



Department of Water
Government of Western Australia

Looking after all our water needs



Derby water reserves drinking water source protection plan

Derby town water supply



Department of **Water**
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Department of Water

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Preface

The Department of Water has prepared a drinking water source protection plan to assess risks to water quality within the Derby water reserves and to recommend management strategies to avoid, minimise or manage those risks. The Department of Water is committed to protecting drinking water source areas to meet public health requirements and ensure the supply of safe, good quality drinking water to consumers.

The *Australian drinking water guidelines* (NHMRC & NRMMC 2004) recommend a risk-based, multiple-barrier approach to protect public drinking water sources. Catchment protection is the first barrier, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection requires an understanding of the catchment, the hazards and hazardous events that can compromise drinking water quality, and development of preventative strategies and operational controls to ensure the safest possible water supply.

This plan details the location and boundaries of the drinking water reserves, providing potable water to the Derby town water supply.

It replaces the Derby Water Reserve water source protection plan published in 2001, and provides information to state and local government land-use planners. It should also be recognised in the Derby town planning scheme, consistent with the Western Australian Planning Commission's *Statement of planning policy: Public drinking water source policy*.

The stages involved in preparing a drinking water source protection plan are:

Stages in development of a plan	Comment
Prepare first Derby water source protection plan	Published in 2001
After six years undertake a review of the 2001 Derby plan	Prepared following catchment survey, review of land-use changes, and assessment of water requirements.
Consultation	The level of consultation with stakeholders was limited due to the natural protection of this groundwater resource.
Publish updated drinking water source protection plan	Final plan published after considering advice received in submissions. Includes recommendations on how to protect water quality.

Summary

Derby is located approximately 2 400 kilometres north east of Perth, in the south east Kimberley Region of Western Australia.

The town of Derby is entirely dependent on groundwater for its water supply. Its groundwater is sourced from the Lower Erskine Sandstone Formation which is considered to be a confined aquifer system, situated at a minimum depth of approximately 200 metres from the surface.

The fact that this source is confined, and at depth, provides a natural protection for the water quality. This means that land-use planning within Derby is not constrained by the water quality protection measures.

The source is abstracted by five Water Corporation production bores which are located in a south east direction starting in the Derby townsite, each of the production bores has an approximate separation distance of one kilometre.

The old Derby water reserve used a combination of unconfined and confined groundwater sources. Under the recommendations made within the Derby water source protection plan published in 2001, the old Derby water reserve was abolished in 2003.

Currently, Derby does not have a proclaimed public drinking water source area.

The following strategies are recommended to maximise the protection of this public drinking water supply:

- The five existing production bores at Derby need to be proclaimed as water reserves under the *Country Areas Water Supply Act 1947*.
- The five water reserve boundaries and their priority one classification need to be recognised in the Shire of Derby–West Kimberley town planning scheme and other applicable schemes and strategies.
- The management principles outlined in this plan should be incorporated into the Shire of Derby–West Kimberley town planning scheme and other applicable land-use planning schemes and strategies.
- Best management practices for existing or future bore construction (or abstraction licensing) in close proximity to the five water reserves should be implemented.

1 Drinking water source overview

1.1 Existing water supply system

The Derby wellfield comprises five Water Corporation production bores located approximately one kilometre apart, which continue in a south east direction from the townsite. The five production bores use a confined aquifer system to supply the Derby town water supply. The bores are drilled into the Lower Erskine Sandstone Formation, to a maximum depth of 245 metres. The production bores are screened between 220 m to 240 m below the natural surface. The zone of groundwater abstraction is also confined by an extensive shale layer. The Erskine Sandstone Formation is a multilayered aquifer with shale interbeds, and is generally confined from above by the Munkayarra Shale. The location of the five production bores are shown in Figure 1 and Figure 2.

1.2 Water treatment

Raw water from the Derby production bores is pumped through the bore mains pipe to the treatment plant located on Knowsley St in the Derby townsite. The raw water is then aerated, chlorinated and fluoridated before being transferred to ground tank one (2250 kilolitre(kL)) and ground tank two (2500 kL). Water from ground tank two is then pumped to a 500 kL elevated tank, where it is distributed through the scheme reticulation system to consumers.

It should be recognised that although treatment and disinfection are essential barriers to ensure a safe, good quality drinking-water supply, catchment management is the fundamental first barrier for protecting water quality. This approach is endorsed by the *Australian drinking water guidelines* (NHMRC & NRMCC 2004) and reflects a risk-based, catchment to consumer, multiple-barrier approach for providing safe drinking water to consumers. The combination of catchment protection and treatment delivers a safer drinking water source than either barrier could achieve individually. The confined nature of this groundwater source, and depth of bores, provides significant natural protection of its water quality from land-use activities.

1.3 Catchment details

1.3.1 Physiography

The topography is gently undulating, the main features of which are the Grant Range and isolated erosion scarps, including The Sisters Plateau, Erskine Range in the east and the Reeves Hill – Dampier Hill Scarp in the west. The terrain is low lying in the north and rises about 150 metres Australian Height Datum south-west and south-east of King Sound. Widely spaced, easterly trending longitudinal sand dunes occur throughout the area. The main drainages for Derby are the Fitzroy, May, Meda and Fraser Rivers, and the Alexander and Hawkstone Creeks which are sustained by

groundwater. Ephemeral pools occur in claypans on the Dampier Peninsula and west of the Fitzroy River, and in the wetlands such as the Le Lievre Swamp. King Sound is fringed by mud flats which are covered by normal tides, and by silt plains which are inundated only by spring tides or after heavy rainfall (Smith, R. A 1992).

1.3.2 Climate

Derby has a tropical climate, consisting of hot wet summers and warm, dry winters. The annual average rainfall is 622.3 mm, with 85 per cent of the rainfall occurring from December through to March. Cyclonic low-pressure systems account for the high rainfall occurrence during the summer months. This is the contributing factor regarding the wide range in annual total rainfall, which can be between 129mm to 1200 mm. The mean maximum annual temperature is 33.9 °C, with a mean minimum annual temperature of 21.7 °C. Pan evaporation rates are approximately 3300 mm per annum, exceeding monthly rainfall.

1.3.3 Hydrogeology

The hydrogeology of the Derby area is well documented by Laws (Laws A.T 1989) and Smith (Smith, R. A 1992)

Derby is located in the northern part of the Canning Basin that comprises Phanerozoic sediments of approximately 8000 m in thickness at the Derby Peninsula.

The principal regional aquifers with potential for potable water supply are the Wallal Sandstone and the Erskine Sandstone Formations. Groundwater also occurs at depth in the Liveringa Group, Poole Sandstone and the Grant Group. Except for the Liveringa Group in the deep Derby town bore (600–700 m); these aquifers have only been exploited elsewhere in areas where they occur at shallow depths.

The Erskine Sandstone Formation can be divided into upper and lower sections. The lower section of the formation is mainly shale with minor interbedded sandstone while the upper section is mostly sandstone with minor shale (Laws A.T 1989). The shale interbeds, known as the Munkayarra shale, are considered to confine the lower Erskine Sandstone Formation (currently used for the Derby town water supply) from the upper section and act as an aquiclude between it and the Wallal sandstone. The Erskine Sandstone is about 200 m thick in the Derby area and rests on the Blina Shale that confines the aquifer from below.

The Erskine Formation is recharged well to the south and south east of Derby (greater than 20 km) where the aquifer is unconfined. Groundwater flow is generally in a northerly direction towards the May River.

1.4 Future water source requirements

Sustainable abstraction from the Lower Erskine Formation may require successive production bores to be established further inland to meet future water supply demand.

1.5 Protection and allocation

1.5.1 Existing water source protection

The Derby water reserve was proclaimed in 1979. Due to the shallow depth and unconfined nature for part of the source, the potential for contamination from surrounding land-use activities was considered a high risk. The water reserve was abolished in 2003 as recommended in the Derby water reserve water source protection plan published in 2001.

The current drinking water supply is sourced from a confined aquifer system. As a result, contamination of the source from land-use activities is dramatically reduced due to the confining layer and depth of the Lower Erskine Sandstone Formation.

Contamination risks are now considered to be minimal, except for the compound area immediately surrounding the production bores and inland movement of salt water. In order to protect the Derby town water supply from contamination, it is recommended that production bores 1/82, 1/86, 1/89, 1/99 and 1/04 and the compound areas that contain those bores be proclaimed as priority 1 source areas (Figure 5).

Inland migration of the salt water interface, including leakage from the overlying aquifer which is a result of the current abstraction rate of the Lower Erskine Sandstone Formation will require sufficient monitoring. Monitoring bores to measure the rate of inland movement of the salt water interface into the confined aquifer should be established in order to provide early detection of increased salt water intrusion into the Derby town water supply.

1.5.2 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914*. Under this Act, the right to use and control surface water and groundwater is vested with the Crown. This Act requires licensing of groundwater abstraction within proclaimed groundwater areas.

The Derby groundwater resource lies within the Derby Groundwater Area, which was proclaimed in 1990 under the Rights in Water and Irrigation Act. The Water Corporation is licensed to draw 800 000 kilolitres (Groundwater Well Licences 62823(2) for bores 1/ 82, 1/ 86 and licence 62824(3) for bores 1/ 89, 1/ 99 and 1/ 04) per annum from the Derby wellfield for public water supply purposes.

Abstraction from the bore field may exceed this amount on the proviso that over a three year period the average abstraction for each licence does not exceed the 800 000 kL allocation.

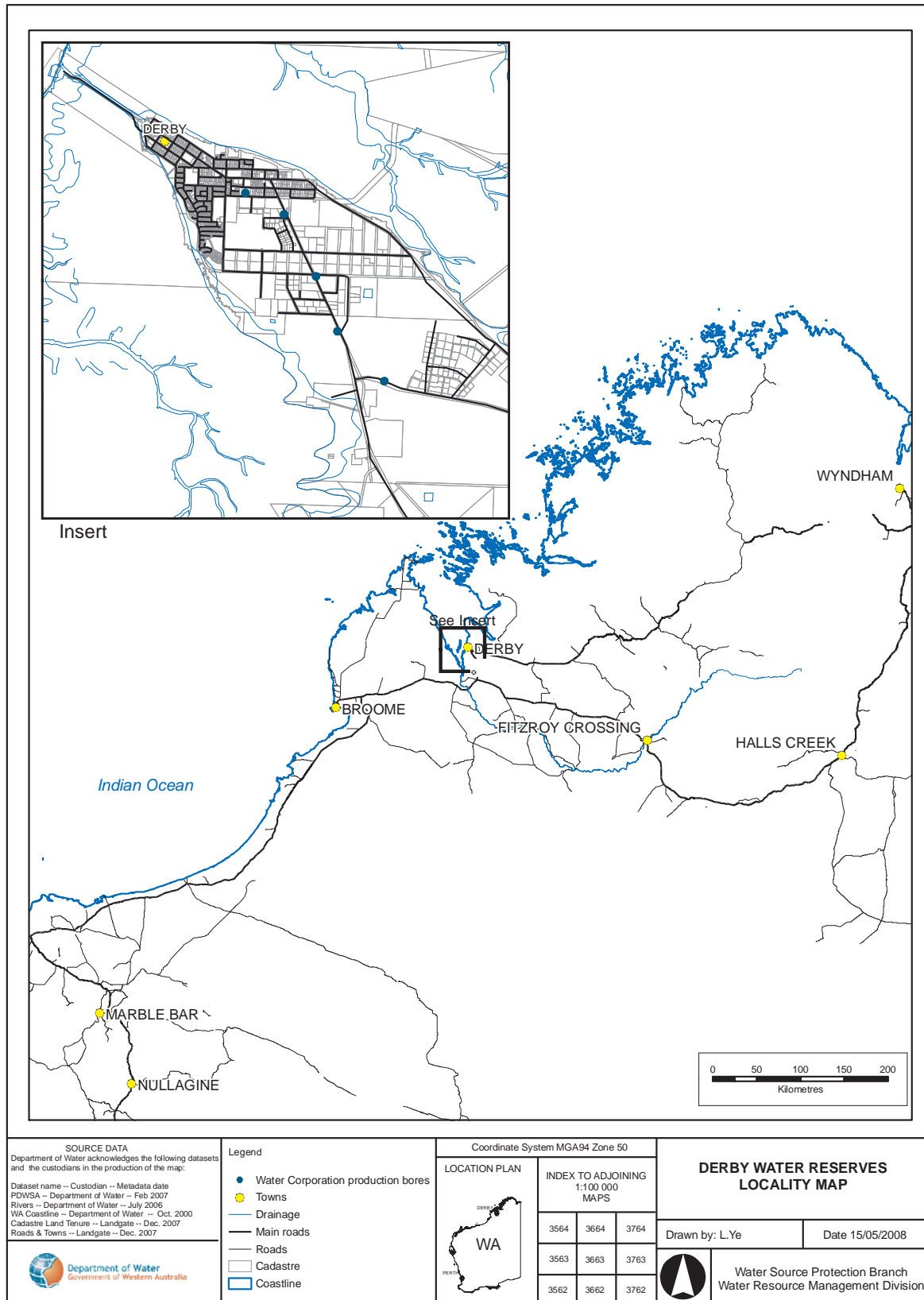


Figure 1 Derby water reserves locality map

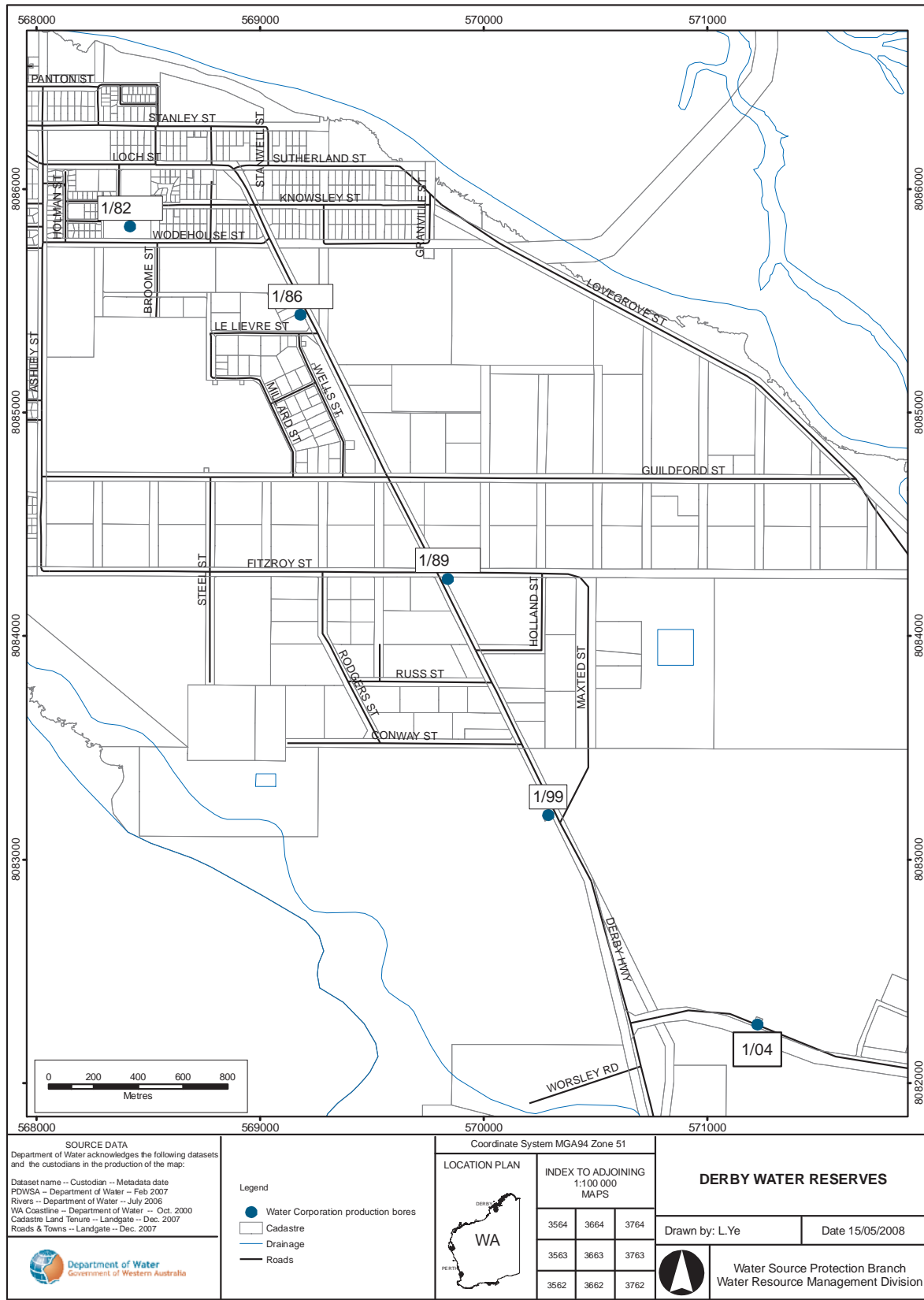


Figure 2 Derby water reserves

2 Water-quality monitoring and contamination risks

A wide range of chemical, physical and microbiological properties can have an impact on water quality and therefore affect the provision of safe, good quality, aesthetically acceptable drinking water to consumers.

The Water Corporation regularly monitors the raw-water quality from the Derby Water Reserve for microbiological contamination, health-related and aesthetic (non-health related) characteristics in accordance with the *Australian drinking water guidelines* (NHMRC & NRMMC 2004). Monitoring results are reviewed by an intergovernmental committee, chaired by the Department of Health, called the Advisory Committee for the Purity of Water.

A water quality summary for the Derby Water Reserve from May 2003 to May 2008 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent Drinking water quality annual report at www.watercorporation.com.au > Water > Water quality > Latest report > Drinking water quality annual report.

Contamination risks relevant to the Derby water reserves are described below.

2.1 Microbiological contaminants

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the faeces of humans and domestic animals.

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. *Salmonella*, *Escherichia coli* and *Cholera*), protozoa (e.g. *cryptosporidium*, *giardia*) and viruses. *Escherichia coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

Microbiological contaminants were detected at low levels for 6 per cent of samples in the raw water from Derby bore fields between 2003 and 2008 (Appendix A).

2.2 Health-related chemicals

A number of chemicals (organic and inorganic) are of concern in drinking-water from a health perspective because they are potentially toxic to humans. Chemicals usually occur in drinking water sources attached to suspended material, such as soil particles, and may result from natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC, 2004b).

The concentrations of all elements detected did not exceed the health guideline of the *Australian drinking water guidelines* (NHMRC & NRMCC 2004). All detected health related chemical parameters are at levels that pose no health concern (Table 2, Appendix A).

2.3 Aesthetic characteristics

Impurities in drinking water can affect the aesthetic qualities of water such as its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, water that is cloudy and has a distinctive colour may not be harmful (NHMRC & NRMCC, 2004b).

Aesthetically, the raw water from Derby bore fields has at times contained high levels of iron and manganese. Levels for turbidity and pH have also exceeded Australian drinking water guideline values. Following treatment all aesthetic guideline levels in the reticulated supply comply with the 1996 *Australian drinking water guidelines* (NHMRC & NRMCC) (Table 1, Appendix A).

3 Land use and contamination risk

3.1 Potential water-quality risks

Under the provisions of section 26D and 5C of the *Rights in Water and Irrigation Act 1914*, a licence is required to construct a bore or extract water within a proclaimed groundwater area. The Derby water reserves and surrounding areas are within the Derby Groundwater Area. It should be noted that any future bores drilled in close proximity to a drinking water source bore have the potential to contaminate the drinking water source. Through the Department of Water's bore application and assessment process it is important to ensure that private bores are appropriately located and constructed in order to prevent contamination and other impacts on the public drinking water source. All bores should be constructed in accordance with *Minimum Construction Requirements for Water Bores in Australia* (National Minimum Bore Specifications Committee 2003).

3.2 Existing land uses

The five Derby water reserves consist of separate compounds containing each of the production bores. Bore compounds 1/ 82, 1/ 99 and 1/ 04 are located on Crown Reserve, of which land is managed by the Water Corporation (1/ 82 and 1/ 99) and the Shire of Derby-West Kimberley (1/ 04). Bore compound 1/ 86 and 1/ 89 are located on freehold land managed through the Minister for Water Resources (1/ 86) and without a current management order (1/ 89) (Figure 3 and 4).

3.3 Future land uses

The Shire of Derby–West Kimberley town planning scheme No. 5 (version 1), was published in October 2007. The zones and reserves for each of the water reserves depicted in the Derby town planning scheme vary. Bore compound 1/ 82 is planned for a public use reserve. Bore compound 1/ 86 is planned for light industrial zoning. Bore compounds 1/ 89 and 1/ 04 are planned for rural zoning and bore compound 1/ 99 is planned for a parks and recreation reserve. The Derby town planning scheme should reflect all the water reserves as public purpose reserves. These should be denoted as water supply or Water Corporation for bore compounds 1/ 82 and 1/ 99 as per the management order. Contamination from land uses is negligible, due to the confining nature of the Lower Erskine Sandstone Formation. The water reserves should be reflected as public purpose reserves to ensure their location and significance is properly recorded.

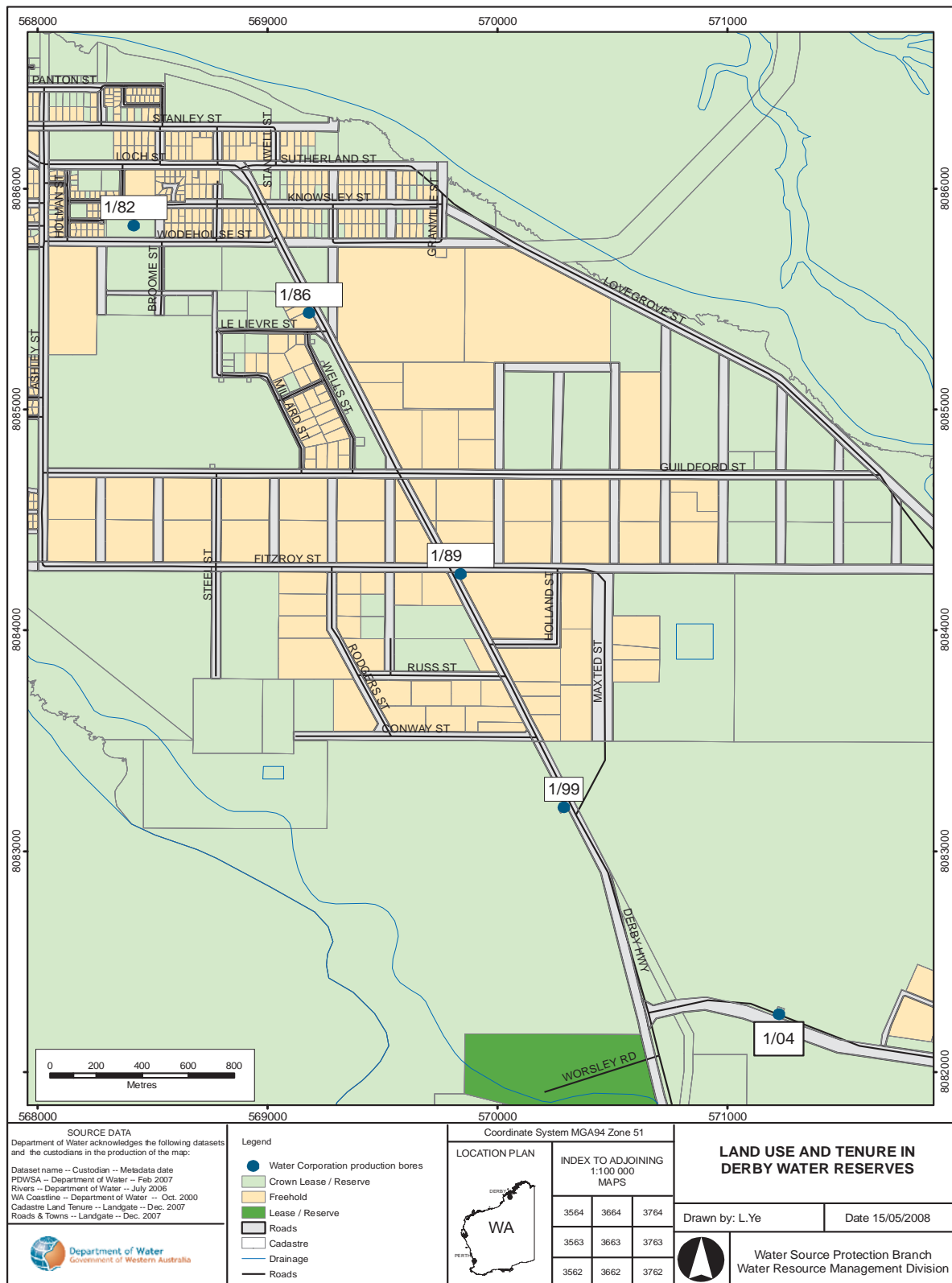


Figure 3 Land use and tenure in the Derby water reserves

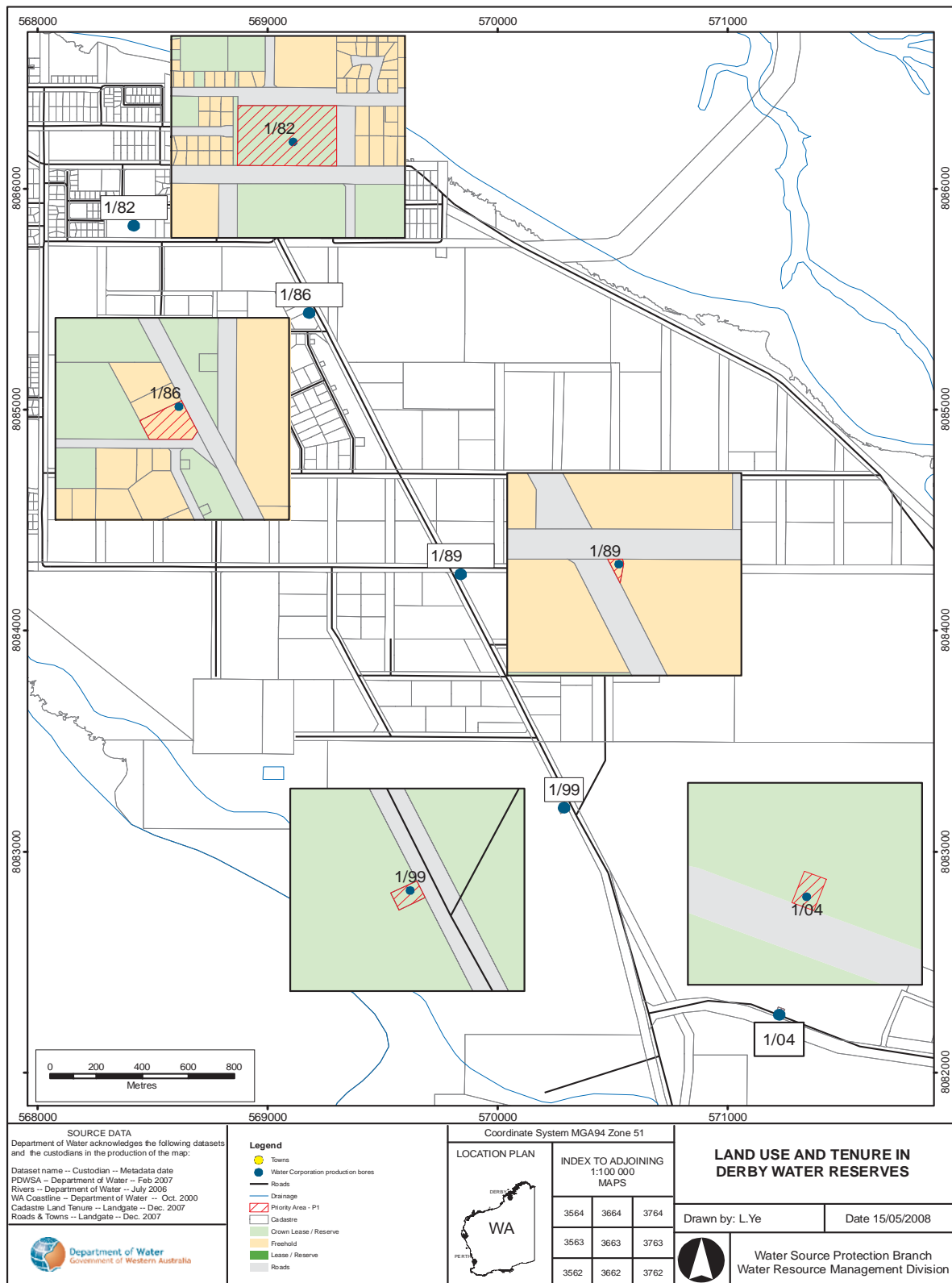


Figure 4 Land use and tenure in the Derby water reserves magnified

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the drinking water source areas in order to ensure safe drinking water is supplied to the town of Derby. Existing approved land uses around the water reserves can continue.

The boundaries for the Derby water reserves have been assigned to ensure consistency with this Department's current framework for public drinking water source protection. The boundaries of each water reserve reflect the land tenure, the strategic importance of the water source, land use and zoning.

4.2 Proclaimed area

The Derby water reserve was proclaimed in 1979 under the *Country Areas Water Supply Act 1947* for the purpose of protecting the public drinking water source from potential contamination. The Derby water reserve was de-proclaimed in December 2003 as recommended by the Derby water reserve drinking water source protection plan published in 2001.

The five Derby water reserves (Figure 5) are recommended for proclamation under the *Country Areas Water Supply Act 1947* to ensure their location and significance is recorded.

4.3 Priority areas

The risk of contamination from existing and proposed land uses is negligible as a result of the depth to the aquifer (200 m), depth and construction of the bores, and the confined nature of the aquifer. Accordingly a wellhead protection zone is not proposed. There will be a priority 1 classification within each of the five Derby water reserves. (Figure 5).

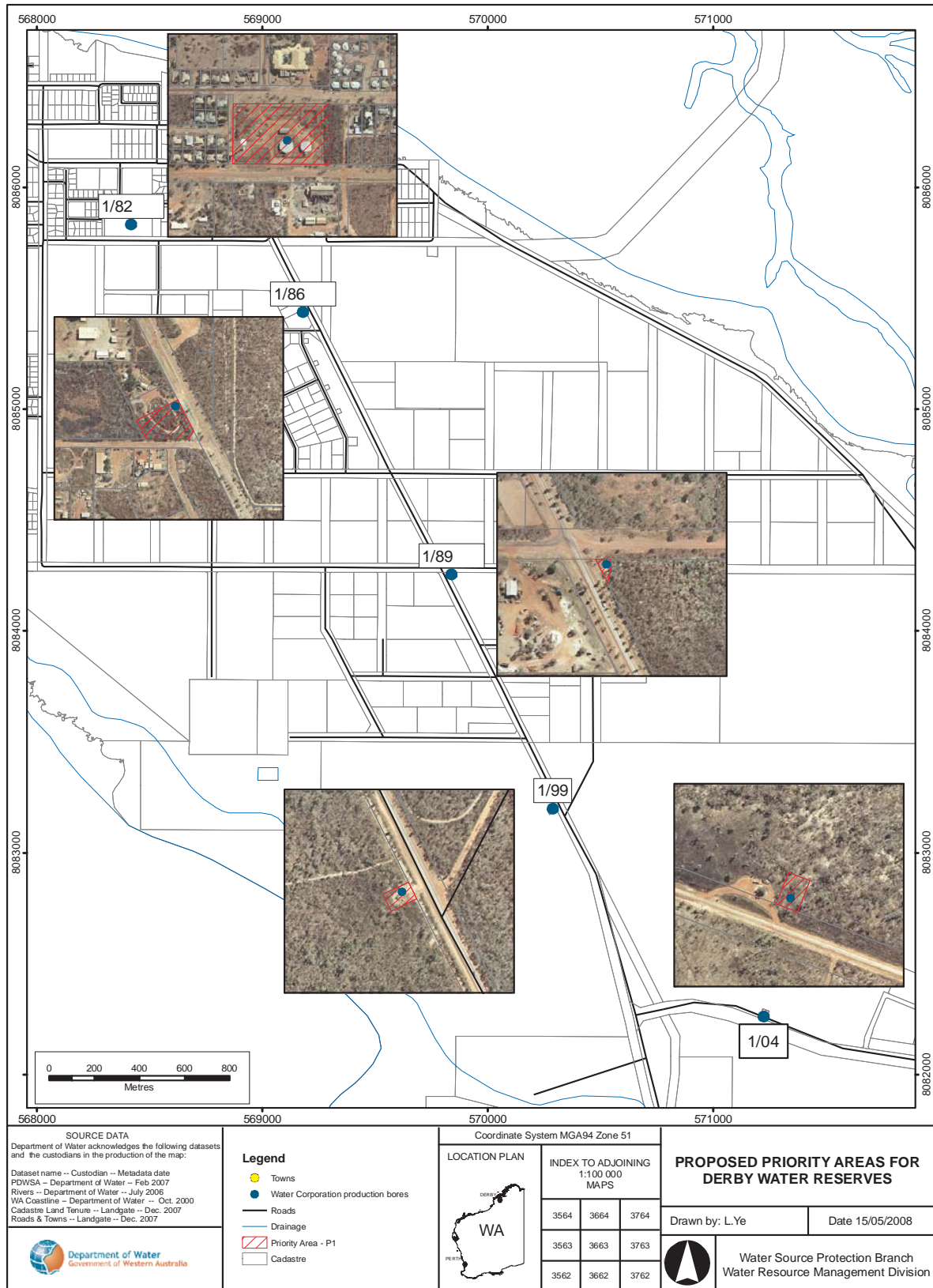


Figure 5 Priority areas and coincidental wellhead protection zones for Derby water reserves

4.4 Land-use planning

It is recognised under the *State Planning Strategy* (Western Australian Planning Commission, 1997) that the establishment of appropriate protection mechanisms in statutory land-use planning processes is necessary to secure the long-term protection of drinking water sources. As outlined in *Statement of planning policy: public drinking water source policy* (Western Australian Planning Commission, 2003) it is appropriate that the Derby water reserves, and their priority one classifications be recognised in the Shire of Derby-West Kimberley town planning scheme.

4.5 Best management practices

There are opportunities to significantly reduce risks to water quality by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect water quality. On freehold land, the Department of Water aims to work with landowners to achieve best management practices for water quality protection by providing management advice.

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. The guidelines help managers reduce the risk of their operations causing unacceptable water quality impacts. They are recommended as best practice for water quality protection.

Education and awareness (e.g. signage and information) are other key mechanisms for water quality protection, especially for those people visiting the area who are unfamiliar with the Derby water reserves. A brochure will be produced once this plan is endorsed describing the Derby water reserves and their location and the main threats. This brochure will be available to the community and will inform people in simple terms about the drinking water source, its location and significance.

4.6 Surveillance and by-law enforcement

The quality of public drinking water sources within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. Gazettal of these areas allows existing by-laws to be applied to protect water quality.

The Department of Water considers by-law enforcement, through surveillance of land-use activities in public drinking water source areas, as an important mechanism to protect water quality.

Signs are erected around public drinking water source area boundaries to educate the public and to advise of activities that are prohibited or regulated. This plan

recommends delegation of surveillance and by-law enforcement to the Water Corporation is continued.

4.7 Emergency response

Escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Derby-West Kimberley Local Emergency Management Committee through the Kimberley Emergency Management District should be familiar with the location and purpose of the Derby water reserves. A locality plan should be provided to the fire and rescue services headquarters for the Hazardous Materials Emergency Advisory Team. Department of Environment and Conservation is the lead agency for wildfire control management for the majority of the Water Reserve that is outside of the gazetted fire emergency response zone. Water Corporation should have an advisory role to any incident requiring action from the Hazardous Materials Emergency Advisory Team in the Derby water reserves.

Personnel who deal with hazardous material incidents within the area should have access to a map of the Derby water reserves.

5 Recommendations

- 1 The Derby water reserves should be proclaimed under the *Country Areas Water Supply Act 1947*. (Department of Water).
- 2 The Shire of Derby-West Kimberley town planning scheme should incorporate this plan and reflect the identified Derby water reserves, and priority 1 areas in accordance with State Planning Policy 2.7 – *Public Drinking Water Source Policy* (Shire of Derby-West Kimberley).
- 3 Incidents covered by WESTPLAN – HAZMAT in the Derby water reserves should be addressed through the following:
 - the Derby Local Emergency Management Committee should be aware of the location and purpose of the Derby water reserves
 - the locality plan for the Derby water reserves is provided to the Fire and Rescue headquarters for the Hazardous Materials Emergency Advisory Team
 - the Water Corporation provides an advisory role during incidents in the Derby water reserves
 - personnel dealing with the Western Australian Plan for Hazardous Materials incidents in the area have ready access to a locality map of the Derby water reserves and information to help them recognise the potential impacts of spills on drinking water quality.(Department of Water; Water Corporation)
- 4 Signs should be erected along the boundaries of the Derby water reserves to promote awareness of Derby's drinking water quality resource. Signs should include an emergency contact telephone number (Water Corporation).
- 5 A review of this plan should be undertaken after five years (Department of Water).
- 6 Inland migration of the salt water interface should be monitored sufficiently by the Water Corporation, to safe guard against over allocation and the resulting loss of production bores to salinity.
- 7 Any proposed future abstraction bores (using the confined aquifer) in a 500 m radius of a Derby water reserve, should be assessed to determine contamination risks to the drinking water source area through the groundwater licence application process.

Appendices

Appendix A - Water quality

The Water Corporation has monitored the raw (source) water quality from the Derby water reserves in accordance with the *Australian drinking water guidelines* (NHMRC & NRMMC 2004) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

- aesthetic related characteristics (non-health related)
- health related characteristics
 - health related chemicals
 - microbiological contaminants.

Following is data representative of the quality of raw water in the Derby water reserves. In the absence of specific guidelines for raw water quality, the results have been compared with *Australian drinking water guidelines* (NHMRC & NRMMC 2004) values set for drinking water, which defines the quality requirements at the customers tap. Results that exceed *Australian drinking water guidelines* (NHMRC & NRMMC 2004) have been highlighted to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment, to name a few, exist downstream of the raw water to ensure it meets the requirements of *Australian drinking water guidelines* (NHMRC & NRMMC 2004). For more information on the quality of drinking water supplied to Derby refer to the most recent Water Corporation Drinking Water Quality Annual Report at: http://www.watercorporation.com.au/W/waterquality_annualreport.cfm?uid=2377-9937-9579-7091.

Aesthetic-related characteristics

Aesthetic water quality analyses for raw water from the Derby water reserves are summarised in Table 1.

The values are taken from ongoing monitoring for the period May 2003 to May 2008. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported, those that have on occasion exceeded the *Australian drinking water guidelines* (NHMRC & NRMMC 2004) are highlighted.

Table 1 Aesthetic-related detections for Derby Borefield

Parameter	Units	Australian drinking water guidelines aesthetic guideline value*	Derby raw water	
			Range	Median
Aluminium unfiltered	mg/L	NA	<0.008 - 0.085	<0.008
Colour - true	TCU	15	<1 - 12	3
Conductivity at 25°C	mS/m	NA	<1 - 77	67
Iron unfiltered	mg/L	0.3	0.006 - 5	0.22
Manganese unfiltered	mg/L	0.1	<0.002 - 0.16	0.01
pH	NOUNIT	6.5 - 8.5	6.48 - 7.97	7.645
Turbidity	NTU	5	<0.1 - 85	0.2

*An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.

Health related characteristics

Health parameters

Raw water from the Derby bore field is analysed for health related chemicals including inorganics, heavy metals and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between May 2003 and May 2008 are summarised in Table 2. Any parameters that have on occasion exceeded the *Australian drinking water guidelines* (NHMRC & NRMCC 2004) are highlighted.

Table 2 Health related detections for Derby Bore field

Parameter	Units	Australian drinking water guidelines health guideline value*	Derby raw water	
			Range	Median
Barium [†]	mg/L	0.7	0.02 - 0.025	0.0225
Boron [†]	mg/L	4	0.5 - 0.56	0.53
Fluoride	mg/L	1.5	0.3 - 0.6	0.5
Iodide [†]	mg/L	0.1	0.06 - 0.08	0.07
Molybdenum [†]	mg/L	0.05	0.0005	0.0005

*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). [†] Water quality data observed from three or less sampling occasions.

Microbiological contaminants

Microbiological testing of raw water samples from the Derby bore field is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals. A detection of *Escherichia coli* in raw water abstracted from any bore may indicate possible contamination of faecal material through ingress in the bore, or recharge through to the aquifer (depending on aquifer type).

During the reviewed period of May 2003 to May 2008, positive *Escherichia coli* counts were recorded in approximately six per cent of samples collected from the bore field. This low occurrence of *Escherichia coli* detections is indicative of minimal contamination of the groundwater from faecal sources.

Appendix B - Photographs

Photo 1 Derby water reserve 1/ 82



Photo 2 Derby water reserve 1/ 86



Photo 3 Derby water reserve 1/ 89



Photo 4 Derby water reserve 1/ 99



Photo 5 Derby water reserve 1/ 04



Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Accumulate on the surface.
ADWG	The Australian drinking water guidelines, outlining acceptable criteria for the quality of drinking water in Australia.
Aesthetic guideline	A water-quality criteria in the <i>Australian drinking water guidelines</i> associated with acceptability of water to the consumer e.g. appearance, taste and odour (NHMRC & NRMCC, 2004).
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example, this is +0.026 m at Fremantle.
Allocation	The quantity of water permitted to be abstracted by a licensee, usually specified in kilolitres per annum (kL/a).
Anisotropic	Having different properties in different directions.
ANZECC	Australian and New Zealand Environment Conservation Council.
Aquiclude	A subsurface rock, soil or sediment unit that does not yield useful quantities of water.
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
Augment	To increase the available water within a storage dam by pumping back water from a secondary storage/reservoir dam.
Bore	A narrow, lined hole, also known as a well, drilled to monitor or draw groundwater.
Bore field	A group of bores to monitor or withdraw groundwater.
Cfu	Colony forming units. A measure of pathogen contamination in water.
Confined aquifer	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.

DEC	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment (DoE) and the Department of Conservation and Land Management (CALM).
Diffuse source	Pollution originating from a widespread area, e.g. urban stormwater runoff; agricultural infiltration.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
EC	Electrical conductivity. This estimates the volume of total dissolved solids (TDS), or the total volume of dissolved ions in a solution (water) corrected to 25 ⁰ C. Measurement units include milliSiemens per metre and microSiemens per centimetre.
GL	Gigalitre (1 000 000 000 litres) or one million kilolitres
ha	Hectare (a measure of area)
HAZMAT	Hazardous materials
Health guideline	A water-quality criteria in <i>the Australian drinking water guidelines</i> associated with human health that, based on present knowledge, does not result in any significant risk to the consumer over a lifetime of consumption (NHMRC & NRMMC 2004).
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
kL	Kilolitre (1 000 litres) or one cubic metre
km	Kilometre (1 000 metres)
km²	Square kilometre (a measure of area) = one million square metres
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.
LEMC	Local Emergency Management Committee.

m	Metres
mg/L	Milligram per litre (0.001 grams per litre) as a measurement of a total dissolved solid in a solution.
mL	Millilitre
ML	Megalitre (1 000 000 litres = one million litres)
mm	Millimetre
MPN	Most probable number (a measure of microbiological contamination).
mSv	Millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2mSv/yr.
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	Nephelometric turbidity units are a measure of turbidity in water.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
Pathogen	A disease producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>cryptosporidium</i> and <i>giardia</i>) and viruses.
Perched	An unconfined aquifer, often ephemeral or seasonal, perched on top of an impermeable horizon near the land surface and separated from deeper groundwater by an unsaturated zone.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.

pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Point source pollution	Pollution originating from a specific localised source, 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.
PSC 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Public drinking water source area (PDWSA)	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
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.
Reservoir	A reservoir, dam, tank, pond or lake that forms part of any public water supply works.
Reservoir protection zone (RPZ)	A buffer measured from the high-water mark of a drinking water reservoir, and inclusive of the reservoir (usually two km). This is referred to as a prohibited zone under the <i>Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981</i> .
Run of the river scheme	A scheme that takes water from a flowing river. Water is taken directly from the source and there is no detention time (storage).
Runoff	Water that flows over the surface from a catchment area, including streams.
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.

Semi-confined aquifer	A semi-confined or leaky aquifer is saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Stormwater	Rainwater which has run off the ground surface, roads, paved areas etc, and is usually carried away by drains.
TCU	True colour units (a measure of degree of colour in water).
TDS	Total dissolved solids: a measurement of ions in solution, such as salts in water.
TFSS	Total filterable solids by summation.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.
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.
Water reserve	An area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Well field	A group of bores to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater. A wellhead protection zone is usually declared around wellheads in drinking water areas to protect the water source from contamination.
WESTPLAN HAZMAT	Western Australian Plan for Hazardous Materials.

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