Appendix A

Water Quality Standards and Monitoring

Table A.1 : Water Quality Objectives for the NWWCZ

Water Quality Parameters	Water Quality Objectives (WQOs)
Aesthetic Appearance	(a) Waste discharges shall cause no objectionable odours or discolouration of the water. (b) Tarry residues, floating wood, articles made zone of glass, plastic, rubber or of any other substances should be absent. (c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam. (d) There should be no recognisable sewage-derived debris. (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. (f) Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.
Dissolved Oxygen (mg/)	> 4mg/
PH	6.5 – 8.5
Temperature (°C)	< 2°C change of natural daily temperature range
Salinity	< 10% variation of the natural ambient salinity level
Suspended Solid (mg/)	(a) < 30% raise of natural ambient level; or (b) Give rise to accumulation of suspended solids which may adversely affect aquatic communities
Unionised Ammoniacal Nitrogen	< 0.021mg/
Total Inorganic Nitrogen (TIN)	< 0.50mg/
Nutrients	(a) Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants; or (b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed).
5-day Chemical Oxygen Demand (BOD_5)	< 3mg/ BOD_5
Chemical Oxygen Demand (COD)	< 15mg/ COD
Toxins	(a) Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other. (b) Waste discharges shall not cause a risk to any beneficial use of the aquatic environment.

Source : Table 1.1, *Marine Water Quality in Hong Kong in 2003*, EPD, November 2004

Table A.2 : Compliance with WQOs at EPD's Marine Water Quality Monitoring Stations

Monitoring Station	Depth Averaged Annual Arithmetic Means				
	Dissolved Oxygen (mg/)	pH	Unionised Ammoniacal Nitrogen (mg/)	Total Inorganic Nitrogen (mg/)	5-day Biochemical Oxygen Demand (mg/)
2003 Results[1]					
NM1 Lantau Island (North)	5.5 ✓	8.1 ✓	0.004 ✓	0.35 ✓	0.9 ✓
NM2 Pearl Island	5.8 ✓	8.1 ✓	0.005 ✓	0.48 ✓	1.0 ✓
NM3 Pillar Point	5.6 ✓	8.1 ✓	0.005 ✓	0.44 ✓	1.0 ✓
NM5 Urmston Road	5.6 ✓	8.1 ✓	0.006 ✓	**0.53 X**[a]	1.1 ✓
NM6 CLK (North)	5.7 ✓	8.1 ✓	0.005 ✓	**0.57 X**[b]	1.2 ✓
NM8 CLK (West)	5.9 ✓	8.2 ✓	0.002 ✓	0.42 ✓	1.0 ✓
2002 Results[2]					
NM1 Lantau Island (North)	5.9 ✓	7.9 ✓	0.004 ✓	0.34 ✓	0.7 ✓
NM2 Pearl Island	6.5 ✓	8.0 ✓	0.004 ✓	0.42 ✓	0.9 ✓
NM3 Pillar Point	6.2 ✓	8.0 ✓	0.004 ✓	0.41 ✓	0.9 ✓
NM5 Urmston Road	5.9 ✓	8.0 ✓	0.006 ✓	**0.56 X**[c]	0.9 ✓
NM6 CLK (North)	6.8 ✓	8.1 ✓	0.004 ✓	0.50 ✓	1.2 ✓
NM8 CLK (West)	6.8 ✓	8.1 ✓	0.002 ✓	0.32 ✓	1.1 ✓
2001 Results[3]					
NM1 Lantau Island (North)	5.8 ✓	8.1 ✓	0.006 ✓	0.39 ✓	0.6 ✓
NM2 Pearl Island	5.7 ✓	8.1 ✓	0.006 ✓	0.45 ✓	0.5 ✓
NM3 Pillar Point	5.7 ✓	8.1 ✓	0.007 ✓	0.45 ✓	0.6 ✓
NM5 Urmston Road	5.7 ✓	8.1 ✓	0.008 ✓	**0.56 X**[d]	0.8 ✓
NM6 CLK (North)	6.2 ✓	8.1 ✓	0.006 ✓	**0.56 X**[e]	0.7 ✓
NM8 CLK (West)	6.0 ✓	8.1 ✓	0.002 ✓	0.41 ✓	0.6 ✓
2000 Results[4]					
NM1 Lantau Island (North)	5.9 ✓	7.9 ✓	0.004 ✓	0.34 ✓	0.8 ✓
NM2 Pearl Island	5.8 ✓	7.9 ✓	0.004 ✓	0.36 ✓	0.6 ✓
NM3 Pillar Point	5.9 ✓	7.9 ✓	0.004 ✓	0.35 ✓	0.6 ✓
NM5 Urmston Road	6.0 ✓	7.9 ✓	0.005 ✓	**0.51 X**[f]	0.8 ✓
NM6 CLK (North)	6.2 ✓	8.0 ✓	0.004 ✓	0.45 ✓	0.6 ✓
NM8 CLK (West)	6.3 ✓	8.0 ✓	0.002 ✓	0.31 ✓	0.6 ✓

Notes : ✓ Compliance with WQO (see Table A.1)
X Non-compliance with WQO (see Table A.1)

a. Maximum TIN exceedance = 1.00mg/
b. Maximum TIN exceedance = 1.61mg/
c. Maximum TIN exceedance = 0.78mg/
d. Maximum TIN exceedance = 0.93mg/
e. Maximum TIN exceedance = 1.27mg/
f. Maximum TIN exceedance = 0.99mg/

Source :
1. Table 8.1, *Marine Water Quality in Hong Kong in 2003*, EPD, November 2004
2. Table D10, *Marine Water Quality in Hong Kong in 2002*, EPD, November 2003
3. Table D10, *Marine Water Quality in Hong Kong in 2001*, EPD, November 2002
4. Table D10, *Marine Water Quality in Hong Kong in 2000*, EPD, November 2001

Table A.3 : Summary of Water Quality Data from Airport Authority's Non-statutory Marine Environmental Monitoring Programme (Contract 194)

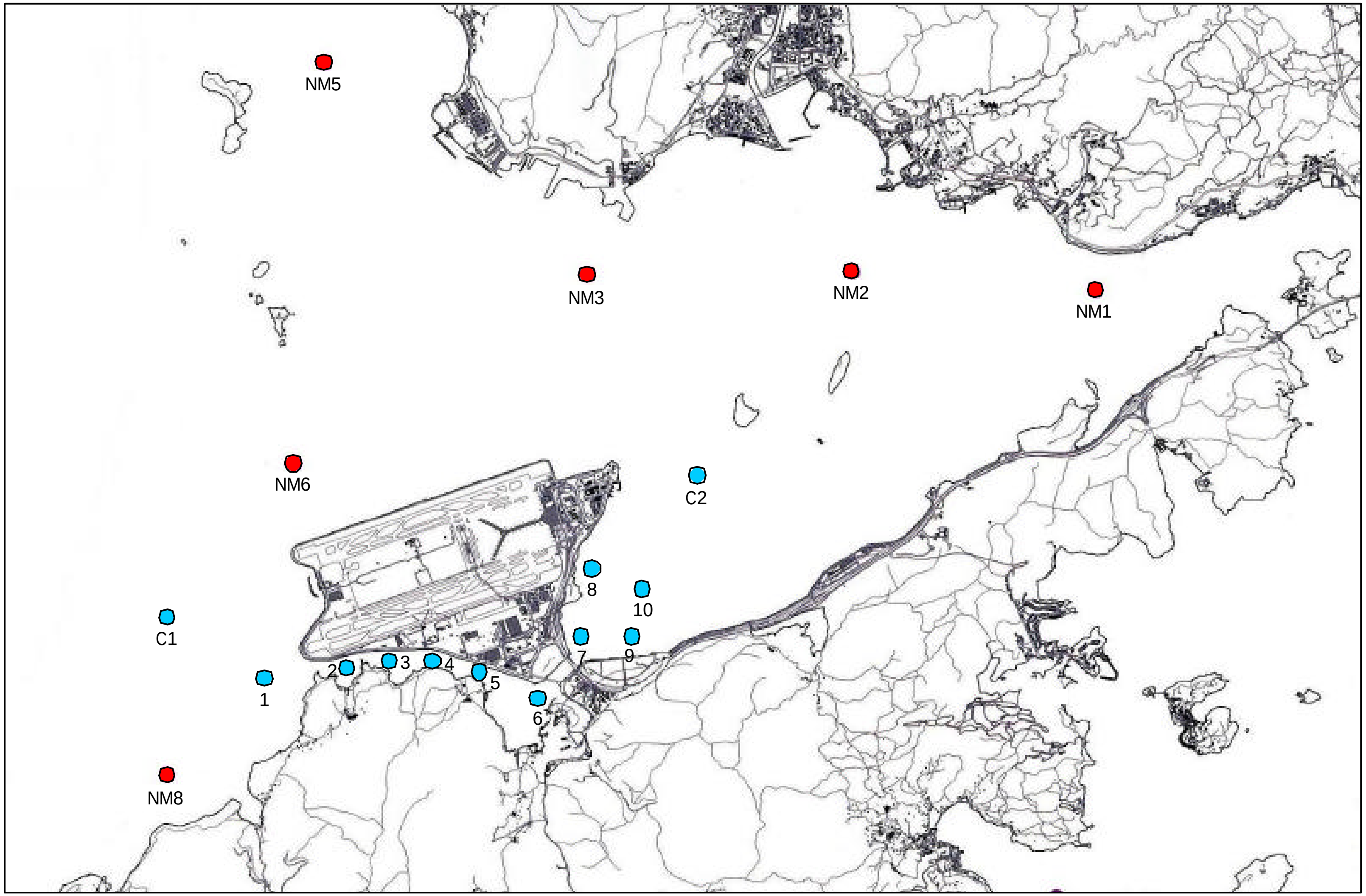
	Item	1	2	3	4	5	6	7	8	9	10	11	12	Yearly Range
	Date	31 Mar 99	30 Apr 99	28 May 99	25 June 99	23 Jul 99	20 Aug 99	24 Sep 99	22 Oct 99	19 Nov 99	17 Dec 99	21 Jan 00	11 Feb 00	
Water Quality Parameters*	Temp (°C)	21.7 (21.1-22.5)	24.7 (24.3-24.9)	26.2 (25.6-26.5)	28.9 (28.2-29.2)	28.9 (27.7-29.9)	29.6 (28.5-30.4)	26.8 (26.3-27.3)	26.3 (26.1-26.5)	22.9 (22.7-23.3)	19.1 (18.8-19.2)	17.0 (16.4-17.4)	17.1 (16.8-17.4)	16.4-30.4
	Salinity (ppt)	33.4 (33.5-34.0)	30.9 (30.0-32.0)	24.8 (21.0-31.0)	14.3 (12.0-16.0)	14.4 (7.8-24.0)	15.0 (8.0-24.0)	28.9 (28.3-29.4)	30.2 (29.2-31.5)	30.4 (30.0-31.9)	30.7 (30.2-31.3)	30.6 (28.9-31.8)	29.5 (28.7-30.4)	7.8-34.0
	Turbidity (NTU)	9.2 (5.2-14.6)	9.0 (3.7-12.2)	11.5 (4.0-18.0)	10.0 (7.2-12.8)	9.8 (7.0-13.0)	10.1 (5.6-13.4)	5.1 (2.8-9.5)	13.0 (8.3-18.0)	7.9 (5.7-12.7)	12.1 (6.0-25.6)	2.2 (0.8-3.3)	4.4 (3.0-6.8)	0.8-25.6
	SS (mg/)	11.5 (7.4-18.0)	14.4 (6.0-24.0)	13.0 (4.3-21.0)	9.0 (6.3-11.0)	10.2 (5.6-16.0)	10.9 (7.7-14.0)	7.2 (3.9-15.0)	19.2 (9.5-32.0)	9.6 (6.0-15.0)	15.0 (8.3-35.0)	5.7 (4.3-6.5)	9.0 (6.7-13.0)	3.9-35.0
	DO (%)	97.3 (92.0-102.0)	101.5 (97.0-109.0)	77.8 (69.0-93.0)	85.8 (71.0-94.0)	103.7 (62.0-160.0)	127.5 (81.0-189.0)	96.3 (92.0-104.0)	93.2 (88.0-98.0)	95.0 (91.0-98.0)	78.5 (72.0-86.0)	96 (87.0-107.0)	100.7 (96.0-107.0)	62.0-189.0
	DO (mg/)	7.0 (6.7-7.5)	7.1 (6.8-7.7)	5.3 (4.7-6.3)	6.1 (5.0-6.7)	7.3 (4.2-11.4)	9.4 (6.2-15.8)	6.5 (5.8-7.0)	6.3 (6.0-6.6)	6.8 (6.5-7.0)	6.1 (5.7-6.8)	7.7 (6.7-8.8)	8.1 (7.7-9.0)	4.2-15.8
	TRC (mg/)	<0.1 (<0.1-<0.1)	<0.1 (<0.1-<0.1)	<0.1 (<0.1-<0.1)	0.02 (<0.01-0.04)	<0.1 (<0.1-<0.1)	0.03 (0.01-0.04)	0.02 (<0.01-0.02)	0.03 (<0.01-0.06)	0.01 (<0.01-0.02)	0.02 (<0.01-0.03)	<0.01 (<0.01-0.02)	<0.01 (<0.01-0.02)	<0.01-0.06
	BOD (mg/)	1.6 (<2.0-2.4)	1.6 (<2.0-2.7)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	3.2 (<2.0-5.2)	3.4 (<2.0-11.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-<2.0)	<2.0 (<2.0-3.4)	<0.2-11.0
	TKN	0.2 (0.18-0.27)	0.2 (0.1-0.2)	0.2 (0.1-0.3)	0.2 (0.18-0.28)	0.4 (0.22-0.68)	0.3 (0.07-1.0)	0.2 (0.15-0.31)	0.1 (0.06-0.16)	0.37 (0.2-1.4)	0.2 (0.11-0.23)	0.23 (0.19-0.30)	0.3 (0.17-0.73)	0.06-1.40
Sediment Quality Parameters*	Cadmium (mg/kg)	0.11 (0.03-0.24)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.14 (0.11-0.17)	n/a	0.03-0.24
	Chromium (mg/kg)	32.4 (16.0-41.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	29.7 (23.0-38.0)	n/a	16.0-41.0
	Copper (mg/kg)	28.4 (16.0-40.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	25.1 (12.0-37.0)	n/a	12.0-40.0
	Lead (mg/kg)	39.9 (26.0-52.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	39.0 (25.0-49.0)	n/a	25.0-52.0
	Mercury (mg/kg)	0.03 (0.03-0.03)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.03 (0.03-0.03	n/a	0.03-0.03
	Nickel (mg/kg)	37.9 (10.0-189.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	20.9 (16.0-27.0)	n/a	10.0-189.0
	Silver (mg/kg)	0.5 (0.5-0.5)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.5 (0.5-0.5)	n/a	0.5-0.5
	Zinc (mg/kg)	101.8 (63.0-130.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	103.3 (76.0-130.0)	n/a	63.0-130.0
	Arsenic (mg/kg)	12.8 (6.0-18.0)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	14.4 (10.0-19.0)	n/a	6.0-19.0
	p,p'-DDE (mg/kg)	<0.05 (<0.05)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.05 (<0.05)	n/a	0.03-0.03
	p,p'-DDT (mg/kg)	<0.05 (<0.05)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	<0.05 (<0.05)	n/a	0.03-0.03
	Total PCBs (mg/kg)	0.5 (0.5-0.5)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	0.5 (0.5-0.5)	n/a	0.5-0.5

Table A.4 : Summary of Water Quality Data from Airport Authority's Non-statutory Marine Environmental Monitoring Programme (Contract M829)

	Item	1	2	3	4	5	6	7	8
Survey Details	Date	13 Nov 02	13 Jan 03	17 Mar 03	12 May 03	12 June 03	16 July 03	11 Aug 03	23 Oct 03
	Weather Conditions	Sunny, moderate northeast winds	Sunny, hazy, light southeast winds	Sunny, good conditions	Sunny	Cloudy with rain and sunny intervals	Sunny with light wind	Sunny and dry	Sunny and dry
	Air Temp (°C)	23	19	26	27	27	32.3	32.0	dtbc
	High Tide (mPD)	1.8	1.4	2.2	1.9	2.1	2.4	2.5	n/a
	Low Tide (mPD)	1.0	1.0	0.4	1.0	0.7	-0.12	0.1	n/a
Water Quality Parameters*	Temp (°C)	23.6 (23.3-23.9)	17.7 (17.4-18.1)	20.7 (20.1-21.5)	25.9 (25.5-26.3)	27.4 (27.2-27.6)	30.0 (28.7-30.9)	29.9 (28.9-30.9)	26.2 (25.8-26.8)
	Salinity (ppt)	31.4 (30.6-32.2)	28.9 (30.6-32.2)	31.7 (31.3-32.2)	26.9 (24.8-29.5)	18.3 (13.3-25.0)	16.6 (15.3-18.1)	21.3 (19.4-23.4)	31.9 31.2-32.5
	Turbidity (NTU)	10.5 (6.9-832.4)	7.1 (4.4-14.5)	13.0 (5.5-18.1)	8.2 (3.4-24.4)	21.0 (5.1-48.6)	31.0 (16.5-76.4)	20.0 (12.1-39.7)	n/a
	SS (mg L^{-1})	14 (6-40)	13 (10-25)	14.1 (7.0-23.0)	14.9 (6.0-29.0)	35.7 (8.0-94.0)	30.6 (5.0 – 131.0)	20.6 (5.0-77.0)	n/a
	DO (%)	87.5 (85.2-90.7)	117.6 (109.8-126.7)	94.1 (89.3-98.5)	108.0 (78.4-127.4)	71.0 (55.4-80.2)	83.5 (61.7-98.8)	81.3 (62.7-103.3)	n/a
	DO (mg L^{-1})	6.2 (6.1-6.4)	9.4 (8.8-10.1)	7.0 (6.7-7.3)	7.5 (5.5-8.9)	5.1 (3.8-5.9)	5.8 (4.3-6.7)	5.6 (4.3-7.0)	n/a
	TRC (mg L^{-1})	0.03 (0.01-0.05)	0.04 (0.03-0.08)	0.10 (0.06-0.17)	0.10 (0.03-0.19)	0.14 (0.05-0.25)	0.14 (0.03-0.60)	0.03 (0.01-0.11)	n/a
	BOD (mg L^{-1})	<2 (<2)	2 (<2-3)	<2 (<2)	<2 (<2)	<2 (<2)	<2 (<2)	<2 (<2)	n/a
	TKN	0.4 (0.3-0.6)	0.5 (0.4-0.6)	0.6 (0.5-0.7)	0.3 (0.3-0.5)	0.3 (0.2-0.4)	0.3 (0.2-0.3)	0.2 (0.1-0.3)	n/a
Sediment Quality Parameters*	Cadmium (mg/kg)	n/a	n/a	n/a	n/a	0.2 (0.13-0.29)	n/a	n/a	n/a
	Chromium (mg/kg)	n/a	n/a	n/a	n/a	45.8 (29-53)	n/a	n/a	n/a
	Copper (mg/kg)	n/a	n/a	n/a	n/a	33.2 (22-41)	n/a	n/a	n/a
	Lead (mg/kg)	n/a	n/a	n/a	n/a	44.5 (32-53)	n/a	n/a	n/a
	Mercury (mg/kg)	n/a	n/a	n/a	n/a	0.1 (0.1-0.21)	n/a	n/a	n/a
	Nickel (mg/kg)	n/a	n/a	n/a	n/a	30.3 (20-36)	n/a	n/a	n/a
	Silver (mg/kg)	n/a	n/a	n/a	n/a	<1 (<1)	n/a	n/a	n/a
	Zinc (mg/kg)	n/a	n/a	n/a	n/a	127.3 (91-157)	n/a	n/a	n/a
	Arsenic (mg/kg)	n/a	n/a	n/a	n/a	18.3 (10.9-24.7)	n/a	n/a	n/a
	p,p' -DDE (mg/kg)	n/a	n/a	n/a	n/a	<0.05 (<0.05)	n/a	n/a	n/a
	p,p' -DDT (mg/kg)	n/a	n/a	n/a	n/a	<0.2 (<0.2)	n/a	n/a	n/a
	Total PCBs (mg/kg)	n/a	n/a	n/a	n/a	0.1 (<0.1-0.4)	n/a	n/a	n/a

Notes : * Data are presented as mean and range (in brackets
n/a not applicable
dtbc data to be collected.

Figure A.1 : Location of Water Quality Monitoring Stations in the NWWCZ



Note : EPD marine water quality monitoring locations are designated NM1, NM2, NM3, NM5, NM6 and NM8
Location of Airport Authority's non-statutory marine environmental monitoring programme is indicated by

Appendix B

Outline Turfgrass Management Plan

B. OUTLINE TURFGRASS MANAGEMENT PLAN

B.1 General

B.1.1 It is proposed to use *Paspalum* as the predominant turfgrass species. *Paspalum* is a highly salt tolerant grass with a reduced need for fertilisers and reduced susceptibility to pests, hence requiring less fertiliser and pesticides. *Paspalum* has been used on two other golf courses in Hong Kong (Shek O Country Club and OGC Golf City, Kai Tak) and at two golf centres in Shenzhen (Sand River Golf Club and Shenzhen Golf Club). It has proved to be both very playable and also environmentally friendly.

B.1.2 The use of *Paspalum* will enable saline water to be used for irrigation, thus avid use of precious fresh water, and also enhancing weed control (and reducing herbicide requirements) since most weeds do not tolerate saline water.

B.1.3 A Summary of the maintenance practices for *Paspalum* is shown in Table B.1, below. The Contractor should modify this Turfgrass Management Plan (TMP) to take into account his detailed design of the golf course, and any particular requirement of a particular *Paspalum* variant (e.g. SeaIsle2000, SeaIsle1, etc.).

Table B.1 : Summary of Cultural/Management Practices Used on *Paspalum* Turf

Activities	**Greens**		**Tees & Fairways**		**Roughs**	
	Winter	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
Mowing height/mm	4	4	14	12	50	50
Cutting Freq/week	4	6	2	4	monthly	fortnightly
Verti cutting/month	1	2		2		
Topdressing/month	1	2	1	1		
Slicing		2	1	2		2
Coring		1		2		
Irrigation/week	3	2	3	1		

B.2 Fertiliser Requirements for Establishment

B.2.1 It is proposed that organic nutrients will be used in preference to artificial chemical fertilisers as far as possible to avoid leaching Total Inorganic Nitrogen (TIN), which is of concern in the waters surrounding the Airport Island – organic nutrients do not contain TIN. There are a number of organic nutrients available as fertilisers in Hong Kong and readily supplied locally by wholesalers/dealers.

B.2.2 An on-site composting facility will be created to allow leaves, grass clippings, etc. that are generated by course maintenance to be composted and returned to the course as organic nutrients, further increasing the overall sustainability of the course.

Objectives

B.2.3 The objective of the TMP is to minimise applications of fertiliser as far as possible. At certain times of a year, nitrogenous fertilisers will be applied to a programme suited to the grasses. Nitrogen and potassium will be applied at a ratio of 1:1 or 1:2. Iron applications will also be made since this will increase chlorophyll content and also harden plant cells increasing resistance to trampling. Micro nutrients will only be applied if soil test results indicate deficiencies. None of the nitrogen, phosphate, potassium (N•P•K) based fertilisers will contain trace elements as this can lead to an imbalance in nutrients.

B.2.4 *Paspalum* grass requires its own specialized management techniques. Healthier growth rates are achieved when the grass is not over fertilized or over watered. A balanced fertiliser and watering programme would allow the grass to stand up to wear and develop disease resistance.

Establishment

Table B.2 : Summary of Fertiliser Requirements for Establishing *Paspalum* Turf

Weeks	Product Applied*	Rate (Kg/ha)	Kg/N/ha Applied
1	18•10•9	275	50
2	3•1.6•1.6	1,000	30
3	18•10•9	275	50
4	19•0•16	260	50
5	3•1.6•1.6	1,000	30
6	19•0•16	130	25

Note : * Includes organic fertilisers with equivalent N•P•K ratio

B.3 Fertiliser Requirements for Maintenance

Nutrient Status

B.3.1 Nutrient status will be monitored every 6 months of the year through the aid of soil and leaf tissue tests. This helps integrate the nutritional programmes for the grass with the nutrient requirements found to be necessary through the laboratory tests. Tests help determine the optimum nutrient provisions for turf grass. To help maintain an even balance of nutrient supply that is not greatly affected by environmental conditions, slow release and organic fertilisers are used. This gradual slow release action helps to minimise the amount of nitrate leached from the soil.

B.3.2 As a general rule, high nitrate fertilisers, such as those mixed in liquid fertiliser form which are prone to leaching are not used. The only area where this form of fertiliser will be used is the greens. However, the quantities of actual nitrogen (N) used when applying this form of nutrition to greens are extremely low e.g. 10kg/ha and significant leaching is not lkely because of rapid foliar uptake. Such applications will not be made if heavy rain is forecast so as to further minimise the chance of any significant nitrogen runoff.

Nitrogen

B.3.3 The nitrogen source used should be in slow release or organic form. The conjugated forms of urea that will be used are methyl urea and polymer sulphur coated urea. With the correct management practices and the use of slow release and organic fertilisers, losses of nitrogenous fertiliser will be minimal. Only mini pill fertilisers will be used as this will also minimise runoff as the fertiliser granules become fixed within the turf canopy.

Phosphorous

B.3.4 Turfgrass does not require large amounts of phosphorous (P) after establishment. This is incorporated into the fertiliser program through an N•P•K blended fertiliser. The phosphorous source will be derived from mono ammonium phosphate after establishment. Before the planting of any grass, phosphorous should be applied at 30kg/ha. As phosphorous will only be applied in small quantities during regular maintenance, the chance of any significant runoff following application is small. Runoff can be controlled by irrigation practices and understanding rain patterns.

Potassium

B.3.5 Potassium (K) is the third most important element for turfgrass. Potassium is important in resistance to disease, drought, heat stress, cold and wear. Losses of potassium into the water system occur under similar conditions to that of nitrogen. Potassium will be applied in conjunction with nitrogen (N•K) at a 1:1 and 1:2 ratio over a monthly cycle. The potassium source is most likely to be derived from potassium sulphate or potassium nitrate.

Micro Nutrients

B.3.6 Micro nutrient requirements for elements such as magnesium (Mg), boron (B) and calcium (Ca) are determined by soil tests. Iron will be applied according to a plan involving six applications per year on tees, greens and fairways. This is necessary for the reasons stated above.

B.3.7 Sufficient sulphur is generally applied, when potassium fertiliser such as potassium sulphate is used as the major source of potassium, therefore avoiding the need for sulphur supplements. Turf Managers consider sulphur to be the most important micro element as it generates strong and hardy plants cells as well as providing fungal control. Calcium and magnesium levels will need to be monitored through soil testing because the sands in Hong Kong easily become deficient of these two elements.

Estimated Fertiliser Usage

B.3.8 It is not possible to state the precise amount of fertiliser which will be used, especially bearing in mind the changing weather and soil conditions. The following serves as a guide to applications, and is summarised in Table B.3. The winter months are November to February (4 months) and the summer months are March to October, as shown on Figure 2.1.

Table B.3 : Summary of Fertiliser Requirements for Established Turf

Location	Period	Product	Rate (kg/ha/app)	No. Applications	Total kgN / ha Applied
Greens	Winter	14•0•26 4•2•8 Ferrous Sulphate	408 500 30	4 3 4	57 20 30*
	Summer	14•0•26 19•2•19	250 184	6 6	35 35
Fairways and Tees	Winter	5•2•10 Ferrous Sulphate	285 30	2 4	14 30*
	Summer	19•0•16	260	4	50
Roughs	Summer	16•0•16	187	1	30

Note : * 30kg/ha applies to S only

Greens

B.3.9 During the winter months, the greens will be fertilized at 4-week intervals. During this period 14•0•26 will be used. This has a high potassium ratio to help protect against cold stress. The nitrogen form is slow release, therefore creating an even release of nitrogen over a long period. Every 4 weeks 14•0•26 will be applied at a rate of 408kg/ha to generate 57kgN/ha per application. This will be supplemented by 3 applications of 4•2•8 fertiliser at a rate of 500kg/ha. This will generate 20kgN/ha per application. Phosphorous will be applied in trace quantities with 4•2•8. Ferrous sulphate will be applied on a 4 week programme at a rate of 30kg/ha.

B.3.10 During the summer months, fertiliser applications will be made at 3-week intervals. 14•0•26 in conjunction with 19•2•19 will be applied alternately. Both fertilisers will be used to achieve 35kgN/ha. Phosphorous will be applied in trace quantities with 19•2•19. Fertilisers with higher phosphorous quantities (such as 19•25•5) will only be applied in response to deficiencies detected in soil tests.

Fairways & Tees

B.3.11 During the winter months, two applications of 5•2•10 will be applied at a rate of 14kgN/ha. Ferrous sulphate will be applied to fairways at a rate of 30kg/ha at 28-day intervals.

B.3.12 During the summer months, Lesco 19•0•16 will be applied at 260kg/ha on 56-day cycle (every 8 weeks) to supply 50kgN/ha. Minimal phosphorous will be required for maintenance of turf on fairways and tees and it will only be applied in response to soil test results. However, total phosphorous application should not exceed 100 kg/year. Ferrous sulphate will be applied to fairways at a rate of 30kg/ha at 28-day intervals.

Rough Areas

B.3.13 Rough areas form an integral part of the facility design strategy. Roughs that come into play on the Golf Facility are fertilized on an as needed basis. A fertiliser such as 16•0•16 with 50% of the nitrogen source in a slow release form will be used. Before this is applied all rough areas will be sliced to ensure maximum penetration of the nutrients into the soil and therefore reducing potential nutrient runoff.

B.4 Pesticide Requirements

B.4.1 It is proposed to follow the Agriculture, Fisheries and Conservation Department (AFCD) Integrated Pest Management (IPM) approach I in order to minimise the amounts of pesticides needed through cultural, biological and chemical means of control. Any use of chemical pesticides will be strictly in accordance with AFCD's *Code of Practice for the Safe and Efficient use of Pesticides on Sports Turf* (1996) and manufacturer's recommendations and a log will be kept of all applications.

B.4.2 It is also proposed that biological pest control will be used in preference to artificial chemical pesticides as far as possible. AFCD have registered a number of biological organisms for use in Hong Kong, and it is proposed that these form part of the IPM. Biological pest control uses naturally occurring organisms and so avoid problems associated with artificial chemical pesticides, which can bio-accumulate within the ecosystem. Biological pest control is non-toxic and an environmentally safe alternative to artificial chemical pesticides.

Weed Control and Herbicide Requirements

B.4.3 Weed outbreaks should mainly be controlled through cultural mowing practices. 80% of weed species are smothered by the dense *Paspalum* grass covering. The density of the grass is created through a close and frequent mowing schedule.

B.4.4 Mechanical methods of removing turfgrass weeds are used whenever practicable. Broad leaved weeds should be removed mechanically by the facility maintenance staff. The proposed usage of salt water for irrigation purposes will restrict the establishment of weeds.

B.4.5 It is the objective to avoid weeds becoming established through good management and cultural practices and to avoid the use of herbicides, even biological ones, wherever possible.

B.4.6 In this project, as the turfgrass is able to tolerate high salt concentration, sea water will be used as a herbicide on the basis that terrestrial weeds normally do not grow in saltwater or in an environment with high salinity content.

Disease Control and Fungicide

General

B.4.7 *Paspalum* grasses are noted as some of the most disease resistance varieties available that are adaptable to the Hong Kong environment. Hong Kong's weather is conducive to fungal attacks at certain times of the year. Disease prevention through cultural methods and a well-developed maintenance regime will provide conditions which limit grass susceptibility to fungal attack.

B.4.8 The golf course area is a very open with low vegetation and constant air movement. This air movement will reduce the amount of moisture surrounding the leaf surface thereby discouraging dew formation which is one of the major causes of fungal infection. With the U.S.G.A. Golf Green Construction method and free draining sand fairways, the soil profiles are not expected to become saturated. Saturated soil profiles have been proven to contribute to disease outbreaks. Landscaping will be kept low around green areas to reduce shading of the turf, direct sunlight is critical in disease prevention.

B.4.9 Thus three major contributors to turf grass diseases in Hong Kong should be minimised by good design, well ventilated location and direct sunlight. Disease attacks should therefore be minimal and easily contained. Disease resistance can be controlled in most cases through a balanced nutritional programme in association with cultural and irrigation practices and the minimal use of fungicides.

Diseases Found in Hong Kong

B.4.10 The most common fungal pathogens that affect grasses of Hong Kong are *Pythium* (blight) and *Helminthosporium* (leaf spot).

- *Pythium* blight causal agent – *Pythium aphanidermatum/Pythium splendens*. This disease causes most concern to GCS because of the short time span for the disease to reach epidemic proportions. During warm to hot, humid weather, purplish, water soaked spots appear on the grass which later turn tan or brown. In early morning, spots appear dark and if the humidity has been high, white fungal mycelium can be seen on the dead, matted leaves of the spot. Large areas become blighted in wet conditions in such cases whole greens may be lost in a matter of days.
- *Helminthosporium* (leaf spot) Causal Agent – *Bipolaris cynodontis*. Initial spots start as a pin-point, purplish water soaked spot, which becomes dead in the centre, turns brown and later grey. Fungal spores need high humidity and a fine film of water on the leaf surface in order to germinate and infect.

B.4.11 Any unidentified infestations will be referred to a plant pathologist for disease identification. After reviewing the results carefully the management should plan the appropriate actions to be taken. Identification of areas most prone to disease attack due to course and soil microclimate will enable the course manager to keep a close watch for diseases if particularly susceptible areas are encountered.

Application of Fungicides

B.4.12 Fungicides should only be applied on greens. Damage to fairways and tees as a result of disease is perceived to be acceptable and consistent with the desired goal of minimising fungicide applications, even biological fungicides, wherever possible.

B.4.13 An integrated pest management system will be adhered to throughout the year. For example. if past experience and documented reports indicate that *Helminosporium* outbreaks occur after the first morning fog in March, where the mornings have a thick cover of fog, high humidity with little sunlight and air movement, then a preventative application of fungicide at low rates will be applied. This is a sensible approach since it will result in less fungicide being applied than would be needed to eradicate an established infestation.

B.4.14 It becomes more expensive and labour intensive to control disease once established. At this point, loss of a suitable playing surface or putting green may occur. Early detection and prompt control of disease during known susceptible periods is the most efficient way of controlling fungal attacks.

Insect Control and Insecticide Applications

General

B.4.15 The most common invertebrate pests likely to be found on golf courses in Hong Kong are, Army Worms, Mole Crickets and White Grubs (family *Scarabaeidae*). White Grubs and Army Worms are usually detected by the feeding habits of the local Magpie *Pica pica*. Mole Crickets push mounds of soil above the turf and destroy roots and tear plants from their growing places. Insect invasions will be most prevalent during the turf establishment stage when the roots and stems of the plant are at a young and immature stage.

B.4.16 By understanding the lifecycle of insects, the most sensitive point in their life cycle when they can be effectively controlled can be determined and appropriate biological control introduced.

B.4.17 Whilst chemical control is considered an important component in controlling insect populations, it forms only part of an integrated pest management approach and should only be used as a last resort.

Mole Crickets

B.4.18 Mole Crickets lay eggs at a peak rate during May and June. Eggs will hatch approximately 2 weeks later. The nymphs will then grow rapidly while feeding constantly and it is at this stage that treatment for mole crickets is most effective.

White Grub

B.4.19 The white grubs' life cycle begins between spring and mid-summer when the female beetle lays her eggs. When this is complete the beetle comes to the surface. Eggs start to hatch in 10 to 12 days and the new born larvae begin feeding on roots immediately. It is at this stage of the life cycle that treatment is most effective. It is important to spray at this point because during the winter, the grubs burrow deep into the soil becoming more sedentary and difficult to control. They are significantly harder to detect at this stage in their life cycle therefore insecticide applications would be ineffective, and optimum control may not be achieved. As the soil warms again, they resume eating for a short time.

Army Worm

B.4.20 The larval stage or caterpillar damages the turfgrass by feeding on the blade, crown and stem. Damaged areas take on a brown, dried up appearance. Active infestations are characterized by having a sharply defined advancing front between defoliated and green undamaged turf. Although turfgrass damage can be severe, recovery is quick and therefore insecticide control for Army Worm is unwarranted.

B.5 Irrigation Requirements

B.5.1 Irrigation is one of the most important aspects of managing a golf facility. Poor or excessive irrigation practices can result in nutrient loss, disease and insect susceptibility.

B.5.2 Watering will generally take place in the morning as this practice minimises evaporation loss and allows the leaf surface to dry during the day. Morning dew that can encourage diseases will therefore also be eliminated. Deeply penetrating watering cycles are the key to strong *Paspalum* grass development on a sand based turf.

B.5.3 Irrigation rates are adjusted according to this assessment of requirements. Evaporation rates are calculated using soil tensometers. Weather forecasts and predictions are also part of the decision to irrigate or not.

B.5.4 Watering is carried out in cycles to eliminate water runoff. Emphasis is placed upon preventing the soil and thatch from becoming hydrophobic. Watering at night is not encouraged as the grass remains wet for long periods creating an ideal micro climate for disease pathogens on the leaves. Irrigation sprinkler heads are only aimed at target areas which reduce water runoff and wastage. Greens should have double sprinkler heads, one head facing in towards the green and the other covering the surrounds of the green. This allows the greens to be watered separately.

B.5.5 Irrigation is an important tool as it helps to stabilize soils and prevent wind erosion in bunkers. All irrigation practices are documented in terms of watering time and millimetres of water applied to an area.

Appendix C

Sewage Generation Rate at SkyCity Golf Course

Table C.1 : Calculations for Sewage Generation Rate

1. Golf Facility			
1a. Total number of golfers	=	464	persons
1b. Design flow - guest	=	50	litre/person/day
1c. Assumed number of employees	=	50	persons
1d. Design flow - employee	=	60	litre/person/day
1e. Sewage generation rate	=	26	m^3/day
2. Other Facilities			
2a. Retail area	=	113	m^2
2b. Assumed floor area per person	=	15	m^2 usable floor area per person
2c. Design flow	=	290	litre/person/day
2d. Area of kitchen in restaurants	=	79	m^2
2e. Design flow - kitchen	=	500	litre/m^2 kitchen area/day
2f. Sewage Generation rate	=	42	m^3/day
Total Flow	**=**	**68**	**m^3/day**