

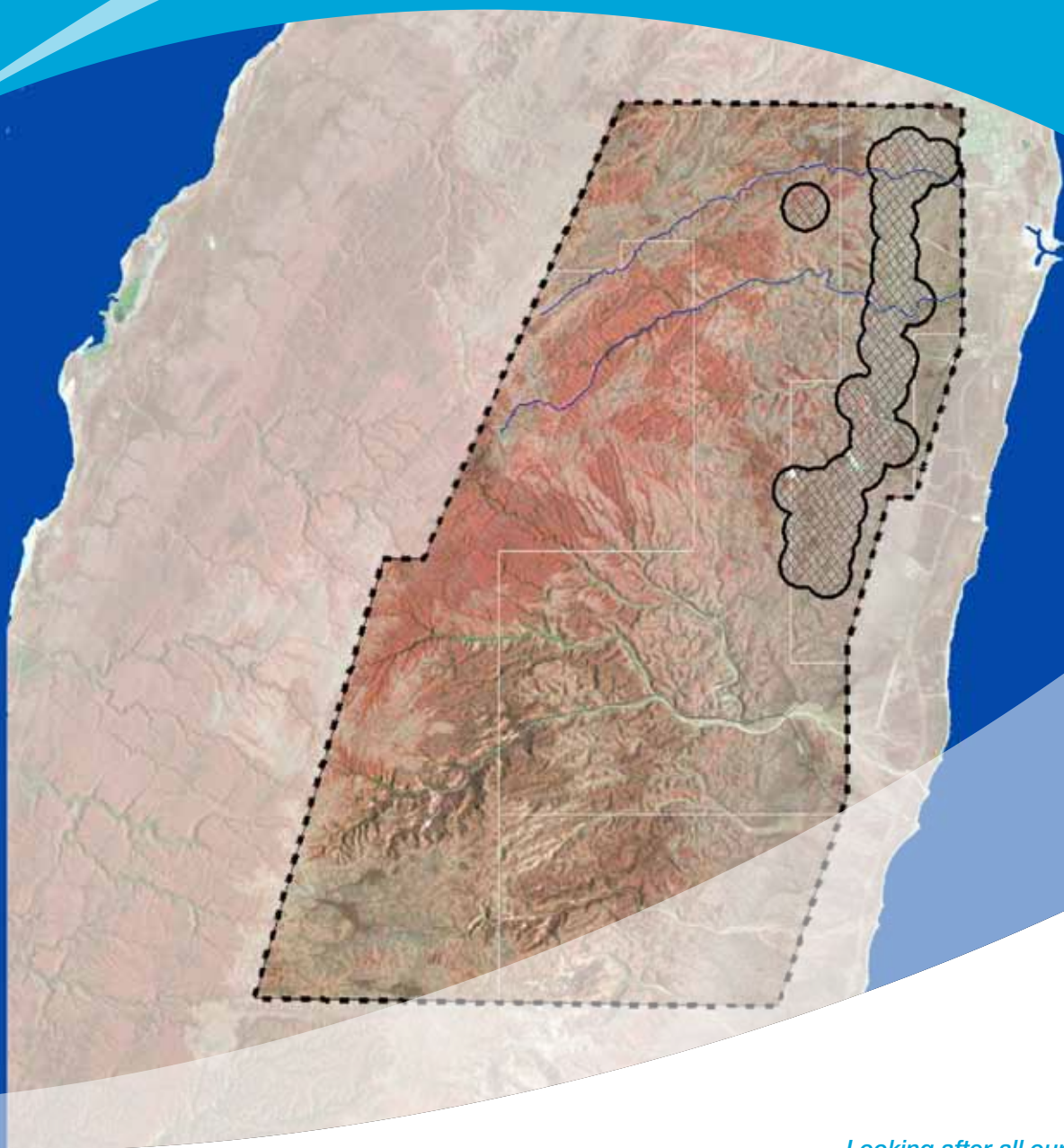


Government of Western Australia
Department of Water

Exmouth Water Reserve

Drinking water source protection review

Exmouth town water supply



Looking after all our water needs

Water resource protection series
Report WRP 122
June 2011

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Department of Water

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Department of Water
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
www.water.wa.gov.au

National Relay Service 133 677

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June 2011

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ISSN 1326-7442 (print)

ISSN 1835-3924 (online)

ISBN 978-1-921907-04-3 (print)

ISBN 978-1-921907-05-0 (online)

Acknowledgements

The Department of Water would like to thank the following for their contribution to this publication: Stephen Watson (Department of Water, program management), Clint Roberts (Department of Water, author), Nathan Conley (Water Corporation, operations) and Chris Qui (Department of Water, mapping).

For more information about this report, contact the Water Source Protection Branch at the Department of Water, on +61 8 6364 7600 or drinkingwater@water.wa.gov.au.

Cover photograph: Exmouth Water Reserve boundary and protection zones.

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Contents

Contents	iii
Preface	iv
Summary	vi
1 Review of Exmouth’s drinking water source protection plan	1
1.1 Water reserve boundary, priority areas and protection zones	1
1.2 Update on water supply scheme	1
1.3 Native title claims	2
1.4 Update on water quality risks	2
1.5 Water quality information	7
2 Implementation of Exmouth’s drinking water source protection plan	8
2.1 Status of previous recommendations	8
2.2 Consolidated recommendations	10
Appendices	13
List of shortened forms	20
Glossary	22
References and further reading	26

Appendices

Appendix A — Figures	13
Appendix B — Water quality data	17

Tables

Table 1	Land use and potential water quality risks	1
Table 2	Status of previous recommendations	8

Preface

How do we protect public drinking water source areas?

The Australian drinking water guidelines (ADWG) (NHMRC & NRMCC 2004a) outlines how we should protect drinking water in Australia. The ADWG recommends a ‘catchment to consumer’ framework that uses a preventive risk-based and multiple-barrier approach. A similar approach is recommended by the World Health Organization.

The ‘catchment to consumer’ framework applies across the entire drinking water supply system – from the water source to your tap. It ensures a holistic assessment of water quality risks and solutions to ensure the delivery of a reliable and safe drinking water to your home.

A preventive risk-based approach means that we look at all the different risks to water quality in order to determine what risks can reasonably be avoided and what risks need to be minimised or managed. This approach means that the inherent risks to water quality are as low as possible. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system.

The first and most important barrier is protecting the catchment of surface water sources and recharge area of groundwater sources. If we get this barrier right, it has a ‘flow-on effect’. We will benefit from a more reliable, lower cost and safer drinking water supply system. Other barriers against contamination include storage of water to help reduce contaminant levels, treating the water (e.g. chlorination) to remove pathogens, maintenance of pipes and testing of water quality. Another community benefit of catchment protection is that it is complimentary to the State’s conservation initiatives.

The research and experience conducted for the ADWG shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That’s why this drinking water source protection review is important. We should not forget that ultimately it’s about protecting your health, and about protecting the catchment’s water quality for our children’s future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by putting the ADWG into practice; writing plans, policies and guidelines; and providing input into land-use planning. The integration of the State’s drinking water protection and land use planning processes has been formalised in Statement of planning policy no. 2.7 – *Public drinking water source protection policy* (WAPC, 2003).

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA) provide us with the tools we need to protect water quality in PDWSAs. These tools allow us to assess and manage the water quality contamination risks from different land uses and activities. We work cooperatively with other agencies in the implementation of this legislation.

An important step in maximising the protection of water quality in PDWSAs is to define priority areas and protection zones to help guide land use planning and to identify where legislation applies. There are three different priority areas. Priority 1 (P1) areas are defined and managed to ensure there is no degradation of the quality of the drinking water source using the principle of risk avoidance. Priority 2 (P2) areas are defined and managed to maintain or improve the quality of the drinking water source using the principle of risk minimisation. Priority 3 (P3) areas are defined and managed to maintain the quality of the drinking water source for as long as possible using the principle of risk management. Protection zones surround drinking water extraction points, to protect the most vulnerable areas from contamination.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, go to <http://drinkingwater.water.wa.gov.au>.

Summary

This drinking water source protection review considers changes that have occurred in and around the Exmouth Water Reserve since completion of the *Exmouth Water Reserve water source protection plan* (Water and Rivers Commission, 2000). Where changes have occurred this review recommends new management strategies, if required.

Both of these documents are available on our website or by contacting us (see details on the inside cover of this report). Both documents should be read together to obtain a full understanding of the Exmouth Water Reserve Public Drinking Water Source Area.

Exmouth is located approximately 1260 km north of Perth on the eastern side of the Cape Range Peninsula. It was established to serve the nearby naval communications base and now also supports fishing and tourism industries.

Exmouth's water supply is sourced from a bore field located to the west and south of town and extends for a distance of about 7 km along the eastern flank of Cape Range (see Figure 1). Water is pumped from the bore field into ground storage tanks where it is treated and then distributed through the town reticulation system.

New production bores have been commissioned or have been identified for future use since the 2000 water source protection plan, increasing the number of production bores from twenty four to thirty four. The new production bores are located south of the existing bore field to reduce the effects of drawdown (refer to figures 2-4).

Despite new bores being commissioned, the water reserve boundary has been reviewed and is not proposed to be amended. The water reserve will continue to be managed as a priority (P1) area due to the unconfined and karstic nature of the water source. The 10 new production bores will be protected by 500m (in radius) wellhead protection zones (see Figure 2-4).

The original plan included 13 recommendations. Eight could be finalised and 5 were ongoing. The recommendations that could be finalised have been completed.

From this review, six ongoing recommendations will continue to be addressed by the Department of Water, including one new recommendation relating to the provision of advice to the Department of Mines and Petroleum and the Office of the Environmental Protection Authority on mining proposals within this water reserve.

The following table shows important information about the Exmouth Water Reserve.

<i>Key Information</i>	
Local government authority	Shire of Exmouth
Locations supplied	Exmouth Town
Source description	The water reserve is managed as a P1 area, and includes 500 m wellhead protection zones for each production bore. The source is unconfined and karstic in nature, as a result, the source is highly sensitive to contamination.
Volume of water pumped	731 948 kL during 2005-2006
Number of bores	34 production bores (previously 24 in 2000 plan)
Bore numbers	1/87(45), 5/87(47), 6/87(49), 8/87(50), 10/87(51), 3/97(29), 4/97(31), 5/97(34), 6/97(30), 7/97(24), 8/97(26), 9/97(35), 10/97(37), 11/97(39), 12/97(40), 13/97(48), 14/97(42), 15/97(38), 5/07, 3/07, 4/07, 8/07, 2/08, 7/07, 1/08, 6/07, 3/08, 5/08, 1/97(10), 16/97(18), 2/87(43), 3/87(44), 2/90(60), 2/97(17)
Publication of drinking water source protection plans (DWSPP)	<ul style="list-style-type: none"> • December 2000, <i>Exmouth Water Reserve, water source protection plan</i>, • June 2011, <i>Exmouth Water Reserve, drinking water source protection review</i>
Proclamation status	The Exmouth Water Reserve was gazetted in 2002 under the <i>Country Areas Water Supply Act 1947 (WA)</i> . No changes are proposed to the water reserve boundary.

1 Review of Exmouth's drinking water source protection plan

1.1 Water reserve boundary, priority areas and protection zones

The Exmouth Water Reserve was proclaimed in 2002 under the *Country Areas Water Supply Act 1947* (WA). The boundary includes 500 m wellhead protection zones (WHPZs) around each of the production bores, and is managed as a P1 area (see Appendix A, Figure 1).

Since the publication of the *Exmouth Water Reserve water source protection plan* (Water and Rivers Commission, 2000), the bore field has been extended south to reduce the effects of draw down (Figures 2 - 4).

The department has reviewed the existing water reserve boundary and P1 area and has determined the existing water reserve adequately reflects the recharge area and management objectives consistent with drinking water source protection policy.

If you require more information on the background to and support for protection of PDWSAs, please refer to water quality protection note (WQPN) no.36: *Protecting public drinking water source areas*.

1.2 Update on water supply scheme

The Exmouth bore field consists of 34 bores which draw water from the Tulki and Trealla limestone (unconfined aquifer) under a groundwater allocation licence as per the *Rights In Water and Irrigation Act 1947*. Groundwater from this source undergoes chlorine disinfection, fluoridation and calgon dosing to reduce the effects of hardness and scaling. Treated water is held in a 5 ML ground - level storage tank, and distributed via gravity to the town scheme. The water maintains chlorine residuals during the treatment process and through the reticulation to ensure microbiological quality of the water supplied to customers.

In 2000, the northern and southern borefields were connected, creating a single pipeline into Exmouth, with a combined allocation of 1.0 GL using two allocation licenses split into separate areas. There are 24 duty production bores currently in operation, with an additional 10 bores still to be commissioned. These bores were constructed in 2008/2009 to alleviate pressure on the northern borefield (town sub area).

The Exmouth borefield licence areas are:

- The town sub area with a licence allocation of 168 000 kL (Ground Water Licence (GWL) 108182 (version 4))
- The central sub area with a licence allocation of 832 000 kL (GWL 108177 (version 4)).

1.3 Native title claims

There is a native title claim within the existing Exmouth Water Reserve registered as the Gnulli claim (WAD 6161/98). This claim covers approximately 87 876 km² of land and sea in Gascoyne - Murchison region. It lies in the Shires of Ashburton, Carnarvon, Exmouth, Shark Bay and Upper Gascoyne.

The Department of Water is committed to working with Aboriginal people in its planning and management activities. The department recognises that Native title provides an important framework for water management.

1.4 Update on water quality risks

As part of this review the Department has conducted a new assessment of water quality contamination risks to the Exmouth drinking water source, in accordance with the ADWG. As Exmouth's drinking water is drawn from an unconfined groundwater source, there is potential for contamination from above-ground land uses due to the karstic nature of the aquifer. Karst features such as solution channels can provide conduits for the rapid transport of contaminants in to the aquifer. The karst forms also make identification and prediction of the movement of contaminants extremely difficult. Table 1 shows an assessment of the risks to water quality.

Previous contamination risks associated with the airfield and Qualing Scarp waste disposal site are no longer applicable, due to those land uses being excluded from the water reserve as part of the amended water reserve boundary (proposed within the 2000 water source protection plan), and their location being down-gradient of the groundwater flow.

The Exmouth Water Reserve encompasses Crown land that includes livestock grazing, five mining tenements and the Cape Range National Park. In addition there is:

- a Geothermal exploration permit (PA67 GEP36)
- two petroleum exploration permits (EP 359 R2 and EP 433)
- two petroleum wells (Lease number LP-35-H) within the water reserve (refer to Figure 3).

Significant land uses that have the potential to contaminate the drinking water source are (see Figure 2):

- livestock grazing
- limestone mining (*Exmouth Limestone (formerly Whitecrest), Alcoa and Exmouth Quarries and Contracting*)
- unauthorised use of unsealed tracks for camping and off road vehicles.

Bores drilled near a public drinking water supply bore (e.g. for irrigation or private purposes) can cause contamination of the drinking water source. For example, a poorly constructed bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source.

This will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914* (WA). All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

Table 1 Land use and potential water quality risks

Land use/activity	Hazard	Management Priority	Compatibility of land use/activity	Best management practice guidance
Crown Land				
Mining tenements (M8/6, M8/145, M8/224, M8/62 and L8/10)	Hydrocarbons from mining operations	High	Compatible with conditions in P1 areas, special conditions apply in WHPZs.	Proposals may be subject to an Environmental Impact Assessment in accordance with Part IV of the <i>Environmental Protection Agency Act 1986</i> (WA). Current limestone mining operations within the water reserve are regulated through <i>Ministerial Statement 461</i> , Environmental Management Plan – E3787E and subject to performance and compliance submissions.
Geothermal Exploration Permit (PA67 GEP 36)	Turbidity from mining operations	Medium	Elevated chemical storage tank systems are prohibited by water source protection by-laws within WHPZs.	
Petroleum Titles (EP 359 R2 & EP 433)	Microbiological from human activity	Medium	Within P1 and P2 areas, routine servicing and wash-down of operating equipment is unacceptable.	
Petroleum Wells (Lease LP-35-H)				
Pastoralist grazing	Pathogens from animal excreta	Medium	Compatible with conditions in P1, special conditions apply in WHPZ such as the storage and use of chemical substances.	WQPN no. 35: <i>Pastoral activities in rangelands</i>
	Nutrients from animal excreta	Medium		WQPN no. 65: <i>Toxic and hazardous substances – storage and use</i>

Land use/activity	Hazard	Management Priority	Compatibility of land use/activity	Best management practice guidance
Recreation– private (within non-designated recreation areas on Crown land)	<p>Hydrocarbons from off-road vehicle use</p> <p>Pathogens from human activity</p>	<p>Medium</p> <p>Medium</p>	<p>Camping and off-road vehicles are an Incompatible land use in P1 areas</p> <p>Unauthorised vehicles are not permitted on Crown land within PDWSAs except on public roads.</p>	<p>Statewide Policy No 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land</i></p>

1.5 Water quality information

The Water Corporation have provided updated water quality information for the Exmouth bore field (refer to Appendix B). 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 the ADWG.

Aesthetic raw water quality exceeded the ADWG standards for chloride, hardness (CaCO_3) and Total filterable solids by summation. Microbiological contaminants during the review period of December 2005 to November 2010 resulted in detections of *Escherichia coli* counts in low concentrations. Investigations were undertaken to determine the potential source of the *E.coli* including microbiological sampling from each operational bore and an inspection of the Water Reserve. The source was not conclusively identified, but may have been associated with the decomposition of a kangaroo carcass or *Stygofauna* within the bores.

2 Implementation of Exmouth's drinking water source protection plan

2.1 Status of previous recommendations

This table outlines recommendation from the 2000 plan and their current status.

Table 2 Status of previous recommendations

No.	Description	Status	Comments
1	Gazettal of water reserve.	Complete	Gazetted in 2002 under the <i>Country Areas Water Supply Act 1947 (WA)</i> .
2	Management for P1 source protection.	Ongoing	Guidelines have been provided through the water quality protection note series for P1 areas. Development proposals within the water reserve are referred to our Mid-West Gascoyne Region office.
3	Ensure town planning scheme is compatible with water quality protection objectives for the Exmouth Water Reserve.	Complete	The Exmouth Water Reserve and P1 management objective have been included in the proposed Exmouth Townsite Structure Plan (July 2009).
4	Refer all rezoning, subdivision and development proposals within the Water Reserve to the Water Rivers Commission (Department of Water)	Ongoing	Development proposals within the water reserve are referred to the Mid-West Gascoyne Region office of Department of Water.
5	Ensure disposal of oil to Qualing Scarp tip site has ceased.	Not applicable	No longer considered applicable to the management of the water reserve, as disposal of oil at the Qualing scarp tip site is now outside of the water reserve boundary as amended in 2002 by gazettal.
6	Investigate approaches to limit fires at the Qualing Scarp tip site.	Not applicable	The Shire of Exmouth regulates waste disposal at the Qualing scarp tip site.
7	Consider recommendations of this report in management planning for the Cape Range National Park.	Complete	Recommendations from the 2000 report were incorporated into the Cape Range National Park Plan in 2005.

No.	Description	Status	Comments
8	Maintain access tracks in good condition.	Ongoing	Currently there sixteen access tracks within the water reserve boundary. Maintenance and responsibility for those tracks should be reviewed by the Water Corporation in collaboration with the Department of Environment and Conservation and the relevant mining tenement lessee.
9	Manage vehicle access to the water reserve.	Ongoing	Surveillance is undertaken by the Water Corporation. Vehicle access is restricted to authorised vehicles as notified by signage. A review of access entry points should be undertaken, to determine where entry can be restricted.
10	Erect signs identifying the water reserve and water source protection requirements.	Complete	A further three signs were installed in 2009 for the Exmouth Water Reserve.
11	<p>Incidents covered by State Emergency Management Plans (WESTPLANS) and hazardous materials (HAZMAT) in the Exmouth Water Reserve should be addressed through the following measures:</p> <p>(i) the local emergency management committee (LEMC) (through the Karratha Emergency Management District) being familiar with the location and purpose of the Exmouth Water Reserve</p> <p>(ii) the locality plan for the Exmouth Water Reserve being provided to the Fire and Rescue Services Authority (FESA) headquarters for the HAZMAT Emergency Advisory Team</p>	<p>Complete</p> <p>Complete</p> <p>Complete</p>	<p>The relevant information to address incidents was sent to FESA, LEMC and the WA Police Service headquarters in 2002.</p>

No.	Description	Status	Comments
	(iii) the Water Corporation advising the HAZMAT emergency advisory team during incidents in the Exmouth Water Reserve (iv) personnel dealing with WESTPLAN – HAZMAT incidents in the area are given ready access to a locality map of the Exmouth Water Reserve and training to understand the potential impacts of spills on the surface water source	Ongoing Ongoing	
12	Support establishment of a 5 (g) Reserve for conservation and limestone mining in the area where water resources are least vulnerable and recommend mining proposals be consistent with the approach outlined in recommendation 12 within the Exmouth water source protection plan 2000 publication.	Ongoing	5 (g) reserves are vested in or placed under the care, control and management of the Conservation Commission and managed for a variety of purposes including recreation and conservation. The Department of Water supports the establishment of a 5 (g) Reserve for the purpose of future mining proposals.
13	Review i) these Recommendations ii) this Plan	Complete Complete	Consolidated recommendations (section 2.2) have been prepared in this review and changes in land use detailed in the 2000 plan.

2.2 Consolidated recommendations

Based on the findings of this review (2011), the following recommendations will now be applied to the Exmouth Water Reserve. The bracketed stakeholders are those expected to have a responsibility for, or an interest in the relevant recommendation being implemented.

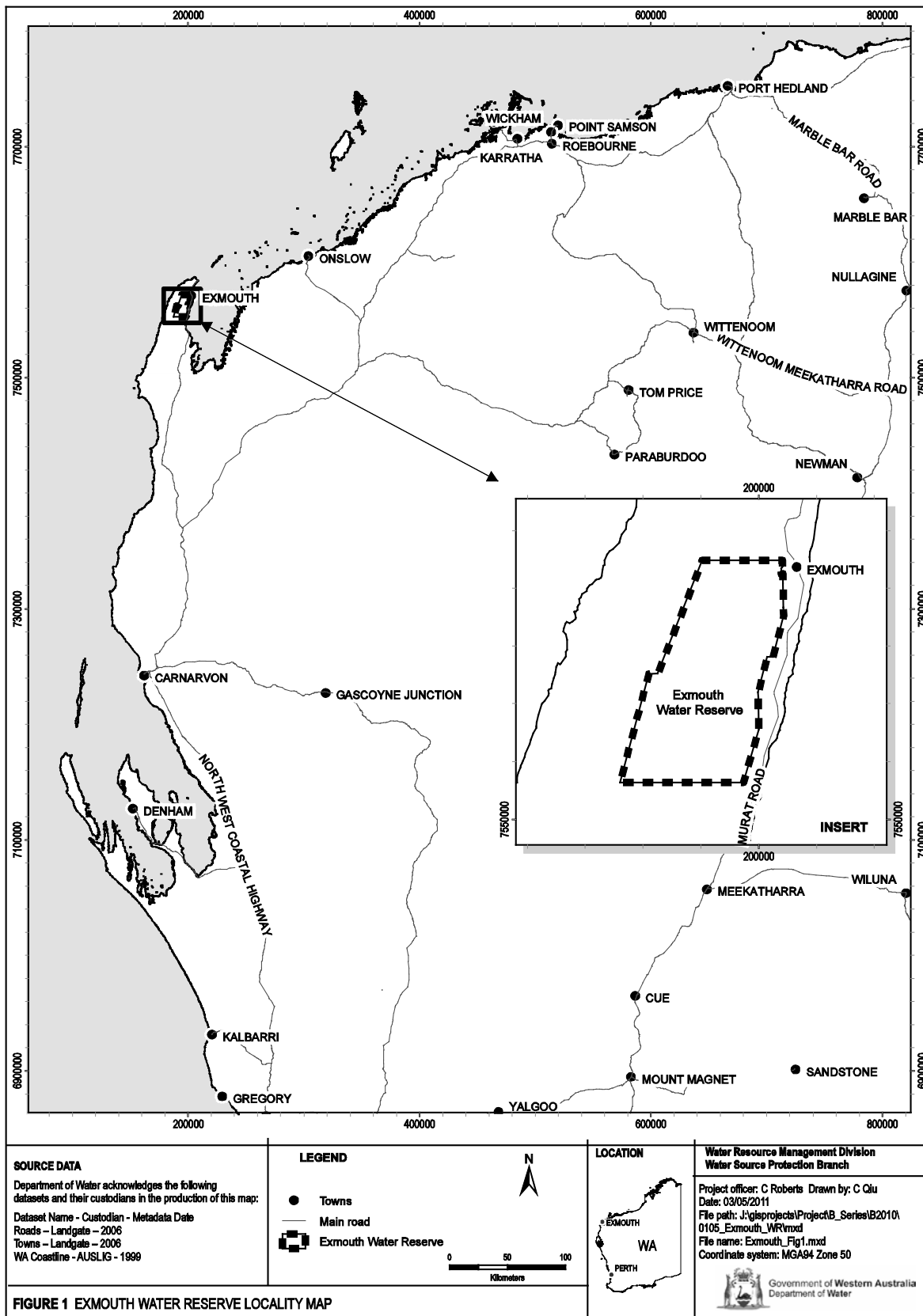
- 1 All development proposals within the Exmouth Water Reserve that are inconsistent with the Department of Water's WQPN no.25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be

referred to the Department of Water's Mid-West Gascoyne regional office for advice and recommendations. (Department of Planning, Shire of Exmouth, proponents of proposals)

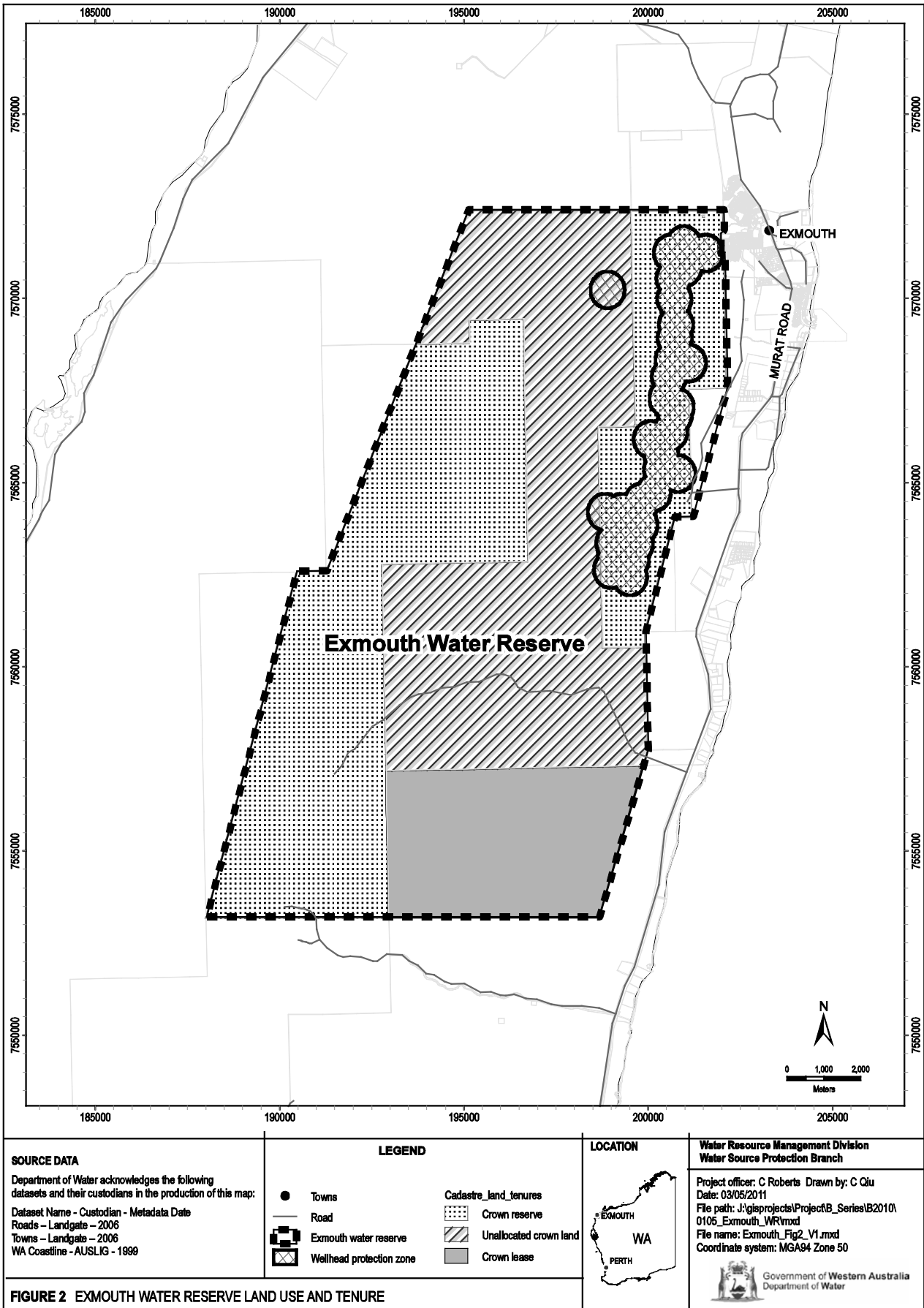
- 2 Recognise the Exmouth Water Reserve boundary, its P1 area and WHPZs in the Shire of Exmouth *Townsite Structure Plan* (July 2009) in accordance with the Western Australia Planning Commission's Statement of planning policy no.2.7: *Public drinking water source policy*. (Shire of Exmouth)
- 3 Develop an implementation strategy for the Exmouth Water Reserve recommendations. (Department of Water, applicable stakeholders)
- 4 Provide advice to the Department of Mines and Petroleum and the Environmental Protection Authority for mining proposals and the ongoing operations of extractive industries within the Exmouth Water Reserve. (Department of Water, Department of Mines and Petroleum and Environmental Protection Authority)
- 5 Formally delegate by-law enforcement and surveillance to the Water Corporation. (Department of Water)
- 6 Review this document after five years. (Department of Water)

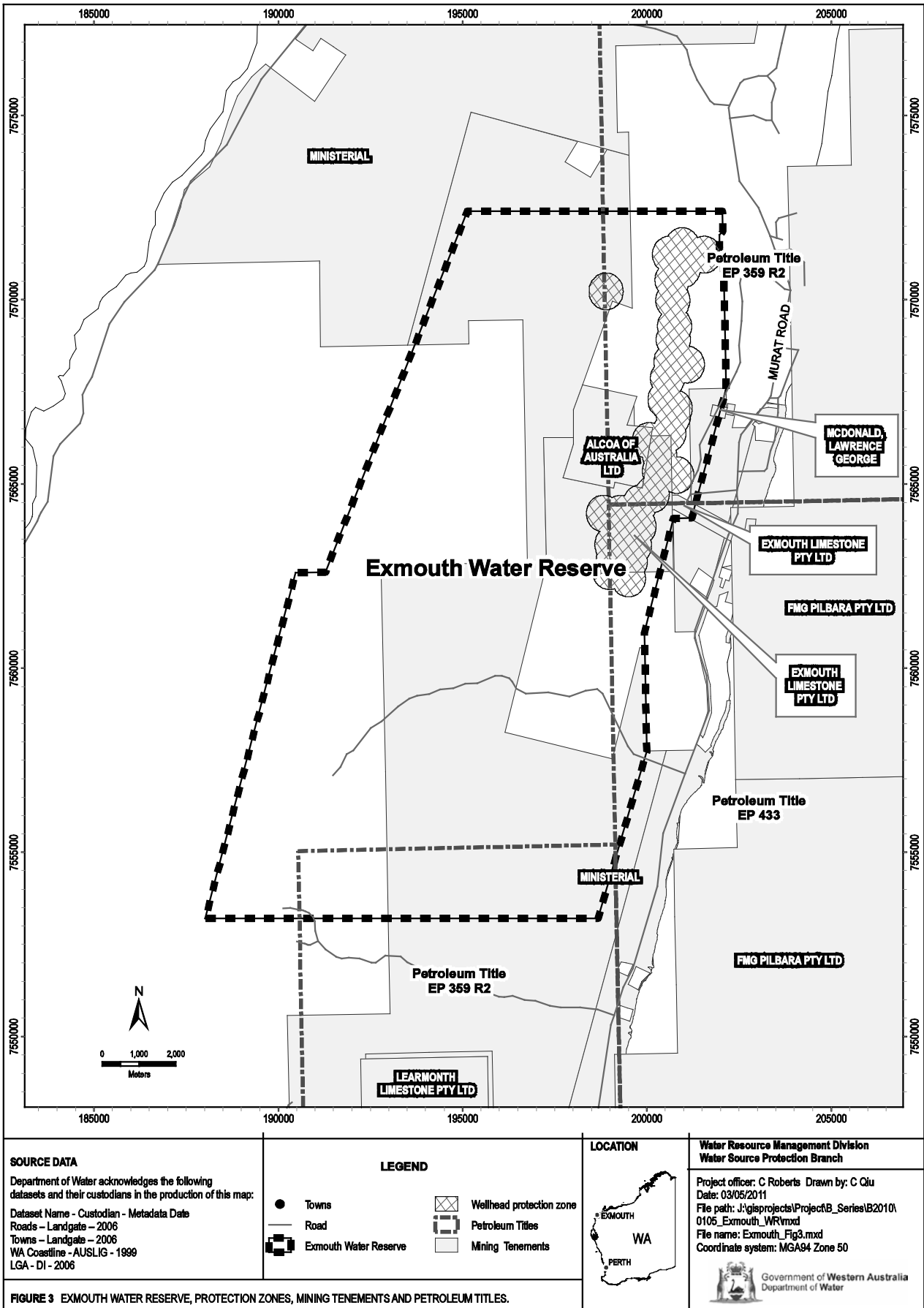
Appendices

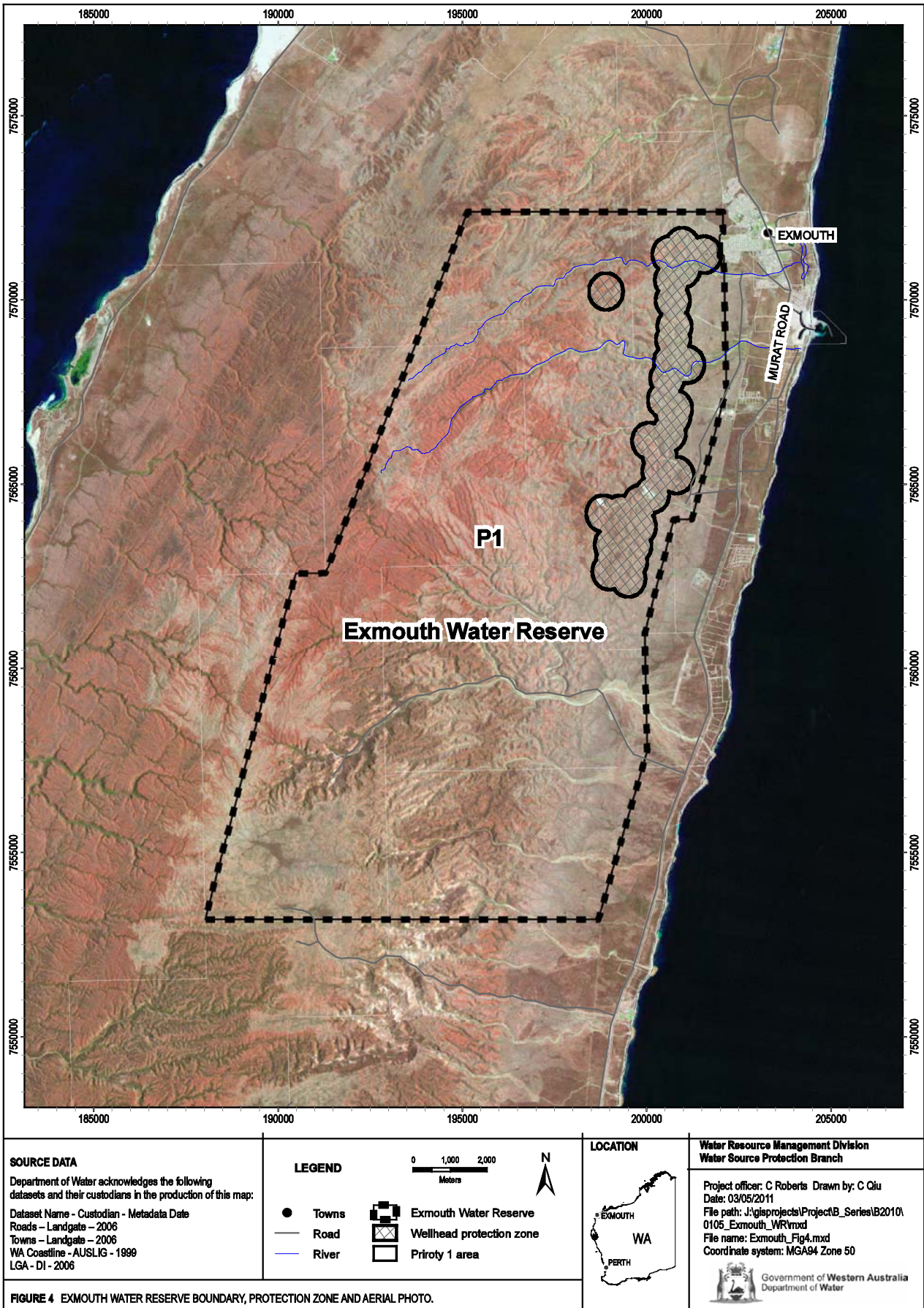
Appendix A – Figures



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Appendix B – Water quality data

The Water Corporation has monitored the raw (source) water quality from Exmouth bore field in accordance with the *Australian drinking water guidelines* (ADWG) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

a. Aesthetic-related characteristics– (non-health related)

b. Health-related characteristics:

- health related chemicals
- microbiological contaminants.

Following is data representative of the quality of raw water in Exmouth bore field. In the absence of specific guidelines for raw water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customers tap. Results that exceed the ADWG have been shaded 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 the ADWG. For more information on the quality of drinking water supplied to Exmouth refer to the most recent Water Corporation drinking water quality annual report at

<www.watercorporation.com.au/W/waterquality_annualreport.cfm>

Aesthetic-related characteristics

Aesthetic water quality analyses for raw water from Exmouth bore field are summarised in Table 1.

The values are taken from ongoing monitoring for the period December 2005 to November 2010. 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 ADWG are shaded.

Aesthetic-related detections for Exmouth bore field

Parameter	Units	ADWG aesthetic guideline value*	Exmouth raw source	
			Range	Median
Chloride	mg/L	250	230 – 260	260
Colour – true	TCU	15	<1 – 1	<1
Hardness as CaCO ₃	mg/L	200	306 - 347	330
Iron unfiltered	mg/L	0.3	<0.003 – 0.016	<0.003
Sodium	mg/L	180	115 – 135	135
Total filterable solids by summation	mg/L	500	779 – 852	831
Turbidity	NTU	5	<0.1 – 0.2	<0.1
pH measured in laboratory	No Unit	6.5 – 8.5	7.19 – 7.6	7.305

Health- related detections for Exmouth bore field

Parameter	Units	ADWG Health Guideline Value*	Exmouth raw water	
			Range	Median
Nitrate as nitrogen	mg/L	11.29	1.3 – 2.2	1.8
Nitrite as nitrogen	mg/L	0.91	<0.002 – 0.006	<0.002
Nitrite plus Nitrate as N	mg/L	11.29	1.3 – 2.2	1.9
Sulphate	mg/L	500	24 – 31	29
Fluoride laboratory measurement	mg/L	1.5	0.15 – 0.2	0.2

* 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 (NHRMC & ARMCANZ, 2004).

Microbiological contaminants

Microbiological testing of raw water samples from Exmouth 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.

A detection of *Escherichia coli* in raw water abstracted from any bore may indicate contamination of faecal material through ingress in the bore, or recharge through to the aquifer (depending on aquifer type).

During the review period of December 2005 to November 2010, positive *Escherichia coli* counts were recorded in 11 percent of samples. These detections occurred at low concentration (maximum count was 25 MPN/100 mL), but indicates the vulnerable nature of this unconfined aquifer to contamination. Raw water undergoes disinfection and storage barrier prior to entering Exmouth reticulation.

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CFU	colony forming units
DEC	Department of Environment and Conservation
EC	electrical conductivity
GL	gigalitre
ha	hectare
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
km²	square kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
mm	millimetre
MPN	most probable number
mSv	millisievert
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PDWSA	public drinking water source area
TCU	true colour units
TDS	total dissolved solids

TFSS	total filterable solids by summation
WHPZ	wellhead protection zone
WESTPLAN- HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMCC 2004a).
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMCC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Bore	A bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Bore field	A group of bores to monitor or withdraw groundwater is referred to as a bore field (also see <i>wellfield</i>).
Department of Environment and Conservation	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
Draw down	The change in hydraulic head observed at a well in an aquifer, typically due to pumping a well as part of an aquifer test or well test.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include millisiemens per metre and microsiemens per centimetre.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.

Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMCC 2004a).
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.
Karst	An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Most probable number	Most probable number is a measure of microbiological contamination.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
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.
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.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.

Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
Recharge	Recharge is the action of water infiltrating through the soil/ground 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.
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 and industrial use or for irrigation.
Stygofauna	Stygofauna are animals that live in underground water. Stygofauna include a number of higher order taxa made up predominantly of many kinds of crustaceans but includes worms, snails, insects, other invertebrate groups, and, in Australia, two species of blind fish. Most species spend their entire lives in groundwater and are found nowhere else.
Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).
Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO ₄ equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO ₂ (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.

True colour units	True colour units are a measure of degree of colour in water.
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.
Upconing	Process by which saline water underlying freshwater in an aquifer rises upward into the freshwater zone as a result of pumping water from the freshwater zone.
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	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947 (WA)</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
Wellfield	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	A wellhead protection zone (WHPZ) is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.

References and further reading

- Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & Australian and New Zealand Environment and Conservation Council (ANZECC) 1996, *Draft rural land uses and water quality – A community resource document*, ARMCANZ & ANZECC, Canberra.
- Department of Health 2007, *Use of herbicides in water catchment areas*, Circular no: PSC 88, February 2007, Department of Health, Perth.
- Department of Water various dates, Water quality protection note – *various titles*, Department of Water, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for water quality protection notes.
- Department of Water & Department of Health 2008, *Risks from pathogenic micro-organisms in public drinking water source areas*, Department of Water, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our advisory brochures relevant to drinking water.
- Environmental Protection Agency 1997, Ministerial Statement 461, *Statement that a proposal may be implemented (pursuant to the provisions of the Environmental Protection Act 1986)*.
- Geldreich, EE 1996, 'Pathogenic agents in freshwater resources', *Hydrological Processes*, vol. 10, pp. 315-333.
- Government of Western Australia 1986, *Environmental Protection Act*, Reprinted under the *Reprints Act (WA) 1984* as at 11 February 2011, available <<Western Australian Legislation - Environmental Protection Act 1986 - Home Page>
- 1914, *Rights in Water and Irrigation Act*, Reprinted under the *Reprints Act (WA) 1984* as at 1 February 2008, available <www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_844_homepage.html>.
- 1947, *Country Areas Water Supply Act (WA)*, reprinted under the *Reprints Act 1984* as at 14 April 2008, available <www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_208_homepage.html>.
- 2007, *State water plan 2007*, Department of the Premier and Cabinet, Perth, available <www.water.wa.gov.au> Publications > Find a publication > A-Z browse.
- Hrudey, SE & Hrudey, EJ 2004, *Safe drinking water – Lessons from recent outbreaks in affluent nations*, IWA Publishing, London.
- Krogh, M, Davison, A, Miller, R, O'Connor, N, Ferguson, C, McClaughlin, V & Deere, D 2008, *Effects of recreational activities on source protection areas – Literature review*, Water Services Association of Australia, Melbourne.
- National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) 2004a, National Water Quality Management Strategy: *Australian drinking water guidelines*, Australian

Government, Canberra, available
<www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.

NHMRC & NRMCC 2004b, *Water made clear – A consumer guide to accompany the Australian drinking water guidelines 2004*, Australian Government, Canberra, available <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.

National Minimum Bore Specifications Committee 2003, *Minimum construction requirements for water bores in Australia*, 2nd edn, Land and Water Biodiversity Committee, Queensland, available <www.water.wa.gov.au> Publications > Find a publication > A-Z browse.

State Emergency Management Committee 2005, Policy statement no. 7: *Western Australian emergency management arrangements*, Government of Western Australia, Perth.

Water and Rivers Commission 2000, Statewide policy no. 2: *Pesticide use in public drinking water source areas*, Water and Rivers Commission, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our policies.

– 2003, Statewide policy no. 13: *Policy and guidelines for recreation within public drinking water source areas on Crown land*, Water and Rivers Commission, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our policies.

Water Corporation 2006, *SG097 Source protection operations manual*, Water Corporation, Perth.

Western Australian Planning Commission 1997, *State planning strategy*, Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/52.aspx>>.

– 2003, Statement of planning policy no.2.7: *Public drinking water source policy*, Government Gazette Western Australia, 10 June 2003, pp. 2077-82, Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/149.aspx>>

– 2006, State planning policy no.2.9: *Water resources*, Government Gazette Western Australia, 19 December 2006, pp. 5707-22 Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/1281.aspx>>

World Health Organization 2004 *Guidelines for drinking water quality – Volume 1 – Recommendations*, 3rd edn, World Health Organization, Geneva, available <www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html>

Department of **Water**

168 St Georges Terrace, Perth, Western Australia

PO Box K822 Perth Western Australia 6842

Phone: 08 6364 7600

Fax: 08 6364 7601

www.water.wa.gov.au