GOVERNMENT OF WESTERN AUSTRALIA

DUNSBOROUGH AND YALLINGUP TOWN WATER SUPPLIES

WATER SOURCE PROTECTION PLAN

WATER RESOURCE PROTECTION SERIES

WATER AND RIVERS COMMISSION REPORT WRP 23

1999

WATER AND RIVERS
COMMISSION

WATER AND RIVERS COMMISSION
HYATT CENTRE
3 PLAIN STREET
EAST PERTH
WESTERN AUSTRALIA 6004
TELEPHONE (08) 9278 0300
FACSIMILE (08) 9278 0301
WEBSITE: http://www.wrc.wa.gov.au

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Water and Rivers Commission
Policy and Planning

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Acknowledgments

Contribution	Personnel	Title	Organisation
Supervision	Ross Sheridan	Program Manager, Protection Planning	Water and Rivers Commission
Report Preparation	Steve Chase	Water Resources Planner	Water and Rivers Commission
Drafting	Nigel Atkinson	Mapping Contractor	McErry Digital Mapping Pty Ltd

For more information contact:

Program Manager, Protection Planning
Water Quality Protection Branch
Water and Rivers Commission
3 Plain Street
EAST PERTH WA 6004

Telephone: (08) 9278 0300
Facsimile: (08) 9278 0585

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Foreword

Water source protection plans

Water Source Protection Plans establish the level of protection required within Water Reserves. The plans identify sources of contamination that should be investigated and set out programs for management of the resource. Water Source Protection Plans are developed in consultation with affected landowners and industry groups and relevant government agencies.

Proclaiming Water Reserves under the *Country Areas Water Supply Act 1947* protects the quality of water sources in country Western Australia. The Act's by-laws enable the Water and Rivers Commission to control potentially polluting activities, to regulate land use, inspect premises and to take steps to prevent or clean up pollution.

The Commission aims to work pro-actively with planning agencies to incorporate water protection in the land planning process. Decisions on land-use zoning and subdivision applications have a significant impact on the protection of water sources. The Commission supports the amendment of town planning schemes and development strategies that reflect land use compatible with Water Source Protection Plans.

This Water Source Protection Plan provides a basis for establishing compatible land uses within the Water Reserve at Butterworth Springs and is a mechanism for practical implementation of the Commission's protection strategies. Local government decision-makers, State planning authorities and operational staff are encouraged to recognise this document as a basis for ensuring the long term protection of this groundwater resource for generations to come.

Water quality protection framework

The Water and Rivers Commission is responsible for managing and protecting Western Australia's water resources. The Commission has developed policies for the protection of public drinking water source areas that include three levels of priority classification of lands within Public Drinking Water Source Areas (PDWSAs):

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 the highest quality public drinking water is the prime beneficial land use. P1 areas would typically include land under Crown ownership. They are managed in accordance with the principle of **risk avoidance,** and so land development is generally not permitted.

Priority 2 (P2) source protection 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 in these areas. They are managed in accordance with the principle of **risk minimisation,** and so some development is allowed under specific guidelines.

Priority 3 (P3) source protection areas are defined to **minimise the risk of pollution** to the water source. P3 areas are declared over land where water supply sources need to coexist with other 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. If the water source does become contaminated, water may need to be treated or an alternative source found.

In addition to priority classifications, **wellhead protection zones** and **reservoir protection zones** are defined to protect the water source from contamination in the immediate vicinity of production wells and reservoirs. Wellhead protection zones are usually circular, with a radius of 500 metres in P1 areas and 300 metres in P2 and P3 areas. Reservoir protection zones usually consist of a 2 kilometre wide buffer area around the top water level of a reservoir and include the reservoir itself. These zones do not extend outside water reserves. Special restrictions apply within these zones.

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Summary

Dunsborough is a coastal resort town located about 250 kilometres south of Perth on Geographe Bay. Yallingup is a coastal resort town on the western side of Cape Naturaliste Peninsula, 7 km south-west of Dunsborough. The town water supply for Dunsborough and Yallingup is derived from seven Water Corporation production bores and the Butterworth Springs.

Six of the bores abstract water from the Leederville Aquifer and the seventh draws from the Sue Coal Measures. This aquifer is recharged directly from rainfall on the Blackwood plateau, where the formation subcrops. There is a very low risk of contamination from land uses surrounding the wellfield because of the confined nature of the aquifer. Further consideration should be given to the protection of the remote recharge areas.

Butterworth Springs has the potential to be impacted by land uses within the catchment. A Water reserve should therefore be proclaimed around the Butterworth Springs and the water quality monitored for possible contaminants. The Crown Land in the Water Reserve should be managed for Priority 1 water source protection and the remainder for Priority 3 source protection. Any development proposals that may affect the quality of the water supply must be referred to the Water and Rivers Commission.

Consultation

This plan has undergone extensive consultation during its development process. A draft plan was released for comment to all key stakeholders including affected landowners, the Water Corporation, the Ministry for Planning, Main Roads WA, the Department of Conservation and Land Management, the Shire of Busselton and the Sussex Land Conservation District Committee (LCDC). Stakeholder comments were addressed in the preparation of this plan.

1. Introduction

Dunsborough is a coastal resort located about 250 kilometres south of Perth in the Shire of Busselton (see **Figure 1**). Yallingup is a coastal resort town on the western side of Cape Naturaliste Peninsula, 7 km south-west of Dunsborough. The public drinking water supply for the two towns comes from groundwater abstracted from a Water Corporation wellfield and, during peak times, from Butterworth Springs.

The wellfield that supplies Dunsborough and Yallingup is called the Quindalup Wellfield and is located approximately 7 km south-east of the town. The production bores draw water from the Leederville (confined) aquifer and in a minor way from the Sue Coal Measures (bore 1/92). The Quindalup wellfield is located within the Busselton-Capel Groundwater Area and consists of seven equipped production wells (1/74, 2/74, 1/86, 1/91, 1/92, 1/93 and 2/96 - see **Figure 2**).

The Butterworth Springs are located approximately 3 km west of the Dunsborough (see **Figure 2**). Dams have been constructed to capture groundwater seepage (see **Plates 1** and **2**) and abstraction from them (No. 3 White Dam and No. 4 Black Dam) occurs during peak demand periods between November and March, when water colour permits.

The current licensed allocations for the Quindalup Wellfield and Butterworth Springs are respectively 850000 kL/year and 35 000 kL/yr. During 1996/97, 1788 services consumed 638 944 kL of water.

Dunsborough and Yallingup experience a Mediterranean climate, characterised by cool wet winters and warm dry summers. Around 90% of rainfall occurs between the months of April and October, peaking around June to August. The closest rainfall station to Dunsborough is that at Cape Naturaliste which receives a mean annual rainfall of 825 mm/yr. Rainfall hyetographs suggest the mean annual rainfall for Quindalup and Dunsborough is likely to be slightly higher than this (approximately 900 mm/yr). The annual potential for evaporation is around 1300 mm/yr.

2. Hydrogeology

2.1 Quindalup wellfield

The Dunsborough Fault defines the western margin of the Southern Perth Basin and the eastern margin of the Leeuwin Block, and it transects Dunsborough and Quindalup townships. The Busselton Fault subdivides the Southern Perth Basin into the Bunbury Trough to the east and the Vasse Shelf to the west. The Vasse Shelf is thought to be underlain by Precambrian basement at a depth of less than 2 km. The Wirring Fault further subdivides the Vasse Shelf. The Quindalup wellfield is found west of the Wirring Fault on the Vasse Shelf (see **Figure 1**).

The Superficial deposits of the Vasse Shelf comprise Tertiary and Quaternary sediments up to a thickness of 15 m. This groundwater aquifer is generally utilised for livestock, as yields are often limited by a high clay content and water quality is inclined to be brackish.

The Leederville Formation unconformably underlies the Tertiary and Quaternary sediments and represents the best quality groundwater resource in the area. The Leederville aquifer is an interbedded, multilayered aquifer consisting of fine to medium grained quartz sandstone and interbedded grey shale. Its thickness on the Vasse Shelf ranges from 50 m to 250 m approximately. The direction of groundwater flow in the Leederville Formation and Sue Coal Measures around the production bores is north. Recharge to the Leederville aquifer is by direct rainfall infiltration on the remote Blackwood Plateau, where the formation subcrops, and by downward leakage from the Superficial aquifer near the Whicher Scarp.

There are also other areas of potential downward leakage from the Superficial Formation to the Upper Leederville aquifer south of Caves Road (Hirchberg 1987). However, the confining layers between the upper and lower Leederville limits the leakage.

Discharge from the Leederville aquifer generally occurs near the coast into creeks and swamps, over an area that extends several kilometres inland and by upward leakage into the Superficial formations. The Lower Leederville contains water of potable quality but that in the upper Leederville near the coast, has a high salt content and is therefore not used as a drinking water supply.

The Leederville Formation is unconformably underlain by the Sue Coal Measures west of the Wirring Fault at depths greater than -150 m AHD. East of the Wirring Fault the Leederville formation is unconformably underlain by the Cockleshell Gully Formation. The Permian sediments west of the Busselton Fault are referred to as the Sue Coal Measures and consist of multicoloured shale, moderately consolidated fine-coarse grained quartz sandstone, accessory feldspars and pyrite and carbonaceous materials. The Sue Coal Measures contain water of potable quality but, to date, wells drilled into this formation are low yielding. Discharge occurs from the Sue Coal Measures to the Leederville aquifer; recharge occurs by downward leakage from sandier areas of the overlying Leederville aquifer.

All of the public water supply bores are screened in the Leederville Formation except for 1/92, which is screened in the Sue Coal Measures.

These bores extract from the lower Leederville (approximately 40 m below ground) or deeper. As the Leederville Formation is stratified, flat-lying and predominantly shaley, leakage from the Superficial aquifer to the lower Leederville Formation is not regarded as significant, and it is therefore not considered vulnerable to contamination from land uses around the wellfield.

The raw water quality in the production bores often exceeds guideline values for iron and turbidity, and it is therefore partially treated for iron removal before entering the Dunsborough/Quindalup reticulation system.

Plate 1. Butterworth Springs Dams

2.2 Butterworth Springs

The Butterworth Springs are located on the Leeuwin Block west of Quindalup where groundwater seeps from a thin layer of Superficial sediments overlying Precambrian rock. The gravel and sand soils upstream of the springs are highly permeable and vulnerable to contamination.

The raw water quality in the Butterworth Springs dams often exceeds the NH&MRC guidelines for colour and acidity, and occasionally those for aluminium. Appendix B also shows some evidence of elevated nitrates, but concentrations remain well within NH&MRC drinking water guidelines. The elevated concentrations are probably due to historical land use, because they are higher than the normal background levels for this area. The fact that historical landuse has probably caused elevated nitrate levels reinforce the need for management of this land so that concentrations will not increase. (see **Appendix B**).

Plate 2. Seepage point for Butterworth Springs

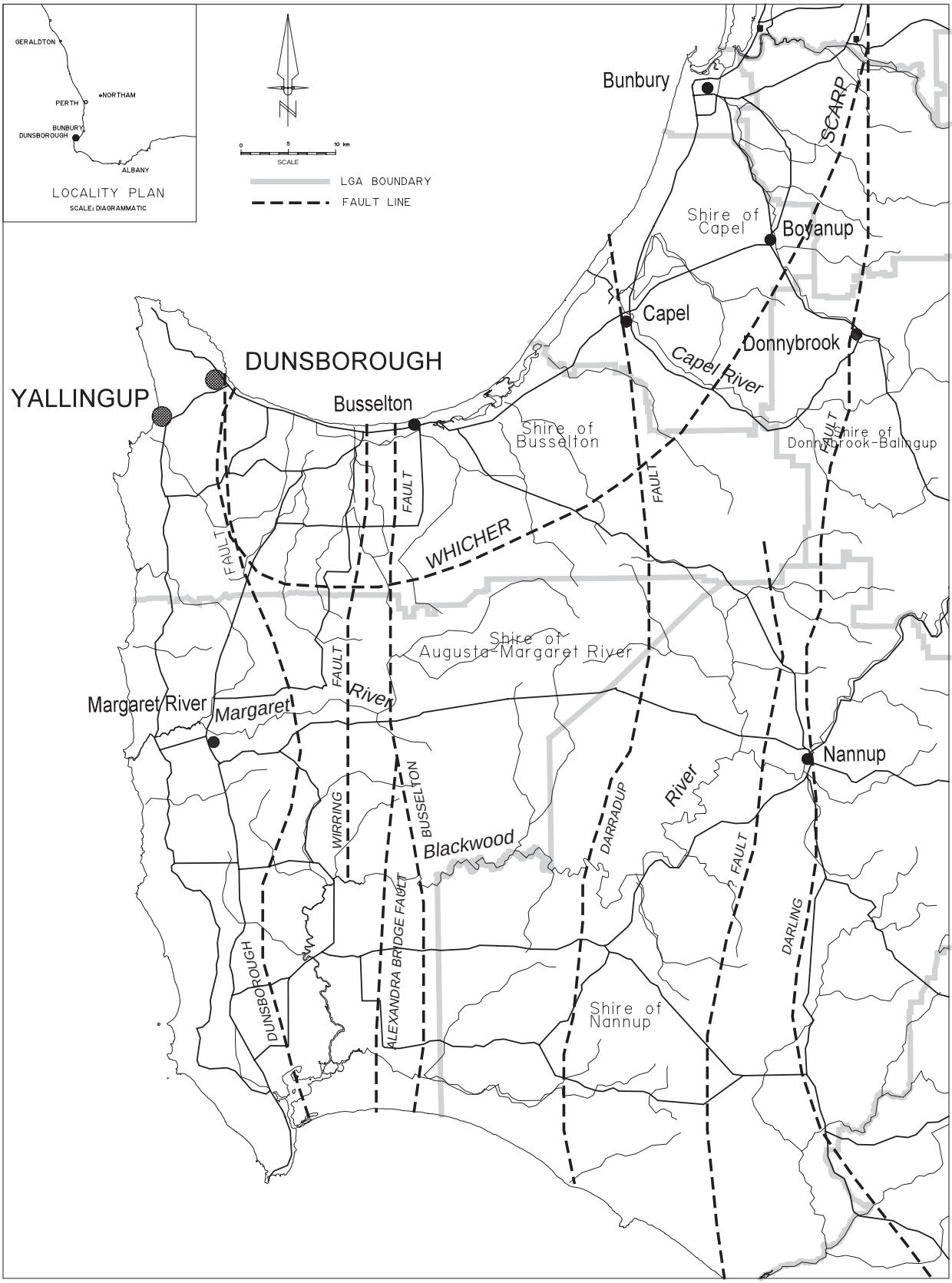

Figure 1. Dunsborough locality map showing nearby fault lines

3. Existing and proposed land use

3.1 Butterworth Springs

A Land Act Reserve (# 32949) vested in the Water Corporation surrounds the core area of the Butterworth Springs. Apart from the dams and associated infrastructure, the vegetation within the reserve is undisturbed and mainly composed of native species. The land surrounding it is zoned rural and largely used for low intensity grazing of sheep and cattle. Other land uses are a small vineyard, sheep-holding yaRoads, hay cultivation and gravel extraction.

The owner of the surrounding land has indicated plans for subdivision, floriculture, aquaculture, tree farming and expansion of the existing viticulture operation. Recent amendments of the Busselton Town Planning Schemes propose that land abutting the existing Land Act reserve be rezoned from rural to special rural. Some of this proposed special rural land is located within the proposed Butterworth Springs Water Reserve.

3.2 Quindalup Wellfield

All production bores are located along Quindalup-Siding Road, except for 2/96, which is located on Mewitt Road. The land in the immediate vicinity of the wellfield is mostly cleared, very low lying and seasonally inundated. It is zoned as agricultural/rural and the Shire of Busselton has confirmed that there are no plans for rezoning.

Toby's Inlet, listed as an Environmental Protection Policy (EPP) Wetland, is located to the north and down hydraulic gradient. The land up-gradient and surrounding the Dunsborough wellfield has been largely cleared to develop pasture, and is used for the grazing of sheep and some cattle (see **Plate 3**). There is a small ostrich farm opposite the water treatment plant on the south side of the intersection of Quindalup-Siding Road and Mewitt Road.

The Water Corporation is proposing the relocation of a tertiary wastewater treatment plant to south of the intersection of Quindalup-Siding Road and Vasse-Yallingup Siding Road.

The wastewater will be used to irrigate a treelot. Future production bores will be located at 1-km intervals going east along Yallingup-Vasse Siding Road from where it intersects Quindalup Siding Road.

An artificial drain called the Station Gully Drain runs south to north through the proposed tertiary treatment plant land, past the production bores and through pastoral land before feeding into Toby's Inlet. Another drain comes to within 200 m west of Lot 601 (location of the Wastewater Treatment Plant) and discharges onto seasonally inundated land near the production bores.

4. Potential for contamination

4.1 Butterworth Springs

Some of the existing land uses around the Butterworth Springs, such as viticulture and sheep-holding yards, do pose a risk to water quality. The landowner uses best management practices in the use of fertilisers and pesticides on the existing vineyard, and it is essential that this continue if degradation of the water source is to be prevented.

Planned intensive agricultural activities such as floriculture and aquaculture are a potential threat to water quality. Best management practices will be required to ensure these land uses do not pose an unacceptable risk to the quality of the water source.

The change in zoning from rural to special rural is compatible with source protection if appropriate conditions are placed on land use, i.e. no livestock or intensive agricultural practices. It is important that provisions in the Town Planning Scheme that govern land use are enforced.

Plate 3. Typical farmland near the Quindalup wellfield

4.2 Quindalup Wellfield

4.2.1 Remote Recharge areas

The Leederville Formation is recharged by direct infiltration of rainfall on the Blackwood Plateau to the south. The key recharge areas for the Sue Coal Measures are in the overlying Leederville aquifer where it contains larger proportions of sand. Because the aquifer recharge areas are located well away from the wellfield and the storage in the aquifers is large, travel times to the wellfield are long and contaminants are diluted to the extent that it is resistant to contamination. As a result, the wellfield is resistant to contamination. However, because of the strategic importance of the water resource, land uses in the recharge areas should be managed so as to not degrade its quality.

Current land uses in these areas include low intensity grazing and viticulture. Providing the operators use best management practices, these land uses pose no major risk to the quality of the groundwater.

spills of diesel have occurred, they will not contaminate the drinking water aquifer because of its confined nature.

Tertiary treated wastewater from the woodlot irrigated by the Water Corporation is unlikely to contaminate the

4.2.2 Local activities

The wellfield is not vulnerable to contamination from the surrounding land-uses because thick layers of impermeable material occur between the lower Leederville aquifer and the superficial formations.

All bores, except bore 2/96, are mounted on impermeable concrete pads that are elevated above the surrounding land (see **Plates 4** and **5**). Therefore they are not vulnerable to contaminants entering the water source.

Land surrounding bore 2/96 is seasonally inundated and the unsealed pad on which it is constructed is low to the ground. During a high water or flood event, water containing contaminants may enter the annulus of the bore and thus the aquifer. It is therefore, recommended that this bore be provided with the same type of structural protection as the others.

Bore 2/96 had been powered by a diesel pump until recently, when it was connected to electricity. There is no evidence of any fuel spillage or leakage. If any

lower Leederville aquifer due to its confined nature. This also applies to future bores planned for the Sue Coal Measures.

Two drains run close to the production bores. Both originate in farmland close to the Whicher Scarp and

may be contaminated with agricultural chemicals such as pesticides and nutrients. It is not likely that water from the drains will contaminate the drinking water source, as the aquifer is confined.

4.3 Emergencies

Escape of chemicals during unforeseen incidents and use of chemicals during emergency response can cause groundwater contamination. The Shire of Bunbury Local Emergency Management Advisory Committee, through the Bunbury Emergency Management District, should be familiar with the location and purpose of the Quindalup Wellfield and the Butterworth Springs Water Reserve. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. The Regional Manager Water and Rivers Commission should have an advisory role to any HAZMAT incident that might occur in either of these two areas. [NB: on occasions the Regional Operations Manager Water Corporation may be more appropriate, depending on distances.]

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

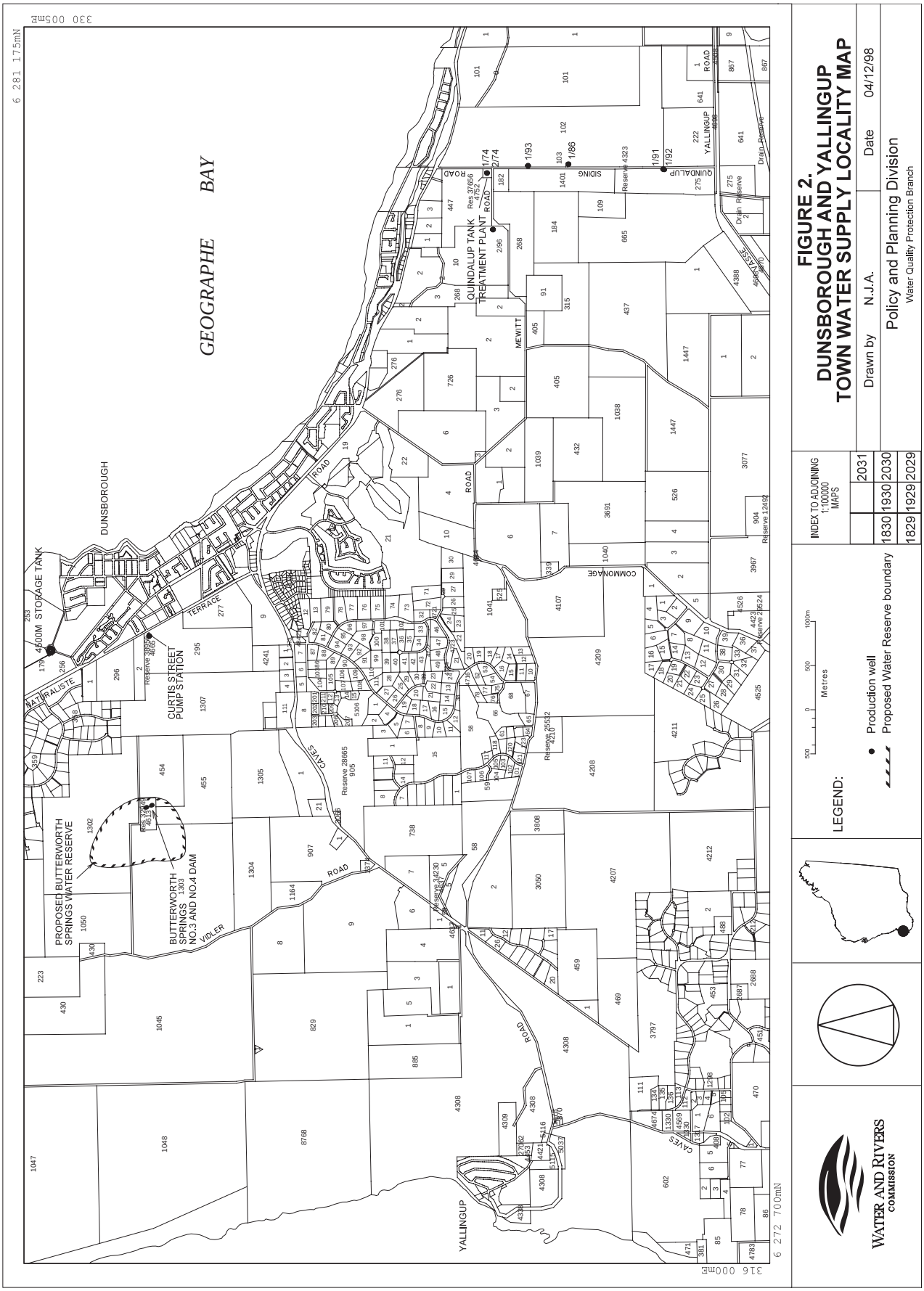

Figure 2. Dunsborough town water supply locality map

Plate 4. Typical mounting of production bores within the Quindalup wellfield

Plate 5. Bore 2/96 – Inadequate wellhead protection

5. Proposed proclaimed area

5.1 Butterworth Springs

A water reserve should be proclaimed under the *Country Areas Water Supply Act (1947)*, around the Butterworth Springs. The quality of this public water supply needs to be protected from potentially contaminating activities.

The proposed Butterworth Springs Water Reserve boundary has been defined to include the most likely areas of groundwater recharge. It is aligned along topographic contours capturing downgradient surface and ground water flow into the area surrounding the springs (see **Figure 3**).

The existing Land Act reserve within the proposed Butterworth Springs Water Reserve is vested in the Water Corporation and should be classified for Priority 1 source protection. This does not conflict with its current use/status as a reserve.

The remaining area inside the boundary should be classified a Priority 3 source protection area based on the following criteria:

- Priority 3 water source protection areas are managed with the objective of minimising the risk of pollution to the water source. They are declared over land where water supply needs coexist with other land uses, water quality protection being achieved by management of land-use activities.
- this water source is of importance to the communities at Dunsborough and Yallingup the annual contribution from the springs being approximately 4% of the total allocation for the towns' water supply. When further production bores are constructed and yielding required amounts of potable water, the water source at Butterworth Springs may be decommissioned but this option will not be considered by the Water Corporation until after the new production bores have been installed in the year 2000.
- The Water Reserve is the recharge area for the springs.
- All of the land is privately owned.
- The hydrogeology and soil conditions in the area are such that more intensive development could lead to groundwater contamination occurring.
- Current and future uses of land inside the proposed Priority 3 area do not generally conflict with its classification. Currently, best management practices are adhered to by the landowner and it is essential that this continue to prevent degradation of the water source. However, floriculture, which has been identified as a possible future land use, is a restricted use and it is important that provisions for land-use restrictions within the Town Planning Scheme are enforced.

5.2 Quindalup Wellfield

Due to the confined nature of the Leederville and Sue Coal aquifers in the vicinity of the wellfield, it is not considered necessary to proclaim a protection area. Further consideration should be given to appropriate protection of recharge areas of confined aquifers.

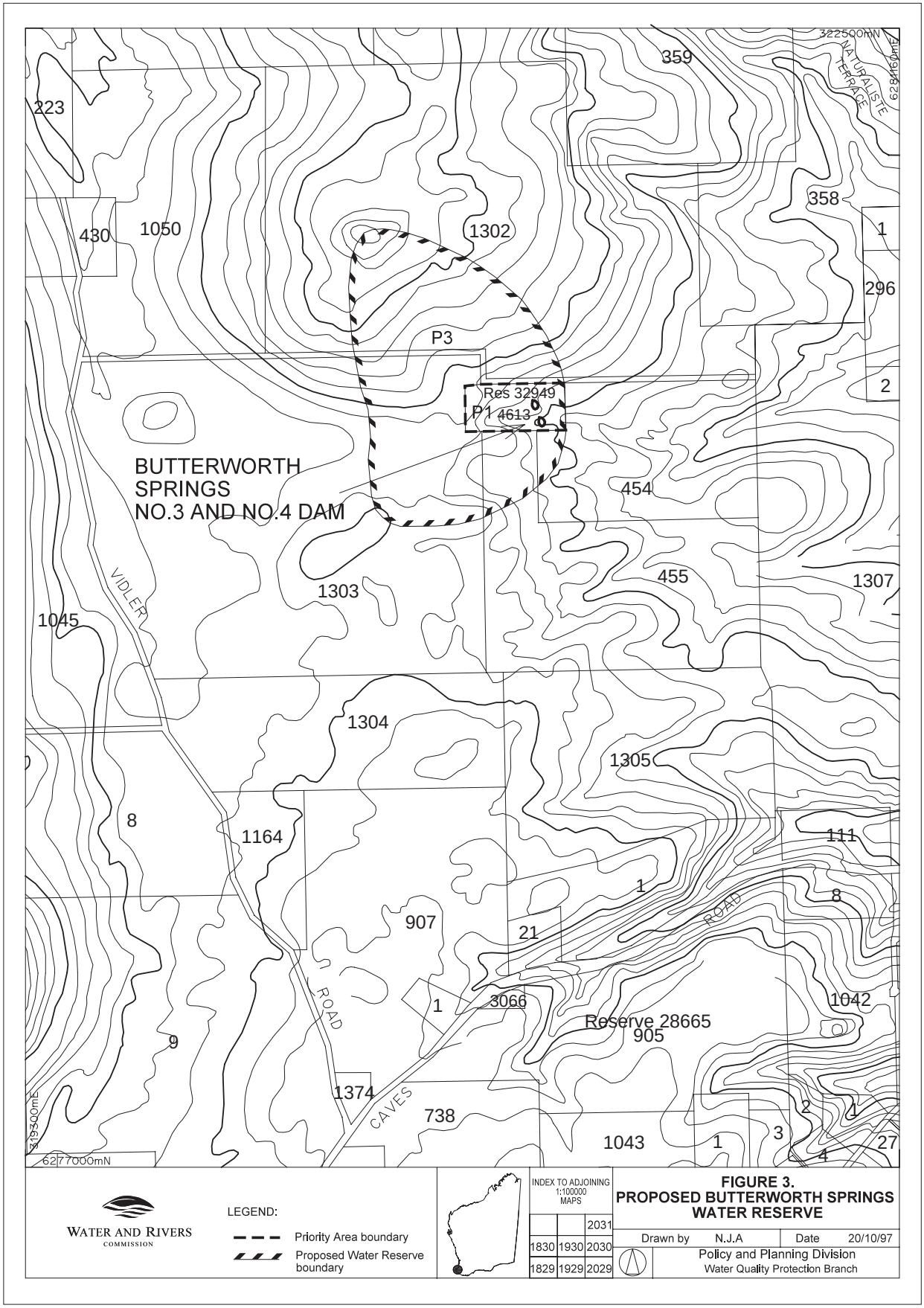

Figure 3. Proposed Butterworth Springs Water Reserve

Recommendations

1. The proposed Butterworth Springs Water Reserve be gazetted under the *Country Areas Water Supply Act 1947*.

2. Planning strategies incorporate the management principles outlined in the Water and Rivers Commission's *Acceptability of Land Use Within Public Drinking Water Source Areas* (see **Appendix A**) and reflect the Priority 1 and 3 classification given to the Water Reserve.

3. All development proposals in the proposed Water Reserve that are likely to impact on water quality should be referred to the Water and Rivers Commission.

4. The boundary and implications of the proposed Butterworth Springs Water Reserve should be explained in detail to the landowners affected by the Reserve.

5. The headworks of Bore 2/96 should be upgraded to ensure that water from possible inundation does not enter the aquifer.

6. Consideration should be given to the appropriate protection of the key recharge areas for the source aquifer of the Quindalup Wellfield, i.e. formation subcrops on the Blackwood plateau and areas of the Superficial aquifer adjacent to the Whicher Scarp.

7. Incidents covered by WESTPLAN–HAZMET in the Quindalup Wellfield and the Butterworth Springs Water Reserve should be addressed through the following measures:

- The Shire of Busselton Local Emergency Management Advisory Committee (through the Bunbury Emergency Management District) being familiar with the location and purpose of the Quindalup Wellfield and the Butterworth Springs Water Reserve.
- The locality plan for the Quindalup Wellfield and the proposed Butterworth Springs Water Reserve being provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team.
- The Water Corporation advising the HAZMAT Emergency Advisory Team during incidents in the Quindalup Wellfield and the Butterworth Springs Water Reserve.
- Personnel dealing with WESTPLAN-HAZMAT incidents in the area being given ready access to a locality map of the Quindalup Wellfield and the proposed Butterworth Springs Water Reserve and training to understand the potential impacts of spills on the groundwater resource.

8. The current monitoring program should be tailored to detect groundwater contamination from land-use activities within the proposed Butterworth Springs Water Reserve. That is, the sampling parameters for routine monitoring programs of the water from Butterworth Springs should include nutrients and pesticides likely to be detected in water as a result of the activities of nearby land uses.

9. A surveillance program should be established to identify any incompatible land uses or potential contaminant threats within the proposed water reserve.

10. Implementation of these recommendations should be reviewed one year after this plan is endorsed. A full review of this protection plan should be undertaken approximately every five years.

Implementation strategy

No.	Description	Implemented by	Timing
1.	Gazettal of Water Reserve.	Program Manager, Assessment and Advice (WRC)	1998/99
2.	Incorporation into land planning strategies.	Shire of Busselton	Ongoing
3.	Referral of development proposals: (i) WRC to provide the Shire of Busselton with guidelines for referral of development proposals. (ii) referral of development proposals.	(i) Program Manager, Protection Planning (WRC) (ii) Shire of Busselton, Ministry for Planning and Department of Environmental Protection.	(i) Done (ii) Ongoing
4.	Exact boundary description and description of implications for the owner whose land is affected by the Reserve: WRC to provide the landowner with the WSPP and a detailed topographic map of the Water Reserve.	Regional Manager, South West Region (WRC)	(i) 1998/99
5.	Headworks upgrade for 2/96.	Water Corporation	To be determined
6.	Protection of key recharge areas. Consideration be given to appropriate protection measures for confined aquifers.	Program Manager, Protection Planning (WRC)	To be determined.

7	Incidents covered by WESTPLAN – HAZMET in the Harding Dam Catchment Area to be addressed through the following measures: (i) The Shire of Busselton Local Emergency Management Advisory Committee (through the Bunbury Emergency Management District) being familiar with the location and purpose of the Quindalup Wellfield and the Butterworth Springs Water Reserve. (ii) The locality plan for the Quindalup Wellfield and the Butterworth Springs Water Reserve being provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory. (iii) The Water Corporation advising the HAZMAT Emergency Advisory Team during incidents in the Quindalup Wellfield and the Butterworth Springs Water Reserve. (iv) Personnel dealing with WESTPLAN-HAZMAT incidents in the area being given ready access to a locality map of the Quindalup Wellfield and the Butterworth Springs Water Reserve and training to understand the potential impacts of spills on the groundwater resource.	(i) Shire of Busselton Local Emergency Management Advisory Committee through WRC (South West Region) (ii) WRC (South West Region) (iii) Water Corporation (iv) Shire of Busselton Local Emergency Management Advisory Committee	(i) 1998/99 (ii) 1998/99 (iii) Ongoing (iv) Ongoing
8.	Confirmation of groundwater travel times. Water quality monitoring program: incorporate monitoring of indicator parameters into the ongoing program.	Water Corporation	1998/99
9.	Surveillance program: i) Develop guidelines for the surveillance of water reserves. ii) Implement the surveillance program.	i) Water Quality Protection Branch (WRC) ii) Water Corporation	i) 1998/99 ii) On completion of (1)
10.	Review of this plan and recommendations.	Water Quality Protection Branch (WRC)	(i) Review Implementation Strategy 1999/00. (ii) Full review 2003/04

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Glossary

Abstraction	Pumping groundwater from an aquifer.
Allocation	The quantity of groundwater permitted to be abstracted by a well licence, usually specified in kilolitres/year (kL/a).
Alluvium (alluvial)	Detrital material which is transported by streams and rivers and deposited.
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
Bore	A narrow, lined hole drilled to monitor or withdraw groundwater.
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Confined Aquifer	An aquifer that is confined between shale and siltstone beds and therefore contains water under pressure.
Diffuse Source Pollution	Pollution originating from a widespread area, e.g. urban stormwater runoff, agricultural runoff.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
Fault	A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.
Groundwater	Water which occupies the pores and crevices of rock or soil.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Interbedded	occurring between beds, or lying in a bed parallel to other beds of a different material; interstratified.
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.
Nutrient Load	The amount of nutrient reaching the waterway over a given time (usually per year) from its catchment area.

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.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Point Source Pollution	Specific localised source of pollution, e.g. sewage or effluent discharge, industrial waste discharge.
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.
Public Water Source Area (PWSA)	As for UWPCA, but allowing the taking of groundwater for public supplies.
Recharge	Water infiltrating to replenish an aquifer.
Recharge Area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Runoff	Water that flows over the surface from a catchment area, including streams.
Saltwater Intrusion	The inland intrusion of saltwater into a layer of fresh groundwater.
Scheme Supply	Water diverted from a source (or sources) by a water authority or private company and supplied via a distribution network to customers for urban, industrial or irrigation use.
Storage Reservoir	A major reservoir of water created in a river valley by building a dam.
Stormwater	Rainwater which has run off the ground surface, roads, paved areas etc and is usually carried away by drains.
Superficial/Surficial	Characteristics of, pertaining to, formed on, situated at, or occurring on the earths surface; especially consisting of unconsolidated residual, alluvial, or glacial deposits lying on the bedrock.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Unconfined Aquifer	An aquifer containing water, the upper surface of which is lower than the top of the aquifer. The upper surface of the groundwater within the aquifer is called the watertable.
Unconformable	Having the relation of unconformity to the underlying rocks; not succeeding the underlying strata in immediate order of age and in parallel position.
Unconformity	A surface of erosion that separates younger strata from older rocks.

Underground Water Pollution Control Area (UWPCA)	An area defined under the Metropolitan Water Supply Sewerage and Drainage Act, in which restrictions are put on activities that may pollute the groundwater.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water Quality	The physical, chemical and biological measures of water.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores to monitor or withdraw groundwater.

Appendix 1

Land use compatibility in public drinking water source areas

Water Quality Protection Note

LAND USE COMPATIBILITY IN PUBLIC DRINKING WATER SOURCE AREAS

Purpose

To provide information for activities that may impact on the quality of the State's water resources.

These notes provide a basis for developing formal guidelines in consultation with key stakeholders.

Scope

These notes apply to existing and proposed activities within Public Drinking Water Source Areas (PDWSAs).

PDWSAs include Underground Water Pollution Control Areas, Water Reserves and public water supply catchment areas declared under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*, and the *Country Areas Water Supply Act 1947*.

General requirements

The following notes reflect the Commission's current position. They are recommendations only, and may be varied at the discretion of the Commission.

Overview of Protection Framework

The Water and Rivers Commission is responsible for managing and protecting Western Australia's water resources. The Commission has developed policies for the protection of public drinking water source areas, which are based on three levels of priority classification.

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 the highest quality public drinking water is the prime beneficial land use. P1 areas would typically include land under Crown ownership. P1 areas are managed in accordance with the principle of **risk avoidance** and so land development is generally not permitted.

Priority 2 (P2) source protection 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 in these areas. P2 areas are managed in accordance with the principle of **risk minimisation** and so some development is allowed under specific guidelines.

Priority 3 (P3) source protection areas are defined to **minimise the risk of pollution** to the water source. P3 areas are declared over land where water supply sources need to co-exist with other 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. If the water source does become contaminated, then water may need to be treated or an alternative water source found.

In addition to priority classifications, **well-head protection zones** and **reservoir protection zones** are defined to protect the water source from contamination in the immediate vicinity of production wells and reservoirs. Well-head protection zones are usually circular, with a radius of 500 metres in P1 areas and 300 metres in P2 and P3 areas. Reservoir protection zones usually consist of a 2 kilometre area around the top water level of a reservoir and include the reservoir itself. These zones do not extend outside water reserves. Additional restrictions apply within these zones.

Land Use Compatibility Tables

These tables should be used as a guideline only. Further information relating to land use and developments within PDWSAs including those not listed in the table, can be obtained from the Commission's Water Quality Protection Branch.

These tables do not replace the need for assessment by the Commission. Please consult the Commission regarding any land use proposals in Public Drinking Water Source Areas that may impact on water resources.

Definitions Used In The Following Tables

Compatible	The development / land use is compatible with the management objectives of the priority classification.
Incompatible	The development / land use is incompatible with the management objectives of the priority classification.
Restricted	The development / land use may be compatible with the management objectives of the priority classification, with appropriate site management practices. Restricted activities should be referred to the Commission for assessment on a case specific basis.
Extensive	Where limited additional inputs are required to the land to support the desired land use. eg supplementary feed during seasonal dry periods.
Intensive	Where regular additional inputs are required to support the desired land use. eg irrigation, additional feed, fertilisers.

More information

We welcome your comment on these notes. They will be updated from time to time as comments are received or industry standards change.

If you wish to comment on the notes or require more information, please contact the Commission's Water Quality Protection Branch at the Hyatt Centre in East Perth.
Phone: (08) 9278 0300 (business hours) or Fax:(08) 9278 0585

Land Use Compatibility Tables

AGRICULTURE - ANIMALS

Development	Priority 1	Priority 2	Priority 3
Apiary	Restricted	Restricted	Restricted
Aquaculture eg. marron farms, fish farms, algae culture	Incompatible	Restricted	Restricted
Dairy Farming	Incompatible	Restricted	Restricted
Feedlots	Incompatible	Incompatible	Restricted
Livestock grazing (extensive)	Restricted	Compatible	Compatible
Livestock grazing (intensive)	Incompatible	Incompatible	Restricted[11]
Piggeries	Incompatible	Incompatible	Incompatible
Poultry farming (housed)	Incompatible	Restricted	Restricted
Stables	Incompatible	Restricted	Compatible
Stockholding and saleyards	Incompatible	Incompatible[7]	Restricted[7]

AGRICULTURE - PLANTS

Development	Priority 1	Priority 2	Priority 3
Broad acre cropping i.e. non-irrigated	Incompatible	Restricted[1]	Compatible
Floriculture (extensive)	Incompatible	Restricted	Compatible
Floriculture (intensive)	Incompatible	Incompatible	Restricted
Field horticulture	Incompatible	Incompatible	Restricted
Hydroponic horticulture	Incompatible	Restricted	Restricted
OrchaRoads	Incompatible	Restricted	Compatible
Potted Nurseries	Incompatible	Restricted	Compatible
Silviculture (tree farming)	Restricted	Restricted	Compatible
Turf Farms	Incompatible	Incompatible	Restricted
Viticulture (wine & table grapes)	Incompatible	Restricted	Compatible

DEVELOPMENT - COMMERCIAL

Development	Priority 1	Priority 2	Priority 3
Aircraft Servicing	Incompatible	Incompatible	Restricted[6]
Amusement Centres	Incompatible	Incompatible	Compatible[6]
Automotive businesses	Incompatible	Incompatible	Restricted[6]
Boat Servicing	Incompatible	Incompatible	Restricted[6]
Caravan and trailer hire	Incompatible	Incompatible	Restricted[6]
Vehicle parking (commercial)	Incompatible	Incompatible	Compatible
Consulting rooms	Incompatible	Incompatible[7]	Compatible[6]
Cottage Industries	Restricted	Restricted	Compatible
Drive in / take-away food shops	Incompatible	Incompatible	Compatible[6]
Drive -in theatres	Incompatible	Incompatible	Compatible[6]
Dry Cleaning Premises	Incompatible	Incompatible	Restricted[6]
Farm supply centres	Incompatible	Incompatible[7]	Restricted
Fuel depots	Incompatible	Incompatible	Restricted
Garden Centres	Incompatible	Incompatible	Compatible
Local shops	Incompatible	Incompatible[7]	Compatible
Markets	Incompatible	Incompatible	Compatible[6]
Milk depots	Incompatible	Incompatible	Restricted
Restaurants	Incompatible	Incompatible	Compatible
Service Stations	Incompatible	Incompatible	Restricted
Transport Depots	Incompatible	Incompatible	Restricted
Veterinary Clinics / hospitals	Incompatible	Incompatible[7]	Restricted
Vehicle wrecking and machinery	Incompatible	Incompatible	Restricted

DEVELOPMENT - INDUSTRIAL

Development	Priority 1	Priority 2	Priority 3
General Industry	Incompatible	Incompatible	Restricted[6]
Heavy Industry	Incompatible	Incompatible	Incompatible
Light Industry	Incompatible	Incompatible	Restricted[6]
Power Stations	Incompatible	Incompatible	Incompatible

DEVELOPMENT - URBAN

Development	Priority 1	Priority 2	Priority 3
Aged and dependent persons	Incompatible	Incompatible	Compatible[6]
Amenity buildings	Incompatible	Restricted	Compatible
Airports or landing grounds	Incompatible	Incompatible	Restricted[6]
Cemeteries	Incompatible	Incompatible	Restricted
Civic buildings	Incompatible	Restricted	Compatible[6]
Clubs -sporting, recreation or community	Restricted	Restricted	Compatible[6]
Community halls	Restricted	Restricted	Compatible
Family Day Care Centres	Incompatible	Restricted	Compatible[6]
Funeral parlours	Incompatible	Incompatible	Compatible[6]
Health Centres	Incompatible	Incompatible	Compatible[6]
Hospitals	Incompatible	Incompatible	Restricted[6]
Medical centres	Incompatible	Incompatible	Compatible[6]

EDUCATION / RESEARCH

Development	Priority 1	Priority 2	Priority 3
Education centres	Restricted	Restricted	Compatible[6]
Primary / Secondary Schools	Incompatible	Incompatible	Compatible[6]
Scientific Research Institutions	Restricted	Restricted	Compatible
Universities	Incompatible	Incompatible	Restricted[6]

MINING AND MINERAL PROCESSING

Development	Priority 1	Priority 2	Priority 3
Extractive Industries	Restricted[2]	Restricted[2]	Restricted[2]
Mineral Exploration	Restricted[4]	Restricted[4]	Restricted[4]
Mining and mineral processing	Restricted[4]	Restricted[4]	Restricted[4]
Tailings Dams	Incompatible	Incompatible	Restricted

PROCESSING OF ANIMALS / ANIMAL PRODUCTS

Development	Priority 1	Priority 2	Priority 3
Abattoirs	Incompatible	Incompatible	Incompatible
Cheese / butter factories	Incompatible	Incompatible	Restricted[6]
Food Processing	Incompatible	Incompatible	Restricted[6]
Tanneries	Incompatible	Incompatible	Incompatible
Wool-scours	Incompatible	Incompatible	Incompatible

PROCESSING OF PLANTS / PLANT PRODUCTS

Development	Priority 1	Priority 2	Priority 3
Breweries	Incompatible	Incompatible	Restricted[6]
Composting / soil blending (commercial)	Incompatible	Incompatible	Restricted
Vegetable / food processing	Incompatible	Incompatible	Restricted[6]
Wineries	Incompatible	Incompatible	Restricted

SUBDIVISION

Development	Priority 1	Priority 2	Priority 3
Dog Kennel Subdivisions	Incompatible	Restricted	Restricted
Rural - minimum lot size = 4 hectares (un-sewered)	Incompatible	Compatible	Compatible
Rural - minimum lot size = 1 hectare (un-sewered)	Incompatible	Incompatible	Compatible
Special rural - minimum lot size = 2 hectares (un-sewered)[5]	Incompatible	Restricted[8]	Restricted[8]
Special rural - minimum lot size = 1 hectare (un-sewered)[5]	Incompatible	Incompatible	Restricted[8,]
Urban residential	Incompatible	Incompatible	Compatible[6]

Note: Subdivision of land to lots of any size is incompatible within Priority 1 areas.

SPORT AND RECREATION

Development	Priority 1	Priority 2	Priority 3
Equestrian centres	Incompatible	Incompatible	Compatible
Golf courses	Incompatible	Incompatible	Restricted
Irrigated recreational parks	Incompatible	Restricted	Restricted
Motor sports i.e permanent racing facilities	Incompatible	Incompatible	Restricted
Public Swimming Pools	Incompatible	Restricted	Restricted
Rifle Ranges	Restricted	Restricted	Compatible
Temporary recreational activities (active) eg four wheel driving, car rallies	Incompatible	Restricted[3]	Restricted[3]
Temporary recreational activities (passive) eg. horse riding, bush walking	Restricted	Restricted	Restricted

STORAGE OF TOXIC AND HAZAROADOUS SUBSTANCES (THS)

Development	Priority 1	Priority 2	Priority 3
Above ground storage of THS	Restricted[13]	Restricted[13]	Restricted[13]
Bulk Storage Facilities for THS	Incompatible	Incompatible	Restricted[12]
Underground storage tanks for THS	Incompatible	Incompatible	Restricted

TOURISM ACCOMMODATION

Development	Priority 1	Priority 2	Priority 3
Bed and Breakfast accommodation	Incompatible	Restricted	Compatible
Caravan Parks	Incompatible	Incompatible	Restricted[6]
Holiday accommodation eg farm chalets	Incompatible	Restricted[9]	Compatible[6]
Motels, lodging houses, hostels	Incompatible	Incompatible	Compatible[6]

WASTE TREATMENT AND MANAGEMENT

Development	Priority 1	Priority 2	Priority 3
Deep well injection of liquid wastes	Incompatible	Incompatible	Incompatible
Class I, II and III Landfills	Incompatible	Incompatible	Restricted
Class IV and V Landfills	Incompatible	Incompatible	Incompatible
Recycling depots	Incompatible	Incompatible	Restricted
Refuse transfer stations	Incompatible	Incompatible	Restricted
Sewers (Gravity)	Incompatible	Incompatible	Compatible
Sewers (Pressure Mains)	Incompatible	Restricted	Compatible
Sewage pump station	Incompatible	Restricted[13]	Restricted
Used tyre storage facilities (wholesale)	Incompatible	Incompatible	Incompatible
Wastewater treatment plants	Incompatible	Incompatible	Restricted
Water treatment plants	Restricted	Restricted	Restricted

OTHER DEVELOPMENTS

Development	Priority 1	Priority 2	Priority 3
Caretaker's housing	Restricted	Restricted	Compatible
Construction projects	Restricted	Restricted	Restricted
Forestry	Restricted[1]	Compatible	Compatible
National Parks	Compatible	Compatible	Compatible
Nature Reserves	Compatible	Compatible	Compatible
Communications receivers/ transmitters	Restricted	Restricted	Restricted
Major Transport Routes	Incompatible	Restricted[10]	Compatible

Reference notes:

1. Restrictions apply to fertiliser application rates, with strict controls on the application of pesticides and field operations.
2. Restrictions apply to the storage of fuels and chemicals, with strict guidelines for rehabilitation.
3. Restrictions on the use of fuel and chemicals apply.
4. Subject to conditions placed on lease.
5. Special rural development requires appropriate planning justification, including provisions in the town planning scheme text.
6. Must be connected to deep sewerage, where practical, or otherwise to an approved waste disposal system that meets water quality protection objectives.
7. May be permitted if this use is incidental to the overall land use in the area and consistent with planning strategies.
8. Restrictions apply to siting of effluent disposal systems in areas with poor land capability and a shallow depth to groundwater.
9. Restrictions apply on density of accommodation.
10. Restrictions apply on road design and construction and the types of goods that may be carried.
11. Restrictions apply to stocking levels.
12. May be permitted if the type, volume and storage mechanisms for chemicals are compatible with water quality protection objectives.
13. Activity is incompatible in a wellhead protection zone.

Appendix 2

Butterworth Springs/Quindalup Major Components Summary

(courtesy of the Water Corporation, 1997)

BUTTERWORTH SPRINGS MAJOR COMPONENTS ANALYSIS SUMMARY, July 1997	NHMRC	range	G61019024 BORE Jan-74	G61019025 BORE Feb-74	G61019026 BORE Jan-86	G61019027 BORE Jan-91	G61019028 BORE Jan-92	G61019029 BORE Jan-93	G61019020 BORE Feb-96	R6104007 BUTTERWORTH SPRINGS NO.3 DAM	R6104008 BUTTERWORTH SPRINGS NO. 4 DAM
DATE			1995 - 97	1995 - 97	1995 - 97	1995 - 97	1995 - 97	1995 - 97	1995 - 97	1994 - 97	1994 - 97
COLOUR TRUE	HAZEN	15	1	<1 - 2	<1 - 1	<1 - 3	1-Feb	<1 - 2	1-Feb	Apr-19	22 - 133
TURBIDITY	NTU	5	0.6 - 13.1	0.5 - 7.5	0.4 - 3.1	6.4 - 99.1	0.2 - 1.6	0.5 - 2.1	0.2 - 1.8	0.3 - 0.8	1.9 - 3.2
CONDUCTIVITY	mS/m	-	42.5 - 55.5	43.4 - 52.9	45.9 - 56.4	42.9 - 47.0	78.5 - 84.0	48.9 - 54.0	76.6 - 79.5	75.8 - 101.8	49.2 - 54.4
TDS (180C Derived)	mg/L	1000	267 - 320	265 - 320	279 - 317	263- 266	443 - 457	291 - 319	407 - 420	458- 550	272 - 310
pH		6.5 - 8.5	7.5 - 7.7	7.4 - 8.3	75 - 8.2	6.7 - 6.8	8.09 - 8.74	7.39 - 7.77	7.34 - 7.63	5. 5 - 6.0	6.0 - 6.8
ALUMINIUM	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.1 - 0.27	<0.1	<0.1	0.031 - 0.58	0.079 - 0.267
CALCIUM	mg/L	-	14.4 - 15.1	13.0 - 15.6	15.3 - 19.0	20	2.6 - 3.0	15.0 - 16.0	13.6 - 17.8	3.2 - 4.7	2.1 - 2.5
CHLORIDE	mg/L	400	65 - 70	61 - 72	63 - 81	90 - 91	93 - 98	72 - 81	130 - 173	206 - 275	119 - 144
FLUORIDE	mg/L	0.5 - 1.7	0.3	0.7	0.42	N/A	1.75	0.5	0.25 -0.85	N/A	N/A
IRON	mg/L	0.3	0.21 - 0.50	0.13 - 0.85	0.08 - 1.15	5.6 - 7.0	<0.05 - 0.3	0.12 - 1.2	0.35 - 0.45	<0003 - 0.012	0.13 - 0.53
MAGNESIUM	mg/L	-	7.16 - 7.63	6.04 - 8.21	7.12 - 8.99	8.0 - 9.5	0.45 - 0.65	7.5 - 8.0	8.4 - 11.1	15.4 - 20.0	7.57 - 9.46
MANGANESE	mg/L	0.1	<0.04	<0.02 - 0.05	<.04 - 0.05	0.07 - 0.09	0.02 - 0.05	0.02 - 0.06	<.040	0.036 - 0.077	<0.001 - 0.007
NO3 & NO2 AS N	mg/L	10	1	1	1	<1.0	0.004 - 1.00	<0.1	<1.0	1.76 - 3.67	1.0 - 2.18
POTASSIUM	mg/L	-	5.92 - 6.55	5.43 - 6.67	6.03 - 6.95	8.0 - 8.5	1.23 - 4.0	6.0 - 7.0	6.4 - 6.99	4.02 - 4.61	2.41 - 3.30
SILICA	mg/L	-	17.8 - 18.6	12.3 - 17.1	13.5 - 17.3	23.0 - 26.0	14.9 - 18.5	12.5 - 19	21.6 - 26.9	5.8 - 10.4	3.5 - 7.1
SODIUM	mg/L	300	64.1 - 83.4	63.8 - 94.0	70.5 - 89.5	48 - 501	180 - 186	75 - 80	110 - 140	120 - 160	81.4 - 88.5
SULPHATE SO4	mg/L	400	8.4 - 12.0	7.2 - 12.3	9.9 - 12.6	18 - 21	21.0 - 53.9	11.4 - 33.0	10 - 16.5	35.1 - 35.7	30.0 - 33.9
ALKALINITY TOT as CaCO3	mg/L	-	122.4 - 139.4	119.5 - 161.2	131.4 - 153.7	1.4 - 1.8	5.0 - 274.0	2.5 - 143.8	96.9 - 150.4	9.06 - 9.66	10.61 - 11.46
HARDNESS TOTAL	mg/L	500	67- 67	57 - 73	68 - 84	80 - 90	8-Oct	69 - 70	68 - 90	71 - 94	37 - 45
F.O.C.	mg/L	-	0.59 - 0.76	1.70 - 9.54	0.58 - 10.93	4.30 - 5.90	0.58 - 17.5	0.60 - 11.00	0.72 - 2.53	1.08 - 1.75	2.98 - 3.22