Government of **Western Australia**
Department of **Water**

West Mirrabooka Public Drinking Water Source Area

Drinking water source protection assessment

Part of the Integrated Water Supply Scheme – supplying the Perth metropolitan and Mandurah areas and the Goldfields and Agricultural Water Supply Scheme

Looking after all our water needs

Water resource protection series
Report WRP 129
November 2011

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Cover: Aerial photograph of the proposed West Mirrabooka Public Drinking Water Source Area showing proposed wellhead protection zones.

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Preface

How do we protect public drinking water source areas?

The *Australian drinking water guidelines* (ADWG) (NHMRC & NRMMC 2004a) outline how we should protect drinking water in Australia. The ADWG recommend 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 household tap. It ensures a holistic assessment of water quality risks and solutions, providing for the delivery of a reliable and safe drinking water supply 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 kept low as possible. A multiple-barrier approach means that we use different barriers against contamination at different stages of the drinking water supply system to maximise water quality and protect public health.

The first and most important barrier is protecting the catchment of surface water sources and recharge areas of groundwater abstraction bores. If we get this barrier right, it has a flow-on affect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, treating the water (e.g. chlorination to control pathogens), maintenance of pipes and testing of water quality.

Research and experience 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 assessment is important. We should not forget that ultimately it's about protecting your health, and about protecting the catchment's water quality now and for the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by putting the ADWG into practice. We write assessments, plans, policies, guidelines, and we provide advice to land-use planning decision makers at state and local government level.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA) provide us with important powers to protect water quality in proclaimed PDWSAs. These acts allow us to assess and manage the water quality contamination risks from different land uses and activities.

This drinking water protection assessment shows where the proposed West Mirrabooka PDWSA is located, a proposed boundary, land uses and water quality contamination risks. It also includes recommendations on how to deal with water quality contamination risks to protect public health. We will work with the community,

other government agencies and landowners to help put these recommendations into practice.

An important step in maximising the protection of water quality in any 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 objective of risk avoidance. Priority 2 (P2) areas are defined and managed to maintain or improve the quality of the drinking water source using the objective 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 objective of risk management.

There are two different protection zones that surround drinking water extraction points, so areas vulnerable to contamination are protected. Reservoir protection zones protect surface water dams (reservoirs) and wellhead protection zones protect groundwater abstraction (often referred to as production) bores.

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

Nine existing production bores in West Mirrabooka have been modelled to help define the boundary of the proposed West Mirrabooka Public Drinking Water Source Area (PDWSA). The Water Corporation manages and operates theses bores as part of Perth's Integrated Water Supply Scheme (IWSS) which provides scheme water to domestic, industrial and agricultural customers in the Perth metropolitan and Mandurah areas. This IWSS also supplies the Goldfields and Agricultural Water Supply Scheme (including Kalgoorlie).

This proposed PDWSA has an area of 21 km^2 and is located about 10 km north of Perth (refer to *Figure 1*). It lies between the Gnangara Underground Water Pollution Control Area (UWPCA) to the east and Perth Coastal and Gwelup UWPCAs to the west. It includes the suburbs of Alexander Heights, Balga, Girrawheen, Koondoola, Malaga, Marangaroo and Mirrabooka and is located within the cities of Stirling, Swan and Wanneroo (refer to *Figure 2*).

The purpose of this drinking water source protection assessment is to identify a suitable boundary for the proposed West Mirrabooka PDWSA. It also provides information on water quality and contamination risks within that areas and how to deal with them.

The land within this proposed PDWSA is mostly urban. Major land uses consist of residential, commercial and light industrial activities with some parks and recreation areas.

Subject to further stakeholder consultation key strategies to protect water quality include:

- proclamation of a West Mirrabooka PDWSA
- identification of wellhead protection zones (WHPZ) around the nine existing production bores
- management the land within the PDWSA for priority 3 (P3) water source protection
- promotion of best management practices to protect water quality.

These strategies are consistent with other PDWSAs in Western Australia. They also recognise that existing residential, commercial and light industrial land uses will continue. Their purpose is to identify that this PDWSA is part of the IWSS and to promote best practice water quality protection measures.

The following table shows information about the proposed West Mirrabooka PDWSA.

Table 1 Key information for the proposed West Mirrabooka Public Drinking Water Source Area

Local government authorities	Cities of Stirling, Swan and Wanneroo
Locations supplied	Integrated Water Supply Scheme
Aquifer type	Unconfined (therefore vulnerable to contamination from surface land uses)
Volume of water abstracted	Between 155 and 495 ML per bore per year (2009/10)
Number of production bores	Nine bores: M500, M510, M520, M530, M540, M550, M560, M570, M580
Proclamation status	Proclamation will need to be progressed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* (WA) when this assessment is finalised.

1 Overview of the proposed West Mirrabooka Public Drinking Water Source Area

1.1 The Integrated Water Supply Scheme

The Integrated Water Supply Scheme (IWSS) supplies water to 1.5 million of the 1.9 million people living in Western Australia, servicing towns in the south west, Perth metropolitan and Mandurah areas and towns and farmlands in the central Wheatbelt out to Kalgoorlie-Boulder.

The IWSS provides scheme water to domestic, industrial and agricultural customers. The sources supplying the IWSS are an integrated system consisting of large storage reservoirs, pipeheads and pumpbacks, bores into superficial and confined groundwater aquifers, and the Perth Saltwater Desalination Plant. The Water Corporation manages and operates the IWSS.

Groundwater has formed part of the Perth's water supply since the early 1970s, increasing from 10 gigalitres (GL)/year to approximately 165 GL/year in 2010/11. Expansion of the groundwater resource has supported population growth and development in the metropolitan region.

Groundwater for the IWSS is obtained from regional freshwater aquifers within superficial sediments, sandstones of the Coolyena Group and Leederville Formations and sandstones of the Yarragadee Formation beneath the Swan Coastal Plain.

The groundwater supply is obtained from borefields located on the Swan Coastal Plain. The majority of this water is treated at groundwater treatment plants in Jandakot, Mirrabooka, Lexia, Wanneroo, Neerabup and Gwelup before being added to the distribution system. Borefields, licensed under the *Rights in Water and Irrigation Act 1914*, are located within the Jandakot, Mirrabooka, Wanneroo, Gnangara, Perth, Gwelup and Yanchep groundwater areas.

1.2 The proposed West Mirrabooka Public Drinking Water Source Area

The nine bores in the proposed West Mirrabooka Public Drinking Water Source Area (PDWSA) were drilled in 2002 as part of the IWSS drought relief program (refer to *Figure 4*). Although the bores form part of the Gnangara groundwater system, they are outside the proclaimed Gnangara UWPCA. The West Mirrabooka bores draw water from the locally recharged shallow superficial aquifer, which is transferred via collector mains to the Mirrabooka Groundwater Treatment Plant (GWTP) where it is treated to make it suitable for drinking before distribution to customers. Treatment usually involves aeration, settling of suspended solids, filtration and chlorination is undertaken to disinfect the water. Fluoride is also added to provide dental health

protection in accordance with Department of Health requirements. The treated water is then distributed locally and via the Mount Yokine Reservoir.

It should be recognised that although treatment is an essential barrier against contamination, catchment management is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *Australian drinking water guidelines,* 2004 (ADWG) (NHMRC & NRMMC 2004a) and reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower-cost drinking water to consumers than either approach could achieve individually.

For more information on why it is so important to protect our catchments, read the preface at the front of this assessment.

1.3 Water 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 water is vested with the Crown. This means that a licence is required for drilling bores and abstracting groundwater (pumping water from a bore, spring or soak) within proclaimed groundwater areas throughout the state. Some exemptions may apply such as abstracting water for domestic purposes only.

The proposed West Mirrabooka PDWSA is located within the Perth Groundwater Area and the City of Stirling and Whitfords subareas which are proclaimed under the *Rights in Water and Irrigation Act 1914*.

The Water Corporation holds licences to take water from the bores in the proposed West Mirrabooka PDWSA. Licence details are as follows:

- *Licence no. 151738*: bores M510, M530, M540, M560, M570, M580, 2009/10 allocation 1,340 ML/year, expires 30June 2012
- *Licence no. 100631*: includes bores M500, M520, M550, 2009/10 allocation 2,250 ML/year, expires 30June 2012

1.4 Characteristics of the catchment

1.4.1 Physical environment

The physiography of the proposed West Mirrabooka PDWSA is dominated by the coastal dunes of the Swan Coastal Plain (Davidson, 1995). The western part of the area is characterised by calcareous sand remnants of the Spearwood Dune System and the gently undulating quartz sand plains of the Bassendean Dune System in the eastern portion.

Most areas have been cleared of native vegetation and replaced with an urban landscape.

1.4.2 Climate

The West Mirrabooka area has a Mediterranean type climate and is characterised by hot, dry summers with mild, wet winters.

On average, about 90 per cent of rain falls between April and October. During the hot and dry summer months of November to February, the climate is characterised by high evaporation rates.

Rainfall has been significantly less over the last decade and may reflect a shift in the climate pattern to one with drier winters for the south-west of Western Australia.

2010 was one of the driest years on record across the Perth Metropolitan area. Lowest annual rainfall records were broken at a number of sites due to a culmination of a record dry summer, a record dry winter and below average rainfall in spring. Annual rainfall totals were generally 40 - 50 per cent lower than normal and in the 350 - 600 mm range.

The mean maximum temperature ranges between 18^{o}C and 32^{o}C, with the hottest months being January and February. The mean minimum temperature ranges between 8^{o}C and 17^{o}C, with the coldest months being July and August (Bureau of Meteorology, 2011).

1.4.3 Hydrogeology

The West Mirrabooka production bores are located within the Swan Coastal Plain that has an elevation of 30 to 60 m AHD near the study area.

Production bores within the West Mirrabooka borefield have been constructed to draw water from the superficial aquifer of the Gnangara groundwater system. At the borefield the superficial aquifer consists of highly permeable Tamala Limestone that has an average saturated thickness of 25 m. The Tamala Limestone underlies the semi-confined Coolyena Group Mirrabooka aquifer, and the confined aquifers of the Leederville and Yarragadee formations.

Groundwater flow is mainly in a westerly direction discharging into the Indian Ocean at the coast. The regional watertable across the site ranges from 30 m AHD in the north-east to 20 m AHD in the west. Recharge is mainly through direct rainfall infiltration during the period from June to September. Infiltration rates are influenced by local land uses and are generally high, with percolation of rainfall towards the watertable readily occurring.

The groundwater system within the proposed West Mirrabooka PDWSA is vulnerable to contamination because of the direct recharge that occurs from rainfall across the whole area, the shallow depth to the watertable in many locations, karstic nature of the Tamala Limestone and the hydraulic connection between aquifers.

1.5 How is the drinking water currently protected?

Current measures that are undertaken by Water Corporation to ensure water source protection include bore maintenance and water quality monitoring.

1.6 Other useful information

1.6.1 Other groundwater bores in the area

The Water Corporation operates the drinking water bores in the proposed West Mirrabooka PDWSA. If bores for other purposes (e.g. irrigation or private household use) are drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private 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 this public drinking water source. Where required this will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914.* All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

2 Common contamination risks

Land uses and activities within a PDWSA can directly affect the quality of the drinking water and how it is treated. Contaminants can reach drinking water sources through run-off over the ground and infiltration through the soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of safe, good quality drinking water to consumers.

Some contaminants in drinking water can impact on human health. Other impurities can affect the water's aesthetic qualities, including its appearance, taste, smell and 'feel' but they are not necessarily hazardous to human health. For example, cloudy water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful, undetectable microorganisms (NHMRC & NRMMC 2004b). Contaminants can also interfere with water treatment processes, and destroy water supply infrastructure (such as pipes).

The ADWG provide water quality criteria for drinking water to protect human health, aesthetics and water supply infrastructure.

For more information about water quality in this drinking water source, see section 3.

Some commonly seen contamination risks relevant to groundwater drinking water sources are described below for information purposes only.

2.1 Microbiological

Pathogens are types of microorganisms that are capable of causing disease. These include bacteria, protozoa and viruses. In drinking water supplies, pathogens that can cause illness are commonly found in the faeces of humans and domestic animals (such as dogs and cattle).

Pathogens can enter drinking water supplies from faecal contamination in the water reserve. In groundwater sources, this occurs indirectly – faecal material can infiltrate through the soil and into the groundwater. For example, contamination can occur from septic tanks or grazing animals.

A number of pathogens 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. *E. coli* counts are a way to measure these pathogens and provide an indication of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

The survival and movement of pathogens in groundwater is influenced by the characteristics of the pathogen (such as its size and the length of time it normally takes to die) and the groundwater properties (including flow rate, porosity, amount of carbon in the soil, temperature, and pH). Inactivation rate (the time it normally takes a pathogen to die) is one of the most important factors governing how far pathogens may travel. Typical half-lives of pathogens range from a few hours to a few weeks. For example, maximum reported migration distances of bacteria in groundwater are:

- 600 m in a sandy aquifer
- 1000 – 1600 m in channelled limestone
- 250 – 408 m in glacial silt-sand aquifers (Robertson & Edbery 1997).

Therefore it is important to understand the groundwater system to be able to protect the drinking water source from pathogens.

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town's water supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMMC 2004b).

Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

2.2 Physical risks

Turbidity is the result of soil or organic particles becoming suspended in water (cloudiness). Increased turbidity can result in cloudy or muddy looking water, which is not very appealing to consumers. Turbidity can also reduce the effectiveness of treatment processes (such as disinfection). This is because pathogens can adsorb onto soil particles and may be shielded from the effects of disinfection. Chemicals can also attach to suspended soil particles.

Some physical properties of water such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes. Other properties such as iron and dissolved organic matter can affect the colour and smell of water. Although not necessarily harmful to human health, coloured or 'hard' water will not be as appealing to consumers. Salinity can affect the taste of drinking water.

2.3 Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage

areas. In these cases, the relevant authorities should be notified promptly and the spill cleaned up to prevent contamination of a drinking water source.

Hydrocarbons (e.g. fuels, oils) are potentially toxic to humans, and harmful chemical by-products may be formed when they are combined with chlorine during the water treatment process. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles.

Drinking water sources can also be contaminated by nutrients (such as nitrogen) from fertiliser applications, faulty septic systems, leach drains and from domestic and feral animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite (forms of nitrogen) can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2004a).

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter drinking water sources and could potentially be harmful to human health.

3 Contamination risks in this drinking water source

3.1 Water quality

The Water Corporation regularly monitors the quality of raw water from the IWSS production bores and water supply sampling points within the proposed West Mirrabooka PDWSA for microbiological, health-related and aesthetic (non health-related) characteristics. This data shows the quality of water in this proposed PDWSA. An assessment of the drinking water quality once treated is also made against the ADWG. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the proposed West Mirrabooka PDWSA (from December 2005 to November 2010) is presented in *Appendix B*. This data is for raw water (not water distributed to consumers' homes) and does not take into account pumping times and rates for individual bores or mixing with water from other Mirrabooka bores. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Click on the most recent *Water quality annual report*.

3.2 Land uses and activities

The proposed West Mirrabooka PDWSA is located over an urban area within the suburbs of Marangaroo, Alexander Heights, Girrawheen, Koondoola, Balga, Mirrabooka and Malaga (refer to *Figure 2*). The proposed West Mirrabooka PDWSA is fully developed. Most of the area is privately owned land with some land vested in the local or state government (refer to *Figure 3*).

Most urbanised catchments promote infiltration of stormwater through soak wells and stormwater sumps. This enhancement of recharge over a large area helps to maintain groundwater levels but may also increase the risk of contaminating the water source.

Recharge and current land uses and activities and their risks to the drinking water source are described below. *Table 3*, at the end of this section, summarises this information in an easy-to-read format.

3.2.1 Industrial and commercial

Malaga is the major industrial suburb for the City of Swan, and is designated a strategic industrial area for Western Australia. It is an industrial suburb providing an excellent location for light industry and service establishments. Malaga is rapidly becoming one of Perth's major industrial areas with huge projected growth (City of Swan, 2011 a and b). Part of the Malaga Industrial Area is located in the south-

eastern portion of the proposed West Mirrabooka PDWSA. Activities in the Malaga Industrial Area include manufacturing, processing, warehousing and distribution, retail, panel beating, spray painting, scrap metal, bus depot, automotive servicing, printing, rubber and plastic manufacturing, oil and gas drilling, engineering, butchering and small goods, pest and weed control, woodwork, brick and paving manufacturing, bulk and bagged soil, soil conditioner, mulch and manure blending and supply, construction, building and related activities. These industries are located within a few kilometres and in the flow path of some of the Mirrabooka bores and pose a contamination threat through the possible leakage of stored fuels, chemicals, leaching of mulch and manure, inappropriate waste disposal and contaminated stormwater.

There are a number of commercial areas within the proposed West Mirrabooka PDWSA. These include businesses such as shopping centres, large retail outlets, food processing businesses, fast food outlets, taverns, leisure centres, drycleaners, general industry operations, light industrial businesses, car sale yards, car wash and mechanical servicing workshops. These land uses can pose a risk to the water quality of the drinking water source by contamination with pesticides and other chemicals as a result of accidental spills, incorrect use or leakage from storage areas, inappropriate waste disposal and contaminated stormwater.

There are numerous car parks within these commercial areas and shopping centres which pose a risk from potential leakage of fuels.

There are several service stations in the proposed West Mirrabooka PDWSA. These can be a contamination threat through possible leakage of fuel stored in underground tanks. The potential for contamination depends upon the age of the service station, the tanks and whether the underground fuel storage employs double walled tanks and pipe work.

Motor vehicle repair businesses also occur in Mirrabooka and can be a contamination threat to water quality because of the potential for spills from workshop areas, contaminated drainage entering stormwater drains, leakage from storage areas and inappropriate disposal of fuels and chemicals.

3.2.2 Urban

Residential land is the major land use in the proposed West Mirrabooka PDWSA and most of the area is connected to deep sewerage. A potential risk to water quality from residential areas is nutrient and chemical contamination from the use of household chemicals, fertilisers and pesticides use on gardens, hydrocarbon contamination from fuel and oil use, storage and spills and pathogen contamination from pets.

There are several recreational parks, ovals, reserves, playgrounds, barbeque and picnic areas in the urban area. Although these areas can act as buffer zones to the bores from the surrounding urban development, a potential risk to water quality exists from nutrient and chemical contamination if fertilisers and pesticides are used inappropriately and from inappropriate rubbish disposal.

Major roads form part of the proposed PDWSA boundary, including Reid Highway (southern boundary), Wanneroo Road (western boundary) and Hepburn Avenue and Marangaroo Drive (northern boundary). There are also many local roads within the proposed West Mirrabooka PDWSA, which are part of an extensive network of roads servicing the central northern suburbs of Perth. These roads pose a contamination threat through the possible fuel and chemical spills if a road accident occurs.

3.2.3 Contaminated sites

A number of sites throughout the proposed West Mirrabooka PDWSA have been reported as known or suspected contaminated sites under the *Contaminated Sites Act 2003*, administered by the Department of Environment and Conservation (DEC). Some of these sites require investigation, several are still awaiting classification and others have been classified and require remediation. Hydrocarbons from pipeline leaks and old underground storage tanks are common forms of contamination. Other known or suspected contaminated sites include an unlined landfill site, former brickworks, bus depot and a power substation.

Table 2 Land use and potential water quality risks in the proposed West Mirrabooka Public Drinking Water Source Area

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance (see below for details)
Urban				
Industrial	Chemicals and hydrocarbons (fuel and oil) from leaks, spills, inappropriate waste disposal and contaminated stormwater runoff.	High/medium	Acceptable or Compatible with conditions	WQPN no. 10 WQPN no. 20 WQPN no. 28 WQPN no. 51 WQPN no. 52 WQPN no. 56 WQPN no. 65 WQPN no. 93
Commercial	Hydrocarbons and chemicals from leaks and spills.	Medium	Acceptable or Compatible with conditions	WQPN no. 10 WQPN no. 28 WQPN no. 93
Service stations	Hydrocarbons from fuel and oil leaks and spills, old underground tanks and contaminated stormwater runoff.	High/medium	Acceptable or Compatible with conditions	WQPN no. 10 WQPN no. 28 WQPN no. 49 WQPN no. 56 WQPN no. 62 WQPN no. 64
Residential	Nutrients and chemicals from fertilisers and pesticides.	Low	Acceptable or Compatible with conditions	Brochure: *Living and working in PDWSAs*
Roads	Hydrocarbons and chemical spills and contaminated stormwater runoff.	Low	Acceptable or Compatible with conditions	WQPN no. 44 WQPN no. 83
Community purposes and parks and reserves	Nutrients and chemicals from fertilisers and pesticides.	Low	Acceptable or Compatible with conditions	Statewide policy no. 2: *Pesticide use in PDWSA* Circular no: PSC 88 *Use of herbicides in water catchment areas* *Environmental guidelines for the establishment and maintenance of turf and grassed areas*

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance (see below for details)
Contaminated sites	Nutrients, chemicals and hydrocarbons from contaminated sites.	High/medium	Incompatible	Assess, and remediate if required under the *Contaminated Sites Act 2003.*

Details of water quality protection notes

- WQPN no. 10: *Contaminant spills: emergency response*
- WQPN no. 20: *General and heavy industry near sensitive waters*
- WQPN no. 28: *Mechanical servicing and workshops*
- WQPN no. 44: *Roads near sensitive water resources*
- WQPN no. 49: *Service stations*
- WQPN no. 51: *Industrial wastewater management and disposal*
- WQPN no. 52: *Stormwater management at industrial sites*
- WQPN no. 56: *Tanks for elevated chemical storage*
- WQPN no. 62: *Tanks for underground chemical storage*
- WQPN no. 64: *Tanks – closure of underground chemical storage following closure of service stations*
- WQPN no. 65: *Toxic and hazardous substances: storage and use*
- WQPN no. 83: *Infrastructure corridors near sensitive water resources*
- WQPN no. 93: *Light industry near sensitive waters*

These water quality protection notes are available <http://drinkingwater.water.wa.gov.au> and scroll down to the link for water quality protection notes.

4 Protecting your drinking water source

4.1 Proclaiming the public drinking water source area

To help protect the quality of this drinking water source the Department of Water will discuss proclamation of this PDWSA with the cities of Stirling, Swan and Wanneroo. Proclamation of the PDWSA would not change the zoning of the land in this PDWSA or its light industrial, commercial and urban land uses.

For more guidance on appropriate land uses and activities in PDWSAs please refer to our WQPN no. 25: *Land use compatibility in public drinking water source areas*.

4.2 Defining priority areas

The protection of PDWSAs relies on statutory and non-statutory measures for water resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes a system that defines three priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance (e.g. state forest and other crown land)
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation (e.g. land that is zoned rural)
- Priority 3 (P3) areas have the fundamental water quality objective of risk management (e.g. areas zoned urban or light/general industrial/commercial).

The determination of priority areas is based on the strategic importance of the land or water source including risks to water quality and quantity, the local planning scheme zoning, the form of land tenure and existing approved land uses or activities.

The priority area for the proposed West Mirrabooka PDWSA has been determined in accordance with current Department of Water policy (refer to *Figure 4*).

We propose to assign all land within the proposed West Mirrabooka PDWSA as P3 for the following reasons:

- The land is privately owned and zoned as urban, residential, industrial, commercial or parks and recreation.
- Existing land uses are considered *acceptable* or *compatible with conditions* in P3 areas.
- The water supply source within this proposed PDWSA co-exists with other land uses.

4.3 Defining protection zones

In addition to priority areas, protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction bores. Specific conditions may apply within these zones such as restrictions on the storage of chemicals or public access.

Wellhead protection zones (WHPZs) are generally circular (unless information is available to determine a different shape or size), with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2 and P3 areas. WHPZs do not extend outside the boundary of the water reserve.

This assessment proposes defining a WHPZ of 300 m around each of the nine bores in the proposed West Mirrabooka PDWSA (refer to *Figure 4*).

4.4 Using best management practices

There are opportunities to reduce water quality contamination risks by carefully considering design and management practices. The Department of Water will continue to encourage the adoption of best management practices in the proposed West Mirrabooka PDWSA to help protect water sources.

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and WQPNs. They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. These guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include WQPN no. 28: *Mechanical servicing and workshops,* WQPN no. 51: *Industrial wastewater management and disposal,* WQPN no. 52: *Stormwater management at industrial sites,* WQPN no. 56: *Tanks for above ground chemical storage* and WQPN no. 65: *Toxic and hazardous substances: storage and use*, which are listed in this assessment's *References*.

4.5 Responding to emergencies

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The cities of Stirling, Swan and Wanneroo local emergency management committee (LEMC), through the Metropolitan Region emergency management district, should be familiar with the location and purpose of the proposed West Mirrabooka PDWSA. A locality plan will be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team.

Personnel who deal with WESTPLAN–HAZMAT (Western Australian plan for hazardous materials) incidents within the area should have access to a map of the proposed West Mirrabooka PDWSA. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source.

5 Recommendations

The following recommendations apply to the proposed West Mirrabooka PDWSA. The bracketed stakeholders are those expected to have a responsibility for, or an interest in the relevant recommendation being implemented.

1. Discuss water quality protection measures for the proposed West Mirrabooka PDWSA with the cities of Stirling, Swan and Wanneroo. (*Department of Water*)
2. Given the advanced level of development in the proposed West Mirrabooka PDWSA, proclamation of this PDWSA (under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA)) could occur based on the information in this drinking water source protection assessment. (*Department of Water*)
3. If required, and subject to recommendations 1 and 2, prepare a drinking water source protection plan for the proposed West Mirrabooka PDWSA. (*Department of Water*)

Appendices

Appendix A – Figures

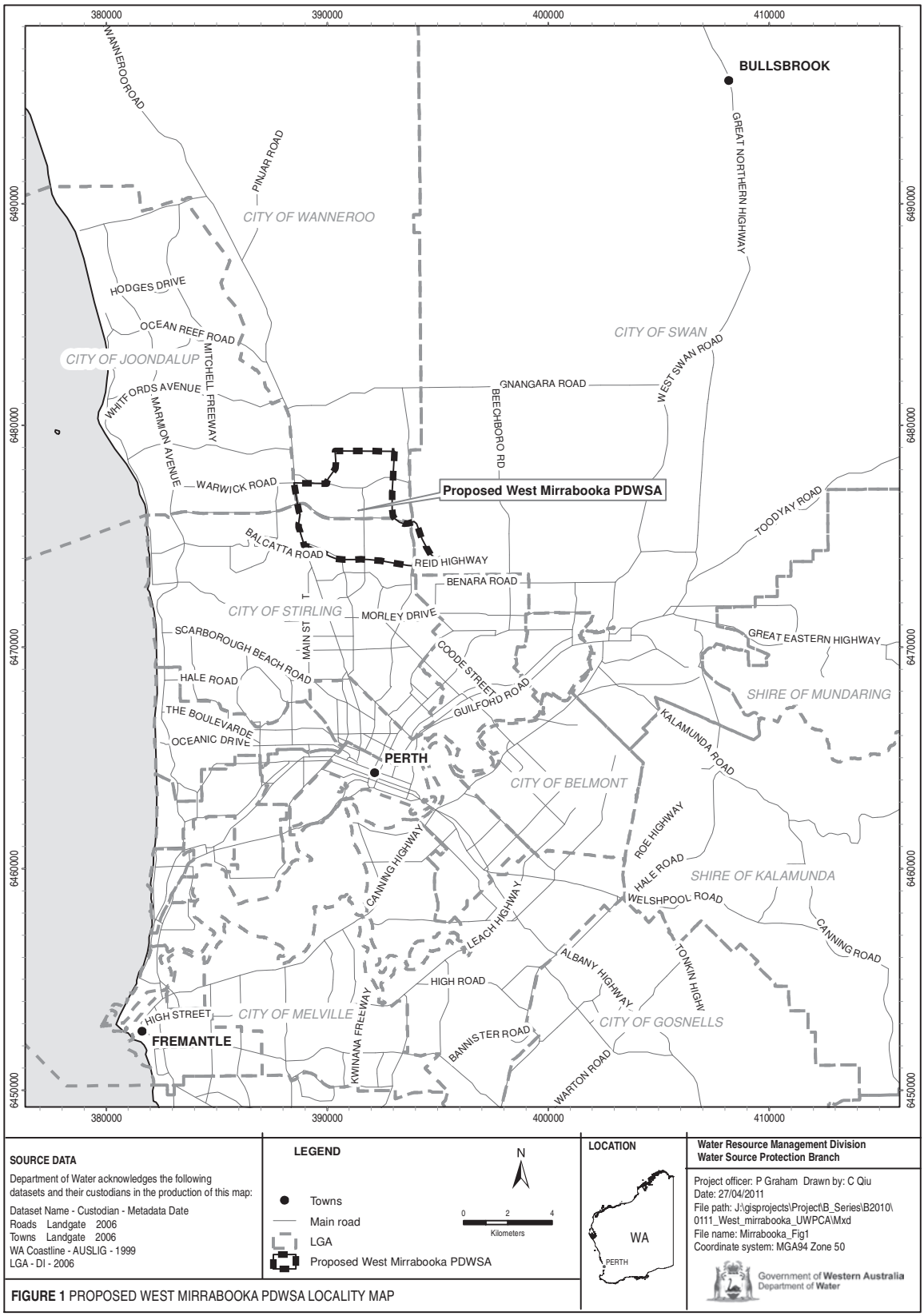

Figure 1 Proposed West Mirrabooka PDWSA locality map

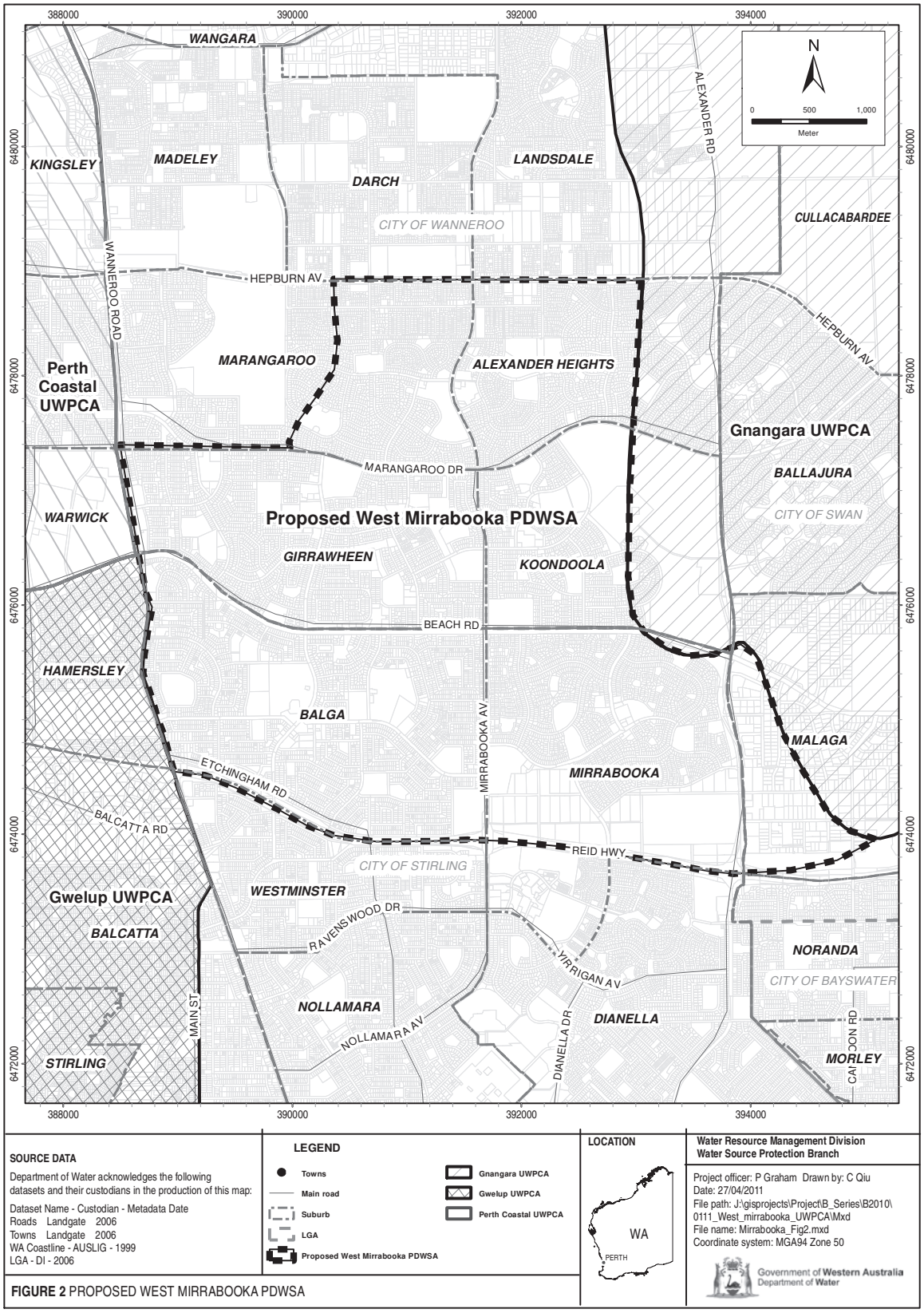

Figure 2 Proposed West Mirrabooka PDWSA

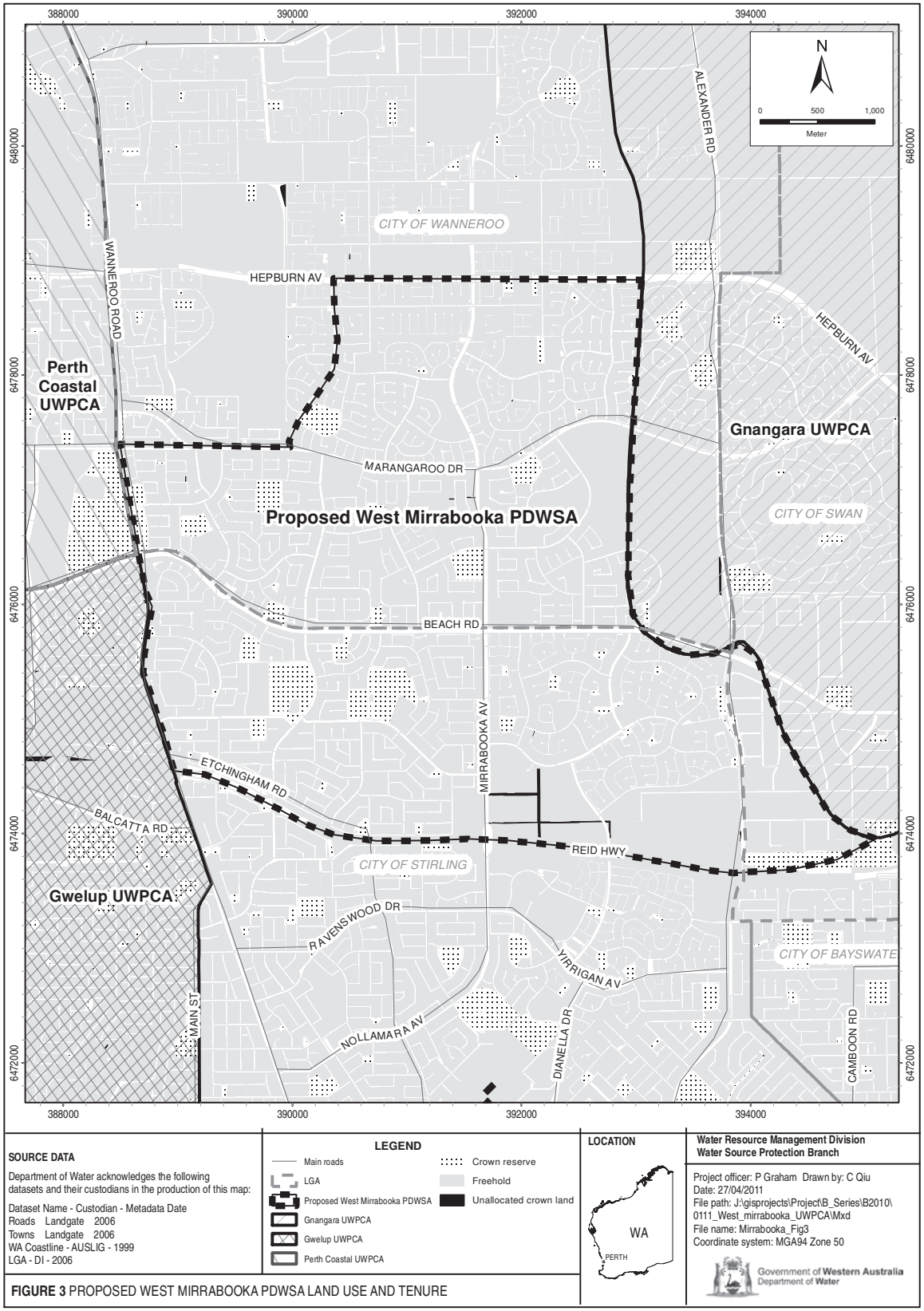

Figure 3 Land use, activities and tenure in the proposed West Mirrabooka PDWSA

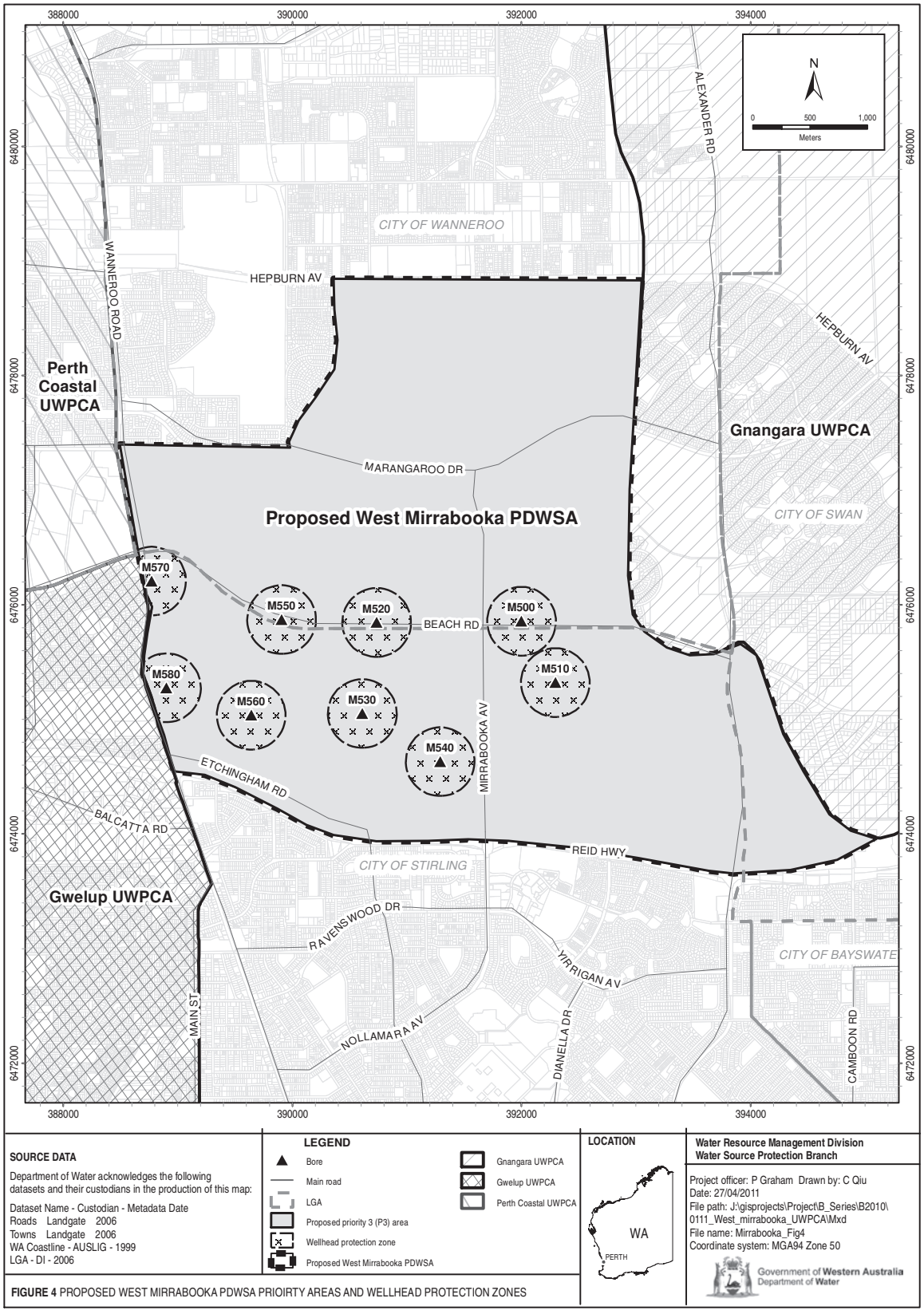

Figure 4 Proposed boundary, priority area and wellhead protection zones for the proposed West Mirrabooka PDWSA

Appendix B – Water quality data

The Water Corporation has monitored the raw (source) water quality from Mirrabooka bores M500 – M580 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 the Mirrabooka bores M500 – M580. 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. The raw water data is a summary of Mirrabooka bores M500 – M580 and does not take into account pumping times and rates for individual bores and shandying with other Mirrabooka bore water. Barriers such as disinfection, storage and extensive water treatment, to name a few, also 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 Mirrabooka 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 Mirrabooka bores M500 – M580 are summarised in *Table 4*.

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.

Table 3 Aesthetic-related detections for Mirrabooka bores M500 – M580

Parameter	Units	ADWG aesthetic guideline value*	Summary of Mirrabooka bores M500 – M580	
			Range	Median
Chloride	mg/L	250	81 – 105	95.5
Colour – true	TCU	15	3 – 25	11
Hardness as CaCO3	mg/L	200	57 – 190	69
Iron unfiltered	mg/L	0.3	0.146 – 4.2	0.7
Sodium	mg/L	180	48 – 63	55
Total filterable solids by summation	mg/L	500	222 – 458	264
Turbidity	NTU	5	0.4 – 35	2.6
pH measured in laboratory	No unit	6.5 - 8.5	5.81 – 7.27	6.44

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

Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

Health-related characteristics

Health parameters

Raw water from Mirrabooka bores M500 – M580 is analysed for health-related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related water quality parameters that have been measured at detectable levels in the source between December 2005 and November 2010 are summarised in *Table 5*. No health parameters exceeded the ADWG.

Table 4 Health-related detections for Mirrabooka bores M500 – M580

Parameter	Units	ADWG health guideline value*	Summary of Mirrabooka bores M500 – M580	
			Range	Median
Nitrate as nitrogen†	mg/L	11.29	<0.002 – 2.8	0.49
Nitrite as nitrogen	mg/L	0.91	<0.002 – 0.29	0.0035
Nitrite plus nitrate as nitrogen†	mg/L	11.29	<0.002 – 2.8	0.52
Manganese	mg/L	0.5	0.005 – 0.014	0.008
Sulphate	mg/L	500	15 – 35	24
Arsenic	mg/L	0.007	<0.002 – 0.004	<0.002
Barium	mg/L	0.7	0.045 – 0.085	0.06

Parameter	Units	ADWG health guideline value*	Summary of Mirrabooka bores M500 – M580	
			Range	Median
Boron	mg/L	4	<0.02 – 0.03	<0.02
Selenium	mg/L	0.01	<0.003 – 0.003	<0.003
Uranium	mg/L	0.02	<0.001 – 0.002	<0.001
Fluoride laboratory measurement	mg/L	1.5	<0.10 – 0.8	<0.10

* 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).

† The guideline value of 11.29 mg/L (as nitrogen) has been set to protect bottle fed infants under three months of age. Up to 22.58 mg/L (as nitrogen) can be safely consumed by adults and children over three months of age.

Microbiological contaminants

Routine microbiological testing of raw water samples from Mirrabooka bores M500 – M580 is currently conducted on an annual basis (weekly from the composite monitoring point for all Mirrabooka bores). *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 reviewed period of December 2005 to November 2010, *Escherichia coli* was not detected in raw water samples from Mirrabooka bores M500 – M580.

Appendix C – Photographs

Photograph 1 Bore M550 adjacent to Beach Road, in Bardsley Park

Photograph 2 Celebration Park in bore M580 WHPZ is irrigated and fertilised

Photograph 3 Bushland conservation area in bore M570 WHPZ adjacent to Wanneroo Road

Photograph 4 Fieldgate Square Reserve playground and park in bore M570 WHPZ

Photograph 5 Reid Highway forms the proposed West Mirrabooka PDWSA southern boundary

List of shortened forms

ADWG	*Australian drinking water guidelines*
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
DEC	Department of Environment and Conservation
FESA	Fire and Emergency Services Authority of Western Australia
GWTP	groundwater Treatment Plant
GL	gigalitre
IWSS	Integrated Water Supply Scheme
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
km^2	square kilometre
LEMC	local emergency management committee
m	metre
mg/L	milligrams per litre
ML	megalitre
mm	millimetre
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PDWSA	public drinking water source area
PSC 88	public sector circular number 88
TCU	true colour units
TDS	total dissolved solids
UWPCA	underground water pollution control area

WESTPLAN–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	Water quality protection note

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something.
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 & NRMMC 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 *National water quality management strategy: Australian drinking water guidelines 6*, 2004 (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this assessment'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).
Borefield	A group of bores to monitor or withdraw groundwater is referred to as a borefield.
Capture zone	Groundwater flowpaths that contribute water to groundwater abstraction bore.
Catchment	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
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.
Drinking water	Means water that is intended primarily for human consumption, but can have other domestic uses.
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 & NRMMC 2004a).
Hydrocarbon	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 science dealing with water on the land, its properties, laws, geographical distribution, etc.
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.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
MODFLOW	Three dimensional finite difference groundwater flow model developed by United States Geological Survey (USGS).
MODPATH	MODPATH is a particle tracking post-processing package that was developed to compute three-dimensional flowpaths using output from steady-state or transient groundwater flow simulations by MODFLOW. MODPATH also keeps track of the time of travel for particles moving through the groundwater system.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrient	A mineral, 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 *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticide	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 *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA).
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution.
Runoff	Water that flows over the surface from a catchment area, including streams.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.
Superficial 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.
Supply scheme	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.
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 micrometre filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulphate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 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 (sulphate) or S (sulphur) 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/ superficial 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.
Underground water pollution control area	An area defined under the *Metropolitan Water Supply Sewerage and Drainage Act 1909*, in which restrictions are put on activities which 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	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
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.

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