Appendix 6.1 Calculations for Total Inorganic Nitrogen

No nitrification or denitrification of total inorganic nitrogen (TIN) was assumed for a more conservative approach. The method of calculation of the near field concentrations of TIN is the same as that used in the approved EIA report for Outlying Islands Sewerage Stage 1[1] (OISS) and Development of the Integrated Waste Management Facilities Phase 1[2] (IWMF) for suspended sediment plumes.

In this method, a simple model is used to calculate the depth averaged TIN concentrations along the centreline of a plume by solving the advection-diffusion equation for a continuous line source[3]. This model is considered appropriate for the calculation of TIN from the proposed storm discharge because the equation is based on a continuous line source of sediment, which is a reasonable approximation of the TIN release due to stormwater discharge, assuming a similar property between suspended sediments and TIN.

The equation used in this model is appropriate for areas where the tidal current is unidirectional for each phase of the tidal cycle (i.e. the ebb and flood phases), which is the case at the Project area where the tidal current is also uni-directional for each phase of the tidal cycle.

The near field concentration formula is as follows:

$$C(x) = \frac{q}{(D \times x \times \omega \times \sqrt{\pi})}$$

where:
C(x) = concentration at distance x from the source (mg/L);
q = TIN release rate (kg/s);
D = water depth (5 m);
x = distance from source (m);
w = diffusion velocity (0.01 m/s).

The diffusion velocity represents reductions in the centre-line concentrations due to lateral spreading, the value of 0.01m/s was recommended by Wilson, 1979 and adopted for the EIA reports of OISS and IWMF. q is calculated based on the following formula:

$$q = f \times [TIN]$$

where:
f = discharge flow rate (m^3/hr)
[TIN] = Event mean concentration for storm water of total inorganic nitrogen (TIN)

With reference to Li et al. 2003[4], **Table 1** summarised the event mean concentrations of ammonium and nitrate adopted for calculating the TIN concentration for with and without Project scenarios. Due to the reactive nature of ammonia and nitrite, it has been assumed that the concentration of ammonium accounts for both ammonium and ammonia, and nitrate accounts for both nitrate and nitrite.

Table 1: Event Mean Concentration of Ammonium and Nitrate

Ammonium (mg/L)	Nitrate (mg/L)
4.92	0.57

Source: Table 4, Li et al. 2003

[1] EIA study for Outlying Islands Sewerage Stage 1, Phase II Package J – Sok Kwu Wan Sewage Collection, Treatment & Disposal Facilities, 2003, Drainage Services Department (AEIAR- 075/2003)
[2] EIA study for Development of the Integrated Waste Management Facilities Phase 1, 2011, Environmental Protection Department (AEIAR-163/2012)
[3] R E Wilson, A Model for the Estimation of the Concentrations and Spatial Extent of Suspended Sediment Plumes. Estuarine and Marine Coastal Science (1979), Vol 9, pp 65-78
[4] H.E. Li, J.H.W. Lee, A. Koenig, A.W. Jayawardena, Nutrient Load Estimation of Nonpoint Source Pollution For Hong Kong Region, Diffuse Pollution Conference Dublin 2003

The below formulae summarised the calculations used to derived the TIN concentration.

$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$
$2\ NH_4^+ + 3\ O_2 \rightarrow 2\ NO_2^- + 2\ H_2O + 4\ H^+$
$NH_3 + O_2 \rightarrow NO_2^- + 3H^+ + 2e^-$
$NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-$
$TIN = NO_3 + NO_2 + NH_4 + NH_3$

NH_3 = Ammonia
NH_4 = Ammonium
TIN = Total Inorganic Nitrogen
NO_3 = Nitrate
NO_2 = Nitrite
O = oxygen
H = Hydrogen
E = electron

Table 2 summarised the discharge flow rates and calculated TIN release rates for the with and without Project scenarios.

Table 2: Discharge Flow Rate and TIN Release Rate

	Discharge Flow Rate (m3/hr)	TIN Release Rate (kg/s)
With Project	16,243	0.02477058
Without Project	4,765	0.00726663

As Outfall No. 3 is closest to the Southern Water Control Zone (WCZ) and with a significant increase in stormwater load after commissioning of the Project, the calculated TIN concentrations were based on the different distances from Outfall No. 3 to provide a mixing zone, and the calculated results have been summarised in **Table 3** below.

Table 3: Calculated TIN concentrations

		Calculated TIN Concentrations (mg/L)	
Distance (m)	TIN WQO (mg/L)	With Project	Without Project
1	0.4	2.80E-01	8.20E-02
5	0.4	5.59E-02	1.64E-02
10	0.4	2.80E-02	8.20E-03
50	0.4	5.59E-03	1.64E-03
100	0.4	2.80E-03	8.20E-04
150	0.4	1.86E-03	5.47E-04
190*	0.1	1.47E-03	4.32E-04
200	0.1	1.40E-03	4.10E-04

*Direct distance from Outfall No. 3 to Southern WCZ without taking consideration into the land boundary