Chapter 1

Environmental Issues & Golf Course Management
Water Management

Irrigation

The production of healthy turf for year-round play requires irrigation under the seasonally dry conditions prevailing on most of the Australian continent. Australia’s freshwater resources are limited and frequently become scarce in extended drought periods. The use of these resources to maintain recreational facilities such as golf courses has been perceived by environmentalists and the public as wasteful. This public perception is being corrected by various golf courses who place signage on perimeter fences stating that alternative sources to town water are used for irrigation.

The reduction of the use of potable water for irrigation can be achieved by using the most efficient irrigation design, minimising the area irrigated, using technology to determine irrigation requirements, selecting plant species with reduced water requirements and developing alternative sources.

Alternative irrigation water sources are increasingly sought and used for turf irrigation.

Effluent and storm water sources of irrigation water offer a benefit to the community. Water with contaminants which would otherwise pollute local waterways and beaches can be filtered through the turf system. The quality of these waters is actually improved by the filtering which occurs as the water passes through the turf, thatch and soil on a golf course. In addition, the turfgrass utilises nutrients contained in the water.

Price has also been an incentive for golf courses to investigate alternative water sources. Potable water is becoming more expensive, with golf courses paying up to $75 000 per year for town water. This price rise has been influenced by the ‘user-pays’ regime for resources. Many clubs are investigating alternative sources to find water of a quality satisfactory for irrigation of turf. An irrigation water quality monitoring program should be implemented for irrigation sources which are of marginal quality or which show fluctuations in quality.

Golf courses which use alternative water sources to mains water may consider placing signs appropriately to state this, especially in times of water restrictions. This shows the local community that the club is taking steps to conserve water.

Turfgrass species vary in their water requirements. The use of local native grasses for turf has been discussed, because they are adapted to local rainfall conditions, however the supply of these species is still very limited and knowledge on their management is even more scarce. The selection of turfgrasses must involve evaluation of their suitability for the local climate. Species which are grown outside their optimum climate will require greater inputs for their management, and water is one of the most significant inputs.

Table 1. The potential environmental impacts of golf course management activities

The impacts have been separated into those which cause disturbance and those which cause pollution. Ratings indicate the potential for impact, which can be reduced through diligent management.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Disturbance</th>
<th>Pollution</th>
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<tbody>
<tr>
<td></td>
<td>Soil</td>
<td>Vegetation</td>
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<tr>
<td>Construction</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>Pesticide Application</td>
<td>N</td>
<td>H</td>
</tr>
<tr>
<td>Irrigation</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td>Fertiliser Application</td>
<td>N</td>
<td>L</td>
</tr>
<tr>
<td>Mowing</td>
<td>N</td>
<td>M</td>
</tr>
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N = Negligible   L = Low potential   M = Medium potential   H = High potential
governments have established guidelines for such irrigation. For those currently using effluent water or planning to use effluent water in the future it is advisable to contact the environmental agency, (eg the EPA) to obtain a copy of these guidelines. A particular concern with effluent water is the health hazards to golfers, maintenance staff and the public. The use of effluent water for irrigation may therefore involve restriction of hours of operation, restriction on proximity to the neighbouring community and withholding periods before access to irrigated areas is allowed. This raises important issues for golf course management in educating their staff, members and the public. Governments also regulate the use of effluent for irrigation on the depth of groundwater from the surface.

Guidelines for irrigation farming are available from some state departments of agriculture. While these guidelines are written in general for irrigation agriculture, the principles are valid for golf courses.

Tensiometers are devices used for measuring the soil water content. These devices are frequently used in various fields of horticulture and agriculture to determine irrigation scheduling. It the last few years increased use of such devices in Australian turf management has been reported. Such devices can help determine when to irrigate and how much to irrigate.

Concerns for water pollution and contamination of the environment by golf courses are both from point and diffuse sources. Point source pollution arises from a distinct ‘point’, or location. Potential sites of point source pollution from golf courses are the drainage pipes from a machinery washdown bay or a green into a stormwater drain. Diffuse source pollution cannot be geographically defined. An example of this type of pollution occurs when run-off water from a thunder storm flows across a fairway picking up grass clippings, soil particles and fertiliser granules and then flows into the adjoining waterway.

Potential point sources of pollution on a golf course need to be identified and appropriate measures taken to minimise the risk of pollution. This may involve water treatment.

Potential diffuse source pollution on a golf course, is more dependent on good general management of the practices which may generate or influence diffuse water pollution. These include fertiliser and pesticide application, and erosion control practices.

Often with stormwater events, the concentration of pollutants will be highest in the first water in the runoff process. This phenomenon is sometimes known as “first flush”. This water in small impervious catchments, such as carparks and roofs, can be detained by a “first flush system”. The system retains the “first flush” in a pit and allows the following water to continue on its normal path. The pit can then be pumped out onto the surrounding turf to filter pollutants as the water percolates through the soil. It is most important to clean out the pit immediately after each stormwater event. Expert technical advice will be needed on the pit design and construction. Stormwater management consultants or the state environment protection agency may be able to help. The NSW EPA in its Environmental Protection Manual has a document “Stormwater First Flush Pollution” which provides some information on designing such a system.

The ultimate solution to effectively prevent pollution is to contain all contaminants on site. Golf courses which are able

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**Table 2. The potential environmental impacts of irrigation**

<table>
<thead>
<tr>
<th>High or Medium</th>
<th>Low or Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Erosion of exposed soil</td>
<td>- Vegetation, unless irrigation is very excessive</td>
</tr>
<tr>
<td>- Water and air pollution, especially with effluent. Nutrients in effluent water may run-off or leach and cause water pollution while biological organisms in the water may drift in the air and become a health hazard</td>
<td>- Disturbance to wildlife and heritage sites</td>
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<tr>
<td></td>
<td>- Soil pollution, however there may be some contaminants in effluent water</td>
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<td></td>
<td>- Noise pollution</td>
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to capture water before it leaves the course are in a position to contain contaminants within the golf course and possibly even re-use that water for irrigation.

**Fertilisers**

The production of a healthy turfgrass sward requires nutrient inputs from fertilisers. The development of a sound nutrient management plan is required to ensure the supply of nutrients to the turf meets turf requirements while minimising any environmental impacts.

Development in technology is making an increasing range of fertiliser forms available. Slow release and controlled release fertiliser are now being incorporated into fertiliser management plans. These fertilisers have the potential to decrease the risk of water pollution when compared to soluble fertilisers.

Testing of the nutrient status of soil is practised by most Australian golf courses. Data on the quantities of essential elements for plant growth in the soil is used to determine the exact quantities and types of ameliorants and fertilisers required. Soil and leaf tissue testing are important tools for monitoring and matching turfgrass requirements with fertiliser inputs.

Wetlands and waterbodies are very susceptible to poor nutrient management practices. An excess of nitrogen and phosphorus in these ecosystems results in algal blooms, excess aquatic plant growth and decrease in oxygen levels. Protection of wetlands and waterbodies through the maintenance of buffer zones is recommended for all golf courses. The buffer zone should be well vegetated and an area with minimal fertilizer and pesticide application. The edge vegetation filters pollutants before they enter the waterbody.

Cadmium is a heavy metal which is found in some fertilisers and soil amendments. As is common with heavy metals, it can accumulate in plants and also persists in the soil for hundreds of years. Golf course managers need to be aware of heavy metal contaminants in their fertilisers and soil amendments as this may influence the contamination level of their soil and turfgrass refuse (clippings, corings etc.). This in turn may present an increased environmental hazard from these materials and may affect disposal options for such waste.

**Soil Conservation**

**Erosion**

A cover of plants or mulch should be maintained on all exposed areas to minimise erosion risk. The construction phase of most golf courses is the most susceptible for soil erosion. Standard practices to control soil movement developed for construction sites should be used in such cases.

Suspended soil particles in run-off water can contain nutrients, heavy metals or pesticide residues. Minimising soil erosion will also reduce the risk of water pollution from these pollutants.

**Soil Salinity**

One of the greatest challenges currently facing agriculture in Australia is soil salinity. Golf courses are also subject to soil salinity problems. An understanding of the salinisation processes for each site is required. Remedial action with the use of salt tolerant plants, soil amendments or structural works can then be designed to help improve the situation. State departments of agriculture (or equivalent) have a wide variety of information available on management of saline soils.

![Soil Salinity is influenced by:](image)
- fertiliser residues
- soluble salts in irrigation water (common in effluent and bore water)
- rising water tables
- exposure of saline sub-soils

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### Table 3. Potential Environmental Impacts of Fertilizer Use

<table>
<thead>
<tr>
<th>High or Medium</th>
<th>Low or Negligible</th>
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<tbody>
<tr>
<td>- Vegetation - some native species are sensitive to high nutrient levels</td>
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</tr>
<tr>
<td>- Wildlife - some wildlife habitats, like aquatic environments, can be degraded by high nutrient levels</td>
<td></td>
</tr>
<tr>
<td>- Soil pollution - heavy metal impurities can be found in fertilizers</td>
<td></td>
</tr>
<tr>
<td>- Disturbance to soil and heritage sites</td>
<td></td>
</tr>
<tr>
<td>- Air and noise pollution</td>
<td></td>
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<tr>
<td>- Waste generation</td>
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The Australian Golf Club is a high profile course in the eastern suburbs of Sydney, NSW. Due to its location in the sand belt, with drainage from the course flowing to the Botany wetlands, the club had concerns that water used to wash down golf course management equipment may have been causing water pollutants such as oils and pesticides.

In 1991 the club installed a state-of-the-art water recycling system for their wash down bay. The system separates organics, soil, oils and pesticides from the water, which is reused for washing equipment - a true closed-loop system. Any excess water from the system is used to irrigate the garden at the maintenance shed, or as water for the first or second rinse of the spray tankers.

The system presented a considerable initial investment for the club, but ensured a minimisation of the risk of environmental pollution from this potential source, and ensured the risk of environmental pollution from their wash down bay is minimised.
**Acidification**

All Australian states contain acid soils which present problems for the growing of many important agricultural and horticultural species.

Accelerated soil acidification can develop through the use of acidifying fertilisers. On golf courses this can lead to non-optimum conditions for turfgrass growth. Turfgrass growing in an acid soil may then be more susceptible to stress from pests, diseases, moisture and heat. This may lead to increased use of pesticides, fertilisers and water, therefore it is best to maintain optimum pH for turfgrass growth. This can be achieved by regular soil testing (including subsoil pH for deep rooted turfgrass species) and use of appropriate amendments. Many Australian native plants are adapted to grow in acidic soils. In such situations raising the soil pH will not have a benefit to the plant community, and may be detrimental by creating unfavourable conditions for the native plants, and conditions which favour invasion by exotics.

**Acid Sulphate Soils**

Acid sulphate soils (ASS) contain iron sulphides or their oxidation products. When these soils are excavated or drained they come into contact with oxygen which reacts with the sulphides to produce sulphuric acid.

These soils are found extensively in coastal areas and therefore have the potential to affect many coastal golf clubs. Mapping programs for ASS have been conducted around Australia and guidelines for their management have been prepared. The state land and water conservation agencies are able to provide further details on the maps and the guidelines.

Golf courses with ASS or potential acid sulphate soils (PASS) have to be careful with any activities which may disturb these soils. Construction works and activities which may expose these soils or lower the water table require careful consideration. Consultation with the published guidelines is recommended.

**Pesticides**

Answering the questions of the members, visiting players and the general public on pesticide usage can be difficult. It is advisable to take any raised concerns as being genuine and be open about pesticide use on the golf course. Explain why pesticides are used, how pesticides undergo rigorous toxicological and environmental testing before they are available for use and the practices being used to safely apply and manage pesticides.

Recent research coordinated by the United States Golf Association (USGA) suggests that provided pesticide and fertiliser products are correctly used, pollution by leaching and run-off from turf is negligible. Therefore it is most important for golf courses to have the appropriate equipment, and properly trained staff to be able to use these products correctly.

Damage or invasion by pests can be tolerated to a certain level by golfers, but above this level damage to the playing surface becomes too great and is unacceptable. Even at unacceptable levels of damage, the use of pesticides does not need to be the first option. Biological control, cultural techniques or low toxicity chemicals offer possible alternatives.
If these are not a feasible solution then pesticides may be required.

Education of players to accept a level of imperfection in the playing surface has the potential to reduce the use of pesticides. This will produce economic savings for the club and an advantage for the environment. For example, if some degree of weed invasion is acceptable to the players, this may save on an application of herbicide.

Integrated Pest Management (IPM) is a system of using a range of techniques to manage a particular pest problem, rather than reaching for the quick fix solution. IPM involves having a detailed level of understanding of the life cycles of pests, and finding means to control pests which are successful, of low hazard, effective and use a range of control techniques.

Pesticide regulation in Australia is primarily implemented by a system of registration and enforced by the National Registration Authority. The relevant Act is the Agricultural and Veterinary Chemicals Code Act 1994. The pesticide label is a legal document and the directions given on the label must be followed. The chemical in the container must be used for the purpose for which it is registered, at the rates detailed on the label and according to all other directions given on the label.

Long term pesticide use and/or application of higher than recommended rates of a pesticide can lead to problems of pest resistance or enhanced biolegradation of the pesticide. Both of these problems mean a reduction in the efficacy of the pesticide. To avoid such problems the pesticide should be used at recommended rates and intervals to avoid excessive application. Because these problems are chemical specific, the practice of pesticide rotation is also suggested. Pesticide rotation involves the use of pesticides from different activity groups to control a particular pest. Information on pesticide activity groups of herbicides, fungicides and insecticides has been prepared by Avcare (contact details in Appendix 4).

### Table 4. Potential Environmental Impacts of Pesticide Use

<table>
<thead>
<tr>
<th>High or Medium</th>
<th>Low or Negligible</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wildlife - due to the phase out of some chemicals and new technology, the risk is less than in the past</td>
<td></td>
</tr>
<tr>
<td>• Vegetation - drift and direct application</td>
<td></td>
</tr>
<tr>
<td>• Water and air pollution - run off, leaching and spray drift can occur</td>
<td></td>
</tr>
<tr>
<td>• Waste - packaging and container disposal</td>
<td></td>
</tr>
<tr>
<td>• Disturbance to soil and heritage sites</td>
<td></td>
</tr>
<tr>
<td>• Soil pollution and erosion</td>
<td></td>
</tr>
<tr>
<td>• Noise pollution</td>
<td></td>
</tr>
</tbody>
</table>

**Construction Management**

Reconstruction of greens, tees, bunkers and gardens are common practices on golf courses. These activities usually involve minor earth works, however environmental impacts of these and larger constructions need to be considered.

Guidelines have been designed for significant construction sites and are most applicable for new golf course developments. However, these can also offer useful information for management of small construction operations on golf courses.

**Waste Management**

The Commonwealth Government’s 1992 National Waste Minimisation and Recycling Strategy set a target of 50% reduction in waste going to landfill by the year 2000, based on 1990 levels. Although generally not regarded as significant producers of waste, golf clubs as a part of the community, have a responsibility to reduce, reuse and recycle their waste.

The “Draft Waste Management Strategy for Queensland - Discussion Paper (May 1994)” presents not only a detailed overview on waste management in Queensland but some summary information for all other Australian states and territories.

**Pesticides - management checklist:**

- Transport
- Storage – ventilation, security, bunding, isolation
- Staff training
- Signage and withholding periods
- Application – application equipment, safety equipment, weather conditions, buffer zones
- Post application treatment – irrigation
- Waste management – left over chemical, empty containers and wash down bays
- Health monitoring – blood tests
- Record keeping – inventories, application records, accident reporting
- Compliance with legal responsibilities
Australian golf courses will feel increasing environmental and economic pressure to compost their own green waste. Composting green waste on a large scale has been demonstrated to be successful on overseas golf courses, in other industries, and at large green waste processing and composting centres. Special activators and composting worms can be used to help the composting process. The pressure from governments on the management of green waste will increase. The NSW state government in their “Green Waste Action Plan” has called for a ban on green waste going to landfill in the Sydney-Metro Region after 1 July, 1998.

There are some oil purification systems available for installation onto engines which claim to remove contaminants from the oil while the engine is being used. In this way, the oil does not need to be drained and discarded. A filter cartridge needs to be replaced periodically and the oil “topped-up”.

Pesticide containers should be correctly cleaned prior to disposal. Avcare have produced guidelines for this purpose, ‘Effective rinsing of farm chemical containers’. This document can be obtained from Avcare (see Appendix 4). Pesticide container recycling services operate for 20L drums. Contact details for these operators can also be obtained from Avcare.

Organochlorine pesticides (eg. Dieldrin) and mercurials (eg PMA) are persistent and toxic chemicals which are no longer registered for use in turf. Some golf courses may have residual stores of the chemicals from when they were registered for use. The Commonwealth Government through the National Advisory Body and Scheduled Wastes Management Group is currently developing a management strategy for these pesticides. This strategy will give direction on the correct disposal of these pesticides.

**Recycling golf course waste**
- Scrap metals and batteries to metal recycling yards
- Glass through the local council or recycling centre
- Cardboard and paper through the local council or a contractor
- Chipped timber waste can be used as a garden mulch or for lining paths, tracks and roads on the course.
- Recycling services around Australia for motor oil may be supplied by the state government (at Waste Service Depots), local council, Waste Reduction and Disposal Services or at local petrol stations.

<table>
<thead>
<tr>
<th><strong>Table 5. Potential Environmental Impacts of Construction Activities</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>High or Medium</strong></td>
</tr>
<tr>
<td>• Disturbance to soil, vegetation, wildlife, heritage sites</td>
</tr>
<tr>
<td>• Water pollution</td>
</tr>
<tr>
<td>• Erosion</td>
</tr>
<tr>
<td>• Air and noise pollution from machinery</td>
</tr>
</tbody>
</table>

**Waste Streams - from golf courses:**
- green/organic
- recyclable (glass, paper, recyclable plastics, metal)
- hazardous materials (pesticides, oils, batteries, contaminated soils)
- residual waste (non-recyclable plastics)

<table>
<thead>
<tr>
<th><strong>Table 6. Potential Environmental Impact of Mowing</strong></th>
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<tbody>
<tr>
<td><strong>High or Medium</strong></td>
</tr>
<tr>
<td>• Vegetation - mowing grasslands or ring-barking of trees and shrubs</td>
</tr>
<tr>
<td>• Water pollution from nutrients in grass clippings</td>
</tr>
<tr>
<td>• Noise pollution from mowing machinery</td>
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</table>
Contractors are available to dispose of chemical wastes (unwanted pesticides, oils, fuels etc.), as it is illegal to pour these into drains or waterways. Some pesticides may also be disposed of at state Waste Service Depots. Contact them with details of the chemical and the quantity involved.

It is becoming more common to use refillable containers, new formulations and water soluble packaging for pesticides. These will lead to reduced container and packaging waste.

The management of contaminated land may be an issue for golf courses. Firstly, management practices of the golf course, past or present, may have contaminated the site. Secondly, the golf course may be established on land contaminated by a previous land use, for example a landfill or factory.

Where contamination has occurred from course management practices such as fertiliser and pesticide use, the club is responsible. Where contamination is from a previous land use, governments have generally legislated to make the original polluter responsible. Either way the club must realise that this is an issue if removal and disposal of soil is to occur. The environment protection agency in each state is the appropriate contact for further information, see Appendix 1. They can provide information for assessment of contaminated sites and materials, levels of “contamination” and how such materials should be managed. Some states, such as Queensland, keep a register of contaminated sites.

For these reasons it is most important that golf clubs have a documented history of land use. If issues of a contaminated site or contaminated soil are raised and they are identified with previous land use then it may be possible to ensure responsibility for the pollution remains with the polluter.

Soil from construction sites to be taken off site may be reused, classified as clean fill, or classified as contaminated, then requiring special disposal methods.

Contaminated material assessment may require analysis for heavy metals, persistent pesticides (organochlorines and some organophosphates), polychlorinated biphenyls and total petroleum hydrocarbons.

Guidelines for the assessment and management of contaminated sites have been established by the Australian and New Zealand Environment Conservation Council and the National Health and Medical Research Council (January 1992). They also provide guidelines for pollutant levels in soil.

Waste Management Plans are useful to identify wastes being generated and plan management procedures. A Waste Management Plan should assess the wastes being generated, determine current disposal costs and identify options for waste management which are economically and environmentally suitable. A Waste Management Plan also needs to have a component of staff education so that all are aware of the aims of waste minimisation.

Golf clubs need not only manage the waste generated on the course but can also be a benefit to the community by using some of the waste the community generates. Compost from garden and restaurant food waste can be used on golf courses. Crumbed rubber from used tyres is available for use as a successful topdressing on cart paths.

In the urban environment golf courses can be significant areas of bird habitat.