Appendix F

Water Quality Monitoring

2. WATER QUALITY MONITORING

2.1 INTRODUCTION

The study area and location of the yacht club development is shown in Figure 2.1. The key potential impact identified by this EIA has been the increases in suspended solids within the water column resulting from the construction activities. However, this impact will be confined to the very vicinity of the works area, and far from any sensitive waters. Environmental monitoring will therefore focus on collection and analysis of marine water quality around the work's "mixing zone" to verify the model predictions. The mixing zone represents an area where the works may cause the water quality to deteriorate significantly compared to the baseline conditions.

2.2 SAMPLE LOCATION

Monitoring stations will be located at:

i. The boundary of the mixing zone or area where there is the potential for water quality assessment criteria to be exceeded. The extent of the mixing zones is approximately within 100m of the dredging operations according to the EIA final report. These stations have been termed as the impact monitoring stations and are shown in Figure 2.1. Within the mixing zone there will be six impact monitoring stations; three located for ebb tide monitoring and three for flood tide monitoring.

ii. Areas unaffected by the works; control stations are necessary to compare the water quality from potentially impacted sites with the ambient water quality. Control stations will therefore be used to determine the level for non compliance and should be at locations representative of the project site in its undisturbed condition. Control stations should also be located, as far as is practicable, both upstream and downstream of the works area. Figure 2.1 shows the location of the three control stations which will be used during the course of the impact monitoring. C1 is located in the offshore side of the potential sediment plume and therefore unlikely to be affected by the works. C2 and C3 lie to the southern and northern limits of the plume excursion and will be used on the flood and ebb tide respectively.

Measurements shall be taken at 3 water depths, namely, 1m below water surface, mid-depth and 1m above sea bed, except where the water depth less than 6m, the mid-depth station may be omitted. Should the water depth be less than 3m, only the mid-depth station will be monitored. Approval of these monitoring stations shall be obtained from EPD prior to commencement of the monitoring programme.

2.3 BASELINE MONITORING PROGRAMME

The aim of the data set is to establish the suitability of the selected control and impact monitoring stations and to also determine a typical background level at the SRs.

2.3.1 Baseline monitoring at Control and Impact Stations

To determine the suitability of the control stations and impact monitoring stations a simple statistical test (to be undertaken by the ET) is required to test the following hypothesis,

"*prior to commencement of work the water quality at the control station is not significantly different to that at the impact monitoring stations.*"

Data will therefore be collected at the following stations:

- Flood Tide: C1, C2, I4, I5 and I6
- Ebb tide: C1, C3, I1, I2 and I3

Prior to any sampling it will be ensured that there are no marine construction activities in the vicinity of the stations.

Because the data will be used in a statistical test, in order to obtain confidence in the data and have sufficient data on which to perform the test, duplicates of these samples are required. Samples will therefore be collected in duplicate at three depths (surface, middle and bottom), at four tidal states: high water, low water, mean water flood and mean water ebb on 4 alternative tides spreading over 4 days (1st tide on 2 days and 2nd tide on another 2 days) per week for two weeks prior to the commencement of the works .

Parameters to be measured at these stations during the baseline monitoring are:

- Suspended Solids (SS, measured in mg/l)
- Turbidity (Tby, expressed as NTU)
- Dissolved Oxygen (DO, measured in mg/l and % saturation)

The suspended solids data will be used to calibrate the turbidity so that future monitoring at the boundary of the mixing zone can largely focus on collection of field data so that instantaneous assessments of impacts can be made rather than waiting for laboratory analytical data. On each day of the compliance monitoring the calibration will be checked through the collection of 2 samples for suspended solids analysis.

2.4 COMPLIANCE MONITORING

Monitoring should be undertaken three times a week throughout the works period and for two weeks after completion of dredging. However, due to the need for a flexible programme, the monitoring will be subject to a constant review. Table 2.1 shows the parameters and locations to be monitored during the compliance monitoring at the control and impact stations.

Field data and analytical results will be recorded on a field record sheet as shown in Appendix B1. Non compliance will be recorded on a notification form shown in Appendix B2.

Table 2.1 Control Stations and Impact Stations

Parameters:	Location[1]	Frequency
Turbidity	Flood tide (mid flood) C1, C2, I4, I5 & I6 Ebb tide (mid ebb) C1, C3, I1, I2 & I3	Three times a week (or daily at the impact monitoring stations if additional monitoring during non-compliance is required). All samples to be duplicated.
Dissolved Oxygen	Flood tide (mid flood) C1, C2, I4, I5 & I6 Ebb tide (mid ebb) C1, C3, I1, I2 & I3	Three times a week (or daily at the impact monitoring stations if additional monitoring during non-compliance is required). All samples to be duplicated.
Suspended Solids	Flood tide (mid flood) C1, C2, I4, I5 & I6 Ebb tide (mid ebb) C1, C3, I1, I2 & I3	Three times a week. All samples to be duplicated.

1 All samples to be collected from surface, middle and bottom layers of water column

2 See Table 2.3 to determine whether additional monitoring is required. This should be undertaken at the request of the Engineer. If turbidity and not SS is measured during the additional monitoring then it must be correlated using the baseline data for correlation to SS and the values of this additional monitoring converted to SS. Alternatively, SS can be measured rather than DO/Turbidity for this additional monitoring but SS data must be made available from the laboratory within 24 hours.

2.4.1 Statistical Analysis of data

A simple statistical analysis (e.g. Student's t-test) shall be undertaken by the ET, to check whether there is a significant difference between the mean of three days impact monitoring stations data and the mean of three days control station monitoring data. The same test will be performed to determine whether there is a significant difference between the models predicted increases in SS in the mixing zone and actual increases recorded in SS. Finally, at the end of the works period, the two weeks post project monitoring should seek to determine whether there is a) a significant difference between the control and impact monitoring stations and b) the baseline data set and the two week post-project data set.

2.5 MONITORING EQUIPMENT

2.5.1 Dissolved oxygen and temperature measuring equipment

i. The instrument should be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and use a DC power source. It should be capable of measuring:-

- a dissolved oxygen level in the range of 0-20 mg/l and 0-200% saturation
- a temperature of 0-45 degree Celsius

ii. It should have a membrane electrode with automatic temperature compensation complete with a cable. Sufficient stocks of spare electrodes and cables should be available for replacement where necessary. (e.g. YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).

2.5.2 Turbidity Measurement Instrument

The instrument should be a portable, weatherproof turbidity-measuring instrument complete with comprehensive operation manual. The equipment should use a DC power source. It should have a photoelectric sensor capable of measuring turbidity between 0-1000 NTU and be complete with a cable (e.g. Hach model 2100P or an approved similar instrument).

2.5.3 Suspended Solids

i. A water sampler comprises a transparent PVC cylinder, with a capacity of not less than 2 litres, and can be effectively sealed with latex cups at both ends. The sampler should have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth (e.g. Kahlsico Water Sampler or an approved similar instrument).

ii. Water samples for suspended solids measurement should be collected in high density polythene bottles, packed in ice (cooled to 4°C without being frozen), and delivered to a HOKLAS laboratory as soon as possible after collection for analysis.

2.5.4 Locating the monitoring site

A hand-held digital Global Positioning System (GPS) or other equivalent instrument of similar accuracy shall be provided and used during monitoring to ensure the monitoring vessel is at the correct location before taking measurements.

All in-situ monitoring instrument shall be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use, and subsequently re-calibrated at 3 monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes should be checked with certified standard solutions before each use. Wet bulb calibration for a DO meter shall be carried out before measurement at each monitoring location.

For the on site calibration of field equipment by the ET, the BS 127:1993, "Guide to Field and on-site test methods for the analysis of waters" should be observed.

Sufficient stocks of spare parts should be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when some equipment some equipment is under maintenance, calibration, etc.

2.6 LABORATORY MEASUREMENT / ANALYSIS

Analysis of suspended solids shall be carried out in a HOKLAS or other international accredited laboratory. Water samples of about 500 ml shall be collected at the monitoring stations for carrying out the laboratory SS determination. The SS determination work shall start within 24 hours after collection of the water samples. The SS determination shall follow APHA 17ed 2540D or equivalent methods subject to approval of DEP.

If a site laboratory is set up or a non-HOKLAS and non-international accredited laboratory is hired for carrying out the laboratory analysis, the laboratory equipment, analytical procedures, and quality control shall be approved by EPD. The ET shall provide the ER with one copy of the relevant chapters of the "Standard Methods for the Examination of Water and Wastewater" updated edition and any other relevant document for his reference.

2.7 EVENT AND ACTION PLAN FOR WATER QUALITY

2.7.1 Action Levels

The action levels are set out in Table 2.2 below.

Table 2.2 Action Levels for Water Quality

Parameters	Action
Suspended Solids (Depth Averaged)[1]	Depth average of the pooled data for the impact monitoring stations for three days is significantly greater ($p<0.05$) than 30% above the control.
DO[2] in mg/l (Surface Middle & Bottom)	*Surface & Middle* 1%-ile of baseline data for surface and middle layer, or midway between 5%-ile of baseline data and limit levels. *Bottom* 1%-ile of baseline data for bottom layer, or midway between 5%-ile of baseline data and limit levels
Turbidity in NTU (Depth-Averaged)	Depth average of the pooled data for the impact monitoring stations for three days is significantly greater ($p<0.05$) than 30% above the control on three consecutive monitoring occasions.

1 "depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.

2-For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.

2.7.2 Event Contingency Plans

The Event Contingency Plans are presented in Table 2.3 below.

In the event of a non compliance. i.e. exceedances at the impact monitoring stations outside the predicted impact area (i.e. 100m of the dredging operations) on

three consecutive days, then the ET leader should be notified immediately. The ET leader should, in consultation with EPD, IC(E) and ER, recommend any necessary mitigation measures or alternative monitoring stations. In the absence of alternatives it will be necessary to reduce the number of dredging cycles.

Table 2.3 Event and Action Plan for Water Quality

Action/ Limit Level	ET Leader/ET	IC(E)	ER	CONTRACTOR
Action level being exceeded on two consecutive sampling days.	1. Repeat in-situ measurement on next day of exceedance to confirm findings; 2. Identify source(s) of impact; 3. Inform IC(E), Contractor and ER; 4. Check monitoring data , all plant, equipment and contractor's working methods;	1. Check monitoring data submitted by ET and Contractor's working methods;	1. Confirm receipt of notification of failure in writing; 2. Notify Contractor.	1. Inform the ER and confirm notification of the non-compliance in writing; 2. Rectify any unacceptable practice; 3. Amend working methods if appropriate.
Action Level exceeded on three consecutive days at Impact monitoring stations	1. Repeat measurement on next day of exceedance to confirm findings; 2. Identify source(s) of impact; 3. Inform IC(E), Contractor, ER and EPD; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IC(E), ER and Contractor 6. Ensure mitigation measures are implemented;	1. Check monitoring data submitted by ET and Contractor's working method; 2. Discuss with ET and Contractor possible remedial actions; 3. Review the proposed mitigation measures submitted by Contractor and advise the ER accordingly; 4. Supervise the implementation of mitigation measures.	1. Discuss with IC(E) on the proposed mitigation measures; 2. Ensure mitigation measures are properly implemented; 3. Assess the effectiveness of the implemented mitigation measures.	1. Inform the Engineer and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment and consider changes of working methods; 4. Submit proposal of mitigation measures to ER within 3 working days of notification and discuss with ET, IC(E) and ER; 5. Implement the agreed mitigation measures.

1 Reduction in dredging cycles should be made in the absence of alternative or further additional mitigation measures.

2 Engineer may wish to increase measurements of Turbidity and Dissolved Oxygen at the Impact and Monitoring Stations to enable quicker resumption of maximum number of dredging cycles per day.