to project profile of direct-to-permit application DIR-233/2013, this project involves laying of cable in marine waters from Junk Bay, Eastern Buffer, Southern and Mirs Bay WCZ. The marine works would last for around 60 days and is scheduled from Q1 to Q3 of 2014. No overlap in marine construction with works under DIR-233/2013 is expected. No cumulative water quality impact is expected from this project.

TRUNK ROAD T2

Based on the approved EIA of Truck Road T2 (AEIA174/2013), the project is to construct a dual two-lane trunk road of approximately 3 km long with about 2.7 km of the trunk road in form of tunnel between Cha Kwo Ling and South Apron of the former Kai Tak Airport. The project is located at > 6 km from the proposed desalination plant and submarine pipelines. The preliminary construction programme is anticipated between late 2015 and late 2020. According to the approved EIA and the associated environmental permit, non-dredge method using tunnel boring machine would be adopted for the construction of Truck Road T2 and there will be no dredging and reclamation allowed. No cumulative water quality impact is anticipated.

BACKFILLING OF MARINE BURROW AREA AT EAST TUNG LUNG CHAU

Based on our communication with the Fill Management Committee of the Civil Engineering and Development Department, the captioned project is solely used for the disposal of the uncontaminated dredged sediment generated from the formation of new mud pits to the South of The Brothers from October to December of 2014. No overlap in project operation of the captioned project is expected. As such, there will not be cumulative water quality impact from the captioned project.

CROSS BAY LINK

Based on the approved EIA of the captioned project, this project involves the construction of an approximately 1.8 km long dual two-lane road mainly on viaduct with a footpath and a cycle track. The construction of the Cross Bay Link (CBL) is scheduled from January 2017 to July 2020 while the marine dredging and foundation working would be completed in 2018. It is expected that the marine works under the CBL may potentially be conducted concurrently with marine working under this Project. To ensure consistency of modelling results with the approved EIA, the maximum SS elevation predicted at nearby WSRs under the approved EIA has been taken into account in assessing the cumulative water quality impact. Further assessment on the cumulative water quality impact is provided below in *Section 6.11.2*.

TSEUNG KWAN O – LAM TIN TUNNEL AND ASSOCIATED WORKS

Based on the approved EIA of the captioned project, this project involves the construction of a dual two-lane highway connecting TKO at Po Yap Road in the east with Trunk Road T2 in Kai Tak Development in the west and Lei Yue Mun Road Underpass. The project involves a 4.8 km long highway with about 3 km of the highway in the form of a tunnel. The Tseung Kwan O – Lam Tin Tunnel (TKO-LTT) will connect CBL to form a new external road link to meet the anticipated traffic flow in connection with further population intake and development in TKO New Town. The construction of the TKO-LTT and Associated Works is scheduled from February 2016 to April 2020 while the marine dredging and foundation working would be conducted between in May 2018 to August 2018. It is expected that the marine works under the TKO-LTT and Associated Works may potentially be conducted concurrently with marine working under this Project. To ensure consistency of modelling results with the approved EIA, the maximum SS elevation predicted at nearby WSRs under the approved EIA would be taken into account in assessing the cumulative water quality impact. It should be noted that the water quality modelling of the EIAs for the CBL and the TKO-LTT were conducted together and the cumulative impact from both projects would be considered at the same time under this Project. Further assessment on the cumulative water quality impact is provided below in *Section 6.11.2*. The reclamation of TKO-LTT has also been taken into account in both the construction phase and operation phase water quality modelling assessment.

6.11.2 Assessment of Cumulative Impacts

It is expected that the marine construction under the CBL and the TKO-LTT would potentially be conducted within the same time period of the marine dredging under the Project. To ensure conservative and consistent assessment, the predicted maximum SS elevation among all WSRs from the approved EIAs of the captioned projects (i.e. 0.5 mg/L predicted at bottom level of CC2 in wet season) would be taken into consideration. It should be noted that this approach is extremely conservative, since the predicted maximum SS elevation among all WSRs identified under the CBL and the TKO-LTT is used to represent the WSRs which is furthest away from the sediment sources under the two modelling simulations (under the approved EIA of CBL + TKO-LTT and under this Project). Simply adding the two maximum values predicted would very likely be way above the "actual" maximum, even if the marine construction works are indeed conducted concurrently. Similarly, the maximum cumulative sedimentation rate at the WSRs identified under this Project would be estimated based on same approach, by simple addition of maximum sedimentation rate predicted by computational modelling under this Study and the maximum sedimentation rate predicted among all WSRs under the EIA study for the CBL and the TKO-LTT (20 g/m²/day predicted at CC2 and CC3 in wet season). As shown in Appendix 8.2 of the approved CBL EIA, the predicted level of SS elevation and sedimentation rate would be highly localized within the Junk Bay. The level of 0.5 mg/L of SS elevation and 20 g/m²/day are both confined near the marine works area. This means the approach proposed above using simple addition of maximum SS elevation and sediment rate would overestimate the potential cumulative, thus would be conservative. The maximum SS elevation predicted under the two captioned EIAs are provided below in ***Table 6.25***.

Table 6.25 Cumulative SS Elevation at Selected WSRs, under Mitigated Scenario of this Project

WSR (ID)	SS Elevation (mg/L)						Sediment Deposition (g/m²/day)		
	Wet Season			Dry Season			Criteria	Wet Season	Dry Season
	Criteria	Max	Compliance Time %	**Criteria**	Max	Compliance Time %		Max	Max
Fish Culture Zone (Depth-averaged)									
Tung Lung Chau (SR2)	44.87	0.52	100.00%	42.73	0.61	100.00%	-	-	-
Po Toi O (SR27)	46.31	0.50	100.00%	44.63	0.50	100.00%	-	-	-
Coral Communities (Bottom)									
Junk Bay (SR20)	1.74	0.51	100.00%	2.61	0.50	100.00%	100	20.13	20.00
Junk Bay (SR21)	2.77	0.60	100.00%	2.48	0.63	100.00%	100	22.35	21.63
Junk Bay (SR22)	2.77	0.64	100.00%	2.48	0.54	100.00%	100	21.17	20.41
Fat Tong Chau (SR16)	2.06	0.80	100.00%	2.20	1.07	100.00%	100	27.71	24.65
Tai Miu Wan (SR4)	2.46	1.61	100.00%	3.78	0.53	100.00%	100	23.79	20.17
Cape Collinson (SR10)	2.46	0.50	100.00%	3.78	0.50	100.00%	100	20.02	20.02
Cape Collinson (SR11)	2.46	0.50	100.00%	3.78	0.50	100.00%	100	20.01	20.02
Cape Collinson (SR12)	2.46	0.50	100.00%	3.78	0.50	100.00%	100	20.01	20.02
Tung Lung Chau (SR1)	2.08	0.53	100.00%	3.54	0.73	100.00%	100	20.18	21.67
Tung Lung Chau (SR3)	2.46	0.55	100.00%	3.78	0.86	100.00%	100	20.47	23.72
Tung Lung Chau (SR6)	2.03	0.57	100.00%	2.95	0.58	100.00%	100	20.95	20.33
Tung Lung Chau (SR7)	2.03	0.50	100.00%	2.95	0.50	100.00%	100	20.00	20.06
Tung Lung Chau (SR8)	2.03	0.51	100.00%	2.95	0.50	100.00%	100	20.06	20.00
Tung Lung Chau (SR9)	2.08	0.52	100.00%	3.54	0.52	100.00%	100	20.06	20.07

WSR (ID)	SS Elevation (mg/L)						Sediment Deposition ($g/m^2/day$)		
	Wet Season			Dry Season			Criteria	Wet Season	Dry Season
	Criteria	Max	Compliance Time %	Criteria	Max	Compliance Time %		Max	Max
Tai Long Pai (SR32)	2.08	0.51	100.00%	3.54	0.54	100.00%	100	20.04	20.18
D-W (SR33)	2.46	0.50	100.00%	3.78	0.50	100.00%	100	20.00	20.00
D-T (SR34)	2.46	0.50	100.00%	3.78	0.50	100.00%	100	20.00	20.00
D-L (SR35)	2.46	0.60	100.00%	3.78	0.72	100.00%	100	20.71	22.44
Kwun Tsai (SR36)	2.46	0.65	100.00%	3.78	0.65	100.00%	100	22.49	21.23
Tit Cham Chau (SR37)	2.46	1.13	100.00%	3.78	1.43	100.00%	100	24.09	23.32
Gazetted Bathing Beaches (Depth-averaged)									
Big Wave Bay (SR12)	1.54	0.50	100.00%	2.18	0.50	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Shek O (SR15)	1.66	0.50	100.00%	2.15	0.50	100.00%	-	-	-
Rocky Bay (SR14)	1.66	0.50	100.00%	2.15	0.50	100.00%	-	-	-
Coastal Protection Areas (Depth-averaged)									
Clear Water Bay (SR28)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Clear Water Bay (SR29)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Clear Water Bay (SR30)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Clear Water Bay (SR31)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Po Toi O (SR27)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Tai Miu Wan (SR4)	1.54	0.73	100.00%	2.18	0.51	100.00%	-	-	-
Tai Miu Wan (SR5)	1.54	0.50	100.00%	2.18	0.51	100.00%	-	-	-
Cape Collinson (SR10)	1.54	0.50	100.00%	2.18	0.50	100.00%	-	-	-
Cape Collinson (SR11)	1.54	0.50	100.00%	2.18	0.50	100.00%	-	-	-
Big Wave Bay (SR13)	1.66	0.50	100.00%	2.15	0.50	100.00%	-	-	-
Tai Tam (SR25)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Tai Tam (SR26)	1.11	0.50	100.00%	1.61	0.50	100.00%	-	-	-
Seawater Intakes (Mid-depth)									
Tseung Kwan O New Town (SR19)	5.22	0.50	100.00%	5.50	0.50	100.00%	-	-	-
Siu Sai Wan (SR17)	4.76	0.51	100.00%	5.90	0.51	100.00%	-	-	-
Heng Fa Chuen (SR23)	4.76	0.51	100.00%	5.90	0.50	100.00%	-	-	-
Chai Wan Godown (SR16)	1.57	0.56	100.00%	1.23	0.51	100.00%	-	-	-
Pamela Youde Nethersole Eastern Hospital (SR24)	1.57	0.51	100.00%	1.23	0.51	100.00%	-	-	-

As shown in ***Table 6.25***, no exceedance in WQO assessment criteria at all selected WSRs is predicted, with the consideration of cumulative impact from the marine construction of CBL and TKO-LTT. Other WSRs not presented in ***Table 6.25*** are further away from the marine works of CBL and TKO-LTT and are predicted to be even less affected.

In view of the above, it is considered the potential cumulative water quality impacts from other marine construction works within Study Area to be adequately addressed and no unacceptable cumulative water quality impact would be expected.

It is noted that there is no known major discharge from the projects considered above. Road run-off would be expected from the Cross Bay Link and the Lam Tin – Tseung Kwan O Tunnel but appropriate collection system would be in place to avoid direct discharge into marine waters. Cooling water system could be found on the both sides of the Victoria Harbour but cumulative impact is not expected in view of (1) there is no thermal discharge / cooling water discharge from the Project and (2) the limited plume extent for TRC and other constituents as shown in *Annex 6E*. Therefore, no cumulative water quality impact due to other cooling water discharge would be expected.

6.12 Environmental Monitoring and Audit

6.12.1 Construction Phase

Marine water quality monitoring at selected WSRs is recommended for marine dredging at submarine outfall and seawater intake under this Project. Site audit would also be conducted throughout the marine and land-based construction under this Project. In situ testing of TRC should also be conducted for the discharge of chlorinated water for pipeline disinfection to ensure sufficient dechlorination. The marine works contractor is required to complete a silt curtain efficiency test for the combined use of floating silt curtain type and cage type silt curtain for dredging at seawater intake to confirm the silt curtain reduction efficiency assumptions of the assessment.

Details of the environmental monitoring procedures and audit requirements are provided in the standalone EM&A manual.

6.12.2 Operation Phase

To ensure compliance to the effluent standard specified ***Table 6.23*** (or other standard stipulated in the WPCO Discharge Permit), regular monitoring of effluent quality is recommended during normal operation. Furthermore, marine water monitoring at selected nearby WSRs during the first year of project commission are recommended to ensure compliance to WQO or other water quality criteria. Details environmental monitoring procedures and audit requirements are provided in the standalone EM&A manual.

6.13 Conclusions

6.13.1 Construction Phase

Computational modelling has been conducted to predict various potential water quality impacts from the proposed marine dredging operation under this Project, including SS elevation, sedimentation, DO depletion, release of nutrient, heavy metal and trace organic pollutants. Full compliance is predicted at all identified WSRs for all parameters in both seasons, with the exception of exceedances in SS elevation predicted at four coral WSRs including SR4, SR16, SR36 and SR37. With the implementation of silt curtain around grab dredger and reduced dredging rate at seawater intake, the predicted SS elevation at these WSRs would be significantly reduced and would be in compliance to the WQO SS criteria. To ensure environmental compliance, marine water monitoring for the marine dredging works is recommended.

Other potential water quality impacts from marine and land-based construction were also addressed. Appropriate preventive and mitigation measures are recommended to minimize the potential water quality impact from these works. Environmental monitoring and audit is recommended to ensure the proper implementation of these measures.

6.13.2 Operation Phase

The discharge of RO concentrate from the desalination process is the main environmental concern for the Project operation. The potential change in hydrodynamic and water quality from Project operation was assessed in detail using a combination of near field (CORMIX) and far field (Delft3D) modelling tools. The change in salinity, elevation in SS (and sedimentation flux), anti-scalant, TIN and Fe during normal operation, as well as the discharge of TRC and SMBS during bio-growth control works, were all assessed using the near field and far field modelling tools specified above. The effluent plume of the RO concentration is predicted to be highly localized in both seasons. The elevation in salinity and other chemicals are predicted to be diluted soon after leaving the submarine outfall. No observable mixing zone is predicted for most discharge scenarios for most chemicals constituents. Where mixing zone is predicted, it would be closely confined near the submarine outfall and would not encroach to any nearby WSRs. No adverse water quality impact from the discharge of RO concentrate would be expected. To ensure environmental compliance, monitoring of discharge effluent quality and marine water quality at nearby selected WSRs are recommended.

Other potential water quality impact from regular chemical clean, sewage effluent and chemical spillage has been addressed. Appropriate measures are recommended to minimize any potential water quality impact associated with the daily operation of the Project. No adverse water quality impact from the daily operation of the Project is expected.