



*North Dandalup Pipehead Dam Catchment Area
Drinking Water Source Protection Plan*

Integrated Water Supply System



**NORTH DANDALUP PIPEHEAD DAM
CATCHMENT AREA
DRINKING WATER SOURCE PROTECTION PLAN

INTEGRATED WATER SUPPLY SYSTEM**

Prepared by
Water Resources Division
Department of Environment

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Foreword

Drinking Water Source Protection Plans establish the level of protection required in catchment areas. The Department of Environment (DoE) has prepared this Drinking Water Source Protection Plan (DWSPP) to report on the activities and risks to water quality within the North Dandalup Pipehead Dam Catchment Area and to recommend management strategies to minimise the identified risks.

A safe drinking water supply is critical to the wellbeing of a community and catchment protection is necessary to help avoid, minimise or manage risks to water quality in Public Drinking Water Source Areas (PDWSA). The DoE is committed to protecting these areas to ensure the continued supply of 'safe, good quality drinking water' to consumers to protect public health now and in the future.

The Australian Drinking Water Guidelines recommend a multiple barrier 'catchment to consumer' approach to protect public drinking water. The protection and management of a PDWSA is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes:

- Understanding the catchment, the hazards and hazardous events that can compromise drinking water quality; and
- developing and implementing preventive strategies and operational controls necessary to ensure the safest possible raw water supply (i.e. before treatment).

This Plan details the location and boundary of the drinking water catchment which provides potable water to the Integrated Water Supply System. It discusses existing use of the water source, describes the water supply system, identifies risks and recommends management approaches to maximise protection of the catchment.

The Plan should be used to guide State and local government land use planning decisions in Western Australia. This DWSPP should be recognised in the Shire of Murray Town Planning Scheme and other local planning strategies and plans, consistent with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7 *Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the PDWSA.

The process involved in the preparation of a DWSPP is as follows:

Stages in development of a DWSPP	Comment
1 Prepare 'Drinking Water Source Protection Assessment' document	Assessment document may be prepared following catchment survey and preliminary information gathering from State and local government authority stakeholders. This stage is completed by the DoE or a Water Service Provider.
2 Undertake stakeholder consultation	Advice sought from key stakeholders. If a Stage 1 Assessment is available it will be used as a tool for background information and discussion.
3 Prepare Draft DWSPP	Draft DWSPP developed taking into account input from identified stakeholders and any additional relevant information on the catchment.
4 Release Draft DWSPP for public comment	Draft DWSPP released for a six week public consultation period.
5 Publish DWSPP	The Plan is published after considering advice received in submissions on the Draft Plan. Recommendations to protect the drinking water catchment are provided. The Plan is available from the Department's website: < http://drinkingwater.environment.wa.gov.au >.

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Summary

The North Dandalup Pipehead Dam and its catchment are located approximately 150 km south of Perth in the Shire of Murray. The dam supplies approximately 10% of Perth's annual water consumption. It contains high quality potable water from a largely undeveloped catchment and is a strategic source of public drinking water for the Integrated Water Supply System. The North Dandalup Pipehead Dam Catchment Area was proclaimed in 1982 under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* to ensure protection of this water source from potential contamination.

This Plan has been developed to protect drinking water quality for public health. The Plan:

- Identifies potential drinking water quality contamination risks from land use activities within the catchment; and
- recommends strategies to manage these potential risks whilst recognising current land use rights.

The majority of the North Dandalup Pipehead Dam Catchment Area is State Forest vested with the Conservation Commission of Western Australia and managed by Department of Conservation and Land Management. The Water and Rivers Commission and Water Corporation own the remaining land in the catchment. Use of the State Forest and Water and Rivers Commission land currently includes forest and plantation management, such as timber harvesting and fire protection, recreation and bauxite mining by Alcoa World Alumina Australia. Recreational activities include bike riding on the Munda Biddi Trail. Some unauthorised activities, including fishing and marroning, also occur in the catchment.

The following strategies are recommended to protect the water quality of North Dandalup Pipehead Dam:

- The existing Reservoir Protection Zone for the catchment needs to be clearly identified.
- All Crown land should be managed for Priority 1 source protection.
- The catchment, including the Reservoir Protection Zone and Priority 1 classification, should be recognised in the relevant land planning strategies and schemes, specifically the Shire of Murray Town Planning Scheme.
- Best management practices for the current land uses in the catchment should be implemented.

Priority classification areas and the Reservoir Protection Zone provide guidance on appropriate land use planning decisions and define areas where *Metropolitan Water Supply, Sewerage and Drainage Act* by-laws are available to protect drinking water catchments. These areas and zones recognise established approved land uses but may constrain expansion of those uses, or development of alternative future land uses. Implementation of best management practices in the design, construction and operational stages are recommended for existing or approved land uses.

1 Introduction

The North Dandalup Pipehead Dam is a strategic source of public drinking water for the Integrated Water Supply System (IWSS), which provides drinking water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields. It is situated on the North Dandalup River, approximately 150 km south of Perth, in the Shire of Murray.

Figure 1 shows the location of the North Dandalup Pipehead Dam and its associated catchment.

The objective of this Plan is to recommend protection strategies to ensure land uses and activities in the catchment are managed to protect the drinking water quality of this source.

1.1 Water supply system

Construction of the North Dandalup Pipehead Dam was completed in 1994 to a height of 62 m and a length of 192 m. The dam is a rockfill embankment dam, with a reservoir capacity of 75 GL. The current annual flow to the dam is estimated to be 19 GL.

1.2 Existing water source protection

The North Dandalup Pipehead Dam Catchment Area was proclaimed in 1982 under the *Metropolitan Water Supply, Sewerage and Drainage (MWSSD) Act 1909*, to ensure protection of the water source from potential contamination. Boundary alterations were made in 2000.

Figure 2 shows the North Dandalup Pipehead Dam Catchment Area.

1.3 Water resource allocation

Surface water resource utilisation and conservation in Western Australia is administered by the Department of Environment (DoE) in accordance with the *Rights in Water and Irrigation (RIWI) Act 1914*. Under the *RIWI Act*, the right to use and control surface water is vested with the Crown. This Act requires licensing of surface water abstraction within proclaimed Surface Water Areas. The North Dandalup Pipehead Dam Catchment Area also forms the boundary of the North Dandalup Pipehead Dam Surface Water Area proclaimed under the *RIWI Act*.

1.3.1 Current allocation licence

The current allocation licence for the North Dandalup Pipehead Dam, Surface Water Licence No. 0056735, allows the Water Corporation (WC) to divert up to 22.2 GL per annum from the North Dandalup River. This licence is issued for the purpose of providing water to the IWSS for public drinking water supply. Due to reduced rainfall and streamflow, the annual abstraction in 2002/03 was 11.5 GL and 9.3 GL in 2003/04.

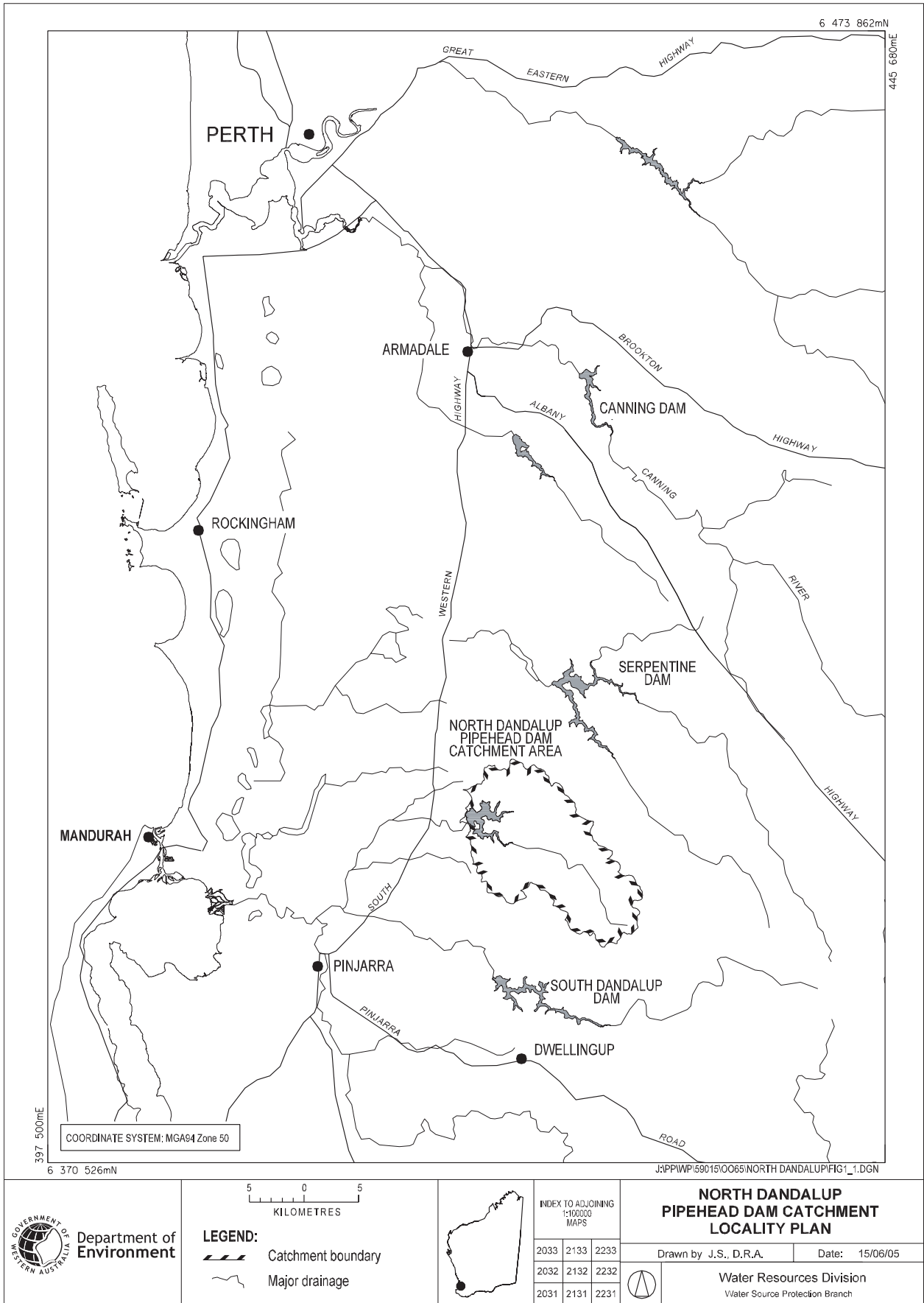


Figure 1. North Dandalup Pipehead Dam Catchment Area locality plan

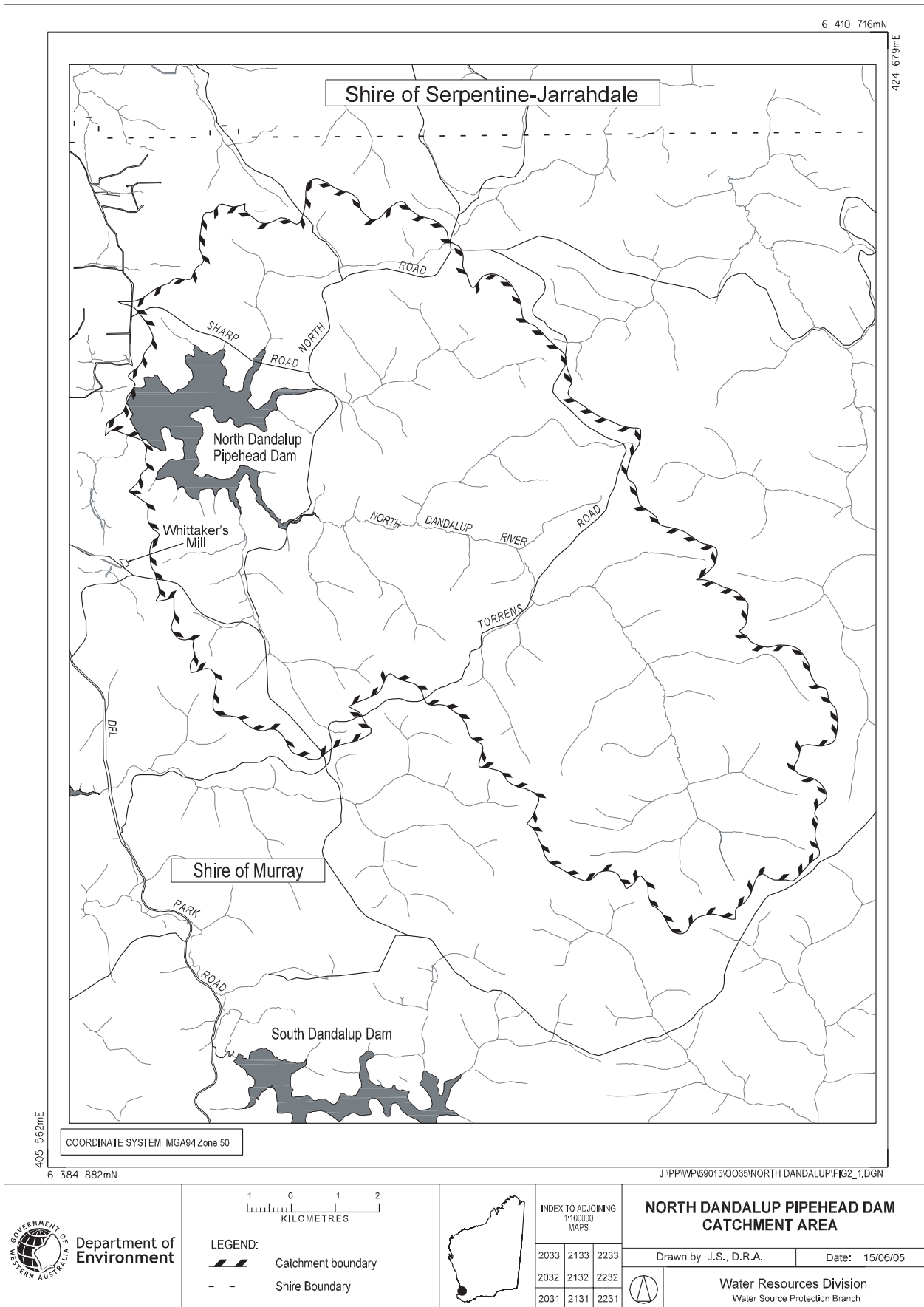


Figure 2. North Dandalup Pipehead Dam Catchment Area

2 Catchment description

2.1 Climate

The region has a Mediterranean type climate, characterised by warm dry summers and mild wet winters.

Since the mid 1970s, the south west of Western Australia has experienced a 10 to 20% decline in its long-term average rainfall. The 70 year average rainfall in the region was approximately 1250 mm, however the average annual rainfall in the catchment between 1971 to 1992 was 990 mm. The average rainfall for the last seven years, 1998 to 2005, was 999 mm, with most of the rainfall occurring between May and September.

2.2 Physiography and vegetation

The North Dandalup catchment is located in the Darling Scarp, which forms the western boundary of the Darling Range. This area forms part of the Archaean Yilgarn Block, which consists mainly of granitoid rock with dolerite dykes and is capped with laterite (Hochstadt, 2000).

The dominant landforms of the catchment area are lateritic uplands, minor valleys and granite outcrops. The main soil association in the catchment area is the Dwellingup Association, which is characterised by duricrust, sandy soils and gravelly soils.

The areas in North Dandalup where slight-minor erosion has been observed are predominantly laterite. Erosion can occur on these sandy gravels due to their water repellence. Moderate erosion has been observed in areas where the subsoil clay is exposed, particularly the white clays that are typically prone to erosion (Hochstadt, 2000).

Most of the catchment is covered by the Murray, Yarragil and Dwellingup vegetation complexes, and consists of open forest or woodland dominated by jarrah (*Eucalyptus marginata*), marri (*E. calophylla*) and wandoo (*E. wandoo*) species. Scattered pines exist in localised areas that were previously privately owned and used for agriculture and other uses.

2.3 Hydrology

The North Dandalup catchment has a total area of 153 km².

The long-term average volume of water entering the North Dandalup Pipehead Dam was 28.8 GL/year (1912-2000). However, since 1975 this has been reduced by 35% to 18.7 GL/year as a result of low rainfall.

3 Water quality and treatment

3.1 Water quality

A wide range of chemical, physical and microbiological properties can affect the health and aesthetic quality of drinking water.

The quality of water in the North Dandalup Pipehead Dam is monitored by WC on a regular basis in accordance with the Australian Drinking Water Guidelines (ADWG) (NHMRC & ARMCANZ, 1996). The ADWG are used in Western Australia by the Department of Health (DoH), DoE and WC to assess the quality of our drinking water.

A summary of the results of the water quality analyses was prepared by WC and is shown in Appendix 2.

The pH, iron and aluminium levels measured in the reservoir have been recorded as exceeding the ADWG aesthetic guideline on occasion.

Simazine is the only pesticide to have been detected. The level remains well below the ADWG values.

The microbiological quality of the water is monitored regularly both before and after treatment. Despite the presence of thermotolerant coliforms (an indicator for potential presence of pathogenic microbes) in raw water, treatment generally removes all traces of contamination. The risk of bacteriological contamination from coliforms in the dam is considered low.

In addition to WC monitoring, the turbidity of major tributaries into the reservoir has been monitored intermittently by DoE and Alcoa World Alumina Australia (Alcoa) during mining operations in the catchment.

3.2 Water treatment

The water abstracted from the North Dandalup Pipehead Dam is disinfected by chlorination, and fluoridated before supplying the IWSS. Chlorination is the final barrier used to ensure good quality public drinking water (NHMRC & ARMCANZ, 1996).

It should be recognised that, although reservoir storage and disinfection by chlorination generally removes microbiological contamination, treatment processes alone cannot be relied upon. Where possible, contamination can and should be prevented or reduced through appropriate land use or activity controls in the catchment area. This approach is endorsed by the ADWG and reflects a 'catchment to consumer' multiple barrier approach for the provision of safe drinking water to consumers.

4 Land use

Land use and activities in the catchment consist of:

- Mining and gravel extraction;
- Forest and plantation management; and
- Recreation.

Land use and tenure in the catchment are shown in Figure 3.

4.1 Crown land

Most of the North Dandalup catchment is under Crown ownership. An extensive area of the catchment is State Forest 14 vested with the Conservation Commission of Western Australia and managed by the Department of Conservation and Land Management (CALM).

4.1.1 Mining and gravel extraction

A Special Mining Lease granted to Alcoa under *Alumina Refinery Agreement Act 1961*, No. 3, covers part of the Crown land in the catchment. Under the State Agreement, Alcoa has rights to extract bauxite from Crown land, with associated responsibilities to protect environmental values and rehabilitate mine sites. Alcoa has a comprehensive *Environmental Management Manual* and Mining and Management Programs that are reviewed and audited by the Mining and Management Program Liaison Group (MMPLG).

Alcoa commenced mining operations within the North Dandalup catchment in 1991. In December 2004, Alcoa completed the move of its crusher from White Road and its main workshop from Huntly (both sites are located within the Conjurunup Creek Pipehead Dam Catchment Area) to the McCoy crusher site within the North Dandalup catchment (Figure 3). Alcoa will continue to operate mining facilities (offices, roads, workshops, crusher, conveyor belts, powerlines and pipelines) within the catchment to support its Huntly mine operations for at least another 25 years. As at 31st December 2004, approximately 2,059 ha (14%) of the catchment had been cleared for mining purposes; 1,487 ha (10%) had been rehabilitated.

Some of the sources of risk associated with mining and its operations in the catchment are sewerage treatment systems, hydrocarbon storage, workshop wastewater, hydrocarbon spills from mining equipment and turbidity from areas cleared for mining pits, roads and infrastructure. All cleared areas have drainage structures (such as sediment sumps) designed to contain sediment and minimise the discharge of turbid water into watercourses within the catchment. The majority of hydrocarbon spills that occur are due to hydraulic hose failures on earthmoving equipment. When spills do occur, contaminated soil is cleaned up immediately.

A dissolved air flotation unit treats water contaminated with hydrocarbons and detergents from the McCoy crusher site. The treated water is discharged into sumps and recycled when it has met the licence conditions set by the DoE.

There are also two on-site biological aeration treatment units (Biomax) that treat sewage water from the McCoy facilities. The effluent from these units is reticulated into a section of the surrounding jarrah forest. Regular inspections and monitoring are undertaken to ensure that effluent is suitable for discharge. Samples of effluent from the sewage treatment systems are tested against standards developed using the National Water Quality Management Strategy Paper No. 11 *Australian Guidelines for Sewerage Systems – Effluent Management* (ARMCANZ & ANZECC, 1997).

4.1.2 Forest and plantation management

Forest Products Commission (FPC) and CALM forestry operations are governed by the *Forest Management Plan 2004-2013* (Conservation Commission, 2004). Forestry activities in the catchment include softwood and hardwood timber harvesting. CALM has advised that there are no plans for hardwood harvesting in State Forest in the North Dandalup catchment within the next ten years. However, commercial logging and removal of minor forest produce may be undertaken prior to clearing for bauxite mining.

Land management by CALM includes fire protection, such as prescribed burning and maintenance of firebreaks. Feral animal control (fox baiting, feral pig hunting and trapping) is undertaken by CALM and WC Rangers in the State Forest and on Water Corporation and Water and Rivers Commission (WRC) land within the catchment.

Firewood collection and other private resource harvesting, including apiaries (nine sites), wildflower picking and seed collection also occur in the State Forest and are licensed by CALM. In addition, the catchment and reservoir are occasionally used for research projects.

4.1.3 Recreation

Several recreational activities currently occur in the catchment, including some approved recreation and other unauthorised activities, which result from open access to the catchment.

Recreation in the catchment is generally discouraged, as there are limited designated sites for recreation. In the past, two motor rally events (Rally Australia and the Clubman Rally) were staged on an annual basis, but these no longer occur within the catchment. A picnic area downstream of the dam wall, which is not located within the catchment, is fully serviced and operated by WC.

A range of recreational activities are associated with the Munda Bididi Trail, a long distance mountain bike trail which passes through a portion of the catchment. It is expected that publicity associated with the trail, including the *Caring for the Trail – Code to Off-road Cycling*, will educate cyclists and discourage unauthorised off-trail cycling in the catchment. In addition, CALM management prescriptions are in place to safeguard the environment.

The off-road bike trail enables easy access to the water body as it passes along the western boundary of the reservoir and along the dam wall before continuing south out of the catchment. The trail lies outside the Reservoir Protection Zone and no part of the bike trail and access tracks are allowed within 50 m of a watercourse. It is estimated that the trail attracts approximately 10,000 cyclists annually, of which some proportion will pass through this area. CALM and the Munda Bididi Trail Foundation manage the Munda Bididi Trail.

Unauthorised recreation activities also occur in the catchment, including swimming, hunting, camping, dog exercising, off-road driving (away from designated roads) and rubbish dumping. Fishing and marroning are prevalent in the reservoir and tributaries over the summer period. It should be noted that these activities are prohibited in the reservoir and catchment under the *MWSSD Act by-laws*.

4.1.4 Water and Rivers Commission freehold land

WRC has freehold ownership of several properties in the catchment, which consist of small cleared or partly revegetated blocks. WC manages these properties.

WRC freehold properties are often used for illegal recreation, including the dumping of stolen cars and rubbish.

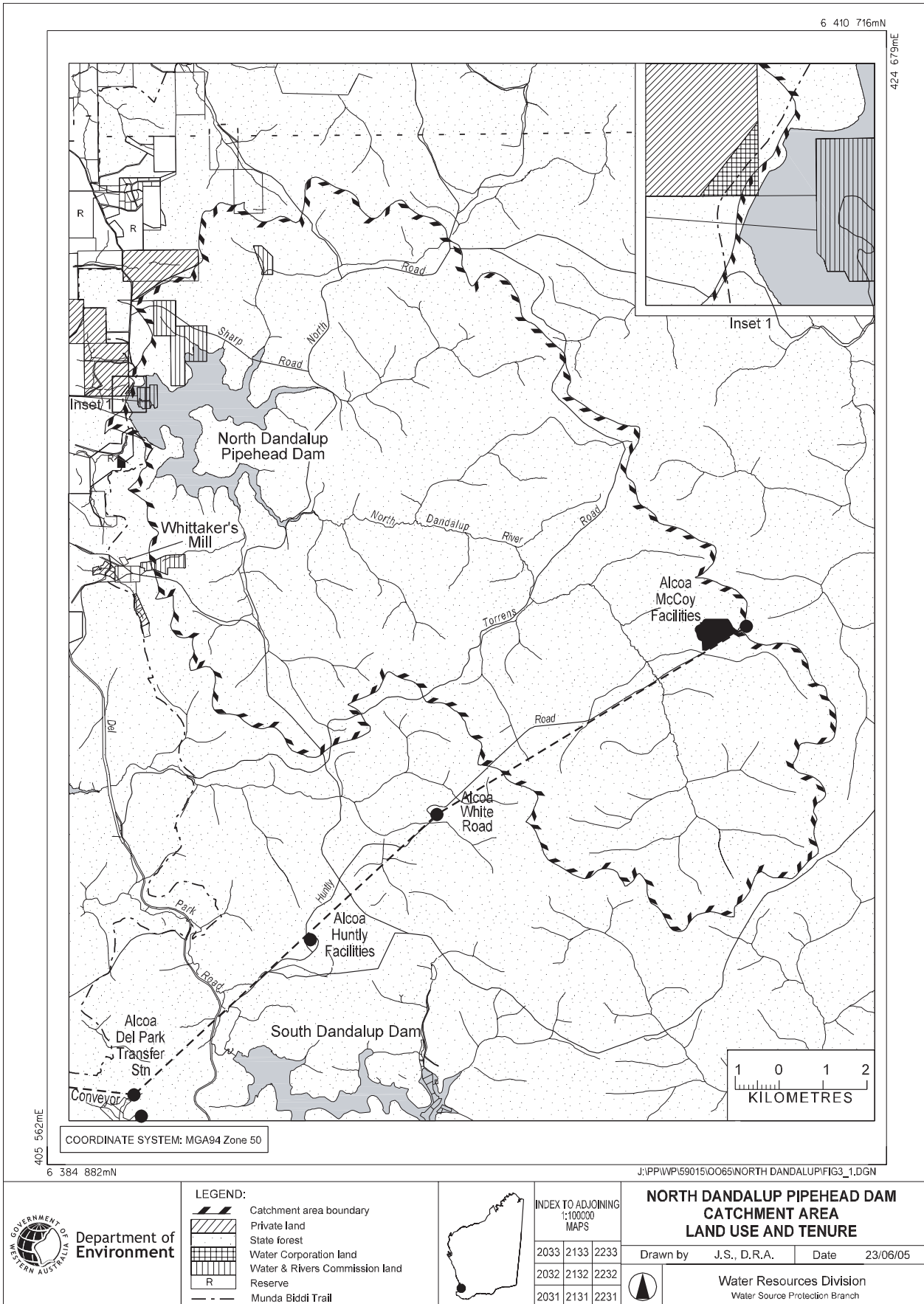


Figure 3. North Dandalup catchment land use and tenure

5 Proclaimed area and priority classification

5.1 Proclaimed area

The North Dandalup Pipehead Dam Catchment Area was gazetted in 1982 under the *Metropolitan Water Supply, Sewage and Drainage Act 1909*. Boundary alterations were gazetted in 2000.

5.2 Priority classification

An explanation of the priority classifications and the protection approach and detail of land use compatibility with each priority classification is provided in Appendix 3.

All land in the North Dandalup catchment should be managed for Priority 1 (P1) source protection. The objective of this priority classification is to protect water quality according to the principle of risk avoidance.

A P1 source protection classification is appropriate for this area as:

- North Dandalup Pipehead Dam is a strategic source for the IWSS and should be afforded the highest level of protection;
- The land is State Forest or owned freehold by State government agencies;
- Existing approved land use practices can be managed with the use of best management practices (Appendix 4).

5.3 Reservoir Protection Zone

To protect the reservoir from immediate risks to water quality, such as human contact, a Prohibited Zone (PZ), also known as a Reservoir Protection Zone (RPZ), exists within 2 km of the upper water level of the reservoir. The RPZ includes the reservoir itself, but does not extend outside the catchment area or downstream of the dam wall. The RPZ is a key barrier in the 'catchment to consumer' multiple barrier approach for protecting the reservoir and its drinking water quality (NHMRC & ARMCANZ, 1996). Figure 4 shows the boundary of the RPZ.

Unauthorised public entry to the RPZ, other than on public or private roads, is prohibited under the provisions of the *MWSSD Act* by-laws. Entry to the RPZ requires specific approval from WC (as the agent with delegated responsibility from DoE).

6 The impact of drinking water source protection planning

General issues raised throughout the State regarding the impact of water source protection planning are addressed below.

6.1 Common areas of concern about the impact of drinking water source protection planning

6.1.1 Existing and future land uses

DoE's water source protection planning recognises existing approvals and does not prohibit currently approved land use activities, even where they are considered incompatible with assigned priority classifications.

DoE will provide advice to the local authority when a landowner applies to expand an existing operation or develop the land for a new use. DoE's Water Quality Protection Note - *Land Use Compatibility in Public Drinking Water Source Areas* (Appendix 3) will be used to determine land uses that may be acceptable in the relevant priority classification.

6.1.2 Compensation for development constraints

The issue of compensation is often raised through water source protection planning. The existing water source protection legislation, the *MWSSD Act*, does not contain any provision for compensation when a protection area is proclaimed and the *MWSSD Act* by-laws become applicable. In this case, there are no private lots within the catchment.

7 Management of potential water quality risks

7.1 Protection objectives

The objective of this Plan is to protect drinking water quality for public health, while recognising current approved land uses.

The Priority 1 classification proposed for this catchment has the fundamental water quality objective of risk avoidance.

7.2 Potential water quality risks

The potential risks to water quality associated with activities in catchments include pathogen contamination, turbidity, pesticides and nutrient contamination. Pathogens pose the most significant risk to public health of all contaminants. Human and domestic animal contact with water involves an immediate threat of pathogen contamination.

There are many pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. *Salmonella*, *Escherichia coli* and *Cholera*), parasites (e.g. *Cryptosporidium*, *Giardia*) and viruses. These pathogens generally arise from faecal contamination. In May 2000, bacterial pathogens from cattle manure contaminated the drinking water supply of the town of Walkerton, Canada. Approximately 2,300 individuals suffered gastrointestinal illnesses and 7 people died.

The percentage of humans in the world who carry various pathogens, and hence have the potential to contaminate, varies. For example, it is estimated between 0.6 to 4.3% of people are infected with *Cryptosporidium* worldwide and 7.4% with *Giardia* (Geldreich, 1996). In 1998, Sydney's drinking water supply became contaminated with these parasites and 'boil water' notices were issued to 3 million residents.

The viability of pathogens in surface waters will also affect the risk. For example, *Salmonella* is viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich, 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) can survive weeks to months in fresh water (NHMRC & ARMCANZ, 2004). These survival times enable pathogen contamination to occur many kilometres away from the original source.

The combination of human pathogen infection, the viable life of the pathogen and human contact with the water, or the presence of humans near the reservoir or feeder streams, creates a serious risk to public drinking water quality and public health. Preventing the presence of pathogens in the water source is the most effective barrier in avoiding a public health risk.

Table 1 summarises the water quality risks associated with existing land uses and activities within the catchment which have the potential to pose some risk to the quality of the water source. Hazards identified as high risks include turbidity associated with native timber harvesting, wildfires, roads and tracks; and pathogens associated with feral animals, decomposition of animal carcasses and people fishing or marroning within the catchment.

7.3 Land use planning

The establishment of appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of water sources.

It is recommended that the North Dandalup Pipehead Dam Catchment Area and its Priority 1 land classification be recognised in the Shire of Murray Town Planning Scheme, consistent with the Western Australian Planning Commission's Statement of Planning Policy 2.7 *Public Drinking Water Source Policy* (June 2003).

DoE provides advice on the compatibility of land uses within proposed priority classification areas based on the Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas* (Appendix 3). Development and works proposals in the catchment that are likely to impact on water quality, or are inconsistent with the *Land Use Compatibility in Public Drinking Water Source Areas* guidance document, should be referred to DoE's Kwinana Peel Regional Office for assessment and recommendation.

7.4 Surveillance and by-law enforcement

The North Dandalup Pipehead Dam Catchment Area has been proclaimed under the *MWSSD Act*, enabling the by-laws of the Act to be used to control potentially contaminating activities within the catchment.

DoE has delegated the responsibility for surveillance and associated by-law enforcement in the catchment to WC, who report annually to DoE on the surveillance program and associated issues.

By-law enforcement, through on-ground surveillance of land uses and activities, is a critical mechanism in protecting the quality of drinking water sources. WC Ranger communication with visitors to the catchment also assists in increasing public awareness of the need to protect drinking water quality.

The use of signs and other informative material is also an important component of water quality protection for those who visit the catchment.

7.5 Best management practices

Best management practices for land use activities are encouraged to help protect water quality. They are often in the form of an industry code of practice or environmental guideline. Guidance documents are usually developed in consultation with industry groups, producers and State government agencies.

Best management practices can be developed for an individual enterprise or have a local or regional focus and must consider the full range of economic, social and environmental issues associated with land, water and vegetation use. Development of best management practices must also take into consideration the needs and concerns of users, consumers and the wider community (ARMCANZ & ANZECC, 1996).

The potential risks to water quality due to current land uses can be significantly reduced by the implementation of best management practices. For example:

- Retention of vegetation along streamlines (refer to DoE's Water Quality Protection Note – *Buffers to Sensitive Water Resources* (draft)).
- Appropriate pesticide application practices as detailed in Statewide Policy No.2 *Pesticide Use in Public Drinking Water Source Areas* (WRC, 2000) and Public Service Circular 88 *Use of Herbicides in Water Catchment Areas* (DoH, 1993).

- Forestry activities can be managed by appropriate road construction and maintenance, the use of sumps or drains for sediment control, and appropriate retention of buffer zones along watercourses. Refer to the Manual of Management Guidelines for Timber Harvesting in Western Australia (CALM, 1999a) and the *Contractors' Timber Harvesting Manual – South West Native Forests* (FPC, 2003).
- Appropriate buffers should be maintained between drinking water resources and bauxite mining operations. Alcoa maintains a 100 m buffer between the top water level of drinking water reservoirs and any mining operations. In addition, Alcoa self-impose a Water Resource Sensitive Zone, which extends 500 m from the reservoir top water level and includes a 200 m stream buffer (from the centre of the streamzone) for 1 km upstream of the top water level. Within this zone, Alcoa undertakes risk assessment to ensure that mining or infrastructure has no impact on the water resource. Strategies in place include maximising mine development work in summer, mining of pits along contours to ensure that stormwater runoff is fully contained and early rehabilitation of significant areas up-slope of the mining face.

The implementation of best management practices for land use activities in the catchment should be encouraged as it assists in protecting water quality. A reference list of best management practices for some of the catchment activities in the North Dandalup Catchment Area is provided in Appendix 4.

7.6 Emergency response

Discharge of chemicals during unforeseen incidents and the use of chemicals during emergency response can cause contamination of water sources. The Shire of Murray Local Emergency Management Committee, through the Peel Emergency Management District, should be familiar with the location and purpose of the North Dandalup Pipehead Dam Catchment Area. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. WC should have an advisory role to any HAZMAT incident in the catchment.

Personnel who deal with WESTPLAN - HAZMAT incidents within the area should be given ready access to a locality map of the catchment area. These personnel should receive training to ensure an understanding of the potential impacts of spills on the surface water resource.

Alcoa have approved emergency response plans which address risks associated with its operations within the catchment.

7.7 Recommended protection strategies

Table 1 identifies the potential water quality risks associated with existing land uses in the North Dandalup catchment and recommends protection strategies to manage these risks.

The potential water quality risks were identified and the resulting management priorities were designated using a risk assessment process. Strategies have been developed in line with the ADWG (NHMRC & ARMCANZ, 1996).

The discussion and recommended strategies balance the need to protect water quality now and in the long term with the rights of land holders to continue to utilise their land for lawful purposes.

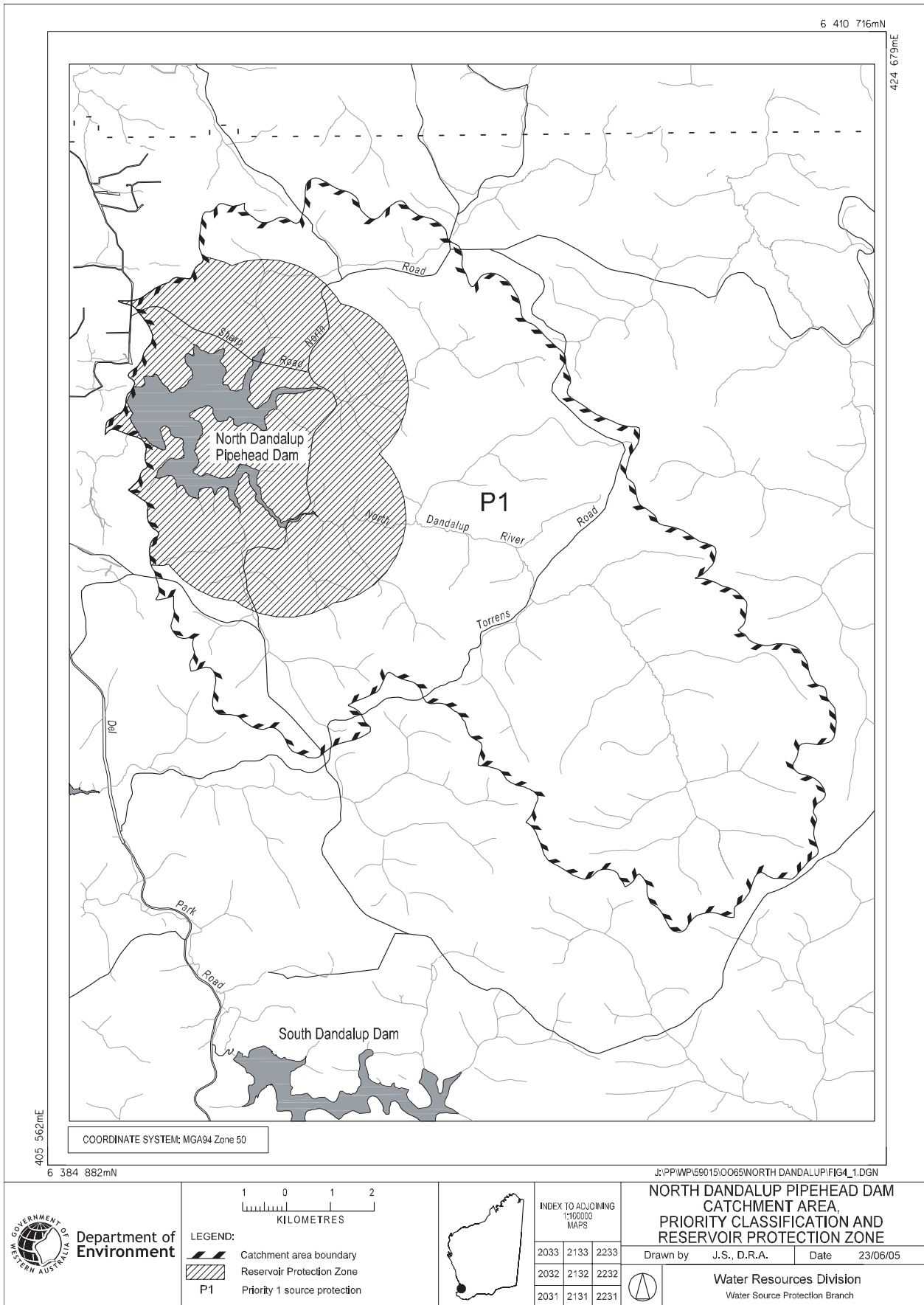


Figure 4. Reservoir Protection Zone and priority classification for North Dandalup Pipehead Dam Catchment Area

Table 1. Land use, potential water quality risks and recommended strategies

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Plantation timber harvesting (pines)</p> <p><i>No current harvesting</i></p>	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • Turbidity due to runoff from cleared areas; • Fuel spills from vehicles and machinery; • Chemical contamination from fertiliser and pesticide application during plantation establishment; • Pathogens due to human presence. 	<p>Low</p> <p>Low</p> <p>Low</p> <p>Medium</p>	<p>The impact of softwood harvesting on water quality can be minimised through proper management, including maintenance of roads, retention of vegetation buffers along watercourses, and appropriate fertiliser and pesticide use.</p> <p>Turbidity from plantation harvesting can be considerable due to the clear-felling harvesting method, but there is no potential for large scale harvesting as no large areas of plantation exist in the catchment.</p> <p>The plantations currently consist of established, mature trees.</p> <p>The potential risks to water quality of harvesting within 200 m of the reservoir and feeder streams are more acute. Increased turbidity is evident from harvesting operations, and pesticides associated with plantations have been detected elsewhere in the world. Best practice management is required.</p> <p>FPC and CALM forestry operations are governed by the <i>Forest Management Plan 2004-2013</i>.</p>	<p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> • Review detailed harvesting and establishment plans during the planning phase to ensure water quality protection objectives are included. • Ensure protocols are in place between relevant agencies on harvesting issues such as pesticide and fertiliser use, stream monitoring, road routes and construction. • Inspect water quality protection measures on site. • Ensure plantation harvesting does not occur in high risk areas, such as areas of steep slope or adjacent to watercourses. • Ensure monitoring of appropriate streams before and after harvesting and chemical application is conducted to identify any impact. • Avoid new plantations within the RPZ and within 200 m of the reservoir. • Ensure contract specifications recognise water quality protection objectives, including the use of chemical toilets during periods of intensive activity on the site. Chemical toilets are prohibited within the RPZ or within 100 m of the reservoir or its tributaries. • Ensure timber harvesting occurs in accordance with the <i>Manual of Management Guidelines for Timber Harvesting</i> (CALM, 1999a) and the <i>Code of Practice for Timber Harvesting</i> (CALM, 1999b). • Ensure pesticides are used in accordance with Statewide Policy No. 2 <i>Pesticide Use in Public Drinking Water Source Areas</i> (WRC, 2000) and PSC88 <i>Use of Herbicides in Water Catchment Areas</i> (DoH, 1993). • Update timber plantation and harvesting manuals in accordance with FPC, CALM, WC and DoE requirements.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Native forest timber harvesting</p>	<p>The risks associated with hardwood harvesting include:</p> <ul style="list-style-type: none"> • Turbidity due to log handling practices and the use of unsealed roads and tracks; • Fuel spills from vehicles and machinery; • Pathogens due to human presence. 	<p>High</p> <p>Medium</p> <p>Medium</p>	<p>The impact of hardwood harvesting on water quality can be minimised through proper management. Water quality protection is a requirement of the <i>Conservation and Land Management Act 1984</i>, which recognises the importance of water as a resource. FPC and CALM forestry operations are governed by the <i>Forest Management Plan 2004-2013</i>.</p> <p>The timber harvesting guidelines indicate that WC should be notified if logging is going to occur within 500 m of the top water level of water reservoirs. Harvesting could occur within the RPZ. The potential risks to water quality of harvesting within 200 m of the reservoir and feeder streams are more acute. Increased turbidity is evident from harvesting operations. Best practice management is required.</p>	<p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> • Continue to review harvesting plans during the planning phase to ensure water quality protection objectives are included. • Inspect water quality protection measures on site. • Where possible, avoid logging in the RPZ and within 200 m of the reservoir. • Ensure contract specifications recognise water quality protection objectives, including the use of chemical toilets during periods of intensive activity on the site. Chemical toilets are prohibited within the RPZ or within 100 m of the reservoir or its tributaries. • Ensure timber harvesting occurs in accordance with the <i>Contractors' Timber Harvesting Manual – South West Native Forests</i> (FPC, 2003) and the Code of Practice for <i>Timber Harvesting</i> (CALM, 1999b). • Update timber harvesting manuals and codes in accordance with FPC, CALM, WC and DoE requirements.
<p>Gravel pits</p>	<p>The risks associated with the use and maintenance of gravel pits include:</p> <ul style="list-style-type: none"> • Turbidity from gravel extraction and cleared areas; • Fuel and chemical spills from vehicles and machinery; • Pathogens from human presence; • Rubbish dumping often in the form of car bodies associated with illegal recreation. 	<p>Medium</p> <p>Low</p> <p>Medium</p> <p>Medium</p>	<p>Gravel pits used for road maintenance require effective site management to reduce risks to water quality. New pits established by CALM are rehabilitated after use.</p> <p>Gravel pits are focal points for illegal and sometimes destructive recreation activities usually involving vehicles. Recreational activities may be responsible for failure of rehabilitation in gravel pits.</p>	<p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> • Ensure gravel extraction occurs in accordance with Policy Statement No. 2 <i>Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves</i> (CALM, 1993), Policy Statement No. 10 <i>Rehabilitation of Disturbed Land</i> (CALM, 1986), and <i>Code of Practice for Timber Plantations in Western Australia</i> (AFG, 1997). • Pits should be rehabilitated immediately after decommissioning. • Ensure gravel pits are constructed outside the RPZ. • Ensure contract specifications recognise water quality protection objectives. • Approval of gravel extraction proposals should include the conditions stated in DoE's Water Quality Protection Note <i>Extractive Industries within PDWSAs</i>.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Bauxite mining <i>Currently occurring</i></p>	<p>The potential risks associated with this activity include:</p> <ul style="list-style-type: none"> • Turbidity from clearing, mining and roads; • Hydrocarbon contamination from fuel spills, vehicles and machinery; • Pathogen contamination from increased human activity. 	<p>Medium</p> <p>Low</p> <p>Medium</p>	<p>Through the Department of Industry and Resources (DoIR), Alcoa holds a Special Mining Lease under the <i>Alumina Refinery Agreement Act 1961</i>, No. 3. The Mining Lease allows Alcoa to mine bauxite in the catchment.</p> <p>A multi-agency group, the Mining and Management Program Liaison Group (MMPLG), oversees the implementation of the State Agreement. This includes reviewing Alcoa's 5 year mine plan and enforcing environmental (including water quality protection) conditions where appropriate. Membership includes the DoE, CALM, WC and DoIR.</p> <p>The Mine Operations Group (MOG) reviews the clearing plans and inspects areas in the field; it can modify proposals that may affect water quality in the reservoir. Membership includes CALM, WC, DoIR, DoE and FPC.</p> <p>Alcoa has programs in place for sediment control, prevention of erosion and monitoring. Results show that mining is not contributing a measurable amount to occasionally high turbidity levels in the dam. Areas identified as high risk to water quality are cleared, mined and rehabilitated in the shortest possible time, usually within a six-month period over summer.</p> <p>As of 31st December 2004, 14% (2059.6 ha) of the catchment had been mined.</p>	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with their <i>Environmental Management Manual</i> (updated biannually). • Ensure Alcoa operates according to the <i>Working Arrangements between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range.</i> • Ensure Alcoa's monitoring program continues.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Rehabilitation of mined areas</p>	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • The leaching of nutrients from the use of fertilisers; • Fuel spills from vehicles and machinery. 	<p>Low</p> <p>Low</p>	<p>A rehabilitation prescription is agreed between Alcoa and CALM, and is included in the <i>Alcoa/CALM Working Arrangements</i>. Annual rehabilitation reports are submitted to CALM to certify that Alcoa has achieved the required standards for rehabilitation success.</p> <p>The rehabilitation is monitored at 9 months and 15 months to ensure it meets completion criteria. Long-term successional monitoring of flora and fauna is also carried out.</p> <p>Fertilisers are applied once, initially in August following seeding. Fertiliser is restricted to rehabilitated areas only. Fertiliser is not applied to stream zones.</p> <p>As at 31st December 2004, 1,486.7 ha of the previously mined catchment had been rehabilitated with jarrah forest species.</p>	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with their <i>Environmental Management Manual</i>. • Ensure Alcoa operates according to the <i>Working Arrangements between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range</i>. • Ensure the <i>Alcoa/CALM Working Arrangements</i> are continued. • Ensure compliance with Policy Statement No. 10 <i>Rehabilitation of Disturbed Land (CALM, 1986)</i>. • Ensure Alcoa's monitoring program continues.
<p>Mining operations</p> <ul style="list-style-type: none"> • Workshops • Crusher and conveyor belt • Offices 	<p>The potential risks to water quality include:</p> <ul style="list-style-type: none"> • The use and storage of chemicals in the catchment which have the potential to leak or spill, contaminating water supplies; • Fuel spills from vehicles, heavy machinery and storage tanks; • Turbidity due to clearing and use of vehicles on unsealed roads. 	<p>Low</p> <p>Low</p> <p>Medium</p>	<p>The crusher and main workshop were moved from the Conjurunup Creek Pipehead Dam Catchment Area to the North Dandalup catchment in December 2004. The infrastructure is located approximately 10 km from the reservoir.</p> <p>Alcoa have operational procedures to deal with the potential risks posed by the infrastructure. Alcoa's best management practices and emergency response procedures will continue in the catchment. Distance from the reservoir should reduce any risk.</p>	<p><i>Acceptable if operated in compliance with conditions imposed by MMPLG.</i></p> <ul style="list-style-type: none"> • Ensure the conditions imposed by the MMPLG specifically pertaining to water quality protection are adhered to. • Ensure Alcoa continues to manage water protection in accordance with their <i>Environmental Management Manual</i>. • Ensure Alcoa operates according to the <i>Working Arrangements between Alcoa World Alumina Australia, the Department of Environment and the Water Corporation covering Alcoa's Mining Operations in the Darling Range</i>.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Mining operations (continued)			Fuels and chemicals are stored in banded areas in accordance with the <i>Explosives and Dangerous Goods Act 1961</i> . There are no underground storage tanks and all underground pipes are double sleeved. The chemicals stored on site are mainly sulphuric acid, battery acid and detergents.	
Fire management	Fuel reduction burning and the construction and maintenance of firebreaks has the potential to cause an increase in turbidity in the short term. In the long term they may reduce the risk to water quality (by minimising the potential for wildfire to run through the entire catchment).	Medium	Wildfire minimisation by fuel reduction burning is an established and essential land management practice in the catchment, and should be managed to limit the potential for turbid runoff into the reservoir. Firebreaks are generally cut in the event of an emergency and are not cut on a routine basis. They may be constructed for pre-suppression purposes or to meet biodiversity outcomes. Turbidity may result in areas of steeper slope close to the reservoir and tributaries.	<i>Acceptable activity with best management practices.</i> <ul style="list-style-type: none"> Establish specific guidelines related to water quality protection for consideration in the burning prescription. Liaise closely with CALM to ensure that these guidelines are incorporated within CALM's <i>Fire Operations Manual</i> and that protocols are put in place for effective communications between agencies managing the catchment. Ensure that any firebreaks required on an ongoing basis are constructed and maintained to minimise the risk of soil disturbance. Ensure stabilisation of soil excavated during construction of water points to prevent turbid runoff into watercourses.
• Fuel reduction burning				
• Firebreaks	Additional risks include carbon and nutrient contamination from airborne and eroded ash.	Low		
• Water points	The potential risks associated with the construction and access of water points for fire fighting include turbidity from the use of unsealed roads and tracks, fuel spills and pathogens from direct contact with water bodies.	Medium		

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
State Forest				
Wildfires	<p>The risk associated with extensive burning by wildfire and emergency construction of firebreaks is primarily turbidity.</p> <p>There is also a risk of carbon and nutrient contamination (from the use of fire suppressants).</p>	<p>High</p> <p>Medium</p>	<p>Intense wildfire can cause turbidity, from the ash made airborne during the burn or through runoff when the burn is followed by rain.</p> <p>WC staff attend fires.</p> <p>The fuel reduction program run by CALM should reduce the incidence of wildfire.</p>	<p><i>Acceptable activity with best management practices.</i></p> <ul style="list-style-type: none"> Where location, extent or intensity of a fire suggests the need, inspect sites following fire to assess the need for turbidity mitigation works, and conduct these works. Ensure sites that need permanent protection from wildfire have adequate firebreaks and/or low vegetation buffer zones to prevent the need for extensive earthworks or clearing at short notice during a fire. Emergency firebreaks should be rehabilitated immediately. For water quality considerations to be sufficiently addressed, a WC staff member should continue to attend fires in catchment areas. Reduce fuel loads with appropriate prescribed burning by CALM.
Firewood collection	<p>The risks associated with firewood collection include:</p> <ul style="list-style-type: none"> Pathogen contamination through the presence of people and domestic animals near watercourses; Rubbish dumping; Turbidity from the use of unsealed roads and damage to vegetation during off-road driving. 	<p>Medium</p> <p>Medium</p> <p>Medium</p>	<p>The primary concern is the potential for people to be close to the reservoir or tributaries during public firewood collection.</p> <p>Firewood collection is not permitted in the RPZ.</p> <p>The collection of firewood is managed by CALM through a permit system.</p> <p>Rubbish dumping is often associated with public firewood collection points.</p> <p>Domestic animals often accompany people during firewood collection.</p>	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> Ensure regional plans for public firewood collection areas give consideration to water quality protection objectives. Promote firewood collection sites outside of the catchment. Where public firewood areas are within the catchment, establish designated public firewood areas outside the RPZ, away from the reservoir and tributaries, and restrict activity to areas at the edge of the catchment. Ensure the public firewood areas are regularly patrolled and rubbish dumped is removed. Use signs and brochures to promote water catchment awareness and to ensure the public are aware that dogs are not permitted within the catchment, unless on private property. Undertake surveillance with by-law enforcement.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Private resource harvesting</p> <ul style="list-style-type: none"> • Apiaries (9) • Wildflower picking • Seed collection 	<p>The potential risks to water quality from bee farming, wildflower or seed collection include:</p> <ul style="list-style-type: none"> • Pathogen contamination through the presence of people near the watercourses; • Increased turbidity due to the use of unsealed roads. 	<p>Medium</p> <p>Low</p>	<p>The primary concern is the potential for people to be in close proximity to the reservoir or tributaries.</p> <p>CALM and Alcoa collect seeds for rehabilitation. CALM licenses a number of apiarists, private seed collectors and wildflower pickers. The permit conditions imposed by CALM cater for water quality protection in PDWSAs.</p> <p>The low numbers of people involved, together with management controls, reduces the risk associated with these activities.</p> <p>The potential risks to water quality are increased when activity is within an RPZ or near a reservoir or feeder streams.</p>	<p><i>Acceptable activities with controls.</i></p> <ul style="list-style-type: none"> • Ensure water required at apiary sites is not sourced from the reservoir, but trucked in as per licence conditions. • Apply a condition of approval for apiarists, wildflower picking and seed collection licences that requires adherence to water quality protection objectives, including exclusion from the RPZ and prohibiting camping within the catchment. • Inspect water quality protection measures on site.
<p>Vehicle roads and tracks</p>	<p>The risks associated with the use of roads and tracks include:</p> <ul style="list-style-type: none"> • Turbidity from erosion of unsealed roads and tracks; • Fuel and chemical spills from vehicles and machinery; • Pathogen contamination from public access to the water body. 	<p>High</p> <p>Low</p> <p>Medium</p>	<p>Some roads and tracks are necessary for forest management. It is essential they are well maintained to minimise the risk of erosion.</p> <p>All roads and tracks in the State Forest are open to the public, and control of access is a major issue in the catchment. Tracks provide direct access to the dam and catchment. Public access to the water body increases all associated risks of rubbish dumping and pathogen contamination.</p>	<p><i>Accepted as necessary for proper land and forest management and requires best management practices.</i></p> <ul style="list-style-type: none"> • Adherence to DoE's draft Water Quality Protection Note <i>Roads in Sensitive Environments.</i> • Review the road network to identify roads not essential for forest management or transport thoroughfare. • Rehabilitate tracks that are not required for forest management or transport thoroughfare. • Define 'Public Road' and educate the public on its definition and implication for by-law enforcement. • Ensure road upgrades follow alignments and incorporate measures to avoid or minimise water source contamination risks.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>State Forest</i></p> <p>Vehicle roads and tracks (<i>continued</i>)</p>			<p>The main unsealed roads that intersect the catchment are North Road and Torrens Road (both CALM roads). These roads are necessary for transportation and operations in the catchment area. North Road passes along the eastern border of the North Dandalup Dam passing within 1 km of the reservoir. Torrens Road passes across the south-eastern part of the catchment passing within 6 km of the reservoir.</p>	<ul style="list-style-type: none"> Avoid the development of new tracks and roads through the catchment, particularly within the RPZ. Use signs along roads to inform people of their presence in a public drinking water source area, and display the emergency contact number for use in the event of a spill.
<p>Feral animals and their control</p> <ul style="list-style-type: none"> Feral pigs Foxes <p>(Rabbits and cats are also present but are not perceived to pose a significant water quality problem)</p>	<p>The major risk to water quality associated with feral animals in the catchment is pathogen contamination. Feral pigs create the largest risk of:</p> <ul style="list-style-type: none"> Turbidity; Pathogens, through excretion of faecal material whilst wallowing. <p>Fox control occurs through baiting, and involves a risk of pathogen contamination from animal carcasses.</p>	<p>Medium High Medium</p>	<p>Under <i>MWSSD Act</i> by-laws shooting, trapping or hunting of game is prohibited in catchment areas, as is the presence of dogs.</p> <p>Illegal introduction of pigs (and their associated diseases) by hunters is known to have occurred and increases all risks associated with the animals.</p> <p>Feral animal control reduces the risks associated with these animals, but may introduce additional risks to water quality if not properly managed. It is essential that feral pig control, in particular, be undertaken in a well-managed and organised manner, in order to minimise the potential impacts on water quality.</p>	<p><i>Acceptable activity with controls.</i></p> <ul style="list-style-type: none"> Ensure feral pig control is performed by the 'trap and shoot' method only, without the use of dogs. Ensure pig carcasses are removed from the catchment. Ensure fox baiting is undertaken in accordance with CALM's current 1080 policy <i>CALM Fox Control Manual</i> (CALM, 1996) and the DoH's <i>Code of Practice on the Safe Use and Management of 1080</i> (DoH, 2000).

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>State Forest</i>				
Feral animals and their control <i>(continued)</i>			Feral pig control occurs through volunteer hunters and local landowners, which involves additional risks associated with pathogen contamination from feral animal carcasses, and from people and dogs in the catchment. WC currently undertakes some feral pig control in the catchment, using the 'trap and shoot' method. This method reduces the risks to water quality as animal carcasses can be removed from the catchment.	
Research projects	The use of the catchment and reservoir for research projects involves a potential risk of pathogen contamination from people remaining in the catchment, particularly close to or on the reservoir.	Low	The risk associated with this activity is minimal, due to the low numbers of people involved, management controls and the ease of education prior to the activity occurring. CALM and WC staff frequently supervise projects.	<p><i>Acceptable activity with conditions.</i></p> <ul style="list-style-type: none"> • Ensure education on water quality protection requirements is undertaken prior to the activity. • Apply a condition of approval that requires adherence to water quality objectives.
<i>Recreation</i>				
All recreational activities within the catchment are to comply with DoE's Statewide Policy No. 13 Policy and Recreation within Public Drinking Water Source Areas on Crown Land (2003).				
Swimming	There is a high risk of pathogen contamination associated with swimming, through direct body contact with the water body.	Medium	Swimming, bathing, bodily contact with water and washing clothes in the reservoir and tributaries is prohibited, as is access to the RPZ, under <i>MWSSD Act</i> by-laws because of the immediate risk to drinking water quality.	<p><i>Swimming is prohibited in the reservoir and tributaries in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and promotional material to ensure public are aware that swimming is prohibited in the reservoir and tributaries. • Undertake after-hours surveillance with by-law enforcement.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>Recreation</i></p> <p>Fishing and marroning</p>	<p>The major risks to water quality from fishing and marroning are:</p> <ul style="list-style-type: none"> • Pathogen contamination from people close to watercourses and the use of bait; • Turbidity from vehicles close to the water body. 	<p>High</p> <p>Low</p>	<p>Human or animal contact with the reservoir and its tributaries poses an immediate threat to water quality. There are additional risks associated with fishing and marroning through on-site camping, the presence of dogs and the use of baits.</p> <p>Fishing and marroning in the reservoir and tributaries are prohibited under <i>MWSSD Act</i> by-laws.</p> <p>By-laws are enforced by WC after-hours surveillance, but penalties are small and the activities continue. It is considered that stopping these activities is essential to protect water quality.</p>	<p><i>Fishing and marroning are prohibited in the reservoir and tributaries in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and advertising material to ensure the public are aware that fishing and marroning are not permitted. • Liaise with and advertise through the Department of Fisheries and fishing organisations. • Undertake after-hours surveillance of the catchment and by-law enforcement with the aim of stopping activities. • Increase the penalties associated with offences under Part 4 of the <i>MWSSD Act</i> by-laws. • Consider alternative enforcement options under the <i>Environmental Protection Act 1986</i>, i.e. Environmental Protection Policy.
<p>Camping</p> <ul style="list-style-type: none"> • Undesignated camping 	<p>The potential risks associated with camping are:</p> <ul style="list-style-type: none"> • Pathogen contamination; • Rubbish dumping. 	<p>Medium</p> <p>Low</p>	<p>There are no designated campsites within the catchment. Camping in undesignated areas is prohibited under <i>MWSSD Act</i> by-laws. Undesignated camping poses a significant risk to water quality, as appropriate facilities are not available and sites are generally close to the reservoir or tributaries. Camping at undesignated sites is likely to involve additional risks associated with illegal activities, such as rubbish dumping, fishing and marroning.</p>	<p><i>Camping is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and advertising material to ensure the public are aware that camping is prohibited in the catchment, and to educate on the importance of protecting drinking water quality. • Undertake surveillance of the catchment with by-law enforcement. • Consider alternative enforcement options under the <i>Environmental Protection Act 1986</i>, i.e. Environmental Protection Policy.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
Recreation Bushwalking and cycling • Munda Biddi Trail • Other informal activities (e.g. bird watching)	The potential risks associated with these activities are: • Pathogen contamination from people in the catchment, particularly in areas close to watercourses; • Turbidity, primarily from cyclists; • Rubbish dumping.	Medium Medium Medium	Cycling through organised groups (for example, along the Munda Biddi Trail) can be managed through approval and education, which reduces the risk to water quality. It is essential that designated tracks be regularly inspected and maintained to minimise the risk of degradation and erosion. CALM is responsible for the establishment of the Munda Biddi Trail which is promoted as a self-guided cycle trail, thus public use is largely informal. Mention of public drinking water catchment protection objectives in information brochures is essential. The use by cyclists is uncontrolled and likely to encourage off-track activity in the catchment; travel off marked trails is widespread, increasing the risk of erosion.	<i>Acceptable activity with conditions.</i> <ul style="list-style-type: none"> No further trails to be developed in the catchment without consultation with the relevant agencies (CALM, WC & DoE). Ensure an environmental management plan is developed, implemented and audited for the Munda Biddi Trail, which addresses water quality protection objectives, such as regular inspections and maintenance of the trail. Ensure bushwalking, including designated trails and informal activity, is restricted to trails outside the RPZ. Use signs and brochures to educate on the <i>MWSSD Act</i> by-laws and the importance of protecting drinking water quality. Consider alternative enforcement options under the <i>Environmental Protection Act 1986</i>, i.e. Environmental Protection Policy.
Rubbish dumping	The risks associated with rubbish dumping include: • Pathogen contamination; • Nutrient, chemical, heavy metal and fuel contamination from domestic, building or industrial waste, tyres and the dumping of stolen cars.	Medium Low	Rubbish dumping is often associated with informal or unauthorised recreation or access to the catchment. Rubbish dumping in the catchment is not prevalent. As all roads and tracks in the State Forest are open to the public, control of access is a major issue in the catchment.	<i>Rubbish dumping is prohibited in the catchment.</i> <ul style="list-style-type: none"> Undertake surveillance with by-law enforcement. Use signage and advertising material to ensure the public are aware that rubbish dumping is not permitted.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>Recreation</i>				
Picnicking	<p>The risk to water quality from this activity is pathogen contamination. The risk is greater for undesignated picnicking than picnicking in designated areas.</p> <ul style="list-style-type: none"> Designated picnicking; Undesignated picnicking. <p>Rubbish dumping is a potential risk.</p>	<p>Low</p> <p>Medium</p> <p>Low</p>	<p>The risk of contamination is increased by proximity to the reservoir being a desirable aspect of a picnic site. However, the risk is minimised where picnic sites and facilities are provided, away from tributaries. The risk is greater for undesignated sites than picnicking in designated areas, due to the lack of management controls.</p> <p>A designated picnic site is maintained downstream of the dam wall in the gazetted catchment. The picnic site is well sign posted to prohibit illegal recreation.</p>	<p><i>Picnicking is an acceptable activity at designated sites only.</i></p> <ul style="list-style-type: none"> Ensure any future designated picnic areas are outside the RPZ and include appropriate facilities with no access to the water body or tributaries. Use signs and brochures to educate on the importance of protecting drinking water quality. Enforce <i>MWSSD Act</i> by-laws that prohibit picnicking in undesignated sites within the catchment.
Animal (dog) exercising	<p>The potential risk associated with this activity is pathogen contamination from people and animals in the catchment, particularly close to the reservoir or tributaries.</p>	<p>Medium</p>	<p>It is prohibited to bring a dog into a catchment area under <i>MWSSD Act</i> by-laws, unless on private property.</p>	<p><i>The presence of dogs is not acceptable in the catchment, unless on private property.</i></p> <ul style="list-style-type: none"> Use signs and advertising material to ensure public are aware that dogs are not permitted in the catchment, unless on private property. Undertake surveillance with by-law enforcement.
<p>Off-road vehicle use</p> <ul style="list-style-type: none"> 4WDs Motorcycles Unlicensed vehicles 	<p>The risks associated with off-road vehicle use include:</p> <ul style="list-style-type: none"> Turbidity; Hydrocarbon contamination from fuel spills; Contamination from vehicle dumping. 	<p>Low</p> <p>Low</p> <p>Low</p>	<p>Under <i>MWSSD</i> By-law 4.7.2: No person shall drive a vehicle on any part of a catchment area other than a road or track which has a graded, gravelled, sealed, primed or other prepared surface without written approval from DoE.</p> <p>Off-road vehicle use is rare in North Dandalup catchment, but does occur.</p> <p>Turbidity results from erosion of land, particularly on the steep slopes close to the reservoir, driving through stream crossings and from damage to vegetation.</p>	<p><i>Off-road driving (away from designated roads) is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> Use signs to advertise that off-road driving away from designated roads is prohibited in the catchment. Undertake surveillance with by-law enforcement. Rehabilitate WRC owned land with local, native vegetation.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<i>Recreation</i>				
Recreational hunting	The major risk to water quality associated with hunting is pathogen contamination from: <ul style="list-style-type: none"> • Feral animal carcasses; • People and dogs in the catchment, and possibly camping. 	High Medium	<p>Under By-law 4.3.4: No person shall shoot, trap or hunt any game or catch, or attempt to catch, any fish or marron within a catchment area, without specific permission in writing from DoE to which it may attach any conditions that it deems necessary.</p> <p>CALM approves hunting in the catchment for feral animal control. WC will only approve feral animal control by the 'trap and shoot' method. Uncontrolled hunting and shooting introduces significant additional risks to water quality particularly due to associated camping and the use of dogs.</p> <p>Surveillance by WC Catchment Rangers currently reduces the occurrence of illegal hunting, but greater surveillance would further minimise the activity.</p>	<p><i>Recreational hunting is prohibited in the catchment.</i></p> <ul style="list-style-type: none"> • Use signs and advertising material to advertise that recreational hunting is not permitted. • Continue surveillance of the catchment with by-law enforcement. • Hunting in the catchment is by the 'trap and shoot' method only, under authorisation as part of the feral animal control program, which is undertaken in an organised manner to minimise water contamination.
<i>Water and Rivers Commission freehold land</i>				
Unauthorised recreation <ul style="list-style-type: none"> • Camping • Bushwalking • Off-road vehicle use • Illegal hunting 	The potential risks associated with these activities have been discussed in detail in previous sections. There are also additional risks of erosion associated with plantations established on Commission land.		WRC owns several properties in the catchment, with most of them directly north of the dam. These properties were previously used for agriculture. Most of the properties are now recovering from heavy logging, and are commonly used for rubbish dumping and unauthorised recreation.	Unauthorised recreation is prohibited on WRC land in the catchment. <ul style="list-style-type: none"> • Investigate the need for the rehabilitation of streamzones with native vegetation. • Prohibit unauthorised access to WRC properties under trespass laws. • Maintain signs to ensure the public are aware of the private ownership of the properties. • Undertake surveillance of WRC properties with enforcement of trespass laws.

Activity	Potential Water Quality Risks		Consideration for Management	Recommended Protection Strategy
	Hazard	Management Priority		
<p><i>Other Land Uses</i></p> <p>Infrastructure maintenance</p> <ul style="list-style-type: none"> • Bridges • Roads <p>(not including operations for bauxite mining)</p>	<p>The major risk associated with these activities are:</p> <ul style="list-style-type: none"> • Turbidity due to clearing of vegetation and the use of unsealed roads; • Herbicides from weed control; • Hydrocarbon contamination due to fuel spills from vehicles and machinery; • Spread of forest disease. 	<p>Medium</p> <p>Low</p> <p>Low</p> <p>Low</p>	<p>Maintenance is necessary for the operation of the infrastructure. However, the risks to water quality associated with maintenance need to be managed, particularly in close proximity to watercourses.</p> <p>WRC's Statewide Policy No. 2 <i>Pesticide Use in Public Drinking Water Source Areas</i> should be considered when dealing with this hazard.</p> <p>There are restrictions on the use of pesticides in catchment areas, reflected in PSC88 <i>Use of Herbicides in Water Catchment Areas</i> (DoH, 1993). PSC88 is currently being updated.</p>	<p><i>Best management practices are required for all infrastructure maintenance activities in the catchment.</i></p> <ul style="list-style-type: none"> • Ensure that all responsible agencies and their maintenance contractors are aware of PDWSA locations and that appropriate best management practices are followed whilst within a drinking water catchment. • Ensure responsible agencies adhere to relevant policies.

8 Recommendations

The following recommendations and identified key stakeholders are proposed to help protect the water quality of the North Dandalup Pipehead Dam.

1. The Town Planning Scheme for the Shire of Murray should incorporate the management principles outlined in this Plan, including recognition of the Reservoir Protection Zone and Priority 1 classification assigned to land in the North Dandalup Pipehead Dam Catchment Area. (Shire of Murray)
2. Development and works proposals in the North Dandalup Pipehead Dam Catchment Area that are likely to impact on water quality or are inconsistent with Department of Environment's Water Quality Protection Notes, including *Land Use Compatibility in Public Drinking Water Source Areas* (as amended from time to time), and guidelines should be forwarded to the Department of Environment for assessment and recommendation. (Shire of Murray, Department for Planning and Infrastructure)
3. Signs should be erected and maintained along the boundaries of the catchment area and Reservoir Protection Zone to define the areas and to promote public awareness of the importance of protecting drinking water quality. (Water Corporation)
4. The Department of Conservation and Land Management, Forest Products Commission, Shire of Murray, Department for Planning and Infrastructure and Alcoa World Alumina Australia should be supplied with a digital copy of the Reservoir Protection Zone and priority classification to facilitate their planning processes. (Department of Environment)
5. The catchment surveillance program and associated by-law enforcement should continue to be implemented by the Water Corporation in the North Dandalup Pipehead Dam Catchment Area. (Water Corporation)
6. Investigate the options for Water Corporation Catchment Rangers and Department of Conservation and Land Management Rangers to be trained to enforce *Metropolitan Water Supply, Sewerage and Drainage Act* by-laws. (Water Corporation, Department of Conservation and Land Management)
7. New recreational events or activities in the catchment should only be approved if in accordance with the requirements of the relevant agencies and Department of Environment's Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land* (2003). The Department of Environment will not support new activities within the Reservoir Protection Zone. (Shire of Murray, Department of Conservation and Land Management, Water Corporation, Department of Environment)
8. A risk assessment of the Munda Biddi Trail should be completed and the risks addressed. Management plans covering the roles and responsibilities of the relevant agency stakeholders should be prepared and audited. (Department of Conservation and Land Management, Munda Biddi Trail Foundation)
9. Streamzones and other areas of the catchment in Water Corporation, Water and Rivers Commission or other government ownership should be assessed for the need for rehabilitation. Rehabilitation with local native species should be carried out where necessary. (Water Corporation, Department of Environment)
10. Personnel dealing with WESTPLAN – HAZMAT incidents in the area should be given ready access to a locality map of the North Dandalup Pipehead Dam Catchment Area and training to understand the potential impacts of spills on the surface water resource. (Department of Environment, Fire and Emergency Services Authority of Western Australia)

11. The strategies detailed in Table 1. *Land use, potential water quality risks and recommended strategies* should be considered for adoption by those with responsibility for the recommended protection strategy. (Stakeholders)
12. The Department of Environment is to work with Department of Conservation and Land Management and Forest Products Commission to update the forestry manuals, codes and guidelines. (Department of Environment, Department of Conservation and Land Management, Forest Products Commission)
13. The Department of Environment should prepare an Implementation Strategy for this Plan involving all relevant stakeholders. (Department of Environment)
14. Implementation of these recommendations should be reviewed periodically after this Plan is endorsed. A full review of this Plan should be undertaken after five years. (Department of Environment)

9 Glossary

Aesthetic Guideline Level	ADWG level ascribed for acceptable aesthetic quality of drinking water.
Allocation	The quantity of surface water permitted to be abstracted by a licence, usually specified in gigalitres/year (GL/a).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Health Guideline Level	ADWG level ascribed for acceptable drinking water quality for human health.
IWSS	The Integrated Water Supply System provides water to Perth, Mandurah, Pinjarra, Harvey and the Goldfields and Agricultural regions, servicing approximately 1.5 million people. 50% of the water is from surface water catchments, 50% is from groundwater. Refer to Figure 1 in Water Corporation's <i>Perth's Water Balance – The Way Forward</i> for a diagrammatic representation.
Leaching / leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater; the material washed out is known as leachate. Leachate can pollute groundwater and waterways.
m AHD	Australian Height Datum. Height in metres above Mean Sea Level +0.026 m at Fremantle.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorus (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
PDWSA	Public Drinking Water Supply Areas are Underground Water Pollution Control Areas, catchment areas or water reserves established under the MWSSD or CAWS Act. PDWSAs are also referred to as drinking water catchments.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Pollution	Water pollution occurs when waste products or other substances, e.g. effluent, litter, refuse, sewage or contaminated runoff, change the physical, chemical, biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses.
Runoff	Water that flows over the surface from a catchment area, including streams.
Storage reservoir	A major reservoir of water created in a river valley by building a dam.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Water quality	The physical, chemical and biological measures of water.

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Acronyms

Alcoa	Alcoa World Alumina Australia
ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CALM	Department of Conservation and Land Management
CAWS Act	<i>Country Areas Water Supply Act 1947</i>
DoE	Department of Environment, formerly the Water and Rivers Commission and the Department of Environmental Protection
DoH	Department of Health
DoIR	Department of Industry and Resources
DRA	Disease Risk Area
DWSPA	Drinking Water Source Protection Assessment
DWSPP	Drinking Water Source Protection Plan
FPC	Forest Products Commission
GL	Gigalitre; 1 thousand million litres
HAZMAT	Hazardous materials
IWSS	Integrated Water Supply System
ML	Megalitres; 1 million litres.
MMPLG	Mining and Management Program Liaison Group
MOG	Mining Operations Group
MWSSD Act	<i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i>
NHMRC	National Health and Medical Research Council
P1	Priority 1 - priority classification for land use
PDWSA	Public Drinking Water Source Area
PZ	Prohibited Zone (also known as Reservoir Protection Zone {RPZ})
RIWI Act	<i>Rights in Water and Irrigation Act 1914</i>
RPZ	Reservoir Protection Zone (also known as Prohibited Zone {PZ})
WC	Water Corporation
WHO	World Health Organisation
WRC	Water and Rivers Commission

Appendix 1 - Overview on protecting our Public Drinking Water Source Areas

PROTECTING PUBLIC DRINKING WATER SOURCE AREAS

Introduction

This agency is the custodian of all of the State's water resources. Our role is to ensure the State's water resources are managed to support sustainable development and conservation of the environment for the long-term benefit of the community.

Next to food, water is the most essential element for life, and our aim is to protect Public Drinking Water Source Areas (PDWSA). Achieving this aim will provide consumers with reliably 'safe, good quality drinking water' to protect public health for now and into the future at a reasonable cost to consumers.

This note provides an overview of policy and processes used to protect PDWSA supplying drinking water to major population centres in Western Australia. Generally, private sources supplying drinking water to a household, business or remote aboriginal community are not subject to the same level of assessment, sampling, treatment and reporting requirements. Accordingly, they are not directly addressed in this protection note. Nonetheless, the approaches described in this note are still recommended for private sources. For example, the Water Corporation have a number of significant private drinking water source areas (eg 'roaded' catchments) that they operate consistent with PDWSA policy and processes.

The former State Government agencies the *Department of Environmental Protection* and *Water and Rivers Commission* are presently being combined to form the *Department of Environment*. This process will not be complete until enabling legislation has been passed by Parliament and proclaimed. This note aims to present a generic 'combined agency' position on the nominated topic.

Who is involved in protecting our drinking water supplies?

Responsibility for the condition (quality) and availability (quantity) of our drinking water must be shared by the community, land owners/developers, industry, agriculture, local government, water service providers and the State government. All of these groups play a significant role in the development of Drinking Water Source Protection Plans (DWSPP) for PDWSAs (also called drinking water catchments in this note). They also may be involved in the implementation of the recommendations in those plans. Their direct and ongoing involvement in the protection of our drinking water catchments is essential to achieve a successful outcome.

The Department of Environment (DOE), is primarily responsible for defining, proclaiming and protecting the catchments of Public Drinking Water Source Areas (PDWSAs). The PDWSAs are made up of any area proclaimed to protect public drinking water source catchments. These areas are proclaimed as Water Reserves, Catchment Areas or Underground Water Pollution Control Areas under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*, and Water Reserves or Catchment Areas under the *Country Areas Water Supply Act 1947*.

The DOE has responsibility to administer the State's catchment protection legislation. This administration includes:

- undertaking and facilitating effective by-law enforcement and catchment surveillance;
- the assessment and permitting of land use developments or activities;
- negotiating protection mechanisms in the land use planning process; and
- advising on the compatibility of land development and use activities.

The DOE also has responsibility for preparing policies and guidelines, drinking water source protection assessments and plans and advising other decision-making agencies on source protection requirements. The Department promotes a coordinated approach to catchment protection encompassing a variety of related measures including regional and local land use planning; health; and environmental legislation.

Where public health is concerned, the Department of Health has primary responsibility. The Department of Health's role is to minimise human exposure to environmental health hazards that pose or have the potential to pose a health risk and to reduce the incidents and impact of communicable disease. To safeguard against unhealthy drinking water, the Department of Health works closely with the DOE and individual Water Service Providers. The Department of Health also chairs an inter-agency committee, called the "*Advisory Committee for the Purity of Water*", established in 1925 and charged with the ongoing responsibility of advising the State on drinking water protection issues. The Office of Water Regulation is another government agency with a key role in regulating drinking water supply issues. It issues licences to individual Water Service Providers such as the Water Corporation, Aqwest (Bunbury) and Busselton Water Board.

The Water Corporation is the largest Water Service Provider in WA, and it was formed in the mid 1990's after the split of the former Water Authority of Western Australia as part of the COAG Water Industry Reform initiatives. The Corporation is the major licensed Water Service Provider in Western Australia, supplying the Perth metropolitan area as well as a further 230 towns across the State. It is a corporation, with the state government being the sole shareholder, and is subject to corporation law. It is managed by a board of directors including the Managing Director (its CEO). The Corporation is required to return a dividend on the Government's investment in the Corporation's assets and in return receives Customer Service Obligation (CSO) payments to subsidise uneconomic services that are required to be provided by the Government. The Corporation also pays federal tax equivalents to the State Government in accordance with the COAG reform agreement.

Source Protection Operational Agreements exist between the DOE and the Water Corporation, which assign roles in catchment protection, clarify responsibilities in catchment protection and ensure the process is carried out effectively. Under the legislation, the DOE may delegate certain catchment management functions to the Water Corporation (or other water service providers). Delegation is appropriate as the Corporation has a strong vested interest in assuring high quality drinking water from the catchments and is also prepared to resource catchment management functions. Currently, delegated functions relate to catchment surveillance, enforcing by-laws regarding transient catchment activities, entry onto land and catchment management planning. The extent of delegated responsibilities may vary between catchments.

Why should we protect our drinking water supplies?

Drinking water should be safe to drink and aesthetically pleasing. Ideally, it should be clear, colourless, pleasant tasting and contain no harmful chemicals or disease-causing microbes. To keep drinking water clean it is important to protect both our surface and underground drinking water sources (e.g. surface dams and groundwater) and the catchments in which they are located.

This advice deals with the water consumed in homes and provided by licensed Water Service Providers (often referred to as ‘scheme’ supplies). These WSP are responsible for water treatment (including disinfection) and distribution services to the community. Advice on alternative (potentially less safe) drinking water sources, such as private bores or rainwater tanks, is available in other documents. As a rule neither the Department of Health or DOE recommend the use of rainwater or private bore water for drinking water purposes where a scheme water source is available. This is because the catchments of these other sources are generally not protected from contamination and they are not analysed or treated to meet the relevant health guidelines for drinking water. Such sources can however be useful for non-potable uses such as in washing machines, toilets or for gardens. If a scheme supply is not available, then it is important that the consumer implements the necessary measures to ensure their drinking water source is safe to drink (i.e. arrange water analyses and treatment as required).

In the mid 1990’s, the Council of Australian Government reforms process took an initiative to pursue the sustainable use of water resources by protecting and enhancing their quality, while maintaining economic and social development. This was achieved through the development of a National Water Quality Management Strategy (NWQMS) presently comprising 21 national guideline documents. Two of these focused on drinking water, the *Australian Drinking Water Guidelines-Summary* and the *Australian Drinking Water Guidelines*, 1996 (an update of the 1987 *Guidelines for Drinking Water Quality in Australia*).

The *Australian Drinking Water Guidelines, 1996* (ADWG) recognised water source protection through catchment management as an effective approach to preventing contamination of drinking water sources and undertook to investigate this issue further.

In May 2001, Western Australia supported the NWQMS (including the ADWG) through the launch of its own State Water Quality Management Strategy (SWQMS). In late 2002, the ADWG were updated and released for public comment. The ADWG 2003 have now been finalised and are planned to be released in late 2003. A ‘consumer guide’ to the ADWG 2003 called *Water made clear* has also been developed to raise awareness of the need to protect drinking water catchments from ‘catchment to consumer’.

Roughly half of Perth’s water supplies come from surface sources with the remainder harvested from groundwater. In 1994, a Parliamentary Select Committee reported on the issue of Perth’s development and groundwater supplies. The Select Committee considered experience from around the world and overwhelmingly concluded, “*an ounce of prevention is worth a pound of cure*”. In his foreword, the chairman of the Select Committee noted: “**experts around the world expressed their envy of our relatively pristine water supply and advised us to protect our groundwater supply at all costs**”.

In 2000, the State Legislative Council’s *Standing Committee on Ecologically Sustainable Development in relation to the Quality of Perth’s Water Supply* expressed confidence in the system managing and operating Perth’s water supply. The Standing Committee noted, however, that various activities posed a contamination risk to water supplies. It found as a “**first priority that water sources be protected through good land use planning. It also noted that** “*Using treatment to deal with contamination is a second-best option. The Committee found support for adopting catchment protection as the major weapon in preventing contamination of water supplies*”. In November 2001, in support of this finding, the Western Australian Planning Commission (in consultation with the Water and Rivers Commission) released a *Public Drinking Water Source Policy* for public comment. The Policy was gazetted in June 2003. This policy will guide State and Local Government land use planning decisions in public drinking water catchments.

Although the above committees were reporting on Perth’s water supplies, their findings apply to all public drinking water sources in Western Australia. This is especially true when a community is reliant upon a single drinking water resource (such as the groundwater bore network in Kununurra or surface water dam

in Quin nip) rather than an integrated series of sources (such as those that supply Perth). Contamination of a single resource from inappropriate land use planning or polluting activities within the catchment can have significant health and economic impacts, which should be avoided.

In February 2003, the Western Australian Government released its State-wide water strategy. Although prepared in response to a number of forums around State focusing on drought, it did however make a significant statement about protecting our public drinking water sources. It stated unequivocally that ***recognition of the primacy of water quality in the management of drinking water catchments, to protect the long term sustainability of the resource, will be used to guide catchment management decisions.***

This is interpreted to mean, when managing and protecting any public drinking water source catchment, the dominant consideration must be maintenance of water resource quality and the prevention of contamination risk. This objective in most cases may prevent or constrain further land development.

More recently in September 2003, the Western Australian Government also released its State-sustainability strategy document – “Hope for the future”. Drinking water catchments are now recognised as important ‘natural resources’ together with the other more common natural resources (eg. agriculture, fisheries, forestry, mining, tourism, aquatic systems, coastal and marine environments and rangelands). The ‘Vision’ in the Strategy is that “Drinking water sources are fully protected for future generations.”. The Strategy lists the following ‘Actions’: (number 3.48) that we “Work to ensure all present and future drinking water sources are protected.”; and (number 3.51) that we “Ensure the activities in catchments are actively managed and sustainable...” through “...investigation of the impact of active catchment management strategies that enhance water quality and quantity outcomes...”.

What are we protecting the drinking water supplies from?

Land use planning decisions and recreational or business activities occurring in drinking water catchments can impact on the quality and quantity of drinking water. Where catchments remain covered with native vegetation with little human activity, the risk of contamination is low. However, contamination risks increase with increased human activity.

Potential contaminants may include:

- physical contaminants e.g. colour, foaming agents and suspended solids;
- chemical contaminants e.g. salts, heavy metals and poisons; or
- microbiological contaminants e.g. bacteria, protozoa and pathogenic viruses.

Although many contaminants can be removed by treatment processes, such treatment increases the cost of the water supply, and continuous effective removal of all contaminants is not considered technically or economically feasible. If contamination does occur, the opportunity to locate and develop a replacement source is often limited, and the provision of alternatives, e.g. bottled drinking water, is costly and can only be considered a short-term solution. Stopping contamination before it occurs prevents the need for costly treatment or the development of often more costly alternative sources. It should also be appreciated that there is a substantial ongoing financial cost to be borne in sampling and testing for contaminants if they become prevalent in drinking water sources. The benefits (environmental, social and economic) of avoiding contamination through best management decisions and practices are recognised in the ADWG 2003.

Clearly drinking water quality and safety cannot be taken for granted. Appropriate State and Local Government controls are required in consultation with, and the support of the community and other stakeholders. These controls are needed to manage a number of threats to drinking water areas, including inappropriate:

- land use planning processes and decisions resulting in high risk developments in catchments;
- recreational activities where the impact of human wastes and damage to natural protective measures associated with higher intensity land use is often underestimated; and
- use and/or disposal of chemicals, animal and domestic wastes and pesticides.

We should also appreciate that beyond the actual catchment and water storage area, drinking water that is not properly treated, or which travels through an inadequately maintained distribution system, also poses a serious public health risk.

Several recent events that have occurred nationally and internationally that highlight the importance of protecting drinking water, especially at the source.

The main finding of an inquiry into the well-publicised [Sydney Water Crisis](#) in 1998 was that the catchments were seriously compromised by many possible sources of contamination, and that there was insufficient regulatory control to guarantee safe drinking water. The Sydney Water Catchment Authority was set up in response to this event which transferred responsibility for land use decisions within the catchment from the Planning Authority to the new catchment Authority.

In Walkerton (Canada), in 2000 a drinking water catchment related tragedy unfolded where a pathogenic E-coli outbreak resulted in over 2300 cases of illness amongst 4,800 residents, 70 people were hospitalised and 7 deaths were attributed to the outbreak. A judicial inquiry concluded that the likely initial cause of the outbreak was from manure application on farmland (a common practice even in WA) that resulted in bacterial contamination finding its way into the shallow underground water-body which was used to supply drinking water. Other contributing factors to the outbreak included a high rainfall event just prior to the contamination outbreak, and an inadequate disinfectant dose rate and monitoring issues related to the distribution system. It is important to appreciate that the drinking water system at Walkerton operated for more than 8 years without major incident up until the year 2000. The over-reliance on treatment to provide a safe drinking water supply was highlighted and a new approach adopted that considered both catchment protection and improved treatment (in combination) to provide a more reliably-safe supply to consumers.

How do we protect public drinking water source areas in WA?

A 'catchment to consumer' multiple barrier approach is used in the management of drinking water quality in Western Australia. Catchment management for protection of the water source (held in storage in surface dams or underground aquifers) is considered the first important barrier. Historically, a heavy reliance was placed on treating water to achieve the desired level of safety, but it is now recognised that treatment alone does not remove all hazards to public health. Therefore, to maximise public health safety effective catchment protection is also essential. Other barriers include:

- selection of an appropriate safe high quality source (where alternatives exist);
- controls over land uses and high risk human activities in catchments underpinned by statutory measures;
- protective undeveloped buffer zones to supply bores, reservoirs and feeder streams;

- catchment protection strategies for education, surveillance, enforcement and monitoring/reporting;
- pre-treatment of drinking water, for example use of detention and settling in reservoirs to induce microbes to die off;
- protection of water storage works, for example water tanks and reservoirs;
- disinfection of drinking water before it enters the distribution system and provision to ensure an adequate disinfectant residual throughout that system;
- maintaining the distribution system as a whole including the pipe system, vermin-proofing of water tanks and preventing back-flow; and
- Promotion of source protection measures in local government planning schemes using the WA Planning Commission's *Statement of Planning Policy– Public Drinking Water Source Policy* (June 2003).

A key process employed by this agency to protect drinking water sources involves the preparation of Drinking Water Source Protection Plans (DWSPP) for the State's PDWSAs.

Drinking Water Source Protection Plans (and Drinking Water Source Protection Assessments)

Drinking Water Source Protection Plans are a key component of the 'catchment-to-consumer' protection strategy for Western Australia's drinking water supplies. This is reflected in the Government's report "*Securing our water future - A State Water Strategy for Western Australia (2003)*" which states that **water source protection plans should be completed for all public drinking water supply catchments throughout the State**. A DWSPP aims to identify existing and potential threats to a drinking water source and to provide risk management strategies and programs for the ongoing management/protection of that source.

Plans are prepared in consultation with the community, potentially affected stakeholders (especially landowners), local government and the State government. Stakeholders are strongly encouraged to consider the risks and potential consequences of inappropriate land-use planning or human activities in the catchment (e.g. contamination of the resource and costs to clean-up or establish a new drinking water source). It should be noted that decisions made following consultation may result in some land use/activity restriction in order to achieve a safe, good quality drinking water supply.

Providing a basis for establishing compatible land uses within PDWSAs, the DWSPP is only one of a suite of measures used by this agency to meet its drinking water protection responsibilities. As at June 2003, there were approximately 139 plans listed for completion. Of this number, 50 are complete and 89 are in production.

While the full suite of DWSPPs await completion, land planners and developers need to be aware of the location of and risks to existing drinking water catchments. To this end the DOE is preparing Drinking Water Source Protection Assessments (DWSPA). These Assessments will provide a broad overview of catchment risks, planning and land uses; and a basic understanding of the drinking water catchment and supply system. They are not intended to include extensive data, but to characterise the drinking water system by providing useful information for decision makers. Generally, the DWSPA will be a desktop assessment followed by a site visit and discussions with local government. In some circumstances the DWSPA may be all that is required to achieve good land planning/activity controls (e.g. through planning schemes or strategies) for the protection of drinking water source areas. Otherwise, the DWSPA will be considered base information for development of the DWSPP described above.

Priority classification system

This agency has also implemented policies to protect public drinking water source areas that includes a differential ‘*priority classification area*’ system that includes special ‘protection zones’ around bores and reservoirs. Through development of a DWSP (or possibly the DWSPA), land in a PDWSA is identified as a mix of Priority 1 (P1), Priority 2 (P2) or Priority 3 (P3) classification areas, with appropriate protection zones.

Priority 1 (P1) source protection areas are defined to ensure that there is **no degradation** of the water source. P1 areas are declared over land where the provision of high quality public drinking water is the prime beneficial land use. P1 areas would typically include land under public ownership but may in a limited number of cases include private land.

P1 areas are managed in accordance with the principle of **risk avoidance**, and hence land development is generally not permitted. Where P1 land is in private ownership this agency may make an offer to the owner to sell their land at agreed market values subject to available funding and priority order purchasing rules. There is no obligation on the owner to sell their land.

Priority 2 (P2) areas are defined to ensure that there is **no increased risk of pollution** to the water source. P2 areas are declared over land where low intensity development (such as rural) already exists. Protection of public water supply sources is a high priority relative to other land use values in these areas.

P2 areas are managed in accordance with the principle of **risk minimisation**, and as such only limited conditional development is supported. Such development must be consistent with the protection of waters within the drinking water catchment. A proposed change in land use from a relatively low to a more intensive use may result in contamination of the PDWSA, and would not be supported.

Priority 3 (P3) areas are defined where it is practical to **manage the risk of pollution** to the water source, and where water supply sources need to co-exist with other generally existing land uses such as residential, commercial and light industrial developments.

Protection of P3 areas is achieved through **management guidelines** rather than restrictions on land use. Key elements in protection of P3 areas are the provision of deep sewerage and land users using best environmental management practices for their activities. In P3 areas, compared to P1 and P2 areas, it is likely that the direct cost of providing the drinking water to consumers is greater, given the need to monitor and treat the water more comprehensively due to the variety of existing and allowable land uses/risks. If water from P3 areas becomes contaminated, then that water may need to be further treated or an alternative water source found.

In these priority areas there is a strong reliance on landowners, developers, regulators and other users to be acutely aware of the drinking water resource and risks, such that the adoption and implementation of best management practices will help protect the drinking water source. Existing lawfully established but non-conforming land uses in PDWSAs are allowed to continue, however land users will be encouraged to adopt environmentally responsible/best practice land use practices. This agency has prepared a “*Water Quality Protection Note -Land Use Compatibility table in PDWSAs*” that provides guidance on the type of land uses appropriate within P1, P2 and P3 areas.

Reservoir and wellhead protection zones

As noted above, reservoir protection zones (RPZ) are also defined to protect the surface water source from contamination in the immediate vicinity of reservoirs. Reservoir protection zones consist of up to a 2 kilometre buffer around the top water level of a reservoir and includes the reservoir itself. These zones do not extend outside the catchment area (i.e. downstream from a dam wall). This agency provides a high level of protection in these zones and does not support land uses or activities that may add to the risk of contamination of the water source. Generally conditions apply in these zones aimed at preventing people from entering the RPZ to avoid the risk of contamination (consistent with the P1 areas).

For underground water sources, well-head protection zones are defined around the abstraction bores and allowable activities/ land uses in these areas are also restricted and subject to approval processes. Well-head protection zones in P1 areas are set at a 500 metre radius around a bore, and in P2 or P3 areas they are set at a 300 metre radius around a bore.

How are priority classification areas and protection zones determined?

The determination of a priority classification area or protection zone over land in a PDWSA is based on the strategic importance of the land or water source, its zoning, ownership and existing approved land uses/activities. The land use tables in this protection note directly relate to the three types of priority classification areas identified in DWSPP or agreed in Land Use and Water Management Strategy documents. In the absence of a DWSPP, the DOE recommends that planning decisions within any gazetted or proposed PDWSA are guided by DWSPA documents (where they exist) and the 'potential' priority classification area or protection zone status of a proposal identified using the following process flow diagram.

Conclusion

We can improve the availability of 'safe, good quality drinking water' to protect public health if we continue to combine catchment protection and water treatment approaches. This 'catchment to consumer' approach to drinking water protection is the basis of the recently updated *Australian Drinking Water Guidelines 2003*.

Many land uses and activities can pose a risk to water quality, so in undeveloped drinking water catchments strict management controls are proposed to 'avoid the risk' of contaminating the source. In catchments with some level of development, management controls recognise the existing development but may place restrictions on alternative land uses or expansion of existing land uses. This approach looks to 'minimise' or 'manage the risk' of contamination in the catchment. These management controls help protect public health, lower the costs of supplying drinking water to consumers and provide a long term source of safe, good quality drinking water.

More information

We welcome your thoughts on this note. The note will be updated from time to time as comments are received, or industry standards change.

If you wish to comment on the note or require more information, please contact our Program Manager, Protection Planning (Stephen Watson) at the Water Source Protection Branch in our head office in the Hyatt Centre. Phone: (08) 9278 0454 (business hours), Fax: (08) 9278 0585.

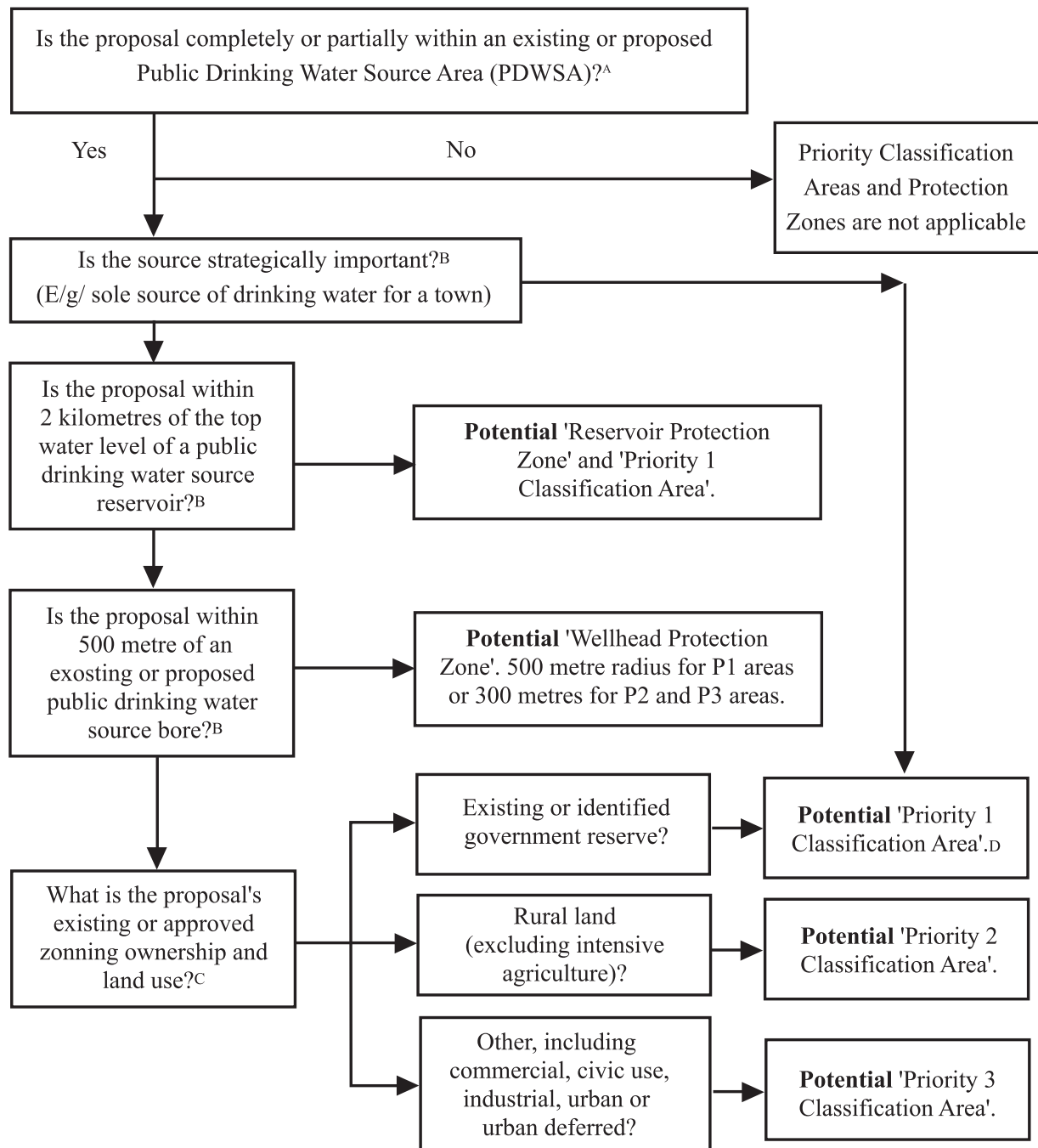


Figure 1. Determination of Priority Classification and Protection Zones

Legend

- A The location of PDWSAs can be found in DOE's Drinking Water Source Protection Assessments and Plans or through your regional DOE office, Local Government office, Water Corporation or from the Department for Planning and Infrastructure.
- B Strategically significant sources and potential contamination from land uses close to drinking water reservoirs or abstraction bores are considered first, due to these involving the highest risk of contamination reaching consumers.
- C Current zoning or land use information is available from your Local Government office.
- D Government land is protected to achieve the highest level of safety for drinking water in all parts of a catchment through a Priority 1 classification, wherever this is reasonable and practicable.

Appendix 2 - Water quality analysis results

WATER QUALITY ANALYSIS RESULTS

Explanatory note

Following storage on site to gain the benefits of natural microbiological improvement, water from North Dandalup Pipehead Dam is disinfected by chlorination before supply to the public. The Water Corporation are required to comply with health related parameters of the Australian Drinking Water Guidelines (ADWG). There have been no exceedences of the health guidelines. Compliance with aesthetic parameters of the ADWG is not required; occasional exceedences of aesthetic water quality have occurred.

Health parameters

Raw water from North Dandalup Pipehead Dam is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between July 1999 and July 2004 are summarised in the following table.

Parameter	Units	Health Guideline Value*	North Dandalup Pipehead Dam	
			Range	Median
Metals				
Barium	mg/L	0.7	0.015 – 0.018	0.016
Boron	mg/L	4	0.02 – 0.03	0.02
Inorganics				
Nitrate + Nitrite (as N)	mg/L	11.3	0.004 – 0.1	0.016
Pesticides				
Simazine	mg/L	20	No Detection – 0.3†	No Detection

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ, 1996).

† Single detection only.

Aesthetic water quality data

Aesthetic water quality analyses for raw water from North Dandalup Pipehead Dam are summarised in the following table. The values are taken from ongoing monitoring for the period July 1999 to July 2004. The values are in milligrams per litre (mg/L) unless stated otherwise. The water quality parameters that have on occasion exceeded the ADWG are shaded.

Parameter	Units	Aesthetic Guideline Value	North Dandalup Pipehead Dam	
			Range	Median
pH	6.5 – 8.5	7.1 – 7.6	7.3	
Turbidity	NTU	5	0.4 – 4.07	1.85
ColourTCU	15	1 - 7	2	
Conductivity	mS/m	-	24 - 26	32
Total Dissolved Solids	mg/L	500	134 - 184	156
Iron (unfiltered)	mg/L	0.3	0.04 – 0.48	0.12
Manganese (unfiltered)	mg/L	0.1	<0.002 – 0.024	0.006
Aluminium (unfiltered)	mg/L	0.2	0.02 – 0.23	0.11
Sodiummg/L	180	35 - 50	43	
Potassium	mg/L	-	1.4 – 2.2	1.6
Calciummg/L	-	2.4 – 3.8	3	
Magnesium	mg/L	-	4.4 – 6.5	5.5
Hardness (as CaCO ₃)	mg/L	200	24 - 36	29
Alkalinity (as HCO ₃)	mg/L	-	8.1 - 16	12.9
Chloridemg/L	250	62 - 90	76	
Sulphatemg/L	250	6.5 - 9	7.5	
Silica (as SiO ₂)	mg/L	-	2.3 – 5.3	3.35
Filterable organic carbon	mg/L	-	1.6 – 3.4	2

Microbiological analysis

Microbiological testing of raw water samples is conducted on a weekly to monthly basis, depending on the season, i.e. more frequent sampling is undertaken during summer and autumn. Thermotolerant coliform counts are used as an indicator of the degree of faecal contamination of the raw water from warm-blooded animals. A count of less than 20 colony forming units (cfu) per 100 mL is typically associated with low levels of contamination and is used as a microbiological contamination benchmark (WHO, 1996).

During the review period from July 1999 to July 2004, positive thermotolerant coliform counts were recorded in 42% of samples, with 3% of the positive samples exceeding 20 cfu/100 mL.

Appendix 3 - Land use compatibility in Public Drinking Water Source Areas

LAND USE COMPATIBILITY IN PUBLIC DRINKING WATER SOURCE AREAS

Purpose

The Department of Environment (DoE) is responsible for managing and protecting the State's water resources. This note provides advice on the acceptability of land uses and activities within specific catchments that are the water source for schemes supplying cities and towns. These catchments are termed Public Drinking Water Source Areas (PDWSAs) and they require comprehensive water resource quality and land planning protection measures to ensure the ongoing availability of a 'safe, good quality drinking water' supply to protect the health of consumers for now and into the future. This note supports the DoE's Public Drinking Water Resource Policy (July 2004).

The note also forms an integral part of the Western Australian Planning Commission's *Statement of Planning Policy No. 2.7- Public Drinking Water Source Policy 2003* (relevant to approximately 140 existing PDWSAs in Western Australia) prepared by the Department for Planning and Infrastructure under Section 5AA of the *Town Planning and Development Act 1928*. It is also intended to support the proposed *Statement of Planning Policy for Water Resources* designed to guide planning decisions in future PDWSAs. This note should be used by Local Government when developing local planning strategies, structure plans and town planning schemes. It should also be used in the assessment of subdivision and other development applications. The note will also assist the development of formal guidelines on land use activities in PDWSA prepared in liaison with key stakeholders such as the Water Corporation, Department of Health, Department of Conservation and Land Management, Department of Agriculture, Department of Industry and Resources, Department for Planning and Infrastructure and local government.

A review of this note may occur within 12 months (depending on feedback) to reflect DoE's policy position (which is influenced by public consultation undertaken for PDWSAs), advances in technology or land use activity standards, and Government decisions made concerning drinking water quality protection. This note may not consider all the circumstances that exist for planning strategies, plans and schemes across the State. Accordingly, changes to this note will only be considered if they apply broadly across the State. Other means of addressing localised special circumstances may be employed and the DoE will assist in achieving this outcome provided those changes do not place the PDWSA at a higher contamination risk.

Scope

This note provides the DoE's position on a range of land uses assessed against the Department's water quality protection strategy and management objectives within PDWSAs. Where a specific land use has not been covered in the accompanying tables, it should be referred to the Department's Water Source Protection Branch for assessment and a written response concerning its acceptability or any necessary water resource protection measures.

Public Drinking Water Source Area in Western Australia is the collective description for:

- Underground Water Pollution Control Areas,
- Water Reserves, and
- Catchment Areas,

declared under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.

This note is intended to complement the statutory role and policy of State and local government authorities, but it does not override Government policy or the need for proponents to fulfil their legal responsibilities for land use planning, and environmental, health, building or other necessary approvals.

PDWSA protection framework

The protection of PDWSAs relies on statutory measures available in water resource management and land use planning legislation. The DoE policy for the protection of PDWSAs includes three risk management based priority classification areas and two types of protection zones. The priority classification areas and protection zones are determined via specific Drinking Water Source Protection Plans (DWSPP) that are prepared in consultation with State government agencies, landowners, local government, and key industry and community stakeholders. Where a fully consulted DWSPP does not exist for a PDWSA, the DoE initially prepares Drinking Water Source Protection Assessment (DWSPA) documents to reflect readily available information for use in land use planning assessments and decision making.

Priority classification areas

Priority 1 (P1) classification areas are managed to ensure that there is **no degradation** of the drinking water source by preventing the development of potentially harmful activities in these areas. The guiding principle is **risk avoidance**. This is the most stringent priority classification for drinking water sources. P1 areas normally encompass land owned or managed by State agencies, but may include private land that is strategically significant to the protection of the drinking water source (e.g. land immediately adjacent to a reservoir). Most land uses create some risk to water quality and are therefore defined as “**Incompatible**” in P1 areas.

Priority 2 (P2) classification areas are managed to ensure that there is **no increased risk** of water source contamination/ pollution. For P2 areas, the guiding principle is **risk minimisation**. These areas include established low-risk land development (e.g. low intensity rural activity). Some development is allowed within P2 areas for land uses that are defined as either “**Compatible with conditions**” or “**Acceptable**”.

Priority 3 (P3) classification areas are defined to **manage the risk of pollution** to the water source from catchment activities. Protection of P3 areas is mainly achieved through guided or regulated environmental (risk) management for land use activities. P3 areas are declared over land where water supply sources co-exist with other land uses such as residential, commercial and light industrial development. Land uses considered to have significant pollution potential are nonetheless opposed or constrained.

Wellhead and reservoir protection zones

In addition to the three Priority Classification Areas, specific protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Within these zones by-laws may prohibit, restrict or approve defined land uses and activities to prevent water

source contamination or pollution. Special conditions, such as restrictions on storage and use of chemicals, may apply within these zones. The legislation is currently being reviewed to simplify and enhance the protection of public drinking water sources.

Wellhead protection zones (WHPZ) are used to protect underground sources of drinking water. They are circular (unless information is available to determine a different shape), with a radius of 500 metres in P1 areas, and 300 metres in P2 and P3 areas. WHPZ do not extend outside PDWSA boundaries. Reservoir protection zones (or '**prohibited zones**' as they are called in the by-laws) consist of a statutory 2 kilometre wide buffer area around the top water level of storage reservoirs in the Perth water supply area, and include the reservoir water-body. The reservoir protection zones (RPZ) apply over Crown land and prohibit public access to prevent contamination (physical, chemical and biological) of the source water. RPZ do not extend outside PDWSA boundaries. The DoE is currently considering a provision for RPZ buffer areas of less than 2 kilometres, and creation of consistent by-laws for country and Perth PDWSAs.

Special protection measures apply in WHPZ and RPZ (prohibited zones) as described in the By-laws *under the Metropolitan Water Supply, Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.

The determination of priority classification areas or protection zones over land in a PDWSA is based on:

- the strategic importance of the land or water source,
- the local planning scheme zoning,
- form of land tenure, and
- existing approved land uses/activities.

The land use tables in this protection note directly apply to the three types of priority classification areas identified in DWSPP or agreed in specific *Land Use and Water Management Strategy* documents. Currently there are 45 DWSPPs available to guide land use planning decisions in PDWSAs, and (nearly 100) others are in development. In the absence of a DWSPP, the DoE recommends that planning decisions within any gazetted or proposed PDWSA are guided by DWSPA documents (where they exist) and the '**potential**' priority classification area or protection zone status of a proposal identified using **Diagram 1: Assessment of potential priority classification areas and protection zones** (overleaf).

Compatibility of land uses within PDWSAs

The tables in this note have been prepared for use by local governments, State planners and other agencies as a basis for regulating land use within PDWSAs. The note complements the Western Australian Planning Commission's *Statement of Planning Policy Number 2.7 (June 2003) Public Drinking Water Sources*. These tables define land uses in terms of their compatibility with the sustainable use of the drinking water source. They promote a priority for protection of the environmental value: 'drinking water' within a PDWSA over other values that may exist. The three definitions used are '**Incompatible**', '**Compatible with conditions**' and '**Acceptable**'. In previous versions of this note the definitions were 'Incompatible', 'Conditional' and 'Compatible'.

The DoE recognises that there may be special circumstances which may occasionally result in an '**Incompatible**' land use receiving approval. Where planning decisions result in this outcome it is important for project proponents to have demonstrated an overriding community benefit and that the land use will not increase the risk of contamination to the PDWSA. The DoE expects to have significant, early involvement in planning decisions of this nature to maximise the protection of the drinking water resource.

It should be noted that where a water source is the sole supply for a community, or has a particularly high strategic value for the supply of drinking water, then it would be difficult to understand how that source might be put at any risk of contamination.

Detailed information on water quality protection issues and recommended best management practices for ‘**Compatible with conditions**’ land uses are being developed in approved environmental policy, codes of practice, management guidelines and water quality protection notes. These documents, along with the most recent version of this note, can be found on the DoE Internet site <http://www.environment.wa.gov.au>. Information on land use and development regulation within PDWSAs can also be obtained from DoE’s regional offices.

The DoE’s Water Source Protection Branch, presently located in East Perth, is custodian of this water quality protection note and will provide detailed advice on its application and coordinate any suggested amendments.

Existing approved land uses

Many land uses covered in this note may have been legally established prior to establishment/ gazettal of the PDWSA or modern protection measures being required. The DoE policy is that existing approved land uses/ activities can continue at their presently approved level, provided they operate lawfully. Where necessary, negotiations may be arranged with land owners to acquire property rights in P1 source protection areas. Where practical, this agency will also negotiate with the operators of existing ‘*Incompatible*’, or ‘*Compatible with conditions*’ activities to implement environmental management practices that minimise risks to water sources.

Proposed land uses

After reading this protection note, please view the DoE Internet site and/ or contact your nearest DoE Regional Office for advice on the location of PDWSAs, priority classification areas, and reservoir or wellhead protection zones. You may discuss with DoE staff any proposed land use activities that may affect water resources. The early identification of water resource protection issues in development stages of land use planning proposals is recommended in both the June 2003 *Statement of Planning Policy for Public Drinking Water Sources* and proposed *Water Resources Policy* by the Western Australian Planning Commission.

Definition of terms used in the following tables

‘**Acceptable**’ (equivalent to ‘compatible’ in previous version of this note)- means the land use is accepted by DoE as not likely to harm the drinking water source, and is consistent with the management objectives of that priority classification. The adoption of best practice environmental management methods for new proposals to protect water quality is expected. Existing land users are also encouraged to adopt best practice environmental management methods to help protect water quality. These land uses generally do not need referral to the DoE.

‘**Compatible with conditions**’ (equivalent to ‘conditional’ in previous version of this note) - means the land use is likely to be accepted by DoE as not likely to harm the drinking water source, (and is consistent with the management objectives of the priority classification) provided best environmental management practices are used. This may result in the application of ‘specific conditions’ (via the planning or environmental approval processes) that must be complied with to ensure the water quality objective of the priority area is maintained.

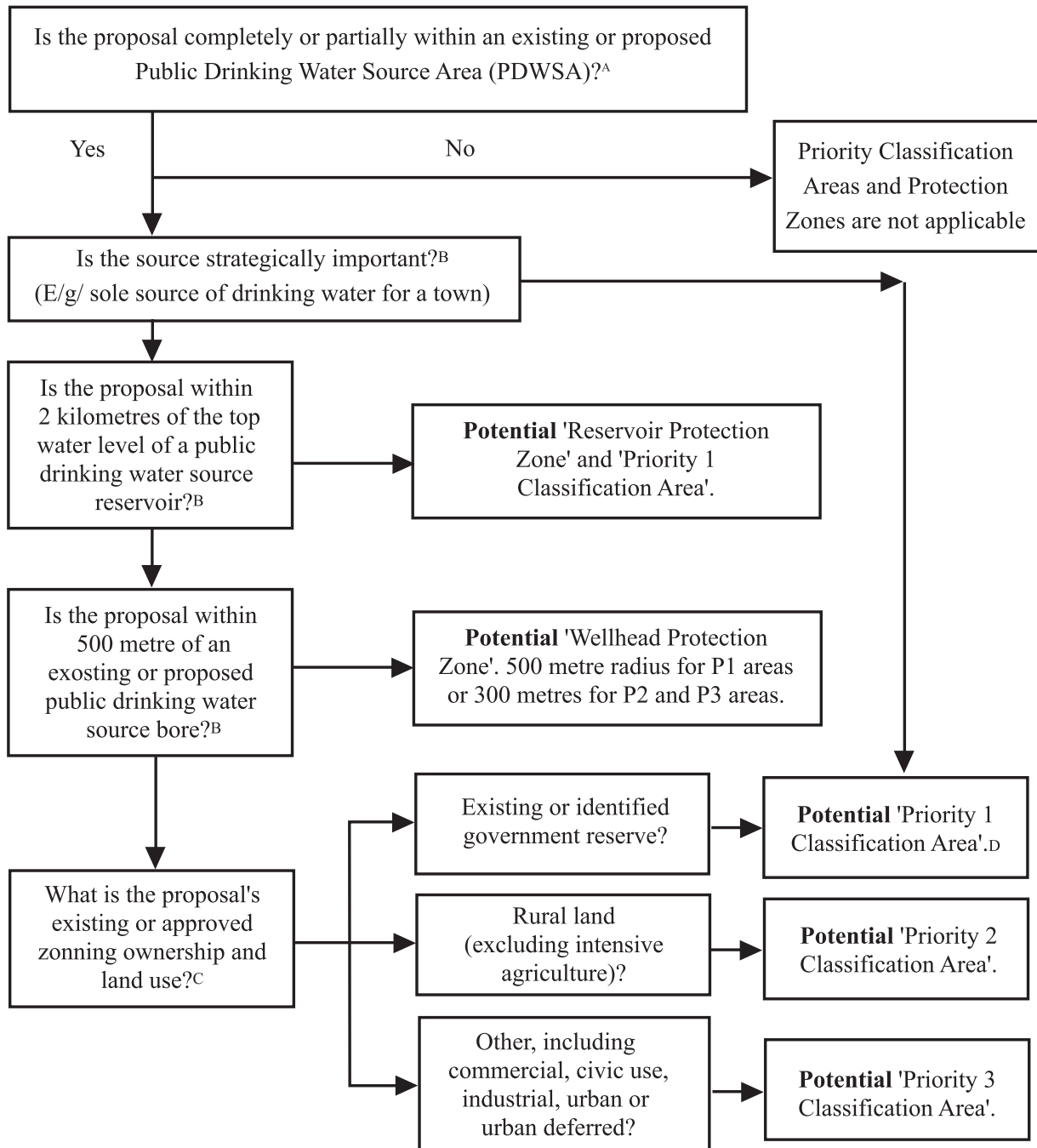


Figure 1. Assessment of potential priority classification areas and protection zones

Legend

- A The location of PDWSAs can be found in DOE’s Drinking Water Source Protection Assessments and Plans or through your regional DOE office, Local Government office, Water Corporation or from the Department for Planning and Infrastructure.
- B Strategically significant sources and potential contamination from land uses close to drinking water reservoirs or abstraction bores are considered first, due to these involving the highest risk of contamination reaching consumers.
- C Current zoning or land use information is available from your Local Government office.
- D Government land is protected to achieve the highest level of safety for drinking water in all parts of a catchment through a Priority 1 classification, wherever this is reasonable and practicable.

Land uses described as 'Compatible with conditions' need ONLY to be referred to DoE for assessment and a written response if the activity does not follow recommendations endorsed by DoE such as those made in policy, environmental management guidelines, protection notes; Ministerial Conditions, Works Approvals, Licenses or agreements (e.g. a 'Memorandum of Understanding' developed between any Local Government and DoE).

'**Incompatible**'- means the land use is UNACCEPTABLE to DoE as it does not meet the management objectives of the priority classification area. DoE will normally oppose approval of these land uses through the planning decision making process and under legislation administered by DoE. If planning decisions are made to approve these land uses (e.g. as a consequence of a planning appeals process), then DoE should be advised of that decision and have been directly involved in providing advice to the planning decision makers on water quality protection issues. It should be noted that contentious proposals may be referred to the EPA for Environmental Impact Assessment under the *Environmental Protection Act 1986*.

'**Extensive**'- means limited additional inputs beyond those supplied by nature are required to support the land use, e.g. for agriculture- animal feed supplements only during seasonal dry periods, or during the final preparation of stock for the market.

'**Intensive**'- means regular additional inputs are required to support the desired land use, e.g. for agriculture- irrigation, fertilisers, pesticides, or non-forage animal feeding dominates.

Interpretation of land use recommendations for planning schemes and development approvals

When using the following land use compatibility tables to guide planning schemes and development approval decisions, the following relationships should be used:

- a) Where the table identifies a land use as '**Acceptable**', this use is permitted by DoE within that priority classification area. It may be identified as a 'P' (permitted) use in a scheme, providing the use complies with the relevant development standards and requirements of the planning scheme.
- b) Where the table identifies a use as '**Compatible with conditions**', this use should be a discretionary use within the priority classification area and should be identified as either a 'D' or 'A' (after special notice) use in the scheme. Proposals for '**Compatible with conditions**' uses should ONLY be referred to DoE for assessment and response if they do not meet existing agency policy, guidelines or protection note measures, unless prior agreement has been made between a specific local government and DoE on alternative measures.
- c) Relevant environmental management guidelines, codes of practice, water quality protection notes or agreements should be used in the first instance to define DoE's position on any land-use and limit the need to refer proposals to the DoE. Where these do not exist, site specific advice may be provided by the DoE.
- d) Where the table identifies a use as '**Incompatible**', that use should not be permitted within that priority source protection area, and should be identified as an 'X' (unacceptable use) in the scheme.

Where the table does not include a proposed land use that could affect water quality, that use should be considered to be '**Incompatible**' until the proponent can demonstrate that it meets the drinking water quality protection objective of the designated priority classification area. Specific advice on the proposed land use should be obtained from the DoE's Water Source Protection Branch.

If the land use planning approval process supports a proposal that is inconsistent with this water quality protection note, then DoE Water Source Protection Branch should be advised of this situation and the reasons for that decision. This advice will trigger DoE's assessment of the significance/ consequence of that decision to the drinking water source and the outcome will be considered in future strategies for water quality protection, and in the periodic review and update of this note. A means to ensure the DoE's effective early involvement with such cases is currently being developed.

Tables defining compatibility of various land uses within PDWSA

It is important to note that this table provides the DoE's recommended compatibility of land uses for the current zoning of land. It must not be used to support rezoning of land to provide for more intensive land uses. For example, although P3 areas provide for high density urban development when the land is already zoned Urban or Urban deferred, this Table must not be read to justify a zoning change within P3 areas to allow for high density urbanisation of rural zoned land.

Model Scheme Text (MST) land uses are shown in **bold** in the first column. Definitions covered in the MST (see note 23) can also be found in the *Town Planning Amendment Regulations 1999*.

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Agriculture – extensive - pastoral leases - floriculture (non-irrigated), stock grazing (excluding pastoral leases) and broad hectare cropping	Compatible with conditions Incompatible	Acceptable Compatible with conditions (see notes 11, 12)	Acceptable Acceptable
Agriculture – intensive - aquaculture (fish, plants and crustaceans) - orchards; production nurseries – potted plants; viticulture– wine and table grapes - floriculture; market gardens (see note 24); turf farms - hydroponic plant growing - plant nurseries / garden centres	Incompatible Incompatible Incompatible Incompatible	Compatible with conditions Compatible with conditions Incompatible Compatible with conditions Compatible with conditions (see note 2)	Compatible with conditions Acceptable Compatible with conditions Compatible with conditions Acceptable
Agro-forestry	Incompatible	Compatible with conditions	Acceptable
Amusement parlour	Incompatible	Incompatible	Acceptable (see note 1)
Animal establishment - animal saleyards and stockyards (see note 13) - apiaries - catteries - dairy sheds - dog kennels - equestrian centres (see note 17) - feedlots, intensive outdoor livestock holding - stables (see note 18)	Incompatible Compatible with conditions Incompatible Incompatible Incompatible Incompatible Incompatible Incompatible	Compatible with conditions (see note 2) Acceptable Acceptable Compatible with conditions (see notes 2, 3, 12) Compatible with conditions Incompatible Incompatible Compatible with conditions	Compatible with conditions (see note 2) Acceptable Acceptable Compatible with conditions (see note 3) Compatible with conditions Acceptable Compatible with conditions Acceptable
Animal husbandry - intensive - piggeries - poultry farming - housed	Incompatible Incompatible	Incompatible Compatible with conditions	Incompatible Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Bed and breakfast (accommodating a max of 6 guests) - farm stay accommodation, rural chalets)	Compatible with conditions (see notes 6, 16) Compatible with conditions (see notes 6, 16)	Acceptable (see note 23) Compatible with conditions (see note 4)	Acceptable Acceptable
Betting agency	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Caravan park	Incompatible	Incompatible	Compatible with conditions (see note 1)
Caretakers dwelling	Compatible with conditions (see note 2)	Compatible with conditions	Acceptable
Car park	Incompatible	Compatible with conditions (see note 2)	Acceptable
Cemeteries	Incompatible	Incompatible	Compatible with conditions
Child care premises	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Cinema/theatre	Incompatible	Incompatible	Acceptable (see note 1)
Civic use	Incompatible	Compatible with conditions (see note 1)	Acceptable (see note 2)
Club premises - sporting or recreation clubs - health centres	Incompatible Incompatible	Compatible with conditions Incompatible	Acceptable (see note 1) Acceptable (see note 1)
Community purpose - community halls - irrigated golf courses or recreational parks - motor-sports (permanent racing facilities) - public swimming pools/ aquatic centres	Incompatible Incompatible Incompatible Incompatible	Compatible with conditions (see note 2) Incompatible Incompatible Incompatible	Acceptable Compatible with conditions (see note 11) Compatible with conditions Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
- rifle ranges	Incompatible	Compatible with conditions	Acceptable
Consulting rooms	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Convenience store	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Corrective institution	Incompatible	Incompatible	Compatible with conditions (see note 1)
Educational establishment - community education centres, scientific research institution - primary / secondary schools, tertiary education facilities	Compatible with conditions (see note 2) Incompatible	Compatible with conditions (see note 2) Incompatible	Acceptable (see note 1) Acceptable (see note 1)
Exhibition centre	Incompatible	Incompatible	Acceptable (see note 1)
Family day care	Incompatible	Acceptable (see note 19)	Acceptable (see note 1)
Fast food outlet	Incompatible	Incompatible	Acceptable (see note 1)
Forestry (native forest/ silviculture/ tree farming)	Compatible with conditions (see note 11)	Compatible with conditions (see note 11)	Acceptable
Fuel depot (storage/ transfer)	Incompatible	Incompatible	Compatible with conditions
Funeral parlour	Incompatible	Incompatible	Acceptable (see note 1)
Home business	Incompatible	Acceptable (see note 20)	Acceptable (see note 1)
Home occupation	Compatible with conditions (see note 15)	Acceptable (see note 21)	Acceptable (see note 1)
Home office	Compatible with conditions (see note 15)	Acceptable	Acceptable
Home store	Incompatible	Compatible with conditions	Acceptable (see note 1)
Hospital	Incompatible	Incompatible	Compatible with conditions (see note 1)
Hotel (includes hotels, hostels, resorts)	Incompatible	Incompatible	Acceptable (see note 1)

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Industry			
- abattoirs	Incompatible	Incompatible	Incompatible
- cottage	Compatible with conditions	Compatible with conditions	Acceptable
- drinking water treatment plant	Compatible with conditions	Compatible with conditions	Compatible with conditions
- extractive, includes construction/ mining camps (see note 10)	Compatible with conditions	Compatible with conditions	Compatible with conditions
- food processing, dairy product factories, breweries	Incompatible	Incompatible	Compatible with conditions (see note 1)
- general (chemical manufacture/ formulation, dry cleaners, dye works, laboratories, photo-processors)	Incompatible	Incompatible	Compatible with conditions see note 1)
- general (metal production/ finishing, pesticide operator depots, heavy or energy industry, petroleum refineries)	Incompatible	Incompatible	Incompatible
- general (concrete batching, cement products, fertiliser manufacture/ bulk storage, wrecking)	Incompatible	Incompatible	Compatible with conditions
- general (mineral processing)	Incompatible	Incompatible	Compatible with conditions (see note 9)
- light industry	Incompatible	Incompatible	Compatible with conditions (see note 1)
- milk transfer depots	Incompatible	Incompatible	Compatible with conditions
- mining (includes mineral and energy exploration, oil or gas extraction/ decontamination for transport)	Compatible with conditions (see note 9)	Compatible with conditions (see note 9)	Compatible with conditions (see note 9)
- mining (tailings dams)	Incompatible	Incompatible	Compatible with conditions (see note 9)
- mining (includes construction/ mining camps), (see note 10)	Compatible with conditions	Compatible with conditions	Compatible with conditions
- rural (animal product rendering works, tanneries, wool scourers)	Incompatible	Incompatible	Incompatible
- rural (farm supply centres, manure stockpiling/processing facilities)	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions
- rural (forestry products processing – chip mills, pulp/ paper, timber preservation, wood/ fibre works, composting/ soil blending - commercial)	Incompatible	Incompatible	Compatible with conditions
- service industry	Incompatible	Incompatible	Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Landfill (solid waste disposal) - class I (refer also to 'Storage - used tyres' advice) - class II or III - class IV or V	Incompatible Incompatible Incompatible	Incompatible Incompatible Incompatible	Compatible with conditions Incompatible Incompatible
Lunch bar	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Major transport infrastructure (roads, railways)	Incompatible	Compatible (see note 14)	Acceptable with conditions
Marina (includes boat moorings and servicing)	Incompatible	Incompatible	Compatible with conditions
Marine filling station (boat fuelling)	Incompatible	Incompatible	Compatible with conditions
Market (food; general produce; second-hand goods)	Incompatible	Incompatible	Acceptable (see note 1)
Medical centre	Incompatible	Incompatible	Acceptable (see note 1)
Motel	Incompatible	Incompatible	Acceptable (see note 1)
Motor vehicle, boat or caravan sales (sales yards)	Incompatible	Incompatible	Acceptable (see note 1)
Motor vehicle repair	Incompatible	Incompatible	Compatible with conditions
Motor vehicle wash	Incompatible	Incompatible	Compatible with conditions
National and regional parks and nature reserves	Acceptable	Acceptable	Acceptable
Night club	Incompatible	Incompatible	Acceptable (see note 1)
Office	Incompatible	Compatible with conditions	Acceptable (see note 1)
Park home	Incompatible	Incompatible	Compatible with conditions (see note 1)
Place of worship	Incompatible	Incompatible	Acceptable (see note 1)
Plantation	Compatible with conditions (see note 11)	Compatible with conditions (see note 11)	Acceptable (see note 11)
Reception centre	Incompatible	Incompatible	Acceptable (see note 1)
Recreation – private (within non-designated recreation areas on Crown land)	Incompatible	Incompatible	Acceptable

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Residential building			
- house	Compatible with conditions (see note 16)	Acceptable (see note 4)	Acceptable (see note 4)
- group dwellings (aged and dependent persons)	Incompatible	Incompatible	Acceptable (see note 1)
Restaurant	Incompatible	Incompatible	Acceptable (see note 1)
Restricted premises (adult interests)	Incompatible	Incompatible	Acceptable (see note 1)
Rural pursuit	See Agriculture, Animal establishment or husbandry		
Service station (includes aircraft, automotive repairs, boats, mechanical plant, service stations at transport and municipal works depots)	Incompatible	Incompatible	Compatible with conditions (refer to note 1)
Shop	Incompatible	Compatible with conditions (see note 2)	Acceptable (see note 1)
Showroom	Incompatible	Incompatible	Acceptable (see note 1)
Storage			
- used tyres (see note 22)	Incompatible	Incompatible	Incompatible
- chemical storage in under ground tanks	Incompatible	Incompatible	Compatible with conditions
- chemical storage in above ground tanks	Incompatible	Compatible with conditions	Compatible with conditions
Tavern	Incompatible	Incompatible	Acceptable (see note 1)
Telecommunications infrastructure	Compatible with conditions	Compatible with conditions	Compatible with conditions
Toilet blocks and change rooms	Compatible with conditions (see note 2)	Compatible with conditions	Acceptable
Trade display	Incompatible	Incompatible	Acceptable (see note 1)
Veterinary centre	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions (see note 1)
Warehouse	Incompatible	Compatible with conditions (see note 2)	Compatible with conditions (see note 1)
Waste transfer station (includes recycling depots)	Incompatible	Incompatible	Compatible with conditions

Model Scheme Text & interpreted type of land use	P1 areas	P2 areas	P3 areas
Wastewater infrastructure <ul style="list-style-type: none"> - sewerage – gravity sewers - sewerage – pressure mains - sewer pump stations - treatment plants, wastewater disposal to land - wastewater injection into the ground (see note 25) 	Incompatible Incompatible Incompatible Incompatible Incompatible	Incompatible Compatible with conditions Compatible with conditions Incompatible Incompatible	Acceptable Acceptable Compatible with conditions Compatible with conditions Incompatible
Water treatment plants (drinking)	See Industry		
Winery (includes wine tasting facilities)	Incompatible	Compatible with conditions (see notes 3 & 5)	Compatible with conditions (see note 3)

Table recommending compatibility of land subdivision within PDWSA: Note - This table reflects the recommended size of a subdivision based on the existing zoning and the priority classification area status of land. It should be noted that Town Planning Scheme provisions for specific zones and reserves will take precedence over the following recommended lot sizes.

Form of subdivision (specific to current zoning)	P1 areas	P2 areas	P3 areas
Rural subdivision <ul style="list-style-type: none"> - to a lot size of 4 hectares or greater - to a lot size less than 4 hectares 	Incompatible Incompatible	Acceptable Incompatible	Acceptable Incompatible
Special rural subdivision <ul style="list-style-type: none"> - to a lot size of 2 hectares or greater - to a lot size between 1 and 2 hectares - to a lot size less than 1 hectare 	Incompatible Incompatible Incompatible	Compatible with conditions (see notes 7 & 8) Incompatible Incompatible	Compatible with conditions (see note 8) Compatible with conditions (see notes 7 & 8) Compatible with conditions (see note 7)
Urban subdivision Industrial subdivision	Incompatible Incompatible	Incompatible Incompatible	Acceptable (see note 1) Acceptable (see note 1)

Explanatory notes related to land uses described the tables:

The following notes provide interpretive information based on the scale or type of development described in the preceding tables. They do not list all the conditions that could apply to any activity or development.

1. Must be connected to deep sewerage, except where exemptions apply under State Government Sewerage Policy. The Policy recognises that sewer connection may be impractical in some areas. Under these circumstances maximum wastewater loadings (based on people/ hectare) apply linked to the management Priority of the site.
2. The land use is normally incompatible, but may be conditionally approved where this facility is consistent with approved State and local government planning strategies or schemes.
3. The land use must incorporate best environmental management practices compatible with the management strategy for the designated priority area defined in the relevant source protection plan.
4. In Priority 2 areas: conditions may apply to density of dwellings (i.e. hectares per dwelling).
5. Size of the grape crush shall not exceed 500 tonnes per year.
6. May be approved if occupancy is of equivalent size to a single dwelling household (i.e. less than 10 people– defined by capacity of a septic tank based on-site wastewater treatment system).
7. An average, rather than minimum, lot size may be accepted if the proponent can demonstrate that the water quality objectives of the source protection area are met, and caveats/memorials are placed on titles of specified blocks stating that further subdivision shall not occur.
8. Lots should only be created where land capability assessment shows that effective on-site soakage of treated wastewater can be achieved. Conditions apply to siting of wastewater disposal systems in areas with poor land drainage and/ or a shallow depth to groundwater, animals are held or fertiliser is applied. Alternative wastewater treatment systems, where approved by the Department of Health, may be accepted with ongoing maintenance requirements.
9. Conditions are likely to be placed via a Department of Industry and Resources mineral tenement lease, and / or as a result of Minister for the Environment's approval after an Environmental Impact Assessment.
10. Conditions apply to the storage of fuels and chemicals, the depth of excavation related to the water table and rehabilitation criteria. Underground fuel or chemical storage tanks are prohibited via DoE by-laws in Priority 1 and 2 areas within Underground Water Pollution Control Areas.
11. Conditions apply to regulate fertiliser and pesticide application.
12. Can be approved if animal stocking levels (animals per hectare, guided by the Department of Agriculture's stocking rate guidelines) are consistent with the priority source protection area objectives.
13. This does not include stockyards occasionally used on farms or pastoral leases for animal husbandry.
14. Conditions may be imposed to cover design, construction of infrastructure and the types of goods.
15. May only be approved if *Home Occupation* relates to an existing residence.
16. Limited to one residential building per property.

17. Includes land or buildings dominantly used for the showing, competition or training of horses, and riding schools.
18. Includes any land, building or structure used for equine (e.g. horses, asses, mules and donkeys) housing, keeping and feeding and associated activities.
19. In accordance with *Community Services (Child Care) Regulations 1988: A child care service provided to a child in a private dwelling in a family of or domestic environment. No more than 5 children of pre-school age and no more than 7 children under 12 years old, including the children of the licensee or permit holder.*
20. No more than 2 employees, and the home business occupies an area up to 50 square metres. Compatible if only an office/ administrative business (i.e. overnight parking of only one commercial vehicle, no refuelling or repair/ maintenance of business vehicles, and no activities involving on-site use storage or disposal of chemicals or process wastewater).
21. Employees shall be members of the household, and the home business occupies an area of up to 20 square metres. No provision for refuelling, repair or maintenance of commercial/ business vehicles or on-site use or storage of chemicals.
22. Used tyre use, storage and disposal are subject to *Used Tyre Regulations 1996*, administered by the this agency.
23. As defined in the Model Scheme Text (1997) or the *Residential Design Codes of Western Australia* (2002) prepared by the Western Australian Planning Commission, and covering local government planning schemes.
24. Applies to the commercial production of horticultural crops e.g. vegetables, flowers and fruit crops grown in contact with the ground. Does not apply to cereal or oil seed crops, perennials e.g. orchards, vineyards, nuts; or any crop grown separate from contact with soils in the natural environment e.g. hydroponics.
25. The use of recycled (reclaimed) water to address the diminishing level of scheme water supply in Western Australia is currently being investigated by Government. The social, environmental, health and economic issues related to this option are significant and need to be further progressed before its applicability in PDWSA is reconsidered.

More information or feedback

More information about recommended best management practices is available in Environmental Management Guidelines and Water Quality Protection Notes for some of the listed land uses. These are available on DoE's Internet site <http://drinkingwater.environment.wa.gov.au> or by contacting DoE regional offices.

We welcome your comments on this note. The note will be updated from time to time as feedback is received or land-use activity standards change. For the most up to date version of this note, please refer to <http://www.environment.wa.gov.au>. If you wish to discuss this note, please contact DoE Water Source Protection Branch at the Hyatt Centre in East Perth. Phone: (08) 9278 0300 (business hours); Fax: (08) 9278 0585; or E-mail: use {feedback} section at DoE Internet address <http://www.environment.wa.gov.au> citing the topic and version.

Appendix 4 - Best management practice documents for activities in PDWSAs

BEST MANAGEMENT PRACTICE DOCUMENTS FOR ACTIVITIES IN PDWSAS

Drainage:

Overland runoff should not be channelled into streams. Infiltration into soil should be aided at every opportunity.

- Lloyd, B. and Van Delft R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, Agriculture WA.

Buffers:

Vegetated buffers should be maintained along all streamlines, whether currently flowing or not.

- Department of Environment, 2005, Water Quality Protection Note *Buffers to sensitive water resources (draft)*, Department of Environment. Available from <<http://drinkingwater.environment.wa.gov.au>>.
- Example in Section 4.1: Department of Conservation and Land Management, 1999, *Manual of Management Guidelines for Timber Harvesting in Western Australia*, Department of Conservation and Land Management.
<www.naturebase.net/forest_facts/sy_review/manuals/manual_of_harvesting_specifications/index.html>.
- National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand, 2004, *Australian Drinking Water Guidelines*, NHMRC and ARMCANZ. Available from: <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
- Water and Rivers Commission, 2001, *A Review of Stream and River Logging Buffers in Western Australia, to Ensure their Adequacy in Protecting Waterways from Salinity, Degradation and Turbidity*, Water and Rivers Commission report to the Conservation Commission of Western Australia.

Pesticide application:

Pesticide application should be minimised in catchment areas. For specific needs of crops and best practice contact Department of Agriculture.

- Department of Environment, 2004, Water Quality Protection Note *Pesticide Use in Sensitive Environments (draft)*, Department of Environment.
- Department of Health, 1993, Public Service Circular 88 *Use of Herbicides in Water Catchment Areas*. Government of Western Australia. Available from: <www.population.health.wa.gov.au/environmental/resources/use%20of%20herbicides%20in%20water%20catchment%20areas.pdf>.

- Water and Rivers Commission, 2000, Statewide Policy No. 2 *Pesticide Use in Public Drinking Water Source Areas*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Nutrient application:

Should be minimised in catchment areas. For specific needs of crops contact Department of Agriculture.

- Water and Rivers Commission, 1998, Water Quality Protection Note *Nutrient and Irrigation Management Plan*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Forest management:

- Australian Forest Growers, 1997, *Code of Practice for Timber Plantations in Western Australia*, Australian Forest Growers, Department of Conservation and Land Management.
- Department of Conservation and Land Management, 1999, *Manual of Management Guidelines for Timber Harvesting in Western Australia*, Department of Conservation and Land Management, Available from:
<www.naturebase.net/forest_facts/sy_review/manuals/manual_of_harvesting_specifications/index.html>.
- Department of Conservation and Land Management, 1999, *Code of Practice for Timber Harvesting in Western Australia*, Department of Conservation and Land Management. Available from:
<http://www.naturebase.net/forest_facts/sy_review/manuals/index.html>.
- Forest Products Commission, 2003, *Contractors' Timber Harvesting Manual – South West Native Forests*, Forest Products Commission.

Forest fire management:

Controlled burning should be conducted on a scale and at a frequency to minimise erosion and overland runoff into reservoirs. Therefore, only small proportions of land in a catchment should be burnt in any one year. Guidelines on how to address water quality protection objectives in the Controlled Burning Prescription should be documented by CALM, DoE and WC.

Bauxite mining:

- Alcoa World Alumina Australia. *Environmental Management Manual, Bauxite Mining Operations*, Alcoa World Alumina Australia.
- McIntosh, K.S and Cronin, D.J., 2003, *Bauxite Mining in Water Supply Catchments – Water Conservation and Quality Protection*. Alcoa World Alumina Australia.
- Water and Rivers Commission, 2000, Water Quality Protection Guidelines (Nos 1 – 11): *Mining and Mineral Processing*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

Motor rally events:

- Water Corporation, 2002, 'Managing Motoring Events in Catchments', Draft, *Source Protection Operations Management Manual SG 097.2*. Water Corporation.
- Water and Rivers Commission, 2003, Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*. Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Recreation in PDWSAs:

- Water and Rivers Commission, 2003, Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*. Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Research projects:

Participants should be educated on personal hygiene, erosion prevention and water quality protection objectives in a PDWSA prior to entering the catchment.

Major roads, roads and tracks, infrastructure maintenance:

Drainage must be controlled to prevent soil erosion and minimise sediment transport. Chemical application to control vegetation should be minimised.

- Lloyd, B. and Van Delft R., 2001, *Erosion and Sediment Control Manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, Department of Agriculture.

Extractive industries / gravel pits:

- Department of Conservation and Land Management, 1993, Policy Statement No. 2 *Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves*, CALM.
- Department of Conservation and Land Management, 1986, Policy Statement No. 10 *Rehabilitation of Disturbed Land*, CALM.
- Water and Rivers Commission, 2000, Water Quality Protection Note *Extractive Industries within Public Drinking Water Source Areas*, Water and Rivers Commission. Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Chemical and fuel storage:

- Water and Rivers Commission, 2002, Water Quality Protection Note *Toxic and Hazardous Substances Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Chemical Spills – Emergency Response Planning*, Water and Rivers Commission.
- Water and Rivers Commission, 2000, Water Quality Protection Note *Temporary Above Ground Chemical Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.

- Water and Rivers Commission, 1999, Water Quality Protection Note *Above Ground Chemical Storage Tanks within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Skid Mounted Fuel Transfer and Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Water and Rivers Commission, 1998, Water Quality Protection Note *Temporary Above Ground Fuel Storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
Available from: <<http://drinkingwater.environment.wa.gov.au>>.

Mechanical servicing and workshops:

- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Equipment Washdown*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.
- Water and Rivers Commission, 2002, Water Quality Protection Note *Mechanical Servicing and Workshop Facilities*, Water and Rivers Commission. Available from:
<<http://drinkingwater.environment.wa.gov.au>>.

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