A Partnership for Sustainable and Profitable Dairy Farming in Western Australia

ENVIRONMENTAL BEST PRACTICE GUIDELINES
4.0 WATER MANAGEMENT

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4.0 WATER MANAGEMENT

The Western Australian dairy industry relies on a constant supply of fresh water for irrigation and stock watering. For this reason, production is usually located close to ground and surface water resources.

Wetlands have nature conservation values. Streams need to have ‘environmental flows’, that is, sufficient flowing water to maintain the natural biodiversity in the water and on the banks. Fresh groundwater aquifers may be required for potable water supplies in the future. Many estuaries are used for recreation and tourism activities and fisheries. The water quality of these resources must be maintained at levels suitable for all current and potential uses.

Pollution of water resources by agricultural nutrients and chemicals are major issues for the industry. Excessive levels of phosphorus and nitrogen can cause algal blooms in surface water during summer (Figure 4.1). Groundwater may be contaminated if management fails to prevent the downward leaching of fertilisers. In some parts of Europe and the USA, agricultural activities are regulated because groundwater aquifers have become so badly polluted by nitrates and other chemicals they are now unfit for human consumption.

Figure 4.1 Algal blooms caused by excessive levels of phosphorus and nitrogen in surface waters during warm weather

While the impact on stream water quality and health is enormous, of equal importance is the impact of poor water quality on the health and happiness of both livestock and people in the community.

By following the water management practices discussed below, the expected environmental outcomes include:

- Water resource quality is maintained at levels acceptable for all of its beneficial existing and potential uses.
- Fertilisers and chemicals used for dairying do not pollute water resources.
- Stability and character of waterways are maintained and, where possible, enhanced.

Implementing Good Practice

The best way to fight erosion is to prevent it happening in the first place. Erosion management addresses sheet and rill erosion, wind erosion, stream bank erosion and erosion from construction and irrigation sites. Erosion and sediment control systems can and should be designed to protect against contaminating surface and ground water.

Erosion Management utilises several techniques that include:

- Conservation - Developing perennial cover will protect soil and water resources. Maintaining at least 30 percent residue surface cover will reduce soil erosion by water. Planting vegetation on high risk areas will help reduce erosion. Growing windbreaks will reduce wind erosion
- Contour farming - Farming sloping land on the contour will help stop erosion and reduce sediment and nutrient flow. This includes following established grades of terraces or diversions.
- Water management structures - Developing grassed waterways, whether natural or constructed, for the stable conveyance of runoff. Planting a strip or area of vegetation for removing pollutants from runoff will reduce the amount of sediment reaching the waterways. Building grade stabilization structures and basins to collect and store debris or sediment will reduce sediment loss. Building sediment traps and water detention basins will also reduce erosion.

Nutrient Management focuses on preventing nutrient loss. Carefully planning nutrient applications is the key to controlling nutrient runoff. Useful tools in nutrient management include:

- Testing - Soil surveys will help identify nutrient loss sites. Soil testing and plant leaf analysis helps to work out the right quantity of nutrients that need to be applied.
- Nutrient Inputs - Proper timing, formulation and application methods will maximise nutrient utilization and minimise loss. Split applications or use of slow-release fertilisers will also help control nutrient loss. Use of gypsum instead of superphosphate as a sulphur source will help reduce the amount of phosphorous leaching through the soil or entering waterways.
- Buffer areas - Use buffer areas around high-risk areas such as surface water, areas at high risk of erosion or leaching soils and any irrigated land, to prevent nutrients entering the water flow or the water table. Buffer zones should include vegetation to filter nutrients.

Native vegetation intercepts rainfall and prevents rain splash erosion. Vegetative cover can also reduce gully, rill and sheet erosion by slowing runoff and binding soil together with root matter. It can take up nutrients and can be used in buffer strips for streams and surrounding nutrient-intensive developments. Vegetation also acts to slow and filter sediment from runoff. The following practices can be used:

- Plantings - Planting deep rooted species like lucerne and perennial grasses to prevent erosion will also reduce nutrient runoff. Plant local native vegetation in buffer zones surrounding intensive nutrient use to capture runoff and filter nutrient concentrations.
- Remnant vegetation management - Managing stands of remnant vegetation on paddocks, riparian areas and recreation and wildlife areas using strategic grazing and prescribed burning will ensure a vigorous stand and thereby reduce nutrient concentrations in runoff.
- Fencing - Fencing off remnant vegetation and riparian areas will protect them from over-grazing and reduce the risk of erosion and nutrient build-up from manure.

Proper grazing management is about matching grazing intensity to available feed to ensure enough live vegetation and litter cover remains to protect the soil from erosion. The key considerations for sensitive locations such as stream banks, wetlands, estuaries, and riparian zones include:

- Limiting livestock access. Grazing should only be considered in extreme situations;
- Providing stream crossings or hardened watering point access;
- Providing alternative watering points;
- Locating additional shade away from sensitive areas;
- Reducing the physical disturbance and input of animal waste

In Summary:

1. *Aquatic habitats can be improved with proper livestock management, and*
2. *Sediment and nutrient delivery is reduced through the proper use of vegetation, stream bank protection and planned grazing.*

Water source management. Providing alternative water points away from streams will help keep livestock off sensitive stream banks and riparian zones. This can be done using:

- *Pipelines*- Piping water to watering points away from streams decreases sediment and nutrient pollution from livestock. This will prevent bank destruction with resulting sedimentation and will reduce animal waste directly entering the water.
- *Fencing*- Fences can be used to keep animals out of water or walking down the banks. Fencing can also serve as sediment traps and filters along water channels and impoundments. Controlled crossings and access points help control bank and stream-bed erosion.
- *Constructed wetlands*- Building dams, sediment basins, extended storage ponds or restoring existing wetlands will trap nutrients and sediments. Wetlands reduce the amount of water that flows downstream from the catchment.

Landholders working together to plan and implement strategies for all farms within a catchment is fundamental to the success of this approach

Benefits

- Guarantees suitable water supplies will be available in the future for irrigation and stock watering.
- The quality of water resources are maintained and enhanced to preserve all environmental, social, economic and recreational values.
- Healthy waterways located on private properties increase the land value.

Further Information

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4.1 VEGETATED OUTFLOW DRAINS

Vegetated outflow drains, whether natural or man-made, are essential to the quality of water bodies and wetlands. In addition to filtering out sediments and absorbing excess nutrients, contaminants and bacteria, vegetated outflow drains provide a number of benefits. These include shade for stock, keeping water temperatures low and runoff nutrient stripping that reduces the occurrence of algal blooms and increases water quality. The vegetation also provides a habitat for wildlife.

Constructing vegetated outflow drains (Figure 4.2) is a long-term approach to changing high maintenance artificial drainage to look and function like natural watercourses. It is a technique that can partially overcome long-term maintenance costs on drains and reduce nutrient and sediment loads entering streams and rivers.

Constructing vegetated outflow drains can form part of a farm agro-forestry system. Selected tree species can be managed to produce a range of products. These include paper pulp, saw logs, firewood and fence posts. This system benefits the farm and the environment while providing an additional source of income.

Trees and shrubs use groundwater better than shallow rooted pasture plants. Clearing increases run-off and recharge, resulting in a range of land degradation problems. The strategic use of trees and shrubs on farms reduces pasture decline caused by waterlogging and salinity. When planted along drains, they create linear cones of depression in the water table. This will reduce the amount of seepage water and nutrient entering the drain.

Figure 4.2 A grassed waterway

Implementing good practice

Constructing vegetated outflow drains consists of three main steps:

1. Reshaping the drain to resemble a natural waterway. The existing drainage network can handle a wide range of flow events over many years. As a guiding rule, any drainage modification should not reduce the drain's capacity to remove peak flows. Spoil banks and feeder entry points may need to be modified and in some cases in-drain nutrient retention structures, such as weirs and rock pools, can be added. However, before you do anything you should discuss your intentions with the relevant managed drain authority.
2. Fencing the drain to exclude stock is an important component of streamlining, otherwise bank erosion and loss of vegetation will be a constant costly and time consuming problem. The style and type of fencing and the management of the enclosed area alongside the drain will vary according to manager preference. Further information on fencing and controlled grazing is presented in sections 7.1 (Riparian management) and 7.2 (Fencing channels and drains).

   Many main drains are already fenced on one side so they are logical places to provide shelter belts, drain filters and access tracks. Only one additional fence is needed. In some cases, such as with the vegetative filter strip, it is possible to run a single hot wire along the edge of the drain and strategically graze the area for weed control when bank erosion is not a problem. This same technique can be used to harvest the growth from the vegetative strip.
3. Revegetation of drain banks and reserves The type of vegetation grown adjacent to the drain will depend on the landowner's requirements and the site's capabilities. The establishment of fringing vegetation, wether it is native vegetation or pasture, will reduce erosion of the drain bank. Waterlogging-tolerant grasses (such as couch and kikuyu), reeds and sedges will help stabilise the drain embankment. This vegetation will filter drainage water, help retain silt and organic matter, absorb nutrients and provide an improved habitat for fauna.

The inclusion of a weir, lock or basin will increase the retention time of the drainage water (Figure 4.3). This will encourage an aquatic ecosystem to develop and prevents large amounts of sediment and nutrients from entering the drainage network and ending up in watercourses. The resulting increase in fauna and flora will raise nutrient cycling and further improve the drain's capacity to filter nutrients.

Nutrient removal from the vegetative filter strip that forms parallel to the drain can be increased by harvesting or strategically grazing the area to redistribute the nutrients to the surrounding landscape. Regrowth within the filter area will increase nutrient uptake from the soil. The careful selection of species can provide a source of stock feed that can come in handy during drier months of the year when feed is limited. For further information see section 7.1 Riparian Land Management.

Planting trees and shrubs will create the greatest visual impact while offering the widest range of benefits. These include improving the aesthetics and overall value of your property, creating a series of wildlife corridors and improving water quality in the region.

Further information

Cronin.D. 1998. The Effectiveness of streamlining in improving the water quality of agricultural drains in the Peel- Harvey catchment, Western Australia. Environmental Science Honours thesis, Murdoch University. Department of Environment. Wetland buffers. WF 4. Available from www.environment.wa.gov.au

Heady, G and N Guise. 1994. Streamlining. An environmentally sustainable drainage network for the Swan Coastal Plain (Peel Harvey Catchment). Bulletin 4279. Department of Agriculture and Food Western Australia.

Figure 4.3 A sedimentation settling basin constructed at the end of a main drain.

4.2 OFF-STREAM SHELTER AND WATERING POINTS

Controlling livestock access is the single most important management tool in the protection and restoration of riparian zones.

Unrestricted stock access to riparian areas causes disturbance and pollution resulting in environmental degradation (loss of native fringing vegetation, weed invasion, compacted soils and erosion) and loss of productivity related to poor water quality (Figure 4.4).

Once a stream bank has been fenced you will need to provide alternative watering and shelter options for stock. Ready access to clean, unpolluted water, shade and shelter are essential for optimum animal health and productivity so the cost of providing these will be more than repaid through increased production.

Figure 4.4 Soil pugging caused by unrestricted stock access to riparian areas

Implementing good practice

There are a variety of alternatives to direct river access for watering stock. These include providing limited river access watering points, using an alternative water supply (e.g. reticulated water supply, dam or bore), or piping or pumping water from existing sources.

Formed access points are one of the cheapest and simplest methods of supplying water to stock. Limited access points allow stock to drink from a short section of the stream, while reducing trampling and the amount of urine and feces deposited in stream. If constructed properly, access points require very little maintenance apart from occasional repairs after flooding.

Stock can be watered from a stream or river with minimal damage if a formed access point is built at a carefully selected section of the channel. A graded slope into the stream is selected and its surface is then protected by using concrete, compacted gravel, rocks, logs or similar materials to form a walkway. It is important to consider likely changes in the depth of flow in order to make sure that access to water is available for as much of the year as possible. It is important to avoid boggy areas and the outside of meander bends where flow speed is high and stream banks are especially vulnerable to erosion.

The width of the access point can vary from 2 - 20 metres, depending on the number of sites available and the number of stock. The access points are made by putting a break in the riparian zone fencing and running two fences out into the water to the low water mark and fencing off the end to prevent the stock wading further into the stream. If floods occur regularly, then a permanent fence can be replaced with live electrical tape, as it is easily replaced should it be washed away.

When siting an access point, the following factors should be considered:

- use a maximum slope of 1:6 to prevent erosion and make it easy for the stock to reach the water's edge;
- a lack of shelter will prevent stock from lingering. You will need to provide alternative shelters for stock within paddocks
- to reduce the risk of scour and erosion, locate the access point on the inside of a bend where water movement is slowest
- angle the access ramp away from the direction of flow;
- the ramp surface should consist of compacted soil or gravel, or be covered with flat stone or concrete to minimise damage to the bank and water's edge as well as providing a sure footing for the stock; and
- start the ramp at least 1 metre back from the top of the bank.

Piping versus pumping Water is an option if there is a dam upslope or a reticulated water supply located nearby. You will most likely need to install a tank and trough and these will have to be regularly inspected to check the water supply and clean out the trough (Figure 4.5). This is often a cheaper than attempting to lift and pump water from a river.

Fencing-off watercourses may deny cows the shade and shelter provided by trees and shrubs on the stream bank. Compensate for this by growing shade trees in adjoining paddocks. Contact the local forestry office for advice on fast-growing species for your area.

Figure 4.5 Reticulating water into troughs can relieve stock pressure on riparian areas.

Benefits

- Animal health is maintained
- Erosion of stream banks and drains is reduced
- Water quality is improved

Liabilities

The costs of establishing a trough system should be evaluated against the cost of erosion control, loss of shade and shelter and the loss of wildlife if exclusion is not practised. Access via chutes to the watercourse may offer an alternative but must take account of the concentration of activity as a result of the reduced area. Thus, some form of reinforcement of the bank, such as gravel, will need to be provided. In some districts, assistance may be available through government funding. This is because there is increasing recognition that better management of stock access to riparian lands has benefits for the wider community as well as landholders. Contact your local Landcare group for information on what's available in your area.

Further information

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4.3 DRAINAGE DIVERSION

Effective water management can reduce productivity losses caused by excess water. A system to manage excess water can include:

- surface water management options, through the construction of broad based channels, grade banks or shallow drains;
- sub-surface drainage or groundwater management options, through deep drains, relief wells, siphons or pumping.

Management of excess water also includes methods for disposal of discharge, such as the development of on farm water resources (dams, bores, water distribution systems) for fresh water, or detention storage and evaporation basins for low quality or saline water.

Water management systems are complex and need to be carefully planned and evaluated prior to construction to gauge their impact. Surface water management and subsurface drainage target quite different problems with different engineering techniques. Their impact both on- and off-site needs careful consideration, particularly in regard to neighbouring properties.

Using a combination of systems, such as drains, banks, roaded catchments and dams is likely to produce the best results when trying to manage surface water and near surface recharge.

The degree of protection required depends on gradient and length of the slope, soil type, risk of intense rainfall and cultivation methods used.

Surface water control works are not expensive and are a means of managing risk (Figure 4.6). Although they may not be needed every year, they must be in place to prevent soil erosion and crop damage when unforeseen severe rainfall events occur. The design and degree of protection required depends on soil and site characteristics.

Appropriate surface water control earthworks are essential to minimise erosion where surface run-off is known to occur, in particular the high rainfall (>700 mm) hills areas. In addition to hundreds of tonnes of topsoil loss, thousands of dollars in crop yield reduction per hectare have been common place on unprotected sites.

Figure 4.6 Laser levelling paddocks can prevent water ponding and reduces water logging.

Surface water management

If constructed properly, surface water structures have certain advantages over subsurface drainage. These include:

- cost of construction is relatively low;
- surface run-off water is usually of good quality and can be stored in farm dams and used for stock watering and irrigation or directed into natural watercourses;
- groundwater recharge is reduced;
- peak stream flow in creeks is reduced, so reductions in flooding channel erosion and sedimentation can be achieved;
- minimal maintenance is required;
- notification of surface water earthworks is not required under the Soil and Land Conservation Act, but each landholder has a Duty of Care to make sure that flows are not discharged indiscriminately on a neighbour and that stream flows are not significantly diminished.

Sub-surface drainage

Problems arising from groundwater recharge and high water tables can be tackled through deep drainage or pumping. Issues to consider when developing a drainage management plan include:

- assessing on-site characteristics (soils and slopes) to establish the potential for effective drainage. Deep drains constructed in heavy, clay soils in the lower landscape are generally not effective in lowering the water tables, while drains in coarse, sandy soils are often unstable and prone to erosion;
- determining the permeability or rate at which water will flow from the soil into a deep drain, or the rate at which it can be extracted using a pump. This will establish the area affected by the drain or pump and can be useful in estimating the amount of water likely to be discharged.

Which option to use and where

There is no universal solution for developing a catchment or farm water management plan that suits all the varied landscapes and soil types. The most suitable site for a specific engineering option depends on a number of factors such as where it is located in the catchment, the soil type, rainfall and the nature of the problem to be treated. Because of this, understanding the various water management problems and which option is best for each situation is important for the plan to work and to be cost effective.

A range of earthwork options is commonly used to manage or alleviate problems associated with excess water in a catchment or on the farm. Each option has a set of design criteria for location within the landscape, to reduce risk, improve planning and provide maximum economic benefit. Moving fresh surface water is generally less risky than draining saline groundwater. Also, draining or pumping saline water from a property may have unacceptable impacts on others in the catchment.

Before deciding which management system to adopt, decide if your property is in a high relief landscape, with medium rainfall (450-600 mm) and good natural drainage. If it is then your engineering options are more flexible and you have better opportunities for discharge management. Flat areas along the coast with high rainfall (>600 mm) prone to waterlogging and flooding respond more to drainage than salinity control.

For any management system the benefits need to be at least equal to or greater than the cost of their implementation to ensure that the investment is worthwhile.

Excess water in the landscape can be managed using engineering options such as shallow or deep drains and, in some situations, groundwater pumping or relief wells. These structures are designed to control run-off, to lower groundwater tables and reduce the effects of water erosion, waterlogging, flooding, groundwater recharge, groundwater discharge, high water tables and salinity.

Environmental considerations

Waterways and wetlands in catchments are important for nature conservation and local ecology as well as local drainage and floodwater discharge. If additional water is discharged into them, the normal patterns of flow and the natural water balance of the existing ecosystems may be altered. All landholders have a duty of care to the land and to other landholders within their catchment.

Strategic water management

As with most decisions on the farm, the capacity to invest and the effectiveness of the treatment in which you invest, comes down to individual landholders' decisions and the site specific characteristics.

By cooperating with your neighbours and working with the community or catchment group, more effective results can be achieved through co-investment. Consideration can also be given to the incorporation of modified farming systems and revegetation strategies into the catchment water management plan, as this will increase the potential for success and may off-set the investment in engineering strategies.

Be prepared to liaise with neighbours where surface water run-off to or from adjoining properties may impact on them.

Legislation Related to Drainage

The principal control mechanism related to drainage in Western Australia is the Soil and Land Conservation Act 1945 (SLC Act) and this is mainly for saline drainage. In addition, provisions exist within the Rights in Water and Irrigation Act 1914 (RIWI Act). The Environmental Protection Act 1986 (EP Act) may be invoked if there is likely to be a significant effect on the environment.

The RIWI Act provides protection for any watercourse, race or drain flowing through or over the land, however, these are mostly used in gazetted catchments for the management and allocation of surface water flows. The EP Act may be invoked where it can be demonstrated that there is potential for any drainage activities to result in environmental damage.

The SLC Act deals with all aspects of land-related degradation including that resulting from drainage works. This may include the adverse affects of erosion, flooding and eutrophication. The Soil and Land Conservation Regulations are those most often applied to the management of degradation issues on private land. These regulations require that landholders intending to drain or pump saline groundwater, principally for the purpose of reducing land salinisation, notify the Commissioner of Soil and Land Conservation of their intentions. The aim of the notification is to ensure that neighbouring landholders are given an opportunity to comment on the proposal and for an assessment to be carried out. The assessment would include aspects relevant to the other Acts as well as the Soil and Land Conservation Act.

Drainage works on the Scott Coastal Plain are undertaken principally for the management of fresh surface and shallow groundwater to reduce the impacts of waterlogging and inundation. Where they are not for the purpose of lowering saline groundwater or mitigating land salinisation, these works are considered to not require notification, by the proponent, under the Act.

Notwithstanding, the Commissioner for Soil and Land Conservation is responsible for preventing land degradation. Therefore, there is a requirement to assess any proposal or existing activity brought to the Commissioner's attention, on the basis of potential land degradation. As an outcome of any such assessment, conditions may be imposed.

In order to reduce the potential for land degradation and community conflict, landholders are encouraged to work cooperatively in drainage activities. In support of this, the Commissioner may provide comment and assistance to landowners developing water management and drainage plans, if they are referred to the Department of Agriculture and Food.

Refer to the Department of Agriculture and Food publications on engineering water management options and related topics, as well as contacts of officers within the Department who may be able to advise on the best approach to water management in your region

Further information

Coles, N and S Tetlow. 2003. Subsurface drainage and surface water management for salinity control. Farm Note No. 52/2003. Department of Agriculture and Food Western Australia.

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4.4 MONITORING DOWN-STREAM WATER QUALITY

The south west of Western Australia is abundant with streams, rivers, lakes, wetlands, estuaries, open coastal waters and agricultural drains. These are important to the State's economy in terms of their agricultural, social and recreational benefits they provide. They also have their own intrinsic natural values.

Water quality means different things to different users. Different targets may include:

- Safe water for agricultural and industrial use or urban and domestic consumption
- A good aquatic habitat with large numbers and types of plants and animals
- Safe for recreation use (swimming, fishing and other sports)
- Acceptable aesthetic qualities (water free from excessive and unsightly algal growths, aquatic weeds and odours)

Sediments, nutrients and other pollutant loads that enter streams and rivers have a significant effect on water quality, and therefore the desirable values listed above. Careful management and monitoring of drains and waterways located on private and public property will help to preserve and enhance the values of good water quality. Community water monitoring groups and individuals on privately owned land have proven that concerned volunteers can make significant contributions to the health of our waterways and our knowledge of water quality from the local to the catchment scale.

Implementing good practice

Water collected in small agricultural drains during rainfall events and irrigation is usually high in sediment and nutrients from applied fertilisers and animal manures. If these drains are diverted into larger streams and rivers, this water will eventually reach the coastal estuaries and oceans. To reduce the risk of water quality problems and to ensure other farmers downstream are not negatively impacted, it is very important you do all you can to limit the water additives leaving your property. Everybody, albeit unintentionally, produces down stream effects on water quality that can only be minimised with correct on farm management

You should regularly check what material is entering drains and waterways on- farm to reduce downstream water quality problems. Having an effluent management plan fully implemented and following correct fertiliser management practices will ensure minimal nutrients, pathogens and bacteria are entering your waterways. You should also keep a watchful eye on the quality of water in drains and waterways leaving your property.

Water sampling will allow you to accurately determine the quality of water leaving your property

Monitoring water quality can simply involve using your sight and smell to assess the water quality in drains and waterways while travelling around your farm. Algae blooms, fish and other aquatic animals dying, strong odours in drains and waterways or peculiar stock behaviour and weight loss in cows drinking stream water are all possible warning signs that you need to lift your game, or that somebody upstream needs to lift theirs.

More sophisticated water quality monitoring is normally undertaken by community environmental groups, government departments and those farmers keen to accurately determine the physical, chemical and biological attributes of water leaving their properties.

In order to assess trends in water quality over the course of a year, physical, chemical and biological indicators of water quality are measured at a number of sites on a regular basis. Water is sampled mid-stream to avoid surface scum. Some readings are taken on site (in situ) while others are analysed in the laboratory. At estuarine sites, all samples and readings are taken on the ebb (falling) tide. Sediment samples are taken to determine the concentrations of trace elements (metals and metalloids), organic compounds (pesticides, polychlorinated biphenyls and organophosphates) and nutrients (total nitrogen and phosphorus).

A brief description of various water quality indicators is presented in Table 4.1.

Community programs are widespread across Western Australia. Ribbons of Blue and WaterWatch WA are environmental education networks aimed at increasing community awareness and understanding of water quality to promote action towards a better environment. Data collected by such community groups helps identify environmental problems that can then be addressed through management plans.

Seeing dead fish along a river bank is a sure indicator of environmental problems

Table 4.1 Listing and explanation of various indicators used to determine water quality.

Category	Measured Indicator	Explanation
Nutrients	**Nitrogen** (organic, nitrate plus nitrite, ammonia & total) **Phosphorus** (filterable, reactive & total)	Nitrogen and phosphorus are essential for plant growth. High concentrations indicate potential for excessive weed and algal growth.
		Total nutrients are made up of a dissolved component (e.g. nitrate plus nitrite, ammonia and filterable reactive phosphorus) and an organic component, which is bound to carbon (e.g. organic nitrogen).
		Nutrients in the dissolved state can be readily used by plants
		By determining the form of nutrients you can predict where the nutrients came from and develop management actions to reduce nutrient concentrations, for example dissolved is likely to be from fertiliser and organic is likely to be from manures and plant matter.
Microalgal Growth	**Chlorophyll-a**	An indicator of algal biomass in the water. An increase in chlorophyll-a indicates potential eutrophication of the system. Consistently high or variable chlorophyll-a concentrations indicate the occurrence of algal blooms, which can be harmful to other aquatic organisms.
Water Clarity	**Suspended solids**	Small particles (soil, plankton, organic debris) suspended in water. High concentrations of suspended solids limit light penetration through water and cause silting of the benthic (bottom) environment.
	Turbidity	A measure of light scattering by suspended particles in the water column provides an indirect indication of light penetration.
	Secchi depth	The depth to which the black and white markings on a Secchi disc can be clearly seen from the surface of the water provides an indication of light penetration
Oxygen	**Dissolved oxygen**	Essential for life processes of most aquatic organisms. Low concentrations of dissolved oxygen usually indicate the presence of excessive organic loads in the system, while high values can indicate excessive plant production (i.e. eutrophication). Many aquatic organisms will suffocate if there is insufficient concentrations of dissolved oxygen in the water
Acidity	**pH**	A measure of acidity or alkalinity of water. Changes in water pH can be caused by a range of problems (e.g. low values due to acid sulfate runoff). Extreme pH levels (less than 6.5 or greater than 9) are indicative of toxic conditions for aquatic organisms.
Salinity	**Conductivity**	A measure of the amount of dissolved salts in the water. In fresh water, low conductivity values indicate suitability for agricultural use. In salt waters, low conductivity indicates freshwater inflows such as stormwater runoff.
Toxicants in sediments	**Trace elements in sediments**	Trace elements occur naturally in minute quantities. Many are essential for the survival of aquatic organisms. However, high concentrations of trace elements in sediments are toxic and indicate contamination from domestic or industrial sources.
	Pesticides in sediments	Commonly used pesticides accumulate in the sediments of aquatic environments and may reach concentrations toxic to aquatic organisms
Health and Recreation	**Faecal coliforms**	The National Health and Medical Research Council guidelines are widely used to assess suitability of water for recreational purposes. The guidelines specify appropriate counts for primary contact (e.g. swimming, and diving) and secondary contact (e.g. boating and fishing). These guidelines, however, overestimate the health risk to humans if the major sources of faecal pollution are animals such as livestock, pets and wildlife including birds

Secchi discs are used measure water clarity and provides an indication of light penetration

Further Information

Nutrient targets for Western Australian waterways are provided at http://www.deh.gov.au/water/quality/targets/state.php?stateid=4

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