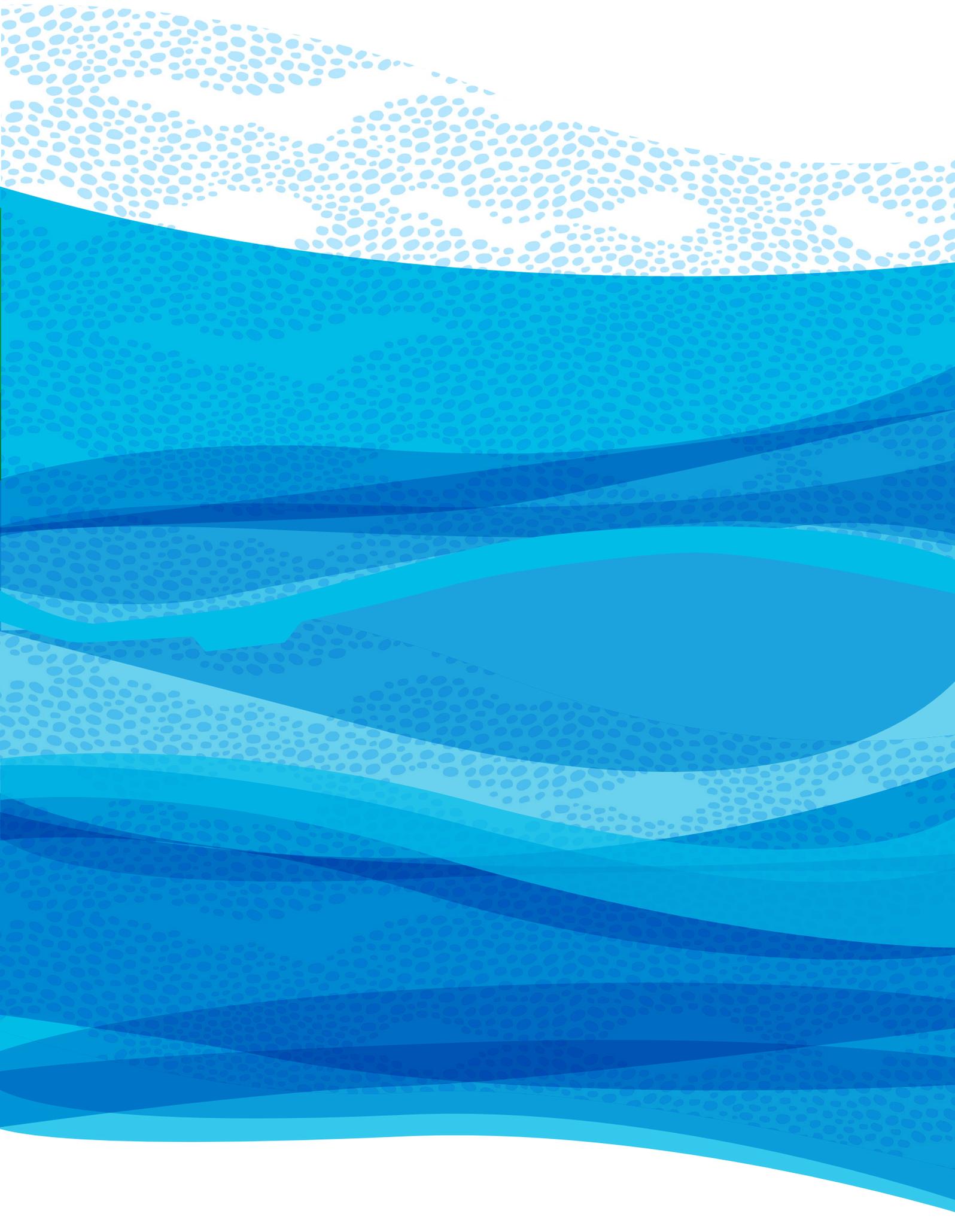


16 October 2017

SUMMARY OF GROUNDWATER STUDIES

FISHERMANS BEND



Summary of Groundwater Studies

Fishermans Bend

Client: Environment Protection Authority Victoria

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Table of Contents

1.0	Introduction	1
2.0	Findings	1
3.0	Fishermans Bend	2
	3.1 Quick Facts	2
	3.2 Timeline	2
4.0	The Fishermans Bend Taskforce	3
5.0	Role of the Environment Protection Authority	3
6.0	Why undertake a groundwater assessment?	3
	6.1 What is groundwater?	3
	6.2 Why was groundwater assessed at Fishermans Bend?	4
	6.3 What were the key objectives?	4
	6.4 Current environmental and historical land use considerations	4
7.0	Policy and legislative drivers	5
8.0	How were the groundwater studies undertaken?	5
	8.1 Staged assessment process	5
	8.2 Assessment Criteria	5
	8.2.1 Selecting Criteria	5
	8.2.2 Beneficial Use	6
	8.2.3 Element of the Environment	6
	8.3 Sampling locations	6
	8.4 Quality Assurance / Quality Control	7
	8.5 How were groundwater wells installed and sampled?	8
9.0	Next steps	9

1.0 Introduction

This document provides a summary of the Fishermans Bend groundwater studies conducted between 2015 and 2017 across the five precincts of Fishermans Bend as part of the proposed redevelopment. The studies focused on confirming the depth of groundwater and the regional groundwater quality. The technical reports can be found here at www.epa.vic.gov.au/fishermansbend. The studies aimed to understand the regional groundwater quality, and therefore did not focus on specific sources of contamination. Some contamination was identified that will need further assessment through the audit system or as part of EPA's regulatory role as development proceeds.

2.0 Findings

The key findings of the regional groundwater studies were:

- Shallow groundwater exists within fill and Port Melbourne Sands in the Fishermans Bend area to a depth of approximately 1 – 3.5 meters below ground level (mBGL).
- The variation in groundwater depth is due to the presence of former landfills/quarries, extensive underground sewer networks, former wetland areas and proximity to the Yarra River and Hobsons Bay.
- The level of groundwater protection in Victoria is based on its natural salinity or the concentration of total dissolved solids (TDS) in the groundwater. For example, the lower the salinity of the water, the more likely the water can be used for different purposes e.g. drinking water, used for watering plants, etcetera. The groundwater was measured to have a TDS ranging between 124 and 30,300 mg/L in Fishermans Bend and is classified in Victoria as an A1 segment (as defined in the State Environment Protection Policy (Groundwaters of Victoria)). This means that drinking water in the Fishermans Bend area is a protected use (including a variety of other uses as well).
- The standards or guidelines that are used to assess whether groundwater is contaminated or polluted are nationally based. The laboratory results are compared against these standards for each of the protected uses according to the individual contaminant (i.e. there are different guideline criteria for each contaminant and the different type of use). Contaminants found in the groundwater through these studies, as detailed below, are likely to preclude this use or mean that it is not suitable for drinking water. *It is always recommended that groundwater is tested by potential users to ensure it is suitable for its intended use.*
- The main contaminants found in shallow groundwater on a regional scale include: Metals (Aluminium, Arsenic, Total Chromium, Iron, Lead, Manganese, Nickel); Ammonia; Nitrate; Chloride; Fluoride, Sodium; Sulfate; Total Recoverable Hydrocarbons (TRH); and Per- and poly-fluoroalkyl substances (PFAS).
- Regional groundwater contamination has been identified beneath Fishermans Bend which may trigger further assessment during future development. A number of contaminants were found to exceed drinking water and primary contact recreational use criteria (water used for recreational purposes such as swimming). This means the groundwater is not suitable for drinking or recreational use, which may warrant regional consideration from a regulatory perspective, for example through a Groundwater Quality Restricted Use Zone (GQRUZ).
- Volatile contaminants (i.e. contaminants that easily become vapours or gases) were identified in a small number of groundwater bores, indicating localised impacts.
- Groundwater north of the Westgate Freeway is likely to discharge to the Yarra River while groundwater south of the Westgate Freeway is likely to discharge to Hobsons Bay.
- Due to the contaminants in groundwater in Fishermans Bend noted above, the following receptors and users may be impacted:
 - Aquatic ecosystems and groundwater dependent ecosystems in the Yarra River and Hobsons Bay.

- Recreational users in the Yarra River and Hobsons Bay.
- Users of groundwater for potable drinking water supply.
- Terrestrial ecology where groundwater is used for irrigation or stock watering purposes.
- There are no obvious groundwater contaminants that would constrain buildings and structures on a regional scale, however, localised impacts of chloride and sulfate do exist in parts of Fishermans Bend and will need to be considered.

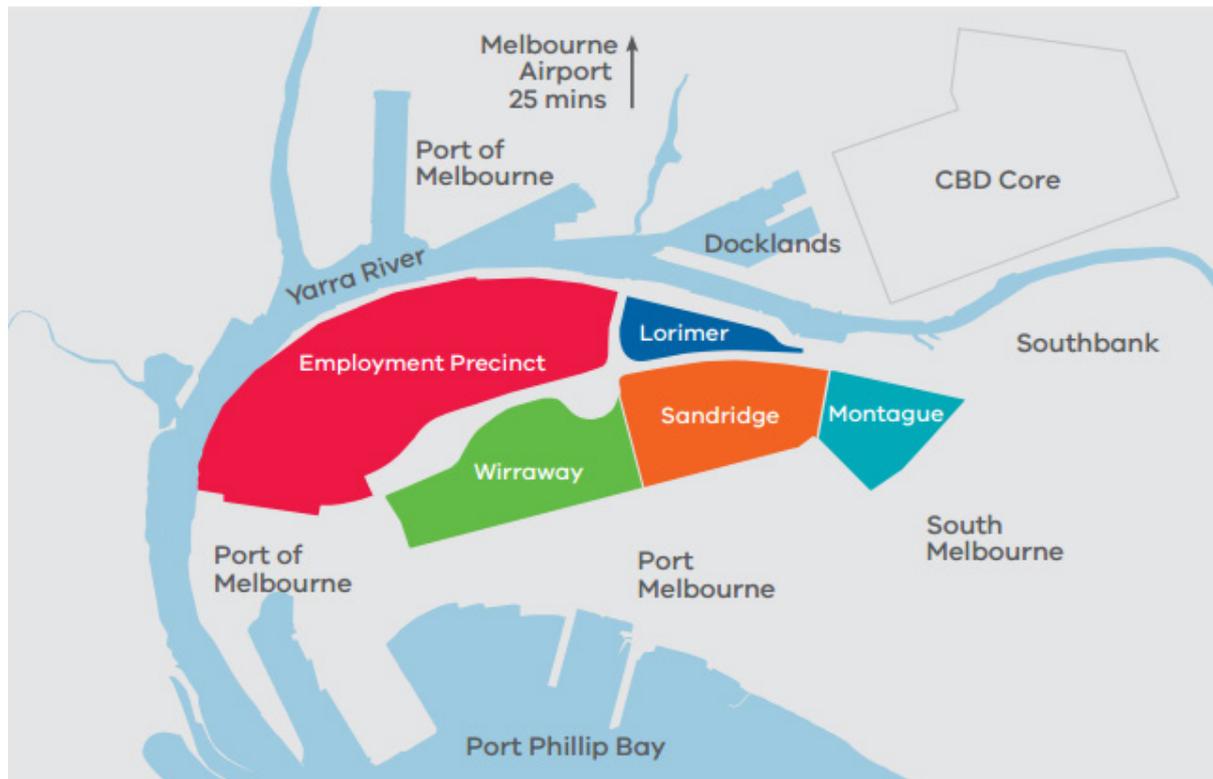
3.0 Fishermans Bend

3.1 Quick Facts

Fishermans Bend is Australia's largest urban renewal project, covering about 485 hectares in central Melbourne, south of the Yarra River.

The district will consist of five precincts across two municipalities (the cities of Melbourne and Port Phillip) and connect Melbourne's CBD to Port Phillip Bay.

It is expected that by 2050 it will be home to about 80,000 residents and provide employment for up to 60,000 people.

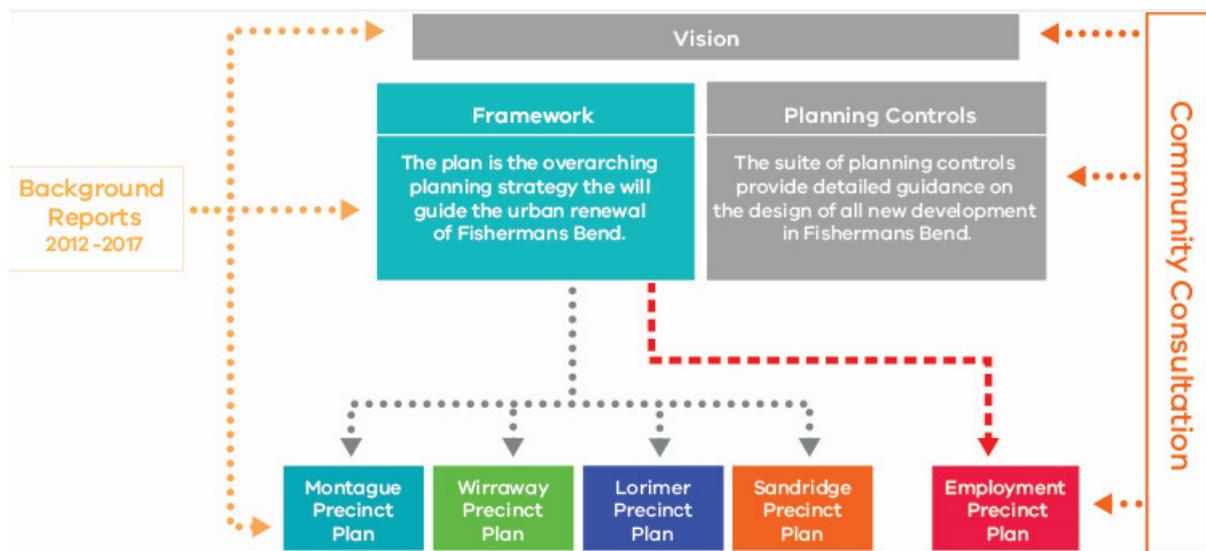


3.2 Timeline

Fishermans Bend is currently in the planning phase for redevelopment, as seen below. The final vision for Fishermans Bend was released in September 2016 following public consultation in May and June 2016. It will be used to guide the development of the Draft Fishermans Bend Framework as part of the next stage in planning.

The purpose of the Framework is to guide the planning for Fishermans Bend, including the strategies for transport, community infrastructure – services and facilities, public space, density, Aboriginal and

cultural historic heritage, activity centres and sustainability. A draft Framework will be released in Spring 2017 for public consultation.



4.0 The Fishermans Bend Taskforce

The planning for Fishermans Bend is being led by the Fishermans Bend Taskforce (the Taskforce), comprising members from the Department of Environment, Land, Water and Planning (DELWP), the Cities of Melbourne and Port Phillip, and Development Victoria.

The Taskforce was established in January 2016 to lead the planning of the area on the recommendation of the independent Ministerial Advisory Committee.

The Taskforce is working together with the Ministerial Advisory Committee, the community and stakeholders to develop a blueprint for Fishermans Bend that will transform it into a place for everyone.

Further information on the Taskforce can be found here: <http://www.fishermansbend.vic.gov.au/>.

5.0 Role of the Environment Protection Authority

In Victoria, protection of the environment is regulated by the Environment Protection Authority Victoria (EPA) which is established via the *Environment Protection Act 1970* (the Act). EPA's role is to protect the environment and people by preventing and reducing harm from pollution and waste.

The EPA provides comments on the environmental aspects of selected planning applications for proposed developments in Fishermans Bend. EPA is also helping the Fishermans Bend Taskforce with the development of some of the background reports.

As part of this, EPA has overseen the groundwater studies across Fishermans Bend since 2015. For further information, refer to: www.epa.vic.gov.au/fishermansbend.

6.0 Why undertake a groundwater assessment?

6.1 What is groundwater?

Groundwater is water that collects or flows beneath the soil surface, filling the porous spaces in soil, sand, clay and rocks. Depending on the quality of groundwater, it can be used as drinking water, for irrigation of crops (including domestic gardens) and parks, livestock water supply, industrial purposes and recreational purposes (such as filling swimming pools). These uses are referred to as beneficial uses. The lower the groundwater salinity level, the more beneficial uses must be protected as defined

in state environment protection policies. For further information on groundwater, refer to: <http://www.epa.vic.gov.au/your-environment/land-and-groundwater/groundwater-pollution>

6.2 Why was groundwater assessed at Fishermans Bend?

Groundwater conditions were assessed to:

- Identify potential regional groundwater contamination risks that may constrain development
- Provide regional groundwater quality data for consideration by EPA when regulating the area, the Environmental Audit System or clean-up processes
- Allow EPA and planning agencies to advise developers on aspects of groundwater management that may require their attention

Given the requirement to assess regional groundwater conditions, specific sites and/or point sources were not targeted during the assessments (**Section 6.3**).

6.3 What were the key objectives?

The objectives of the groundwater assessments were to:

- Summarise the results of the groundwater monitoring in Fishermans Bend
- Provide a Conceptual Site Model in relation to groundwater conditions beneath Fishermans Bend
- Determine the baseline shallow groundwater quality at Fishermans Bend
- Provide possible regional concentrations of contaminants in groundwater.
- Describe any potential point sources of contamination if they were identified
- Confirm the protected and precluded beneficial uses of shallow groundwater at the precinct
- Provide evidence for the identification of a potential regional Groundwater Quality Restricted Use Zone (GQRUZ). GQRUZs identify areas where there is known groundwater pollution as a result of previous industrial or other activities.

GQRUZs do not represent a comprehensive list of all sites where groundwater quality may not be suitable for use. Rather, they represent locations where EPA has formally recognised that groundwater is polluted, following site investigations under EPA's environmental audit system.

6.4 Current environmental and historical land use considerations

Fishermans Bend was home to many industries in the past, operating according to the standards of the time. Additionally, in some locations, old waste was used to fill in former swamps to create flat ground. Historical practices such as these present challenges when planning to develop land for residential and sensitive uses because land and groundwater may be contaminated.

Prior to European settlement, the area was a mix of swamp and wetlands. However, post European settlement, the area has been extensively modified and influenced by historical filling across the entire area. This filling was typically uncontrolled, but at times was also associated with land reclamation activities as the area was being prepared for future development.

The average depth of groundwater is approximately two metres below ground surface, and as such, it is influenced by natural and introduced pathways for contamination to potentially move through. Examples of these pathways include sewer lines, filled quarries, former swamps and low-lying wetlands that have since been filled.

Historical and current uses have the potential to impact the quality of underlying soils and groundwater.

7.0 Policy and legislative drivers

All groundwater assessment works were conducted in accordance with applicable acts, policies, guidance documents and industry standards.

The primary publications referenced and adhered to during the assessment process include the following:

- *Environment Protection Act 1970*
- National Environment Protection Council (as amended 2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure* (NEPM, as amended 2013)
- *Planning and Environment Act 1987*, Section 12(2) (a) Ministerial Direction No1, September 2001
- Potentially contaminated land, general practice note, June 2005 (Department of Sustainability and Environment, now Department of Environment, Land, Water and Planning)
- State Environment Protection Policy (Prevention and Management of Contamination of Land) 2002, varied 2013
- State Environment Protection Policy (Groundwaters of Victoria) 1997, varied 2002
- State Environment Protection Policy (Waters of Victoria), varied June 2003
- EPA Publication 759.3 *Environmental auditor (contaminated land): Guidelines for issue of certificates and statements of environmental audit* (December 2015)
- EPA Publication 840.2 *The Clean Up and Management of Polluted Groundwater* (April 2016)
- EPA Publication 862 *Groundwater Quality Restricted Use Zone* (July 2002)
- For further detail on the above publications and how they were applied during groundwater assessment works, refer to the technical reports found at: www.epa.vic.gov.au/fishermansbend.

8.0 How were the groundwater studies undertaken?

8.1 Staged assessment process

Desktop studies were undertaken prior to groundwater well installation and sampling to establish key factors that may be influencing shallow groundwater on a regional scale e.g. the regional geology and hydrogeology, historical land use and site activities, potential contaminants of concern, location of underground services, etc.) This work was essential to assist in the development of a sampling pattern across Fishermans Bend. The full Desktop Reports can be read here: www.epa.vic.gov.au/fishermansbend.

Following the desktop study phase, and well installation works, four groundwater sampling events were undertaken across Fishermans Bend between 2015 and 2017.

8.2 Assessment Criteria

In accordance with the State Environmental Protection Policy Groundwaters of Victoria (SEPP (GoV)), groundwater quality objectives (i.e. assessment criteria) were primarily sourced from the Australian Water Quality Guidelines for Fresh and Marine Waters, published by the Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ, 2000).

8.2.1 Selecting Criteria

The selection of assessment criteria for this project was based on the consideration of any possible **beneficial use** (**Section 8.2.2**) that may be protected.

Note that the adopted existing guidelines for the protection of beneficial uses (assessment criteria) are preliminary values that were developed using conservative assumptions that may not represent actual conditions at every location across Fishermans Bend. Exceeding the assessment values for a specific

chemical does not necessarily indicate that the impact poses significant human health or environmental concerns, only that additional evaluation is warranted.

8.2.2 Beneficial Use

In accordance with the *Environment Protection Act (1970)*, **beneficial use** means a use of the environment or any **element (Section 8.2.3)** or segment of the environment which is:

- Conducive to public benefit, welfare, safety, health or aesthetic enjoyment and which requires protection from the effects of waste discharges, emissions or deposits or of the emission of noise, or:
- Declared in a State Environment Protection Policy (SEPP) to be a beneficial use.

The SEPP GoV defines **beneficial uses** of groundwater on the basis of the classification of a groundwater segment which is based on background salinity, measured as total dissolved solids (TDS). The TDS or salinity values in Fishermans Bend indicated that the applicable segment is Segment A1 (i.e. TDS 0 – 500mg/L). This means that groundwater is protected for the following beneficial uses as defined in the SEPP (GoV):

- Maintenance of ecosystems [e.g. ecosystems that exist in surface or marine water environment]
- Potable water supply (desirable) [e.g. drinking water]
- Potable mineral water supply [e.g. drinking water]
- Agricultural, parks and gardens [e.g. irrigation of crops (including domestic gardens) and parks]
- Stock watering [e.g. livestock water supply]
- Industrial water use [e.g. water used for industrial purposes]
- Primary contact recreation (e.g. bathing, swimming) [e.g. water used for recreational purposes such as swimming]
- Buildings and structures

8.2.3 Element of the Environment

In accordance with the *Environment Protection Act (1970)*, an **element** of the environment may include land, water, atmosphere, vegetation, climate, sound, odour, aesthetics, fish and/or wildlife. The relevant elements for the Fishermans Bend Groundwater studies are considered to be the following:

- Land across at the site.
- Groundwater beneath the surface of the site and down-hydraulic gradient of the site.
- Surface waters connected to groundwater and/or receiving runoff from the site.

8.3 Sampling locations

8.3.1 How many wells were installed?

The vast majority of groundwater sampling locations were within public land, however, on occasion, assessment was undertaken on private property with the owner's permission due to large land holdings, particularly in the Employment Precinct.

The complete well network consisted of 79 wells, which included 16 pre-existing wells and 63 new wells installed as part of this project.

Five (5) of the 63 newly installed wells were installed on private land, which involved consultation with land owners prior to works. All of the remaining wells were installed in public land.

Note that owners of pre-existing wells were also consulted prior to sampling.

8.3.2 Grid sampling design

A probability-based square grid sampling design was adopted across Fishermans Bend based on the following advantages:

- Designs are unbiased
- Ability to calculate uncertainty associated with estimates
- Reproducible results within uncertainty limits
- Ability to make statistical inferences
- Can handle decision error criteria
- Grid sampling can be used to infer means, percentiles or other parameters and is also useful for defining spatial patterns or trends over time.

Given the presence of large land holdings such as GM Holden (GMH), Boeing, Defence Science and Technology Group (DSTG) and Parks Victoria that represent a combined area of approximately 43% of the Employment Precinct, the number of privately owned roads and the presence of extensive underground/overhead services, some locations needed to be adjusted slightly. Every effort was made to place groundwater well locations within each grid, however, some wells could not be installed due to safety reasons or access constraints. As seen in **Plate 1**, each grid was 250mx250m in area, and 1 well was sampled every 6 hectares (on average).

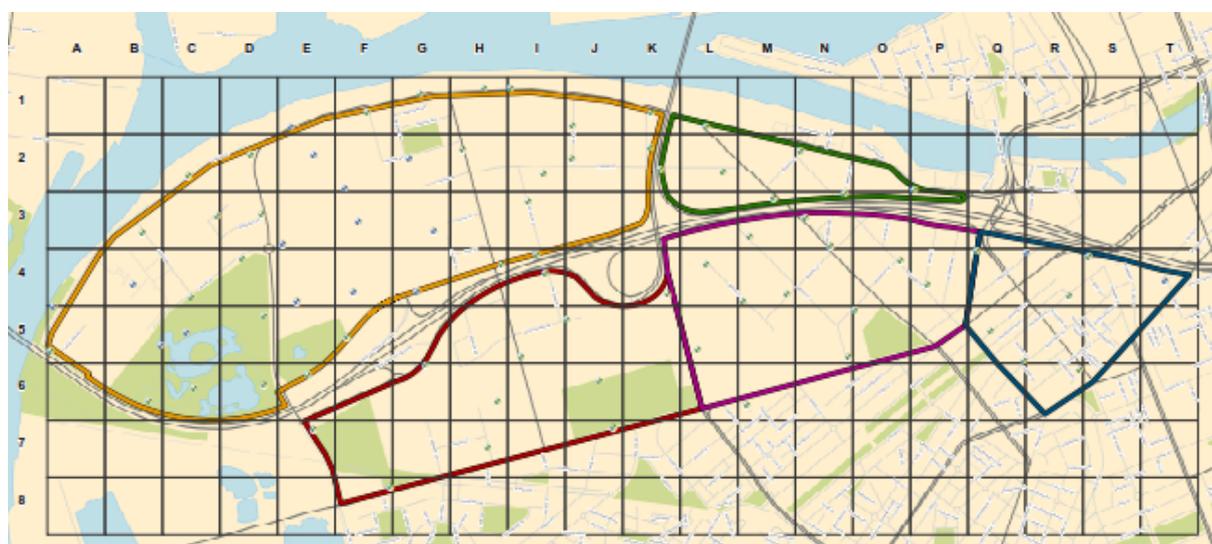


Plate 1 Probability-based square grid sampling design

8.4 Quality Assurance / Quality Control

Quality assurance/quality control (QA/QC) procedures were conducted in general accordance with EPA Publication 669 (Groundwater Sampling Guidelines) (EPA, 2000), Industrial Waste Guidelines, Publication IWRG701 (Sampling and Analysis of Waters, Wastewaters, Soils and Wastes) (EPA, 2009), National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) and Australian Standards (AS4482.1).

The full groundwater studies reports provide a detailed evaluation of the QA/QC process, which included review of work plans (i.e. sampling rationale), qualification of field staff, sample preservation, suitability of analytical suite, accreditation of the laboratories used, decontamination procedures, suitability of sampling methodology, equipment calibration, chain of custody documentation, QA/QC sampling, sampling holding times.

Overall, the number of samples collected, the chemicals analysed, and the sampling procedures followed were considered sufficient for the purposes of each study.

8.5 How were groundwater wells installed and sampled?

Groundwater monitoring wells were constructed in accordance with the *Minimum construction requirements for water bores in Australia – Edition 3* (National Uniform Drillers Licensing Committee 2012) and the NEPM (as amended 2013).

Bore construction permits were obtained from the licensing authority (Southern Rural Water) prior to installation.

All groundwater wells were installed to depths ranging between 4.0 and 5.0mBGL, using multiple drill rigs. See **Plate 2** below for a typical well construction at Fishermans Bend.

Underground services were cleared at every location to at least 1.5mBGL using non-destructive digging techniques prior to the commencement of mechanical drilling.

All soil cuttings and waste water derived from drilling was placed in appropriate labelled 200 litre drums, manifested and then removed by a licensed waste contractor.

Following groundwater well drilling and installation, a surveying contractor recorded the locations and elevations of the top of casing and ground surface at each location to calculate groundwater levels.

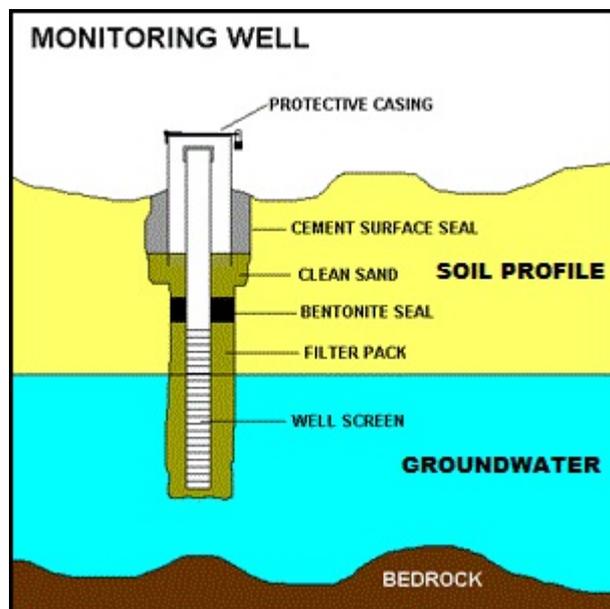


Plate 2 Typical well construction at Fishermans Bend

8.5.1 Soil Sampling and limited analysis of soil samples

Visual assessment and measurement of volatile gases within fill material and soil was undertaken at multiple depths within each groundwater well location during well installation to assess fill/soil type across the area.

Observations of anthropogenic materials (e.g. waste) and field evidence of contamination (i.e. staining and/or odour) were noted. All soil observations were recorded on AECOM's standard field groundwater bore log sheets for uniformity in descriptions.

In addition, soil samples were collected for the purpose of laboratory analysis at various depths within approximately 15% of locations (in an approximately even spacing across Fishermans Bend) to establish a preliminary soil data set within common fill types in the study area.

This soil data was obtained to act as a possible reference point at locations where elevated concentrations of contaminants within groundwater were identified. The soil results are compared to applicable guidelines within each of the full reports, however, no further interpretation of soil data was conducted. The project should be considered as a group of baseline groundwater assessments (only), with opportunistic soil samples collected concurrently.

9.0 Next steps

The results of these groundwater studies will be used by EPA and the Fishermans Bend Taskforce to assess any potential regional constraints to development, which will ultimately be considered when developing precinct plans and infrastructure plans.

EPA is currently reviewing the information gained through the Fishermans Bend groundwater studies with the aim of identifying a GQRUZ over the area.

EPA will also be reviewing the information to confirm any potential point sources and to determine if further investigation of the results is required. Environmental Audits, as triggered by the audit system, will occur on sites as development occurs across the area.

As it becomes available, more information will be provided on the EPA's Fishermans Bend website: www.epa.vic.gov.au/fishermansbend.

