Yee Sun Garden Ltd.

SkyCity Nine Eagles Golf Course

Turfgrass Management Plan

29 August 2006

Report no: 01369R0014

Hyder Consulting

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Co-author: Eric LEE

Co-author: Alexi BHANJA

Checker: Adi LEE

Approver: Guiyi LI

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Hyder Consulting Ltd
COI Number 126012
47th Floor, Hopewell Centre, 183 Queens Road East, Wanchai, Hong Kong
Tel: +852 2911 2233 Fax: +852 2805 5028 www.hyderconsulting.com

Hyder Consulting

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1 Summary

SkyCity Nine Eagles is a nine-hole executive golf course including seven Par 3 holes and two Par 4 holes. Construction specifications for the construction of the Golf Course have been clearly defined and the course conforms to the highest standards set by the United States Golf Association (USGA). One of the unique characteristics of SkyCity Nine Eagles Golf Course it that it will be operated without the use of artificial chemical fertilisers or artificial chemical pesticides, which has significant implications to this Turfgrass Management Plan (TMP).

This TMP is designed to assure that the Golf Course management is fully aware of the Golf Course Superintendent's (GCS) programmes and the ways in which these programmes are planned.

The success of the TMP depends on regular and frequent monitoring and evaluation. The evaluation results will be used to modify the programme to respond to changing environmental, cultural, and pest conditions within the stated objectives. As such, this TMP should be considered an evolving document and will likely be revised as required to benefit from the experience gained in operating theGolf Course.

The turfgrass proposed for SkyCity Nine Eagles Golf Course is *Paspalum SeaIsle 2000* for greens and *Paspalum Salam* for fairways, tees, and roughs (installed as sprigs and sod). *Paspalum Salem* will be sourced from Zhuhai Golden Coast Nursery in China, whereas *Paspalum Sea Isle 2000* will be sourced from Southern Turf Nursery in the USA. Peripheral areas will be landscaped with a restricted number of tree and shrub species (acceptable to Airport Authority and the Civil Aviation Department) that are not attractive to birds. These areas will be treated as low maintenance areas with no regular fertiliser or fungicide/insecticide applications.

The best defence against pest invasion is the provision of a dense, healthy, competitive turf. This is achieved after establishment by providing cultural practices that favour turf growth over pest growth. Important cultural practices in Integrated Pest Management (IPM) programmes include proper irrigation, fertilisation, mowing, aerification, verticutting, and top dressing.

Irrigation is one of the most important aspects of the TMP. Poor or excessive irrigation practices can result in nutrient loss, disease and insect susceptibility. To combat this potential risk, watering schedules will be initiated and closely monitored by the GCS.

The objective of the TMP with respect to fertilisation is to minimise application as far as possible. At certain times of a year, nitrogenous fertilisers will be applied to a programme suited to *Paspalum* turfgrass and the prevailing soil conditions that will be determined through soil testing. Compared to other turfgrasses, *Paspalum* has a lower requirement for nitrogenous fertiliser but *Paspalum* requires its own specialised management techniques, and healthier growth rates are achieved when the grass is not over-fertilised or over-watered. A balanced fertiliser and watering programme will therefore allow the grass to stand up to wear and develop disease resistance.

2 Background Information

2.1 SkyCity Nine Eagles Golf Course

SkyCity Nine Eagles Golf Course is located at the east side of the North Commercial District on the Airport Island, and is an interim arrangement prior to the area's future development as a business park. The Golf Course is intended to serve airport passengers, overseas visitors and airport workers.

SkyCity Nine Eagles is a nine-hole executive golf course including seven Par 3 holes and two Par 4 holes. One of the unique characteristics of the Golf Course it that it will be operated without the use of artificial chemical fertilisers or artificial chemical pesticides, which has significant implications to this Turfgrass Management Plan (TMP). These restrictions were stated in the Project Profile submitted under the Environmental Impact Assessment Ordinance and are also conditions stipulated in the Environmental Permit (EP) for the project.

Each hole of the golf course has its own special design feature. In particular, the Island Green at the 3rd hole, unique in Hong Kong, is inspired by the 17th hole at the Tournament Players Club in Sawgrass in Florida, USA, home of the USPGA Players Championship (see Figure 2-1). Situated on an island in the middle of an artificial lake, the hole is a supreme test of a player's skill, as the slightest mistake would land the ball in water. The golf course's "Extensive Bunker" feature involves extra-large sand bunkers to present a higher level of challenge (see Figure 2-2). The Master Plan for the Golf Course is shown in Figure 2-3.

Comprehensive facilities include golfing equipment rental, luggage storage, and PRO shop. Specially created by professional golf course architects to take into account numerous building restrictions in the vicinity of the airport, the course conforms to the highest standards set by the United States Golf Association (USGA). Equipped with floodlighting, the Golf Course has extended opening hours for the benefit of golfers wishing to engage in evening play – making SkyCity Nine Eagles the only golf course in Hong Kong to offer night-time play.

The Golf Course provides comprehensive teaching, including professional coaching, putting practice green, pitching practice area, sand bunker practice area and driving nets. The luxurious club house, situated in an elevated position, allows customers to take in a panoramic view of the entire golf course while enjoying food of the highest quality, as well as a wide range of various leisure and entertainment activities.

2.2 Purpose of the Turfgrass Management Plan

This TMP is designed to assure that the Golf Course management is fully aware of the Golf Course Superintendent's (GCS) programmes and the ways in which these programmes are planned. The TMP is important to establish objectives for the conservation of water and nutrients, and minimise the use of organic fertilisers/fungicides/insecticides. The integration of these areas is essential in developing an effective TMP that helps the GCS manage the course effectively.

The thresholds which prompt action in the TMP programme are based on pest populations, turfgrass/soil nutrient tests, soil water conditions, soil and thatch physical properties, turfgrass playing conditions and environmental conditions.

The performance of the TMP is assessed in terms of the quality of turf produced in time with the stated objectives of water and nutrient conservation and fungicide/insecticide minimisation.

This performance will be facilitated by the excellent green construction and the complex drainage system with a fully integrated irrigation regime. The success of the TMP depends on regular and frequent monitoring and evaluation. The evaluation results will be used to modify the programme to respond to changing environmental, cultural, and pest conditions within the stated objectives. As such, this TMP should be considered an evolving document and will likely be revised as required to benefit from the experience gained in operating the Golf Course.

2.3 Interface with the EM&A Programme

To meet the conditions specified in the EP, an Environmental Monitoring and Audit (EM&A) programme has been running since the commencement of construction and will continue until the end of operation.

During the Turfgrass Establishment Period and the Turfgrass Management Period, regular monitoring of lake water quality in terms of a range of parameters (including nutrient levels) will demonstrate that environmental impacts have been reduced to an acceptable level.

This TMP implements the necessary procedures and actions that are required by the EM&A programme and/or EP. Following the procedures laid out in this TMP will ensure compliance with the EM&A programme and the EP conditions.

Throughout this TMP, references made to fertiliser are deemed to refer to organic fertilisers and not to artificial chemical fertilisers. Similarly, references made to fungicides and insecticides are deemed to refer to biological pest control species /compounds and not to artificial chemical pesticides.

Figure 2-1 Artist's Impression of Hole 3

Figure 2-2 Artist's Impression of Hole 8

Hole	PAR	Length (m)	Length (yd)
1	3	100	110
2	3	150	165
3	3	120	130
4	3	160	175
5	4	220	240
6	3	90	100
7	3	110	120
8	3	80	90
9	4	280	310
Out	29	1310	1440
10	3	110	120
11	3	170	185
12	3	135	145
13	3	180	195
14	4	290	320
15	3	100	110
16	3	130	140
17	3	90	100
18	4	300	330
In	29	1505	1645
Total	58	2815	3085

Figure 2-3 SkyCity Nine Eagles Golf Course Master Plan

3 Selection of Turfgrass Species and Cultivars

3.1 General

The turfgrass proposed for SkyCity Nine Eagles Golf Course is *Paspalum SeaIsle 2000* for greens and *Paspalum Salam* for fairways, tees, and roughs (installed as sprigs and sod). Paspalum has a similar texture and quality as the popular Bermudagrass, used elsewhere in Hong Kong, but with better environmental qualities and has been selected with the following criteria in mind :

- Multiple environmental stress tolerances
- Improved nutrient uptake and utilization efficiency (requires judicious applications of fertilisers)
- More stable disease and insect resistance (requires minimal pesticides)
- Capability to tolerate a wide range of alternative water resources
- Good playing surface quality
- Good aesthetic appeal with low maintenance approach

3.2 Greens

Paspalum SeaIsle 2000 generates excellent growth while providing a strong tight-knit playing surface. It has a darker green colour than Bermudagrass and performs well at lower mowing heights. Greens planted with *Paspalum SeaIsle 2000* have lower nitrogen requirements, particularly during establishment, and are more resistant to a wide range of pests, meaning minimal pesticide requirements. Used in conjunction with good cultural maintenance practices, *Paspalum SeaIsle 2000* provides an excellent putting surface. *Paspalum SeaIsle 2000* also has better low-light intensity tolerance, traffic tolerance, and cold tolerance, which make it well suited to handle difficult growing conditions between January and April in Hong Kong.

Greens will be established from sprigs, which will be certified and tested for purity to save management control efforts in the long term. Optimum mowing heights for *Paspalum SeaIsle 2000* greens are in the range of 3-5mm. Colour and density of Paspalum greens mown at this height will usually be darker green and more dense than the Bermudagrass greens. Reel mower maintenance will be increased as wear and tear on bed knives and reels are expected to be greater from Paspalum greens.

3.3 Fairways

The fairways will be planted with *Paspalum Salam*, which will be the only other turfgrass species used for planting of the Golf Course, as this avoids any cross-contamination that could require subsequent management and control actions. As for greens, the turfgrass planted on fairways will be certified and tested for purity to reduce management control efforts in the long-term. Greens surrounds, bunker surrounds, and sloped areas will be sod planted for quick establishment and protection against soil erosion. Other areas will use traditional sprig planting methods.

Optimum mowing heights for *Paspalum* fairways vary between 13-16mm, depending on the time of year. Heights should be raised to the higher end of this scale going in to winter to improve carbohydrate load in the crown region and in the rhizomes and to enhance winter hardiness.

3.4 Tees

Tees tend to suffer from extensive wear, especially on Par 3 holes where divots are more frequently removed from the surface – the majority of holes at SkyCity Nine Eagles Golf Course are par 3.

The tees have been designed to enable better traffic rotation and thereby reduce man-made stress levels on the turfgrass. The tee size is considered sufficient to handle traffic through the winter period without over-seeding with a perennial ryegrass. This will conserve water and nutrients that would be required to grow in over-seeded turfgrass on the tees on an annual basis. Large tees also minimise extensive exposure of the soil and reduced the likelihood of disease, thereby obviating the need for pesticide use.

3.5 Bunkering

The extensive bunkering within SkyCity Nine Eagles Golf Course provides a challenging feature. *Paspalum Salam* will also be used as the turfgrass for bunker surrounds. Bunker faces will primarily receive foliar feeding for areas that rotary fertiliser spreaders cannot access.

3.6 Roughs and Non-fairway Areas

Roughs next to fairways are part of the Golf Course, but are kept on a low maintenance regime. Similar to the fairways, they will be planted with *Paspalum Salam*.

Peripheral areas will be landscaped with a restricted number of shrub and tree species (acceptable to Airport Authority and the Civil Aviation Department) that are not attractive to birds. These areas will be treated as low maintenance areas with no regular fertiliser or fungicide/insecticide applications.

3.7 Turfgrass Sourcing

3.7.1 Paspalum Salem

Paspalum Salem will be sourced from Zhuhai Golden Coast Nursery in China (see website at http://www.zhjwyh.com).

- Sods of *Paspalum Salem* will be planted in tee areas (~4,400m^2)
- Sods of *Paspalum Salem* will be planted in surround areas (~13,700m^2)
- Sprigs of Paspalum from Zhuhai Golden Coast Nursery, will be planted in fairway areas (~11,900m^2) and rough areas (45,300m^2)

3.7.2 Paspalum Sea Isle 2000

Paspalum Sea Isle 2000 will be sourced from Southern Turf Nursery in the USA (see website at http://www.southernturf.com).

- Sprigs of *Paspalum Sea Isle 2000* will be planted in greens areas (6,500m^2)

4 Soil Management Practices

Construction specifications for the construction of Nine Eagles Golf Course have been clearly defined and the course conforms to the highest standards set by the USGA.

During construction, special attention has been paid to the soil types on Chek Lap Kok – suitable topsoil will be stockpiled on site and used to cap the outer margins of the Golf Course to provide suitable growing medium for their eventual re-vegetation. Imported growing medium has been selected for the tees, greens and fairways. In conjunction with drainage and irrigation, the imported medium will provide ideal conditions for good soil management.

Greens have been constructed to USGA specifications. An extensive sub-surface drainage system has been installed to control infiltrated water and directs all such water to the artificial lakes. The sub-soil drainage has been constructed both under the fairways and greens. The sub-surface drainage spacing of 12m is considered to be sufficient to ensure that all soils are free draining, and there would be no standing water with its associated turfgrass maintenance problems. The greens and tee surfaces have also been graded to avoid the accumulation of surplus surface water and to ensure that all run-off is directed to the artificial lakes. The USGA green construction method is based on creating a perched water table, which allows the root zone to hold moisture which helps to reduce irrigation requirements.

The tees and fairways will consist of a clay sub-base covered with 200-300mm of inert river sand. In addition to the extensive sub-soil drainage, cultural practices such as coring and spiking ensure that greens, tees, and fairways will remain free draining.

Aeration of all sand surfaces will be carried out twice yearly or as required. This practice will relieve compaction, aerate the sand profile and assist in the free drainage of the sand. Aeration will take place during the months of May and September for all tees, greens and fairways.

Soil testing for nutrient status would be carried out a minimum of 3 times per year. Results of soil tests are an important element of the TMP and provide important feedback to the GCS on the success of fertility programs in place. Conducted at the above frequency, soil testing provides ample warning to the GCS to adjust application rates to maintain the turfgrass in optimum condition.

It should be noted that soil testing for nutrients is purely to assist in turfgrass management. It is not related to the soil testing required by the EP and will not be reported in the EM&A compliance monitoring reports that are issued under the EM&A programme.

5 Cultural Practices

The best defence against pest invasion is the provision of a dense, healthy, competitive turf. This is achieved after establishment by providing cultural practices that favour turf growth over pest growth. Important cultural practices in Integrated Pest Management (IPM) programmes include proper irrigation, fertilisation, mowing, aerification, verticutting, and top dressing.

Prolonged use of incorrect cultural practices and a lack of understanding of the inter-relationships between these practices weakens the turfgrass, encourages pest activity or invasion, and contributes to excessive thatch development. Thatch harbours many insect and disease pathogens, binds herbicides/ insecticides and reduces the efficiency of irrigation.

Tables 5-1, 5-2 and 5-3, below, describe the cultural practices that shall be adopted on SkyCity Nine Eagles Golf Course :

Cultural Practice	Turf Area	How Often	Time of Year	Application Rate
Topdressing	Greens	Every 2-3 weeks, followed by verticutting	All year	
Aerification	Greens	10-12 weeks	Spring, Autumn	N/A
Verticutting	Greens	Biweekly ~3-5mm	All year	N/A
Plant Growth Regulator	---			---
Overseeding	---			
Fans	---			N/A
Other	Hydroject	Monthly	Late Autumn, Winter	---

Table 5-1 Cultural Practice Reference for Greens

Cultural Practice	Turf Area	How Often	Time of Year	Application Rate
Topdressing	Tees	6-8 weeks	Spring, Summer	Light dusting
Aerification	Tees	Once a year	Early Spring	N/A
Verticutting	Tees	6-8 weeks	Spring, Summer	N/A
Plant Growth Regulator	---			---
Overseeding	Tees	Once 2 year	Early Autumn	
Fans				N/A

Table 5-2 Cultural Practice Reference for Tees

Cultural Practice	Turf Area	How Often	Time of Year	Application Rate
Topdressing	Fairways	Follow aeration	Late Spring	Light dusting
Aerification	Fairways	Once a year	Late Spring	N/A
Verticutting		~13-16mm		N/A
Plant Growth Regulator	Fairways	5-6 weeks	Late Spring, Mid Summer	830 ml/ha - prims
Overseeding				
Fans				N/A

Table 5-3 Cultural Practice Reference for Fairways

6 Irrigation Management

Irrigation is one of the most important aspects of the TMP. Poor or excessive irrigation practices can result in nutrient loss, disease and insect susceptibility. To combat this potential risk, watering schedules will be initiated and closely monitored by the GCS.

Watering will generally take place overnight and as close to the early morning as practicable. 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 infrequent watering cycles are the key to strong Paspalum turfgrass development on a sand based turf.

Irrigation rates are adjusted by the GCS according to assessment of requirements. Watering requirements will be determined through the use of soil probes and turf inspection on a daily basis. Weather forecasts and predictions are also part of the decision to irrigate or not.

Watering is carried out in cycles to eliminate water runoff. Emphasis will be placed upon preventing the soil and thatch from becoming hydrophobic. Watering in the early evening is not encouraged as the turfgrass remains wet for long periods, thus creating an ideal micro-climate for disease pathogens on the leaves. Irrigation sprinkler heads will only be directed at target areas which will reduce water runoff and wastage.

Irrigation is an important tool for the GCS as it helps to stabilise soils and prevent wind erosion in bunkers. All irrigation practices will be documented in terms of watering time and depth of water applied to an area. All irrigation water will be sourced from the artificial lakes, which will be replenished by collecting rainfall from within the Golf Course and topped-up with borewater and/or seawater as necessary. It should be noted that irrigation using saline water will be restricted to the turfgrass areas only. All other vegetation will be irrigated with fresh water.

In order to maintain optimum efficiency of the irrigation system, a regular preventative maintenance program will be strictly adhered to. This will include checks to all major components of the system, including lightning protection. All irrigation pumps will be serviced through an annual preventative maintenance contract with system inspection and testing on a quarterly basis.

7 Fertiliser Requirements

7.1 Objectives

The objective of the TMP with respect to fertilisation is to minimise application as far as possible. At certain times of a year, nitrogenous fertilisers will be applied to a programme suited to *Paspalum* turfgrass and the prevailing soil conditions that will be determined through soil testing. Compared to other turfgrasses, *Paspalum* has a lower requirement for nitrogenous fertiliser and its requirements differ significantly from Bermudagrass, with a nitrogen to potassium ratio of 1:2 or 1:3, depending on prevalent soil conditions. 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.

Paspalum turfgrass requires its own specialised management techniques and healthier growth rates are achieved when the grass is not over-fertilised or over-watered. A balanced fertiliser and watering programme will therefore allow the grass to stand up to wear and develop disease resistance.

7.2 Nutrient Types

7.2.1 Nutrient Status

Nutrient status will be monitored every 3 months through soil testing to determine the nutrient levels and the overall health of the soil. This helps integrate the GCS nutritional programmes for the turfgrass 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 fertilisers will be used, together with spoon feeding through foliar applications. This practice will ensure that there would be no nutrient loading within the soil and efficient turf nutrient uptake, minimising potential for nutrient loss from the soil.

7.2.2 Nitrogen

The nitrogen (chemical symbol N) source will be used in slow release form and with the correct management practices, losses of nitrogenous fertiliser will be negligible. Only mini prill fertilisers will be used as this will also minimise runoff as the fertiliser granules become fixed within the turf canopy. As shown in Section 7.3, the estimated use of nitrogen on *Paspalum* will be lower than the requirements for maintenance of Bermudagrass on golf courses elsewhere in Hong Kong.

7.2.3 Phosphorous

Turfgrass does not generally require large amounts of phosphorous (chemical symbol P), which will be incorporated into the fertiliser program through a blended fertiliser containing a small percentage of phosphorous. However, fertilisers with higher phosphorous quantities will be applied in response to deficiencies detected in soil tests.

7.2.4 Potassium

Potassium (chemical symbol K) fertilisation is very important for *Paspalum*. Although *Paspalum* has the capability to extract and accumulate appreciable potassium concentrations in leaf tissues in adverse environments, potassium additions must be included in the management programme. Sufficient potassium must be applied on a regular schedule to prevent “mining” of the soil potassium to very low levels, and to provide adequate potassium for uptake and use in stress-tolerance mechanisms.

Potassium is also important in resistance to disease, drought, heat stress, and cold and wear tolerance and will be applied in conjunction with nitrogen at a 1:2 or 1:3 ratio.

7.2.5 Micro-nutrients

Micro-nutrient requirements for elements such as magnesium boron, and calcium will be determined by soil tests. Iron will be applied according to a plan involving six applications per year on tees, greens and fairways.

Normally, sufficient sulphur is applied when inorganic potassium fertilisers, such as potassium sulphate, are used as the major source of potassium. However, as only organic fertilisers will be used on the SkyCity Nine Eagles Golf Course, additional sulphur supplements may be needed, as determined by soil test results.

Sufficient lime will be applied to adjust or maintain the surface 200mm to a pH >6.0 and would be applied based on soil test results. It is likely that two applications per year would be required, in spring and autumn.

7.3 Estimated Fertiliser Usage During Turfgrass Establishment

Normal grow-in time from sprig planting to full coverage for *Paspalum* is from two to three months, depending on volume of sprigs planted, water quality and quantity, and ambient temperature.

Paspalum absorbs limited amounts of nitrogen during the first month of establishment. Instead the turfgrass prioritises root development and therefore higher levels of phosphorous and potassium will be required. Slow-release fertilisers are adequate when applied at 25kgN/ha+50kgP/ha+75kgK/ha on a bi-weekly basis in the first month (a total of two applications). When stolon growth is first observed emphasis should be shifted to higher nitrogen sources.

During the second and third months, and after stolon growth is first observed, a slow-release formulation will be applied at a rate of 50KgN/ha+50kgP/ha+ 100kgK/ha, and repeated at three-week intervals (a total of three applications) until for full grow-in.

In addition to the above applications a dual-phase approach to enhance stolon/ rhizome/shoot growth will be adopted with light verti-cutting on a weekly/bi-weekly basis followed by spoon feeding low rates of micro-nutrients (calcium nitrate) at 7.5kg/N/ha (a maximum of six applications).

For areas planted with sod, fertilisation would follow the schedule shown for the first month establishment above, and thereafter would follow the turfgrass maintenance programme described in Section 7.4. Whether the turfgrass is established by sod or stolons, nitrogen fertilisation rates should be reduced to that for the turfgrass maintenance programme as quickly as possible.

The total quantities of nutrients required for grow-in of *Paspalum* during the three-month establishment period (calculated in Appendix 1) are summarised below. On this basis, Appendix 1 also provides revised calculations on worst-case nutrient loading in overflow water from the artificial lakes.

- Nitrogen 1,735.4kg
- Phosphorous 1,782.6kg
- Potassium 3,270.1kg
- Lime Powder should be added pending for pH test

7.4 Estimated Fertiliser Usage During Turfgrass Maintenance

It is not possible to state the precise amount of fertiliser that will be used, as this will depend on changing weather and soil conditions. Notwithstanding, the following serves as a guide to applications.

The fertiliser programme is divided into two periods, winter (November to March) and summer (April to October).

7.4.1 Greens

The total approximate area of greens is 6,500m^2.

During the winter period, the greens will be fertilised at eight-week intervals. Fertiliser with a high potassium content will be used to help protect the turf against cold stress. The nitrogen form will be slow release, thereby creating an even release of nitrogen over a long period. Every eight weeks (three applications) fertiliser will be applied at a rate of 49kgN/ha+98kgK/ha per application. This will be supplemented by two applications of fertilisers at a rate of 20kgN/ha+10kgP/ha+40kgK/ha per application.

During the summer period, the greens will be fertilised at six week intervals. The nitrogen form will be slow release, thereby creating an even release of nitrogen over a long period. Every six weeks (five applications), fertiliser will be applied at a rate of 40kgN/ha+5.5kgP/ha+80kgK/ha per application.

With the relatively low quantity of fertiliser applied to the greens it is important to maintain the optimum nutrient balance within the soil. This will be achieved through foliar "spoon feeding", which will ensure low quantity but readily available nutrients through application during the summer months of potassium nitrate (or equivalent) at a rate of 6.5kgN/ha+23kgK/ha per month (five applications).

Micro-nutrients (iron and sulphur, as iron sulphate) will be applied during the winter months on a four-week programme at a rate of 30kg/ha to help maintain the green appearance of the turf and also serves to harden plant cells for improved cold and traffic stress tolerances.

The total annual quantities of nutrients required for maintenance of the greens (calculated in Appendix 2) are summarised below. On this basis, Appendix 2 also provides revised calculations on worst-case nutrient loading in overflow water from the artificial lakes.

- Nitrogen 272.7kg/year
- Phosphorous 30.9kg/year
- Potassium 577.9kg/year

7.4.2 Fairways, Tees and Surrounds

The total area of fairways is 11,900m^2, the area of tees is 4,400m^2 and the area of the surrounds is 13,700m^2. These areas will receive four granular applications per year, applied in spring and autumn and two applications during winter. This will be supplemented with foliar spoon feeding with potassium nitrate and ferrous sulphate at intervals of four to eight weeks, depending on the time of year.

During the winter period, two applications will be made. Fertiliser will be applied at a rate of 40kgN/ha+16kgP/ha+80kgK/ha per application. During the summer period, four applications will be made. Granular fertiliser will be applied at a rate of 50kgN/ha+5kgP/ha+50kgK/ha per application.

Minimal phosphorous will be required for maintenance of turfgrass on fairways, tees and surrounds, and it will only be applied as part of a general fertiliser application. Additional phosphorous applications will not be applied unless soil test results show a deficiency requiring amendment.

Fertiliser will be applied to fairways, tees and surrounds at a rate of 6.5kgN/ha+ 23kgK/ha as a foliar "spoon feed", which will include low quantity yet readily available nutrients to the plant. Micro-nutrients (iron and sulphur, as iron sulphate) will be included with this foliar feed at a rate of 30kg/ha. This foliar feed will be carried out during the summer period at six-week intervals (five applications).

The total annual quantities of nutrients required for maintenance of the fairways, tees and surrounds (calculated in Appendix 2) are summarised below. On this basis, Appendix 2 also provides revised calculations on worst-case nutrient loading in overflow water from the artificial lakes.

- Nitrogen 937.5kg/year
- Phosphorous 156.0kg/year
- Potassium 1,425.0kg/year

7.4.3 Rough Areas

Rough areas form an integral part of the course design strategy and cover approximately 45,300m^2. Roughs that come into play on the Golf Course will be on a low maintenance regime and fertilised on an "as needed" basis. Based on experience, they would receive approximately 50% of the fertiliser of fairway and tee areas (excluding foliar feed applications).

A slow release fertiliser will be used for areas of rough that are maintained. Before application, all rough areas will be spiked to ensure maximum penetration of the nutrients into the soil and thereby reduce potential nutrient runoff.

From the above programme an approximate calculation is given below on the annual amount of nutrients applied to the rough areas. Appendix 2 provides revised calculations on worst-case nutrient loading on this basis.

- Nitrogen 634.2kg/year
- Phosphorous 117.8kg/year
- Potassium 815.4kg/year

7.5 Available Organic Fertilisers

In order to meet EP conditions, all fertilisers to be used on SkyCity Nine Eagles Golf Course will be organic, containing organic nitrogen (N), phosphate (P), and potassium (K). Fertiliser is specified as N:P:K ratios, for example, e.g. a 4:2:1 fertiliser contains 4% nitrogen, 2% phosphorous and 1% potassium. The remainder is considered to be "organic matter", with no nutritional content.

To achieve the fertiliser programmes specified above, various combinations of the organic fertilisers shown in Table 7-4 will be used. It should be noted, however, that this list is not exhaustive and that additional organic fertilisers will be added to the list as they become available and if they are considered suitable.

中文名	English Name	N:P:K Ratio (+Organic Matter)	Certified by HKORC*
動力生機肥(粉)	Dynamic Organic Fertiliser (powder)	2:4:2+30%	✓
綠營高	Nutrismart	0:5:0+20%	✓
機保能	Chito-Power Type-S	4:2:1+15%	✓
豐收1號	Wellgrow 1	2:4:2+30%	
紅牛鉀肥	Sulphate of Potash granular	0:0:50	✓
動力生機肥(粒)	Dynamic Organic Fertiliser (pier)	2:4:2+30%	✓
綠營高	Nutrismart	0:5:0+20%	✓
金葉肉骨粉	Goldleaf Meat & Bone Meal OF	7:7:1	
綠環苦楝粉	GreeNeem Powder	4:3:2	
胺基酸	Amino Acid	5:1:2	✓

Note : * Hong Kong Organic Resource Centre (see http://www.hkbu.edu.hk/~hkorc/)

Table 7-4 Available Organic Fertilisers

8 Integrated Pest Management Requirements

In order to meet EP conditions, all fungicides/insecticides to be used on the SkyCity Nine Eagles Golf Course will be organic in nature. IPM will be adopted to provide a holistic approach in meeting these conditions. The IPM approach will follow that recommended by the Agriculture, Fisheries and Conservation Department (AFCD) – see Appendix 3.

8.1 Weed Control

Close mowing heights for *Paspalum* provide a tight, dense canopy that deters aggressive growth of most weeds. With good cultural mowing practices (as described in Section 5), it is estimated that 90% of weed species would be smothered by the dense Paspalum grass covering. The density of the grass is created through a close and frequent mowing schedule.

All turfgrass supplied for planting will be certified and tested to meet stringent quality control. Emphasis will be on quality control of sprigs and sod delivered to site so that minimal weeds would be encountered. As part of this quality control, application of a pre-emergent chemical herbicide (such as Ronstar) may be carried out off-site prior to planting, as this would greatly reduce infestation of weeds during establishment and would reduce long term weed control requirements by ensuring a pure mono stand of *Paspalum* from the beginning.

Mechanical methods (hand pulling) of removing turfgrass weeds will be the primary means of control during turfgrass establishment and maintenance. Broad-leaved weeds will be removed mechanically by the course maintenance staff. *Paspalum* has been used widely on salt-affected sites due its high tolerance for saline water. In such cases most weeds are suppressed or eradicated by the high salinity. Saline water will be used as a means of weed control management through general irrigation, and should be sufficient to eradicate most annual grass and broadleaf weed problems. An additional weed control strategy will be the use of rock salt in the form of spot application to problem weeds, followed by light irrigation.

The main weed varieties expected to affect the SkyCity Nine Eagles Golf Course are *Axonopus* (Carpet Grass), Sedges, Torpedo Grass, and Crab Grass. These weeds can be controlled through the use of saline irrigation and rock salt.

8.2 Disease Control

Paspalum does not have the wide variety of pathogen problems that tend to affect other warm season grasses, probably due to the fact that it evolved in a wet, humid ecosystem with multiple disease exposure where surviving ecotypes have developed resistance.

The *Paspalum* turfgrasses chosen for SkyCity Nine Eagles Golf Course are some of the most disease-resistant varieties available that are adaptable to the Hong Kong environment. Notwithstanding, Hong Kong's weather is conducive to fungal attacks at certain times of the year.

8.2.1 Common Fungal Pathogens

The most common fungal pathogens that affect grasses of Hong Kong cause diseases such as Brown Patch, Blight, Leaf Spot, and Dollar Spot. Table 8-5, below, provides further information on these diseases and the fungus species responsible :

Name	Fungus Species	Description
Brown Patch	*Rhizoctonia solani* and other *Rhizoctonia* spp	Outbreaks of Brown Patch typically occur during hot, humid weather. Patches or rings of grass die out suddenly, these ranges in size from a few inches to several feet in diameter. Prolonged periods of leaf wetness are necessary for severe damage to occur.
Blight	*Pythium aphanidermatum* *Pythium splendens* *Ascochyta* spp *Leptosphaerulina* spp *Septoria* spp *Curvularia* spp	This disease causes most concern 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 turns 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
Leaf Spot	*Helminthosporium* *Bipolaris* spp *Drechslera* spp	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.
Dollar Spot	*Sclerotinia homeocarpa*	Outbreaks occur from spring through autumn, and are most active during moist periods of warm days, and cool nights in the spring, early summer, and autumn. The disease is spread between area by water, mowers, other equipment, and shoes. The disease appears as round, brown to straw-coloured sunken spots approximately the size of a silver dollar. Cobweb-like mycelium can be seen growing on effected areas in the early morning

Table 8-5 Diseases Found in Hong Kong

8.2.2 Disease Prevention

Disease prevention through cultural methods and a well-developed maintenance regime will provide conditions which limit grass susceptibility to fungal attack. Conditions on the Golf Course will be open, with low vegetation and good 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.

Saturated soil profiles have been proven to contribute to disease outbreaks. In accordance with USGA Golf Green Construction methods and free-draining sand fairways, the soil profiles are not expected to become saturated.

Thus, the two major contributors to turf grass diseases in Hong Kong will have been minimised by the well ventilated location and good construction methods. 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. The use of saline water will be explored used as a means of control for disease treatment.

8.2.3 Application of Organic Fungicides

If diseases cannot be controlled using the methods described above, it may be necessary to apply organic fungicides to combat and eradicate the above diseases. Organic fungicides will be selected from those shown in Table 8-6 – this list is not exhaustive and additional organic fungicides will be added to the list as they become available and if they are considered suitable. The GCS shall approach the Plant and Pesticides Regulatory Division of AFCD for registration under the Pesticides Ordinance should it be decided to use any commercially formulated products for pest control that are not registered with AFCD.

Common Name of the Pesticide Active Ingredient	**AFCD Reg. No.**	**English Product Name**	**中文商品名**	**Certified by HKORC***
Bacillus subtilis	2P296	Brevibacterium WP	依天得	✓
White oils	2P193	SK99 EnSpray	綠油油(SK99石腊油)	✓
Trichoderma harzianum WP	2P255			✓
Copper (II) hydroxide WP	2P53		葉廨寧	

Note : * Hong Kong Organic Resource Centre (see http://www.hkbu.edu.hk/~hkorc/)

Table 8-6 Available Organic Fungicides

An IPM system will be adhered to throughout the year, with the main emphasis on maintaining healthy soil and plant profiles. For example, if past experience and documented reports indicate that “Brown Patch” outbreaks occur after the first morning dews in November, when the mornings are cold and days warm, then a preventative application of organic fungicide at low rates will be applied. This is a sensible approach as it will result in less organic fungicide being applied than would be needed to eradicate an established infestation.

Blight outbreaks occur during the months of April and May when there is a thick cover of fog, and high humidity with little sunlight and air movement. During these months it would be prudent to implement a preventative spray programme of three applications during the two-month period. This will also help prevent Leaf Spot during April and May when it is most likely to attack *Paspalum* turfgrass. A total of four preventative applications of organic fungicides are justifiable if sustained conditions are conducive to disease.

8.3 Insect Control

8.3.1 Common Insect Pests

The most common invertebrate pests likely to be found on SkyCity Nine Eagles Golf Course are Mole Crickets, White Grubs, Armyworms, Cut Worms and Sod Webworms. White Grubs and Army Worms are usually detected by the feeding habits of the local Magpie *Pica pica*, although the presence of this species and other birds will be discouraged by the selection of trees and shrubs used for landscaping. 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. By understanding the lifecycle of insects, the most sensitive point in their life cycle when they can be most effectively controlled can be determined. Table 8-7, below, provides further information on the lifecycles of these insects :

Name	Description
Mole Crickets *Orthoptera: Gryllotalpidae*	Eggs are laid 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 early nymph stage that treatment for mole crickets is most effective. As populations take time to accumulate within the soil, the need for control measures is not expected within the first 6 months after planting.
White Grubs *Scarabaeidae*	Eggs are laid between spring and mid-summer. Eggs start to hatch within 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, because during the winter, the grubs burrow deep into the soil becoming more lethargic and difficult to control. As the soil warms again, they resume eating for a short time. As populations take time to accumulate within the soil, the need for control measures is not expected within the first 6 months after planting.
Army Worm *Spodopteera litura*	The larval stage (caterpillar) damages the turfgrass by feeding on the blade, crown the stem. Damaged areas take on a brown, dried up appearance. Active infestations are characterised by having a sharply defined advancing front between defoliated and green undamaged turf. Although turfgrass damage can be severe, recovery is quick and therefore control measures would only be considered in cases of sustained infestation. As Army Worms are likely to be attracted to the succulent fresh growth during turfgrass establishment, control measures are a likely requirement.
Cut Worms and Sod Webworm *Lasiocampidae*	With multiple generations per year and capacity to damage high profile areas such as greens, Cut Worms and Sod Web Worm are often targeted for regular, preventative control. Nevertheless, with monitoring and knowledge of Cut Worm and Sod Web Worm behaviour, the GCS can maintain high quality turf with a reduced need for control measures.

Table 8-7 Typical Insect Pests Found in Hong Kong

8.3.2 Application of Organic Insecticides

If insect infestations occur and need to be controlled, it may be necessary to apply organic insecticides to combat and eradicate the infestation. Organic insecticides will be selected from those shown in Table 8-8 – this list is not exhaustive and additional organic insecticides will be added to the list as they become available and if they are considered suitable. The GCS shall approach the Plant and Pesticides Regulatory Division of AFCD for registration under the Pesticides Ordinance should it be decided to use any commercially formulated products for pest control that are not registered with AFCD.

Common Name of the Pesticide Active Ingredient	**AFCD Reg. No.**	**English Product Name**	**中文商品名**	**Certified by HKORC***
Bacillus thuringiensis (Bt)	2P12	Xentari	見大利	✓
Spodoptera litura Nuclear Polyhedrosis Virus (WP)	2P242	Chongwen-1	虫瘟一號	✓
Neem 70% (EC)	2P262	Trilogy	三益苦楝油	✓
Oxymatrine/Psoralen	2P291	Kingbo	清源保	✓
Matrine	2P288	Green Earth 1	綠土地1號	✓
White oils	2P193	SK99 EnSpray	綠油油(SK99石腊油)	✓
Steinernema carpocapsae			斯氏線虫	✓
Spinosad RB 0.1 w/w	2P290	Dow Spinosad	催殺	
Abamectin 1.8%EC	2P226	Abamectin	虫螨敵	
Beauveria bassiana	2P239		白蠹菌	
Cnidiadin 0.4%EC	2P298	Cnidiadin	蛇床子素	

Note : * Hong Kong Organic Resource Centre (see http://www.hkbu.edu.hk/~hkorc/)

Table 8-8 Available Organic Insecticides

9 Course Management

9.1 Aesthetic and Functional Thresholds for Pests

Table 9-9 shows threshold levels that represent the area affected or the number of insect/weeds above which control measures would be considered. The proposed threshold levels raise a warning to the GCS who would then decide on the appropriate method of treatment and/or control. It should be noted, however, that these are the initial thresholds and may be modified to reflect actual requirements as experience is gained in managing the course.

Pest	Greens	Tees & Fairways	Roughs	Detection Method
Diseases				
Leaf Spot	5%	Untreated	Untreated	Visual inspection /
Blight	5%			Microscope
Brown Spot	5%			
Dollar Spot	10%			
Insects				
White Grubs	2 no./ft^2	4 no./ft^2	6 no./ft^2	Visual + soil inspect
Mole Crickets	2 no./ft^2	3 no./ft^2	6 no./ft^2	Visual + soap flush
Sod Webworms	4 no./ft^2	8-10 no./ft^2	Not Reqd	Visual + soap flush
Armyworms	Not Reqd.	4 no./ft^2	6 no./ft^2	Visual + soap flush
Cutworms	1 no./ft^2	5 no./ft^2	Not Reqd	Visual + soap flush
Weeds				
Nutsedge	Hand pulled	2 no./ft^2	6 no./ft^2	Visual inspection
Torpedo Grass	Hand pulled	2 no./ft^2	4 no./ft^2	
Broadleaf Weeds	Hand pulled	2 no./ft^2	6 no./ft^2	

Table 9-9 Aesthetic and Functional Thresholds

There are many factors, including pest life cycle, and other maintenance practices that can return turfgrass back to acceptable level. However, if cultural practices are insufficient, treatment will be achieved through the use of organic fungicides or organic insecticides for the diseases and insects shown in Table 9-10 :

Pest	Target	Organic Fungicide/Insecticide
Disease	Dollar Spot	*Trichoderma harzianum* (AFCD Reg. No. 2P255)
Insects	Armyworms	Neem oil (AFCD Reg. No. 2P262)
	Sod Web Worms	*Bacillus thuringiensis* (AFCD Reg. No. 2P12)
	Cut Worms	*Spodoptera litura* NPV (AFCD Reg. No. 2P242)
	Mole Crickets	*Beauveria bassiana* (AFCD Reg. No. 2P239)

Table 9-10 Organic Fungicides/Insecticides and Target Species

9.2 Fertiliser/Fungicide/Insecticide Management Plan

9.2.1 Background

The purpose of the Fertiliser/IPC Management Plan is to provide technical records for management review regarding the organic fertilisers and organic fungicides/insecticides being used on the Golf Course and their method of application. It must be understood from the outset that all employees handling fertilisers have received initial site training regarding storage, handling, and application, after spraying procedures, and spill control procedures.

The GCS will be responsible for fertiliser and fungicides/insecticides applications. No artificial chemicals will be used.

9.2.2 Fungicide/Insecticide Preparation

Preparations take place in a confined segregated and bunded area where spill contingency plans can be implemented. Storage containers that are well labelled will be used to keep any waste within the bunded area.

Records will be kept relating to the purchasing of all these products. The records will document the following :

- Type of fungicide/insecticide
- Amount purchased
- Date purchased
- Supplied by
- Date of arrival
- Received by
- Fungicide/insecticides application

9.2.3 Fungicide/Insecticide Application

Fungicides/insecticides will be applied in liquid or granular form. They will be dispersed through the following devices:

- Hand boom applications – The dedicated spray unit (Toro 5500) will be used for hand boom applications. A 2.5m hand boom with 8 nozzle outlets will be used to apply 300ℓ water solution per hectare. Hand boom (Falcon) nozzles are enclosed by a specially designed polyethylene cover to eradicate drift and increase spray efficiency. This method will be used for fungicide and insecticide treatments to greens.
- Rotary Spreader – A 20ℓ rotary spreader will be used for granular applications. This method of application will not be used frequently as there are limited granular fungicides/insecticides.

9.2.4 Fertiliser Applications

All fertiliser applications will be documented on forms that will record the following :

- Location of applications
- Type of fertiliser applied
- Amount applied in kg per hectare
- Date of applications
- Product applied

Fertilisers will be applied to maintain a groomed turf area comprising tees, greens and fairways. All fertiliser applications will be undertaken according to the GCS programmes. Staff dealing with the application of fertilisers will be made fully aware of the importance of an even application rate and the dangers of over usage.

It is important that staff understand how chemicals applied to the turfgrass work to help it grow, what controlled fertilisation sets out to achieve and how it is achieved. It has already been determined that over-fertilising is detrimental to the health of turfgrass, creates a reduced tolerance to wear, drought and cold, thus creating disease susceptibility and a depleted root structure. It is the responsibility of the GCS to ensure that employees are fully trained and aware of these factors.

Greens

Fertilisers will be applied to greens and tees using a small (hand operated) broadcast spreader. The spreader output will be calibrated to half the required fertiliser needed. The applicator will apply the fertiliser in two opposite directions. This ensures an even coverage and application of the correct amount of fertiliser.

Fairways

Fertilisers applied to the fairways will be applied using mechanical methods which allow for faster application. A 400ℓ broadcast spreader is mounted on the back of a light weight utility vehicle. The utility vehicle speed and broadcast spreader output is calibrated to determine the exact application rate needed. The fertiliser is applied by starting on one side of the fairway and moving up and down the fairway and then across the fairway, each time at 8m to 10m spacings. In this way an even application is achieved.

Boom Spray Applications

Ferrous sulphate will be applied in a liquid form through a boom spray application method. Actual ferrous sulphate or the product “Ferro Mac”, a liquid concentration containing nitrogen and iron, will be applied using this technique.

9.2.5 Safety (Personal Protective Equipment)

For details of personal protective equipment (PPE) for individual fungicides/insecticides, staff should always refer to the safety instruction as stipulated on the product label. Given that all fertilisers/fungicides/insecticides will be organic in nature, it is not anticipated that significant levels of PPE will be needed.

9.2.6 Training

All staff involved in the management and application of fertilisers/ fungicides/insecticides will receive initial site health and safety training regarding the storage, handling, application, decontamination and spill control procedures. Training will be provided for all those involved in the preparation, handling and application of these materials. All staff will be trained in emergency procedures and in dealing with and reporting spillages. Furthermore, these staff will be required attended external Occupational Safety and Health Council courses on the safe handling of fertilisers/fungicides/insecticides.

9.2.7 Spillages

Spillages are extremely unlikely events with spraying equipment all designed to withstand accidents and contain fertilisers/fungicides/insecticides within tanks. Notwithstanding, in the event that any spillages occur on the Golf Course, the following actions would be taken:

- Make every effort to contain the spillage responsibly and safely
- Only staff with appropriate PPE will be allowed to enter the spill containment area
- For spillage on the Golf Course, bunds would be established if required to prevent any flow toward Golf Course drainage or the artificial lakes, and sand (at least double the spill volume) would be used to absorb the spill
- After the spill is contained, the material would be swept up or shovelled into marked containers or heavy duty plastic bags and placed in a secure area to await disposal
- The top 2” to 3” of soil may have to be removed and replaced with clean material.

10 Reporting and Implementation

10.1 Reporting

All reporting relating to implementation of the TMP (i.e. the effect on lake water quality) will be carried out through the EM&A programme, which has already been established (see Section 2.3).

During the Turfgrass Establishment Period and the Turfgrass Management Period, the EM&A programme will provide for regular monitoring and reporting of lake water quality in terms of a range of parameters that include nutrient levels. This will demonstrate that environmental impacts have been reduced to an acceptable level through the implementation of the TMP.

10.2 Implementation

The TMP will be implemented during the Turfgrass Establishment Period and throughout the Turfgrass Management Period by a dedicated team, headed by the Golf Course Superintendent (CGS). The GCS is responsible for all issues relating to the turfgrass management.

Figure 10-4, below, shows the main organisation of the GCS' Team. Additional workers (not shown) will support the Work Foreman on specific tasks.

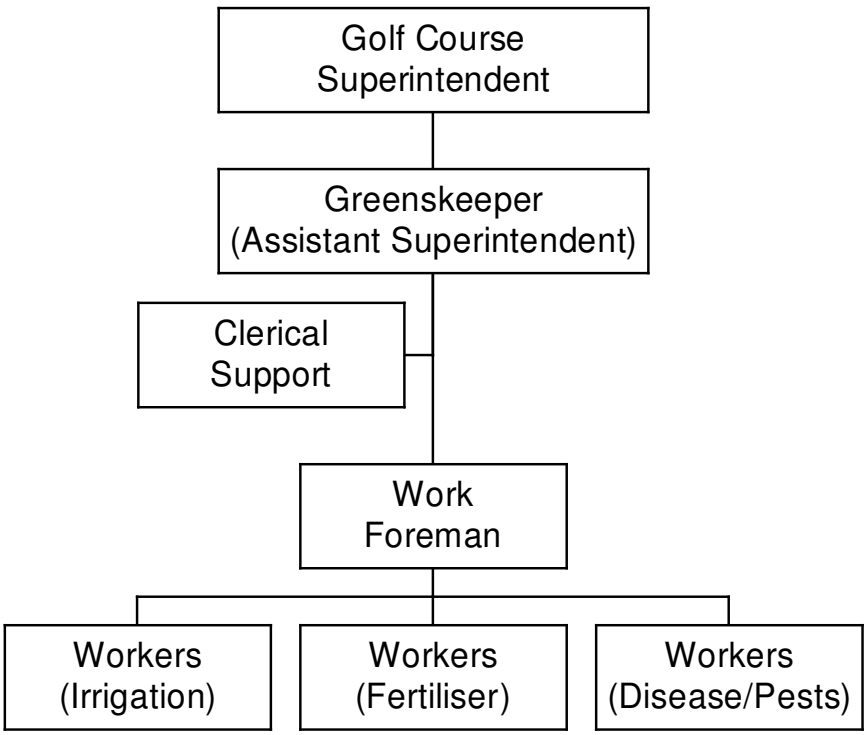


Figure 10-4 TMP Implementation Team Organisation

Appendix 1

Revised Calculations on Worst-case Nutrient Loading During Turfgrass Establishment

	Application Rate (kg/ha/app)			No. Apps	Application Rate (kg/ha)			Area (ha)	Total Application (kg)		
Programme for Sprig Turf	**N**	**P**	**K**		**N**	**P**	**K**		**N**	**P**	**K**
Greens/Fairway/Rough	25.0	50.0	75.0	2	50.0	100.0	150.0	6.37	318.5	637.0	955.5
Greens/Fairway/Rough	50.0	50.0	100.0	3	150.0	150.0	300.0	6.37	955.5	955.5	1,911.0
Greens/Fairway/Rough	7.5			6	45.0			6.37	286.7		
Total for Sprig Planting	**82.5**	**100.0**	**175.0**		**245.0**	**250.0**	**450.0**		**1,560.7**	**1,592.5**	**2,866.5**

	Application Rate (kg/ha/app)			No. Apps	Application Rate (kg/ha)			Area (ha)	Total Application (kg)		
Programme for Sod Turf	**N**	P	**K**		**N**	**P**	**K**		**N**	**P**	**K**
Tees/Surround	25.0	50.0	75.0	2	50.0	100.0	150.0	1.81	90.5	181.0	271.5
Tees/Surround (normal)	50.0	5.0	50.0	1	50.0	5.0	50.0	1.81	90.5	9.1	90.5
Tees/Surround (spoon feed)	6.5		23.0	1	6.5		23.0	1.81	11.8		41.6
Total for Sod Planting	**81.5**	**55.0**	**148.0**		**106.5**	**105.0**	**223.0**		**192.8**	**190.1**	**403.6**

	Application Rate (kg/ha/app)			Application Rate (kg/ha)			Total Application (kg)		
Sprig+Sod Monthly Programme	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
Month 1 (August)	50.0	100.0	150.0	100.0	200.0	300.0	409.0	818.0	1,227.0
Month 2 (September)	57.0	27.5	86.5	125.8	77.5	186.5	672.2	482.3	1,021.6
Month 3 (October)	57.0	27.5	86.5	125.8	77.5	186.5	672.2	482.3	1,021.6
Total Application	**164.0**	**155.0**	**323.0**	**351.5**	**355.0**	**673.0**	**1,753.4**	**1,782.6**	**3,270.1**

Table A1-11 Revised Calculations for Nutrient Application During Turfgrass Establishment

	Aug	Sep	Oct
	← *Summer/Wet Season* →		
Monthly Rainfall (mm)	161.5	316.7	376.0
Rainfall within 10.5ha Lake Catchment (m^3)	16,958	33,254	39,480
Monthly Irrigation (mm)	78	109	111
Irrigation to 3.65ha Irrigated Area (m^3)	-2,847	-3,960	-4,052
Monthly Evaporation (mm)	112.5	143.4	147.7
Evaporation from 1.13ha Lakes (m^3)	-1,271	-1,620	-1,669
Rainfall - Irrigation - Evaporation (m^3)	12,839	27,673	33,759
Max Lake Volume (incl.freeboard) (m^3)	17,500	17,500	17,500
Net Volume of Lake (m^3)	12,839	45,173	51,259
Overflow (Net Vol - Max Lake Vol) (m^3)	none	27,673	33,759
Ave Nitrogen Application (kg)	409.0	672.2	672.2
Assume 100% into Monthly Rainfall (mg/ℓ)	24.1	20.2	17.0
Concentration at Outfall No. 8 (mg/ℓ)	none	5.6	4.7
%age of WPCO (30mg/ℓ)	n/a	18.6%	15.7%
Ave Phosphorous Application (kg)	818.0	482.3	482.3
Assume 100% into Monthly Rainfall (mg/ℓ)	48.2	14.5	12.2
Concentration at Outfall No. 8 (mg/ℓ)	none	4.0	3.4
%age of WPCO (5mg/ℓ)	n/a	80.1%	67.5%
Ave Potassium Application (kg)	1,227.0	1021.6	1021.6
Assume 100% into Monthly Rainfall (mg/ℓ)	72.4	30.7	25.9
Concentration at Outfall No. 8 (mg/ℓ)	none	8.5	7.1

Notes :
1. Monthly rainfall and evaporation rates from Hong Kong Observatory historical data, from 1960 onwards and represents average monthly data (including extreme events).
2. Irrigation rates are typical for *Paspalum* turfgrass. In terms of water balance, whether turfgrass receives water from irrigation or rainfall makes no difference to net volumes.
3. Nutrient application rates based on Table A1-11.
4. Overflow from lake represents 10.5ha of the 38ha catchment of Outfall No. 8. Therefore, overflow from the Golf Course is diluted by 10.5/38 in any flow from Outfall No. 8.
5. There is no WPCO standard for potassium. Standards for Nitrogen and Potassium based requirements stated in the Project Profile for this Project.

Table A1-12 Revised Calculations for Worst-case Nutrient Loading During Turfgrass Establishment

Appendix 2

Revised Calculations on Worst-case Nutrient Loading During Turfgrass Maintenance

	Application Rate (kg/ha/app)			No. Apps	Application Rate (kg/ha)			Area (ha)	Total Application (kg)		
Winter Programme	**N**	**P**	**K**		**N**	**P**	**K**		**N**	**P**	**K**
Greens (normal)	49.0		98.0	3	147.0	-	294.0	0.65	96	-	191
Greens (supplement)	20.0	10.0	40.0	2	40.0	20.0	80.0	0.65	26	13	52
Fairways/Tees/Surround (normal)	40.0	16.0	80.0	2	80.0	32.0	160.0	3.00	240	96	480
Rough	20.0	8.0	40.0	2	40.0	16.0	80.0	4.53	181	72	362
Total	**129.0**	**34.0**	**258.0**		**307.0**	**68.0**	**614.0**		**542.8**	**181.5**	**1,085.5**

	Application Rate (kg/ha/app)			No. Apps	Application Rate (kg/ha)			Area (ha)	Total Application (kg)		
Summer Programme	**N**	**P**	**K**		**N**	**P**	**K**		**N**	**P**	**K**
Greens (normal)	40.0	5.5	80.0	5	200.0	27.5	400.0	0.65	130.0	17.9	260.0
Greens (spoon feeding)	6.5		23.0	5	32.5	-	115.0	0.65	21.1	-	74.8
Fairways/Tees/Surround (normal)	50.0	5.0	50.0	4	200.0	20.0	200.0	3.00	600.0	60.0	600.0
Fairways/Tees/Surround (spoon)	6.5		23.0	5	32.5	-	115.0	3.00	97.5	-	345.0
Rough	25.0	2.5	25.0	4	100.0	10.0	100.0	4.53	453.0	45.3	453.0
Total	**128.0**	**13.0**	**201.0**		**565.0**	**57.5**	**930.0**		**1,301.6**	**123.2**	**1,732.8**

	Application Rate (kg/ha/app)			No. Apps	Application Rate (kg/ha)			Area (ha)	Total Application (kg)		
Totals per Playing Area	**N**	**P**	**K**		**N**	**P**	**K**		**N**	**P**	**K**
Greens	115.5	15.5	241.0	15	419.5	47.5	889.0	0.65	272.7	30.9	577.9
Fairways, Tees and Surrounds	96.5	21.0	153.0	11	312.5	52.0	475.0	3.00	937.5	156.0	1,425.0
Rough	45.0	10.5	65.0	6	140.0	26.0	180.0	4.53	634.2	117.8	815.4
Total Annual Application	**257.0**	**47.0**	**459.0**	**32**	**872.0**	**125.5**	**1,544.0**	**8.18**	**1,844.4**	**304.7**	**2,818.3**

Table A2-13 Revised Calculations for Nutrient Application During Turfgrass Maintenance

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	← *Winter/Dry Season* →			←		*Summer/Wet Season*				→	← *Winter/Dry* →	
Monthly Rainfall (mm)	23.4	48.0	66.9	161.5	316.7	376.0	323.5	391.4	299.0	144.8	35.0	27.3
Rainfall within 10.5ha Lake Catchment (m^3)	2,457	5,040	7,025	16,958	33,254	39,480	33,968	41,097	31,395	15,204	3,675	2,867
Monthly Irrigation (mm)	78	62	71	78	109	111	130	121	117	121	102	87
Irrigation to 3.65ha Irrigated Area (m^3)	-2,829	-2,248	-2,602	-2,847	-3,960	-4,052	-4,752	-4,413	-4,271	-4,413	-3,723	-3,168
Monthly Evaporation (mm)	102.7	81.9	95.9	112.5	143.4	147.7	175.0	161.0	156.0	159.0	135.0	116.0
Evaporation from 1.13ha Lakes (m^3)	-1,161	-925	-1,084	-1,271	-1,620	-1,669	-1,978	-1,819	-1,763	-1,797	-1,526	-1,311
Rainfall - Irrigation - Evaporation (m^3)	-1,532	1,866	3,338	12,839	27,673	33,759	27,238	34,865	25,362	8,994	-1,574	-1,613
Max Lake Volume (incl.freeboard) (m^3)	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500	17,500
Net Volume of Lake (m^3)	15,968	19,366	20,838	30,339	45,173	51,259	44,738	52,365	42,862	26,494	15,927	15,888
Overflow (Net Vol - Max Lake Vol) (m^3)	none	1,866	3,338	12,839	27,673	33,759	27,238	34,865	25,362	8,994	none	none
Ave Nitrogen Application (kg)	108.6	108.6	108.6	185.9	185.9	185.9	185.9	185.9	185.9	185.9	108.6	108.6
Assume 100% into Monthly Rainfall (mg/ℓ)	44.2	21.5	15.5	11.0	5.6	4.7	5.5	4.5	5.9	12.2	29.5	37.9
Concentration at Outfall No. 8 (mg/ℓ)	none	6.0	4.3	3.0	1.5	1.3	1.5	1.3	1.6	3.4	none	none
%age of WPCO (30mg/ℓ)	n/a	19.8%	14.2%	10.1%	5.2%	4.3%	5.0%	4.2%	5.5%	11.3%	n/a	n/a
Ave Phosphorous Application (kg)	36.3	36.3	36.3	17.6	17.6	17.6	17.6	17.6	17.6	17.6	36.3	36.3
Assume 100% into Monthly Rainfall (mg/ℓ)	14.8	7.2	5.2	1.0	0.5	0.4	0.5	0.4	0.6	1.2	9.9	12.7
Concentration at Outfall No. 8 (mg/ℓ)	none	2.0	1.4	0.3	0.1	0.1	0.1	0.1	0.2	0.3	none	none
%age of WPCO (5mg/ℓ)	n/a	39.8%	28.6%	5.7%	2.9%	2.5%	2.9%	2.4%	3.1%	6.4%	n/a	n/a
Ave Potassium Application (kg)	217.1	217.1	217.1	247.5	247.5	247.5	247.5	247.5	247.5	247.5	217.1	217.1
Assume 100% into Monthly Rainfall (mg/ℓ)	88.4	43.1	30.9	14.6	7.4	6.3	7.3	6.0	7.9	16.3	59.1	75.7
Concentration at Outfall No. 8 (mg/ℓ)	none	11.9	8.5	4.0	2.1	1.7	2.0	1.7	2.2	4.5	none	none

Notes :
1. Monthly rainfall and evaporation rates from Hong Kong Observatory historical data, from 1960 onwards and represents average monthly data (including extreme events).
2. Irrigation rates are typical for *Paspalum* turfgrass. In terms of water balance, whether turfgrass receives water from irrigation or rainfall makes no difference to net volumes.
3. Nutrient application rates based on Table A2-13.
4. Overflow from lake represents 10.5ha of the 38ha catchment of Outfall No. 8. Therefore, overflow from the Golf Course is diluted by 10.5/38 in any flow from Outfall No. 8.
5. There is no WPCO standard for potassium. Standards for Nitrogen and Potassium based requirements stated in the Project Profile for this Project.

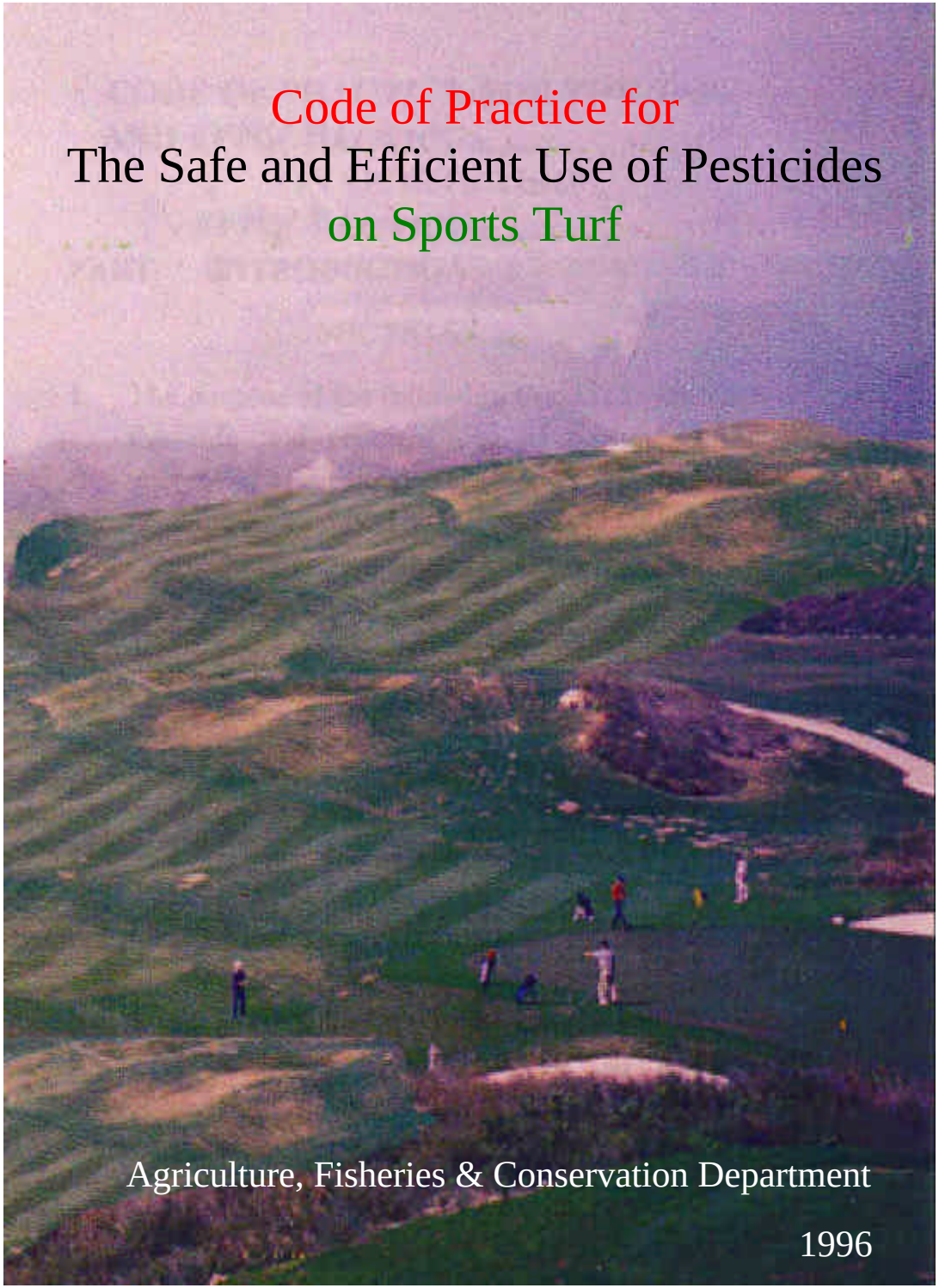
Table A2-14 Revised Calculations on Worst-case Nutrient Loading During Turfgrass Maintenance

Appendix 3

AFCD Code of Practice for the Safe and Efficient Use of Pesticides on Sports Turf

and

AFCD Leaflet on the Safe use of Agricultural Pesticides



CODE OF PRACTICE FOR THE SAFE AND EFFICIENT USE OF PESTICIDES ON SPORTS TURF

PART I INTRODUCTION

1. The purpose of the following Code is to promote the safe and efficient use of pesticides and ensure the protection of the environment (including indigenous flora and fauna), while maintaining good quality turf grass.

2. The practices detailed in the Code should not be taken as strict rules as turf grass management requires a flexible approach to wide ranging problems. The Code will, however, be adhered to as closely as individual circumstances allow.

3. This code of practice on the safe and efficient use of pesticides on sports turf has been drawn up by representatives from all golf courses in Hong Kong and the Hong Kong Jockey Club with assistance from the Hong Kong Agriculture, Fisheries & Conservation Department.

PART II APPOINTMENT OF COMPETENT PERSONNEL

4. Management should employ a person trained in the theory and practice of turf grass management and maintenance as the responsible person who will implement the Code. It is the responsibility of the turf grass manager to keep abreast of relevant up-to-date information on pesticides.

PART III GUIDELINES

a) Training

5. To ensure that pesticides, where needed, are applied safely and efficiently, management will ensure that all pesticide applicators have received training on basic issues including pesticide formulation, application methods, safety measures, effects on the environment and operation of application equipment.

b) Storage, Handling and Disposal

6. Pesticides must be stored in compliance with relevant Ordinances and Regulations. In particular, requirements under the Pesticides Ordinance, Cap. 133 must be met. Chemicals should be kept in secure, well ventilated storage areas with adequate fire control and spillage containment facilities.

7. A responsible person at the appropriate level should be appointed to receive pesticide deliveries and to ensure prompt transport to the established storage facility. He will also ensure all deliveries are in original, undamaged containers.

8. Any waste chemicals and/or containers should be disposed of through a licensed waste collector in accordance with the Waste Disposal (Chemical Waste) (General) Regulations.

c) Planning Pesticide Use

9. When any turf grass problem occurs, the cause must first be correctly identified. If the cause is found to be a pest, non-chemical control methods should initially be considered (e.g. hand weeding). If these are not applicable, the safest (in terms of human exposure and effects on the environment) effective chemicals should be considered. When making such decisions, it is recognized that not all chemicals registered in Hong Kong are necessarily recommended for use in turf grass management. At all times, long term effects, as well as short term controls, should be considered when selecting pesticides and chemicals should be chosen which best fit into an Integrated Pest Management programme.

10. Once a chemical has been identified, formulation and concentration should be selected to maximize effect against the target while minimizing risk of affecting non-target organisms and the environment. Before any control programme is initiated, the safety rules as advocated by the Agriculture, Fisheries & Conservation Department in their leaflet on "Safe Use of Agricultural Pesticides" should be considered.

d) Pesticide Application

11. It is the responsibility of the turf grass manager to ensure that all applications of pesticides are in accordance with the product label instructions. Following such instructions (which should be in English and Chinese) will ensure the safe and effective delivery of the chemical to the target. The guidelines laid down in AFCD advisory leaflet should be followed and from that, a pesticide operation manual be developed, including a checklist of do's and don'ts in pesticide use.

e) Protective clothing and personnel health.

12. Management will provide appropriate protective clothing for pesticide applicators and ensure that it is worn when chemicals are being handled as recommended on the specific product label or material safety data sheet. Management should also arrange for annual medical examinations of their pesticide applicators.

f) Posting notices.

13. As an integral part of the pesticide application process, management will ensure notices are put up informing the turf grass users of product application to the turf. Prior to the application, notices should be posted at prominent place(s) and could include details on the pesticide and where it will be applied.

g) Periodic survey.

14. A periodic survey should be conducted on managed turf grass to assess the possibility of chemical residues. Survey locations should be selected to reflect the different management regimes on different playing surfaces.

h) Record Keeping.

15. Records should be kept on pesticide stocks, analytical data and pesticide use. Turf grass managers should also keep reference material such as copies of relevant Ordinances, material safety data sheets and label information.

Agriculture, Fisheries and Conservation Department

Safe use of Agricultural Pesticides

Pesticide, given its intrinsic properties to kill pests, is toxic in nature. It must not be regarded as a panacea for all pest problems but should only be used in a judicious manner. AFCD recommends the adoption of an Integrated Pest Management (IPM) approach, which is sensitive to both human health and the environment. Such approach can also reduce the use of pesticides and prevent the development of resistance.

The essential components of IPM generally include the followings:

- Selection and rotation of suitable kinds and varieties of crops
- Identification, monitoring and assessment of pest problems
- Good field sanitation
- Integration of physical, biological and chemical control
- Record keeping system

When pesticides are indeed needed for crop protection, you must always handle them safely and responsibly. Some general safety guidelines are listed below for pesticide users to follow:

Preparation

- Select suitable pesticides for the crops and pests concerned.
- Only purchase registered pesticides which are properly labelled and packaged.
- Always read and follow label instructions. In particular, pay close attention to the dilution and application rate, special precautions on safety, pre-harvest interval, phytotoxicity, compatibility etc.
- Use proper measuring cylinders which are reserved for use with pesticides. These must be washed thoroughly after use.
- Measure carefully and mix only the amount needed for the current job.
- Only mix pesticides in a well-ventilated location. Use a stick to stir the mixture. Do not use bare hands.

Equipment

- Wear appropriate personal protective equipment (PPE) as specified on the label. (e.g. overalls, rubber gloves, boots, face mask, goggles etc.) when mixing and applying pesticides.
- Use separate, clearly marked sprayers for insecticides and herbicides.
- Provide proper calibration, maintenance and regular checking of leakages from joints/ pipes and worn or blocked nozzles (uneven spray pattern)
- After using the sprayer:
  - empty any residue through nozzle, do not blow out a clogged nozzle with your mouth
  - fill and rinse tank with clean water, flushing some through nozzle
  - repeat, drain tank and nozzles completely
  - store in a dry place with lid open
- If a motorized sprayer is not going to be used within the next 48 hours, drain fuel tank and carburetor and leave empty.

Field application

- Pregnant or sensitized persons should not apply pesticides.
- Post warning notices (e.g. Poison, no-entry, name of pesticide, date and time of application, etc) at conspicuous locations.
- Do not smoke, eat or drink when spraying.
- Do not spray
  - when crops are wet from rain or dew
  - in a strong wind
  - if you expect rain to fall within the next few hours
  - when flowers are in bloom
- Keep to windward when spraying.
- Beware of spray drift, do not inhale the mist. Avoid contact with mouth, eyes, skin and clothing.
- Stop spraying immediately if you are feeling ill. Bring along the label when seeking medical attention.
- Avoid drift and contamination of non-target objects
- Avoid getting pesticides on you. Keep a bucket of water and soap handy when you spray -- if you splash yourself with pesticide, wash immediately.
- If you are left with a small quantity of spray, spray it evenly over the treated area.
- Unless otherwise directed by label, do not harvest crops for at least two weeks after the last treatment.
- Wash thoroughly with soap and water after handling or using pesticides. Wash clothing worn for pesticide applications after each application and separately from other laundry.
- Triple rinse empty container and wash mixing stick thoroughly, then dispose of the container as standard municipal waste.
- Collect rinsing and spray it evenly over the treated area. Do not contaminate water source.

Storage and disposal

- Purchase and keep only the amount of pesticide required for operational needs
- If it is necessary to store pesticides, always store them under lock and key in their original, labeled container. Make sure all containers are tightly closed. Store pesticides away from food, feed and out of reach of children and livestock animals.
- Do not use the empty container for other purposes.
- Dispose obsolete or unwanted pesticides properly in accordance with requirements laid down in the Waste Disposal Ordinance.

Enquiries:

Agriculture, Fisheries and Conservation Department
Email : mailbox@afcd.gov.hk
Website : http://www.afcd.gov.hk
Agricultural Development Section (Tel : 2656 2333)
Plant Protection Section (Tel : 2679 4354)
Plant and Pesticides Regulatory Division (Tel : 2150 7010)