

Environment Protection Authority

Groundwater Prohibition Area – Allenby Gardens/Flinders Park

EPA determination report October 2014

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Abbreviations

(The) Act	<i>Environment Protection Act 1993</i>
COC	contaminants of concern
DENR	Department for Environment and Natural Resources
DEWNR	Department of Environment, Water and Natural Resources
DHA	Department of Health and Ageing
DMITRE	Department for Manufacturing, Innovation, Trade, Resource and Energy
EPA	South Australian Environment Protection Authority
GMMP	groundwater monitoring and management program
GPA	Groundwater Prohibition Area
MTS	Moorfield Terrace site (source site)
PCA	potentially contaminating activity
REM	Resource and Environmental Management Pty Ltd (environmental consultants)
TCE	trichloroethene (a contaminant of concern)
WHO	World Health Organization

Summary

The Environment Protection Authority (EPA) prepared this report to provide information regarding the groundwater prohibition area (GPA) established in Allenby Gardens and Flinders Park on 13 June 2013 ([Appendix 3](#)).

This report provides the technical information utilised and the process undertaken by the EPA in establishing the GPA.

This report describes:

- the purpose of a groundwater prohibition area ([section 1](#))
- legislation ([section 2](#))
- source of groundwater contamination ([section 3](#))
- EPA groundwater prohibition area investigations ([section 4](#))
- community information program
- conclusion ([section 5](#)).

1 Introduction

1.1 Background

The amendments to the *Environment Protection Act 1993* (the Act), through the *Environment Protection (Site Contamination) Amendment Act 2007*, established the legislative framework for managing site contamination in South Australia, including provisions which enable the EPA to prohibit or restrict the use of groundwater.

Section 103S (Table 1) of the Act enables the EPA to prohibit or restrict the use of groundwater where there is site contamination that affects or threatens groundwater, and take necessary action to prevent actual or potential harm to human health or safety.

If groundwater is affected by contamination and there is the likelihood that it may be used for domestic or irrigation purposes, then the consideration for the establishment of a groundwater prohibition or restriction area is warranted.

The establishment of a groundwater prohibition area (GPA) can eliminate the pathway between the groundwater contamination and human contact and prevent or eliminate human exposure to the contaminants of concern. A GPA provides a regulatory long-term solution in which the use of groundwater is prohibited for any purpose, with the exception for groundwater monitoring, and eliminating human exposure to contaminated groundwater.

1.2 Groundwater Prohibition Area

The EPA established a GPA in the Allenby Gardens and Flinders Park area (Figures 1 and 2) on 13 June 2013 by notice in the Government Gazette ([Appendix 3](#)).

Groundwater from the first and second quaternary aquifers (0–30 m below the ground surface) was prohibited to be used for any purpose, with the exception of groundwater monitoring purposes in the identified area.

Under the Act, a maximum penalty¹ of \$8,000 applies ([Appendix 4](#)). Figure 2 identifies the Allenby Gardens and Flinders Park groundwater prohibition area.

Today, in South Australia, groundwater is widely regarded of as an important supplementary resource to mains and rain water resources. With the variability of a constant supply of reservoir water in SA, there is an increasing demand on groundwater for domestic and market garden purposes. The risk of human exposure to pollutants that may exist in the groundwater also increases. Groundwater contamination arising from point sources and diffuse sources within the aquifers can threaten the health of a whole aquifer system and the health of the environment and potential groundwater users (Figure 3).

¹ At the time of publication of this report

2 Legislation

2.1 Water prohibition or restriction

Section 103S of the Act outlines the legislative framework for the establishment of a water prohibition or restriction area, where contamination of groundwater represents an unacceptable risk to human health and safety.

Table 1 Section 103S

Section 103S – Prohibition or restriction on taking water affected by site contamination
<p>(1) If the Authority is satisfied that –</p> <ul style="list-style-type: none"> (a) there is contamination that affects or threatens water; and (b) action is necessary under this section to prevent actual or potential harm to human health or safety, the Authority may, by notice in the Gazette, prohibit or restrict the taking of the water. <p>(2) A notice under this section must –</p> <ul style="list-style-type: none"> (a) specify the water to which it relates; and (b) give particulars of the site contamination affecting the water. <p>(3) A person must not contravene a notice under this section. Penalty: Division 4 fine.</p> <p>(4) The Authority may, by notice in the Gazette, vary or revoke a notice under this section.</p>

2.2 Liability for site contamination

Sections 103C–G of the Act describes who can be considered liable for site contamination.

3 Groundwater contamination source site

3.1 Site history

The suburbs of Allenby Gardens and Flinders Park were established along the banks of the River Torrens in 1922. Prior to the development of residential and industrial areas, this land north and south of the River Torrens was primarily used for the growing of market produce (Plate 1).

In the 1820s, with the commencement of mechanical brick manufacturing in South Australia (DENR 1998), large quarry pits, otherwise known as 'pug holes', were excavated for clay for the production of clay bricks, primarily in the Bowden and Brompton suburbs (Plate 2).

With the increase in clay brick manufacturing in Adelaide, the land utilised for the excavation of clay material progressively move west along the River Torrens. The 1920s saw the commencement of clay pit excavations at 24 Moorfield Terrace, Allenby Gardens and in other surrounding areas. The southern section of the Moorfield Terrace site (MTS) was never quarried and remained as a market garden area until 1963. The southern portion of the site was then developed for vehicle storage and a scrap yard.

From the mid-1960s to 1990 the depleted clay quarry pit at Moorefield Terrace was back filled with industrial waste material, which included oils and solvents (Plate 3 and Figure 5). Due to the breakdown of the disposed waste material in the clay pits, chemicals have leached from the clay pits into the groundwater and over time moved northwesterly, down groundwater hydraulic gradient, towards the ocean.

The liability for ongoing groundwater monitoring of the contaminant plume arising from the source site is with the original polluters and/or the current owners of the site. The EPA is currently requiring on-site groundwater monitoring by the source site owners as stipulated in the groundwater monitoring and management program (GMMP) (March 2009). Between October 2012 and October 2013, the EPA had not required off-site groundwater monitoring as it was unclear, at the time, who had liability for the off-site contamination. The EPA has investigated the statutory liability of the historic contamination arising from the MTS and off-site groundwater monitoring recommenced in accordance with the GMMP in October 2013.

3.2 Environmental assessments

Intrusive environmental assessments undertaken in relation to the MTS has identified groundwater contamination at the site and off-site locations. These investigations commenced with the initiation of a proposed residential development for the MTS (source site). Reports available on the Public Register are recorded in Table 2. For further information on viewing or obtaining the reports outlined above, contact by telephone 08 8204 2004 or 1800 623 445 (free call for country users) or www.epa.sa.gov.au. Further information may become available on the Public Register after the completion of site associated works.

Table 2 Reports available on the EPA Public Register

Report title	Date of completed report
Site history, property located at Hallett St, Welland	Prepared by Golder Associates, 18 October 1994
Environmental site assessment – Lot 3, Moorefield Drive, Welland	Prepared by Resource and Environmental Management, 8 September 2004
Draft Additional Groundwater Investigation Program – Lot 3, Moorefield Drive, Welland	Prepared by Resource and Environmental Management, 11 March 2005
Groundwater Flow and Contaminant Fate and Solute Transport Modelling – Lot 3 Moorefield Drive, Welland	Prepared by Resource and Environmental Management, 8 November 2005

Report title	Date of completed report
Remediation Action Plan – Lot 3, Moorefield Drive, Welland	Prepared by Resource and Environmental Management, 18 January 2006
Site Audit Report – Lot 3, Moorefield Terrace, Allenby Gardens. RA Graham (Environmental Auditor)	Prepared by Sinclair Knight Merz, 30 June 2009
Groundwater monitoring event (2010) – Lot 3 Moorefield Tce, Allenby Gardens	Prepared by Sinclair Knight Merz, 30 August 2010
2011 Groundwater Monitoring Event, Lot 3 Moorfield Tce, Allenby Gardens	Prepared by Land and Water Consulting, 28 Nov 2011
Site Contamination Audit Report – Former Building 12, Flinders Park Primary School SA. Adrian Hall (Site Contamination Auditor, accredited by the EPA under Division 4 of Part 10A of the Act)	Prepared by GHD, 11 April 2011

The *Site Contamination Audit Report – Former Building 12, Flinders Park Primary School SA* (April 2011) was not prepared in relation to the MTS. However, information within this report was relevant to the determination of the GPA.

To ensure the MTS was suitable for residential development, an environmental auditor was engaged to prepare a site audit report completed on 30 June 2009 (refer to the summary in [Appendix 2](#)).

3.3 Groundwater monitoring events

When contamination of groundwater was identified within the vicinity of the MTS, the quality of the local groundwater or aquifer was impacted and the risk to potential users of that groundwater was also determined to exist. Due to the physical and hydrogeological characteristics of an aquifer system, the removal of the source of contamination in the soil, for example historical landfill materials that are causing the leaching of hydrocarbons, will not remove the contamination from the groundwater.

In accordance with the EPA Groundwater Assessment and Remediation guideline, where site contamination exists that is not trivial, implementation of groundwater assessment and remediation is necessary. The assessment component will generally comprise a site history investigation, characterisation of the geology and aquifer systems, and investigation of the site contamination, including contaminants of concern (COC) and a human health risk assessment.

The remediation of the groundwater contamination is a significant process in eliminating or preventing harm to human health or safety. While full removal of the chemical substances (contaminants) in the water is ideal for the eventual recovery of a groundwater aquifer system, various interim protection measures can be actively employed to reduce human exposure from contaminated groundwater.

The source in the pug hole has been removed to the satisfaction of the site auditor ([Appendix 2](#) and Plate 4). However, it was not practical or financially viable, with current technology, to remove the chemicals from the groundwater. As such, the only option remaining is to allow natural processes to reduce the concentration, mass and toxicity of the chemicals over time. REM (2005) estimates that this will occur by 2050. Monitoring to confirm that these processes are occurring is also required. It is, however, very important to prevent human exposure to these chemicals. The best statutory tool available to the EPA is to prohibit persons from accessing groundwater. This protection measure is the establishment of a groundwater prohibition area (GPA).

4 EPA Groundwater Prohibition Area – Determination

This section describes the conceptual site model of the MTS and the surrounding area potentially affected by site contamination.

The EPA investigation into the proposed establishment of the GPA involved the development of a conceptual site model (Figures 4, 5 and 6) which comprised the following:

- A desktop study for historical potentially contaminating activities (PCAs).
- Summary of regional hydrogeology.
- Characterising contaminants of concern (COCs), nature of groundwater contamination.
- Local hydrogeology, extent of groundwater contamination.
- Considering areas of specific aquifer conditions.
- Determining groundwater quality, including seasonal variations and surface water influences.
- Identifying current and future beneficial uses.
- Identifying exposure pathways (i.e. the existence of private wells within the proposed GPA).
- A human health and safety risk assessment.

The figures show the conceptual model developed throughout the investigations for the MTS.

4.1 Historical potentially contaminating activities

The environment assessment reports prepared in relation to the source site document the PCAs that were undertaken at the site. A summary is provided in [Section 3](#). For further details regarding the site history, refer to Table 2 where the reports listed are available on the EPA Public Register.

4.2 Summary of regional hydrogeology

On the Adelaide Plains (Metropolitan Adelaide) the groundwater system (aquifers) exist within the inter-bedded Quaternary sands, gravels, silts and clays that are deposited along the Torrens River channel and across the plains (REM 2004). The six Quaternary aquifers, named Q1–Q6, reside within the sand and gravels beds and are separated by the low permeability silts and clays of the Hindmarsh Clay (Figure 7).

Underlying the Quaternary sediments are the Tertiary sandstone and limestone sedimentary sequence. The Tertiary aquifers, within this sequence, are confined beneath the overlying thick Hindmarsh Clay unit. The first Tertiary aquifer (T1) comprises the Hallett Cove Sandstone and the second Tertiary aquifer (T2) comprises the Port Willunga Formation, separated by the Munno Para Clay ([Appendix 5](#)).

Groundwater generally flows through the aquifers of the Adelaide Plains from the Mount Lofty Ranges in the east to the Spencer Gulf in the west where groundwater discharge occurs. Figure 7 shows a general model of the groundwater movement across the Adelaide Plains.

4.3 Contaminants of concern

4.3.1 Nature of groundwater contamination

Chlorinated solvents are the contaminants of concern (COC) within the Allenby Gardens/Flinders Park GPA. Chlorinated solvents include tetrachloroethene (PCE), trichloroethene (TCE), 1–2 cis dichloroethene (DCE) and vinyl chloride (VC). They are industrial chemicals used widely for metal cleaning and in production of thermoplastics, lacquers, perfumes and polyvinylchloride (PVC) products (SA Health 2004). More information can be found in [Appendix 6](#).

In the past, PCE and TCE were used in dry cleaning, while TCE, a colourless, non-flammable, volatile liquid, and with a characteristic slightly sweet odour is mainly used as an industrial solvent in a variety of industries, primarily metal degreasing and cleaning operations. TCE can also be found in some household products, including correction fluid, paint removers, adhesives and spot removers. TCE has been used as a carrier solvent for the active ingredients of insecticides and fungicides, as a solvent for waxes, fats, resins and oils; and an anaesthetic for medical and dental use. It has also been used to extract spice oleoresins and caffeine from coffee (NEPM 1999).

TCE was manufactured in Australia for approximately 30 years from the early 1950s to the early 1980s. At present TCE is imported into Australia mainly as a degreasing agent.

When released to the environment TCE can leach through soil into groundwater where it may persist for years depending on soil, microbial and aquifer conditions. Depending on these conditions, reductive dehalogenation to vinyl chloride may occur. Under anaerobic conditions TCE can be intrinsically biodegraded to form DCE and VC.

Limited data is available on the potential for TCE to be taken up by home-grown produce. According to the US Agency for Toxic Substances and Disease Registry or ATSDR (1997), TCE has been detected in small amounts in fruit and vegetables, suggesting a potential for limited phytoaccumulation. Laboratory studies of carrot and radish plants with radioactively labelled TCE (Schroll *et al* 1994) showed some uptake, but it is noted that the experiment indicated that uptake mainly occurred through the foliage (from the air) as opposed to the roots in these plants (with subsequent translocation throughout the plant tissue). Schnabel *et al* (1997) looked at the uptake of TCE in edible garden plants (carrots, spinach and tomatoes) and identified that TCE, when taken up was transformed and bound to plant tissue in a form that was less toxic than the parent compound (NEPM 1999).

The International Agency for Research on Cancer or IARC (1995) has classified TCE as Group 2A—probably carcinogenic to humans. A review by the US EPA (2011) characterised TCE as carcinogenic in humans by all routes of exposure. The WHO (2011) considers TCE to be carcinogenic via all routes of exposure.

4.4 Local hydrogeology and site contamination

4.4.1 Extent of groundwater contamination

Characterisation of known site contamination was investigated to determine the nature and extent of groundwater contamination arising from a known source at the MTS. As part of these investigations, all relevant reports (Table 2) were reviewed by the EPA. Among them, the environmental site audit report, site contamination audit report for the removal of a building at the Flinders Park Primary School and several groundwater monitoring reports undertaken by site contamination consultants between 2004 and 2011. From the overall 25 groundwater monitoring bores and one residential bore, within the environmental assessment area of Allenby Gardens and Flinders Park, and available reports, an understanding of groundwater contaminant movement in the area was determined.

The auditor for the MTS considered that the extent of the groundwater contamination had been adequately delineated and that the contaminated groundwater plume is approaching steady state. Groundwater monitoring events, after soil remediation, have also documented that the nature and extent has not changed considerably.

4.4.2 Specific aquifer conditions, the Quaternary Aquifers (Q1 and Q2)

The groundwater assessments by REM prior to, during and post the soil remediation program (Plates 3 and 4), were conducted to the satisfaction of the site auditor. The groundwater assessments by Land and Water Consulting (LWC) after the soil remediation program were conducted generally to the satisfaction of the EPA.

The EPA groundwater assessment program included desktop investigations into site hydrogeological conditions and groundwater contamination. Hydrogeological investigations at the MTS and immediate surrounding area revealed that the unconfined Q1 aquifer forms the water table in the Allenby Gardens/Flinders Park area. This aquifer has been observed, through groundwater drilling and trench excavations, to occur at a depth of approximately 9–10.5 m below ground level (mbgl). The unconfined Q1 aquifer sits at approximately 0–2 metres below the base of the 9-metre deep pug hole (Plate

4). Records obtained by the EPA from the City of Charles Sturt document that during the operational period of the landfill, water was commonly observed pooling on the bottom of the pughole, indicating that the groundwater may have had surface expression at the base of the pughole.

4.4.3 Groundwater quality

Salinities measured during groundwater monitoring events within the Q1 aquifer range from approximately 1,000 mg/L to 2,500 mg/L (TDS*). The semi-confined Q2 aquifer in Allenby Gardens has been observed at 22 mbgl, through the drilling of a deep well (Q2), with a potentiometric surface at 10 mbgl. This is similar to the standing water level of the unconfined water table aquifer, Q1, indicating that there is no significant pressure head difference between the Q1 and Q2.

Losses from the groundwater system due to evapotranspiration from groundwater are not considered to be a significant discharge mechanism in the catchment because groundwater levels are generally below the extinction depth of the vegetation root zone.

4.4.4 Surface water influences

In 2004 REM investigated the relationship between the salinity levels of the River Torrens and the first and second Quaternary aquifers (Q1 and Q2). Groundwater monitoring investigations undertaken in the Allenby Gardens/ Flinders Park area have shown that the salinity increases down hydraulic gradient from the River Torrens (right bank, moving northwest). The varying salinities within the unconfined Q1 aquifer in the area in close proximity of the River Torrens indicates that the area is probably a mixing zone between the less saline water of the River Torrens (1,000 mg/L* TDS) and the more saline regional groundwater (2,500 mg/L* TDS) [REM 2004]. Losses from the unconfined Q1 aquifer in the area due to evapotranspiration are not considered to be significant due to groundwater levels generally below the extinction depth of the vegetation root zone.

Groundwater sample from the Q2 aquifer is more chloride dominated, indicating that there is no mixing at this location between this aquifer and the River Torrens.

* TDS is calculated by applying a factor of 650 to the electrical conductivity recorded data (REM 2004).

4.4.5 Contaminant transport modelling

REM also undertook groundwater monitoring of the Q1 and Q2 aquifers in the area to determine the hydraulic parameters of the groundwater. After preliminary investigations, REM was further engaged to undertake groundwater flow and solute transport modelling for the COC within both aquifers in the area. The contaminant transport modelling process was primarily used to simulate contaminant transport at the MTS and down hydraulic gradient of the pughole.

The principal objectives of the groundwater flow and solute transport modelling assessed:

- the influence of groundwater contamination with source removal by removing pughole fill material, on the down hydraulic gradient extent of contaminant plume
- the impact of groundwater contamination with trichloroethene (TCE) in the down hydraulic direction of the site.
- the potential beneficial impact of pumping groundwater from the first Quaternary aquifer on site, as part of the remedial measures recommended for site rehabilitation

The first modelling scenario predicted that if pughole soil remediation was implemented, the chlorinated hydrocarbons would be expected to cease being contaminants of concern by 2050. This is the remediation option that was adopted for the MTS.

4.5 Current and future environmental values

In the area of Allenby Gardens and Flinders Park there are 39 registered groundwater wells or bores that access the groundwater from the unconfined aquifer (Q1) and three wells installed in the deeper semi-confined aquifer (Q2) within the proposed prohibition area. The groundwater, when uncontaminated, contains 1,850 mg/L of total dissolved solids and has an average abstraction yield of 1 L/sec. This means the groundwater was considered potentially suitable as a domestic water and domestic irrigation supply. Groundwater in this area has been used for gardening (including watering home grown produce), lawn watering, filling of swimming pools and grey water use, such as toilet flushing.

4.6 Determination of the groundwater prohibition area

To meet the legislative requirements to determine and establish the groundwater prohibition area the EPA required information that documents the existence of site contamination.

4.6.1 Nature of groundwater contamination

To determine lateral and vertical extent of groundwater contamination within the proposed prohibition area the EPA utilised information contained in various environmental assessment reports (refer to Table 2). Chlorinated hydrocarbons (TCE, PCE, DCE and VC) were identified within the upper unconfined Q1 aquifer, which is known to extend off-site approximately 500 m northwest beyond the MTS boundary. Low concentrations of chlorinated hydrocarbons were detected in the deeper semi-confined Q2 aquifer on site. Two wells are recorded as domestic and the third Q2 (nested with MW07) was an on-site, western boundary, monitoring well for the MTS. Concentrations of chlorinated hydrocarbons on and off-site exceed the World Health Organization Guidelines (2011) for potable drinking water.

4.6.2 Lateral and vertical extent of groundwater contamination

The various environmental assessment reports describe a well characterised, point in time, groundwater contamination plume. The prohibition area includes the known lateral and vertical extent of the groundwater contamination and a buffer zone surrounding the groundwater contamination. The buffer zone is an important part of the prohibition area. It is designed to prevent the contamination plume from expanding due to groundwater extraction from current wells.

Contaminants in a deeper aquifer indicate that there is a downward vertical migration of contaminated groundwater, which is supported by the site audit report in 2009. This downward vertical migration results from a hydraulic head pressure which is likely to have arisen from domestic backyard irrigation or stormwater pooling at the bottom of the pughole prior to landfill capping.

Aquifer recharge from domestic irrigation and water pooling in excavations may cause a transient downward hydraulic gradient and assist in the downward migration of the higher density, lower viscosity chlorinated hydrocarbons. Salinity corrected groundwater elevations in all gauging rounds indicated that an upward vertical hydraulic gradient exists at the nested wells MW07 and Q2 (REM 2005). To account for the chlorinated hydrocarbons identified in the Q2 well [TCE above WHO (2011) guideline value of 20 µg/L], the downward vertical migration of contaminated groundwater may be occurring up hydraulic gradient to the well.

Groundwater monitoring wells have registered that COC are detected in the lateral extensions of the groundwater contaminant plume (Figure 7). The widths of contaminant groundwater plumes are generally large relative to the width of the source area. This can be mainly accounted by periods of lateral northeast/southwest flow due again to the changes in the hydraulic head of the water table due to domestic irrigation recharge of the unconfined aquifer (Figure 8).

In 2005 the EPA and DHA were notified of the groundwater monitoring results by the MTS owners. Prior to this notification the DHA had informed resident through a letterbox drop and a media release of the potential health risks if the water was used for domestic purposes. At that time the EPA did not have legislative powers to restrict the use of existing domestic bores in the area affected by the contaminated groundwater plume. Restrictions, however, on installing new groundwater wells were placed on the area surrounding the MTS by DEWNR through the provisions of section 137 of the *Natural Resources Management Act 2004*.

At that time, groundwater monitoring results were modelled to identify the fate and transport of contaminants within the unconfined and semi-confined quaternary aquifers. Modelling predicted the extent of groundwater contaminant movement underneath residential properties in the Allenby Gardens/Flinders Park area of investigation. The source of the COCs was removed prior to the completion of the audit report in June 2009, with possible retention around the boundary of the site.

Unquantifiable residual soil contamination around the boundary of the site was identified by the EPA as a possible disparity between modelled groundwater contaminant results in 2005 and the observed groundwater plume dimensions observed in 2012. The modelled and observed parameters indicate that the groundwater contaminant plume is moving down gradient in a north-west direction towards the Gulf of St Vincent. The mean groundwater linear velocity has been calculated from groundwater monitoring well hydraulic parameter values to be 0.22–1.1 m/year. It was noted by the auditor, however, that this was too low to account for the extent of the contaminated groundwater plume, since the plume front has extended 500 metres in 50 years.

It is important to note, firstly, that the hydraulic parameters and more specifically hydraulic conductivity estimated at sites can be highly variable due to local heterogeneity of aquifer sediments; and secondly, that contaminant migration is highly dependent of the aquifer hydrogeological conditions and natural attenuation parameters. During migration within the groundwater, contaminants attenuate by mechanisms of dispersion, adsorption, ion exchange, precipitation, co-precipitation and biochemical degradation. This process occurs until natural attenuation capacity is reached resulting in a reduction of contaminants in the groundwater.

The process of biodegradation and natural attenuation vary considerably and contaminants will migrate with a non-linear longitudinal extent over time through the aquifer sediments until a stable plume extent is attained. Due to these inherent uncertainties in a hydraulic parameter values, Darcy's calculations of linear groundwater velocity may differ from the observed plume front, by many hundreds of metres.

Due to the inherent difficulties is groundwater contaminant plume migration prediction, an observed conservative approach was utilised from historical site information and measured groundwater monitoring data. Utilising observed time measured patterns can assist in informing the site numerical models for sensitivity analysis and model calibration reiterations. Using all data available a conservative approach to the final plume extent can be predicted giving a GPA that incorporates both a measureable contaminant groundwater plume and a potential conservative plume expansion area, known as a buffer zone. Incorporating a buffer zone into the GPA will also prevent further expansion of the contaminant groundwater plume through groundwater abstraction at a rate higher than the natural groundwater flow.

The GPA includes the source site, MTS, and surrounding properties of Flinders Park in a northerly and west to northwesterly direction. The majority of the properties in the water prohibition area are down groundwater hydraulic gradient to the source site. The buffer area extends beyond the known groundwater contaminant plume extent to allow for variations in model calibrations as well as to prevent expansion of the plume due to groundwater abstraction. Various domestic groundwater abstraction scenarios were identified through the modelling process to inform the development of the buffer area and the area of the GPA (Figure 2).

4.7 Exposure pathways and human health risk assessment

The risk to human health and safety predicted by the presence of contaminated groundwater is determined by investigating the source–pathway–receptors linkages. This process determines what risk is created by the presence of COC through determining if there are pathways through which these COC can impact sensitive receivers.

4.7.1 Groundwater abstraction

The movement of contaminants within the groundwater through advection, diffusion, dispersion and chemical reactions from a site of contamination to an abstraction bore, creates a valid groundwater pathway from source to receptor. The risk to human health and safety exists from the exposure to dissolved contaminants within the groundwater and use of that groundwater by the receptor or sensitive receiver.

In the 2009 site audit report, the site auditor stated that:

Concentration of the chlorinated hydrocarbons on the site and within the off-site plume exceeded the criteria for extractive uses of groundwater.

The auditor was satisfied that the risk to human health and safety via exposure to COC within groundwater is acceptably low when:

Groundwater in the Q1 water table aquifer at the site, and within the groundwater extraction exclusion zone [proposed GPA] to the west of the site shall not be extracted for any purpose other than monitoring or remediation until such time as the exclusion zone is removed.

The groundwater data is considered appropriate for a submission to the auditor and SA EPA, and delineation of a groundwater exclusion zone. Groundwater plume management would include prevention of extractive use of groundwater within the site and the impacted plume area off-site. The management would require that extractive use of groundwater be restricted within a groundwater extraction exclusion zone covering the contaminated plume area on and off-site (Graham 2009).

In March 2013, the EPA wrote to DHA to request SA Health confirm that there is a potential risk to human health or safety from the information provided in the attached minute ([Appendix 7](#)), focusing on the following chemicals of concern; TCE, DCE, vinyl chloride and total petroleum hydrocarbons (on-site only).

The DHA responded stating;

PHT [Public Health Toxicology group of the Department of Health] supports that the shallow groundwater in the area of AGFP [Allenby Gardens-Flinders Park] is polluted and is not suitable for residential use. PHT supports that the EPA introduce GPA around the area of contamination. Abstraction and use of contaminated groundwater poses a risk to human health and safety.

The site auditor for the MTS has endorsed the recommended option that groundwater be managed by monitored natural attenuation in accordance with an approved groundwater monitoring and management plan that will satisfactory protection of human health environmental values.

4.7.2 Vapour intrusion

REM consultants and the auditor recognised that the COC present in the groundwater at and down gradient of the MTS are volatile and may pose a risk to human health from contaminants migrating vertically upward from the groundwater (SKM 2009). Volatile contaminants can migrate vertically upward through the unsaturated soil and enter a building. REM (2007) assessed the potential risks from vapour intrusion entering a residential dwelling or other habitable enclosed space on the MTS. The objective of the vapour modelling and human risk assessment was to assess the potential health risks to on and off-site landusers based on the proposed medium/high density land use of the audit site (MTS) and existing down gradient standard density residential land uses.

The site auditor is satisfied that the risk to human health and safety is through exposure to volatile COC is acceptably low and states in the 2009 site audit report:

The human risk assessment (HRA) estimated that the risks to human health from exposure to the volatile contaminants of concern that may volatilise from the contaminated groundwater into indoor air of residential buildings located on site (in particular the source area in the southwestern part of the site) are acceptably low. The risks associated with outdoor air inhalation are assessed as much less than those for indoor air, and therefore not of concern (Graham 2009).

The auditor accepts the findings of the human risk assessment (HRA) and the conclusion that the present groundwater contamination at the site (and off-site) does not pose an unacceptable risk to human health via the volatile migration and air inhalation pathway (SKM 2009).

4.8 Community information program

Prior to the establishment of the GPA, the EPA undertook a three-month community information program. This included informing owners and occupiers of properties within Allenby Gardens and Flinders Park of the proposed GPA and inviting residents to a series of open house forums.

During the forums many valid questions were raised by residents, the local primary school and kindergarten, including:

- Are fruits and vegetables safe to grow and safe to consume?
- Whether the roots of fruit trees can access contaminated groundwater and affect the fruit?
- Whether the EPA can check the depth of some residential bores to determine what aquifer the bore is accessing?
- Will there be a title blight from the recording of the GPA against the Certificate of Title.

The EPA sought advice from the DHA regarding the health related questions and the advice was the following;

- The likelihood is low, of fruit and vegetables grown in soil near contaminated groundwater, containing TCE and related compounds at levels that might represent a risk to health.
- In areas impacted by TCE contaminated groundwater, home grown vegetables are safe and do not pose an appreciable risk to residents who consume them, provided they are not watered with contaminated groundwater.

The EPA prepared a written response to properties which answered all questions raised during the community information program. Residents were also reminded of their responsibilities not to use the groundwater once the prohibition area has been established.

During the community information program, the EPA did not identify any reason for not prohibiting the taking of contaminated groundwater in the proposed GPA in Allenby Gardens and Flinders Park ([Appendix 8](#), community frequently asked questions).

4.9 Access to GPA information

Once the EPA has established a water prohibition or restriction area under section 103S of the Act, it is required to place the details of the water prohibition or restriction area on the public register (section 109 of the Act).

4.9.1 EPA Public Register

Table 3 Section 109

Section 109 – Public register
<p>(1) The Authority must keep a register in accordance with this section.</p> <p>(2) The register is to be in a form determined by the Authority.</p> <p>(3) The Authority must record in the register the following:</p> <p style="padding-left: 20px;">(i) details of the circumstances giving rise to– prohibitions or restrictions on taking water under section 103S.</p>

4.9.2 Form 1 statements and Section 7 enquiries

It is important that all current and future owners of properties within the GPA area are made aware of the prohibition. The EPA cannot notate on the Certificate of Title the existence of the water prohibition area. Notice will be given to potential purchasers of the land on the Form 1 via Section 7 of the *Land and Business (Sales and Conveyancing) Act 1994*. This provides an ongoing method of ensuring future owners and potential owners are made aware of the statutory prohibition.

Note: This information is not recorded on the Certificate of Title for a property.

5 Conclusion

The EPA established a GPA in Allenby Gardens and Flinders Park on 13 June 2013 under the provisions of Section 103S of the *Environment Protection Act 1993*. This report reviewed the circumstances giving rise to the prohibition on taking of water from the first and second Quaternary aquifers within the area.

In conclusion the EPA has determined that site contamination exists and that the prohibition of abstraction contaminated groundwater is action necessary under section 103S to prevent actual or potential harm to human health or safety.

With the establishment of the GPA it will be an offence to use groundwater from the first and second Quaternary aquifers for any purpose, other than for environmental monitoring, in the prohibition area. A maximum penalty of \$8,000² applies (Division 4 fine).

² At the time of publication



Plate 1 Early tomato crops in Fulham in 1905 (PIRSA March 2012)



Plate 2 Mining of a pug hole in West Street, Brompton in the 1920s (Max Colwell Publications)



Plate 3 Soil remediation of MTS, September 2007



Plate 4 Remediated soils at MTS, August 2011

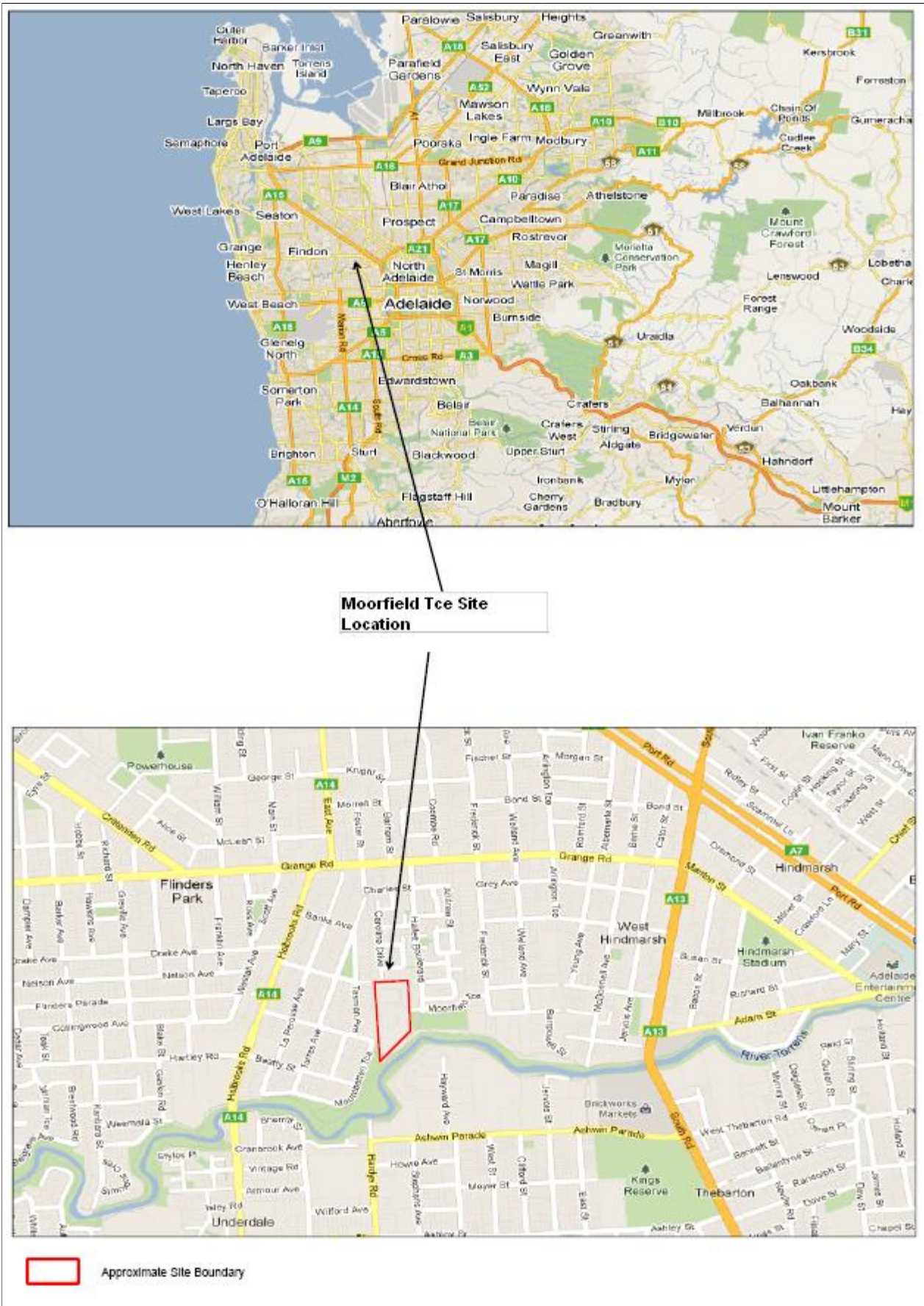


Figure 1 Moorfield Tce site location, Allenby Gardens

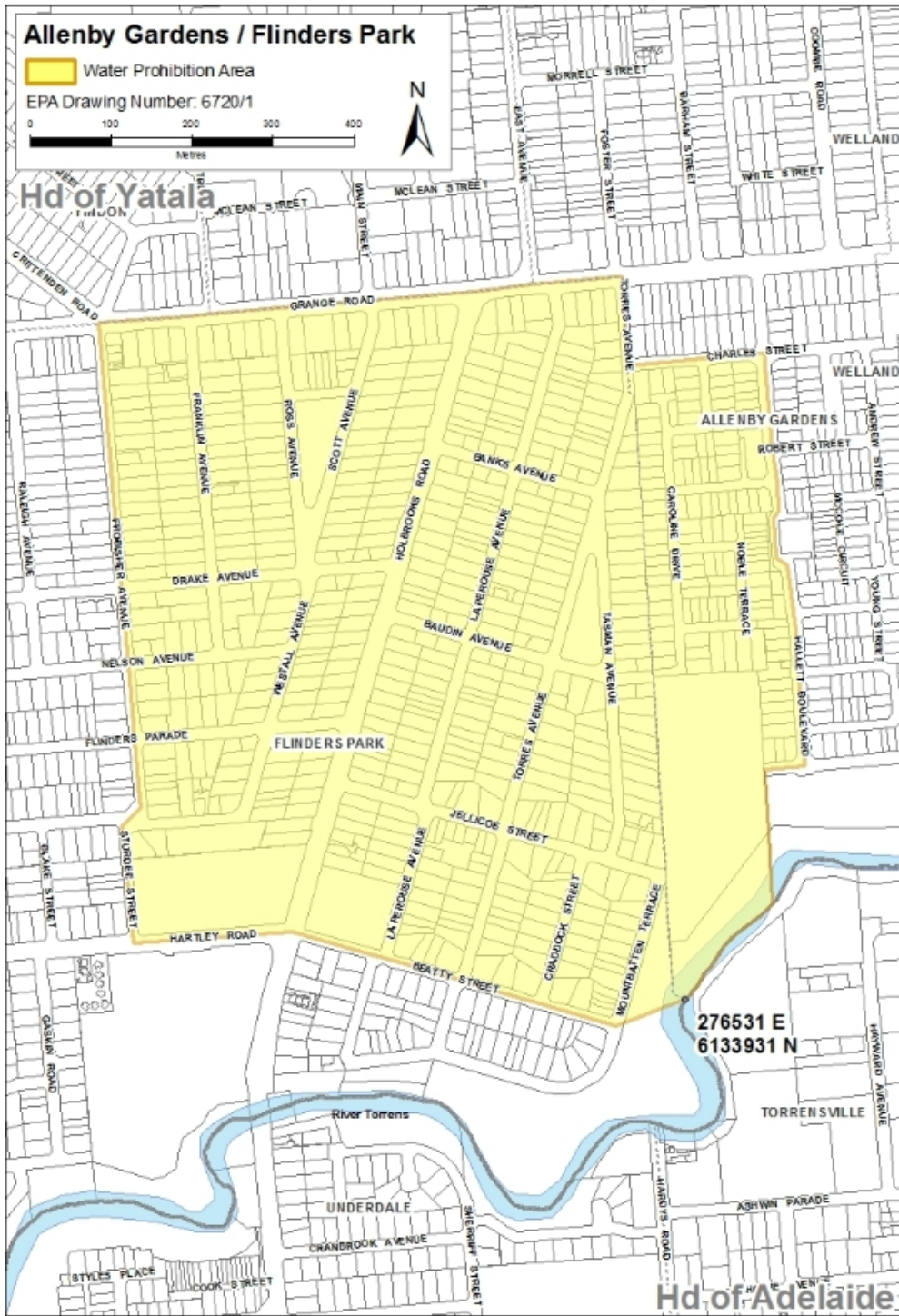


Figure 2 Groundwater Prohibition Area, Allenby Gardens/Flinders Park

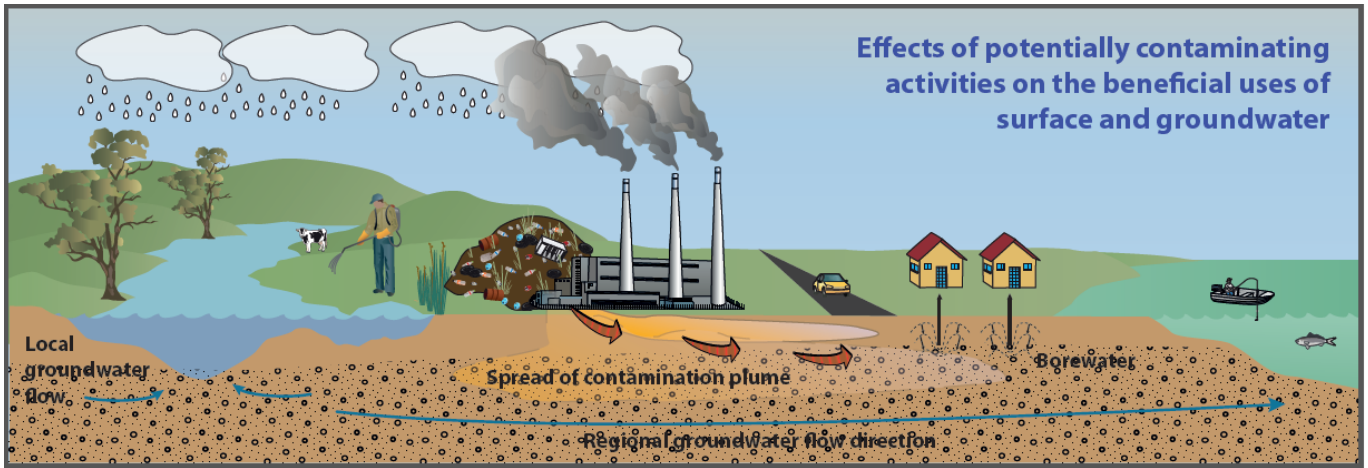


Figure 3 Conceptual pollution model

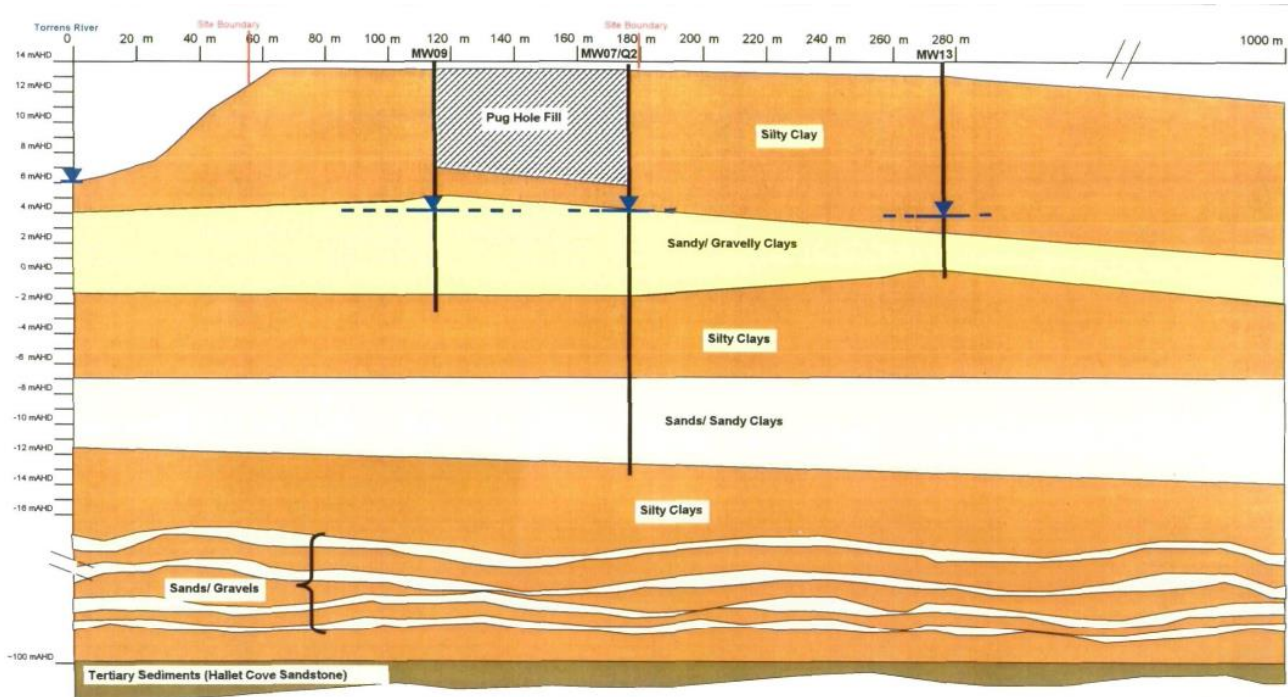


Figure 4 North/south cross section of Allenby Gardens – South/North (from REM 2005)

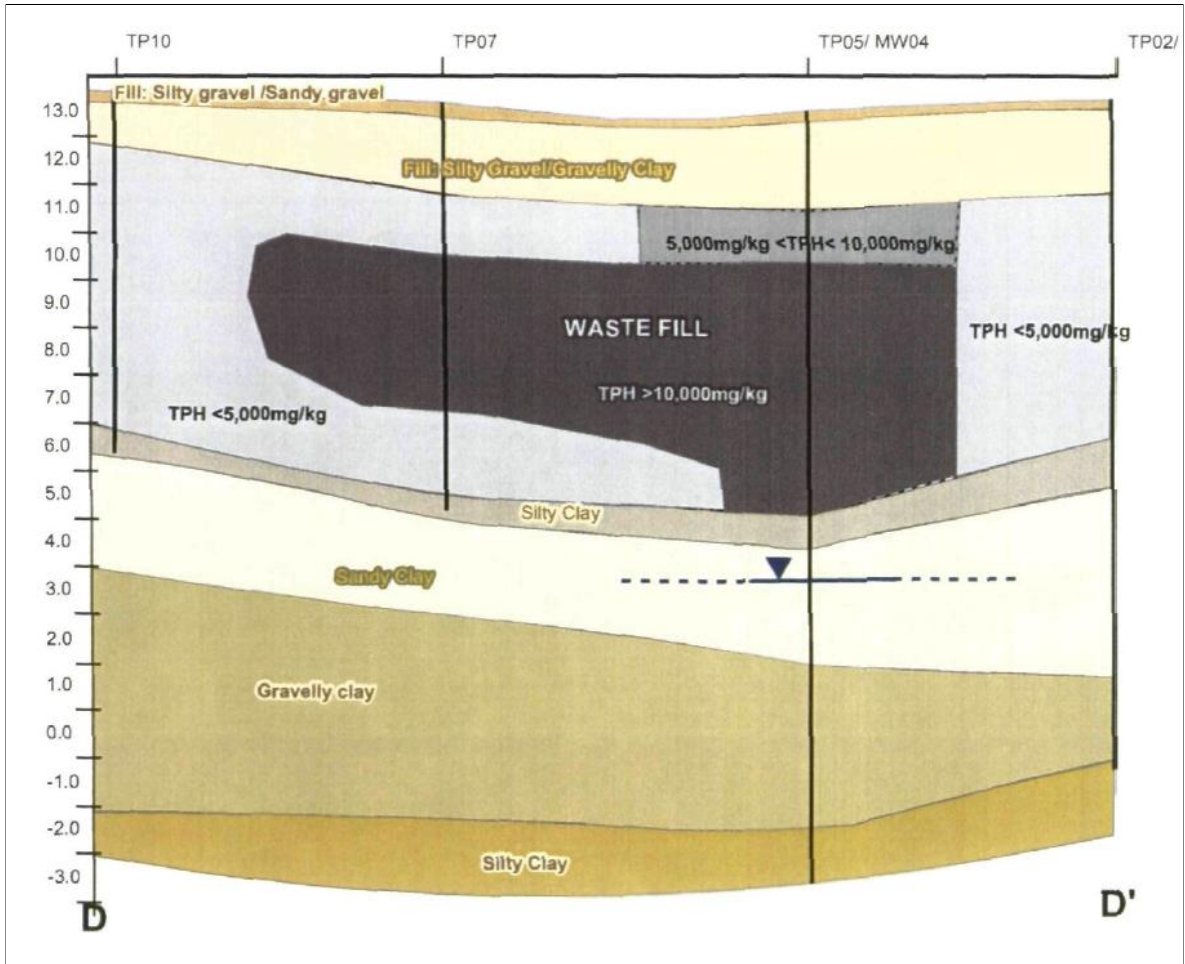


Figure 5 North/south conceptual cross-section of pug hole determined after initial soil assessment (from REM 2004)

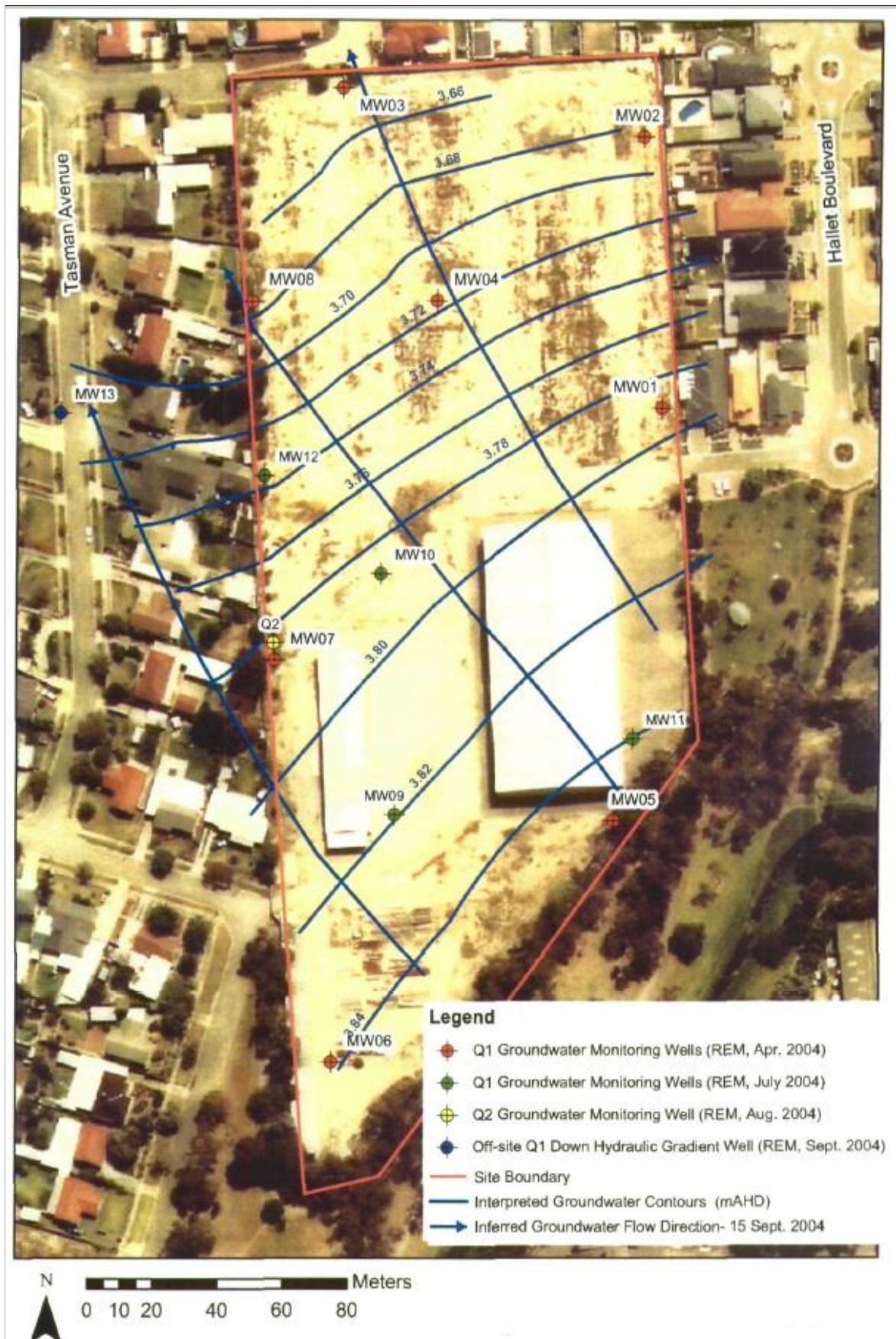


Figure 6 Interpreted groundwater contours and flow direction (from REM 2004)

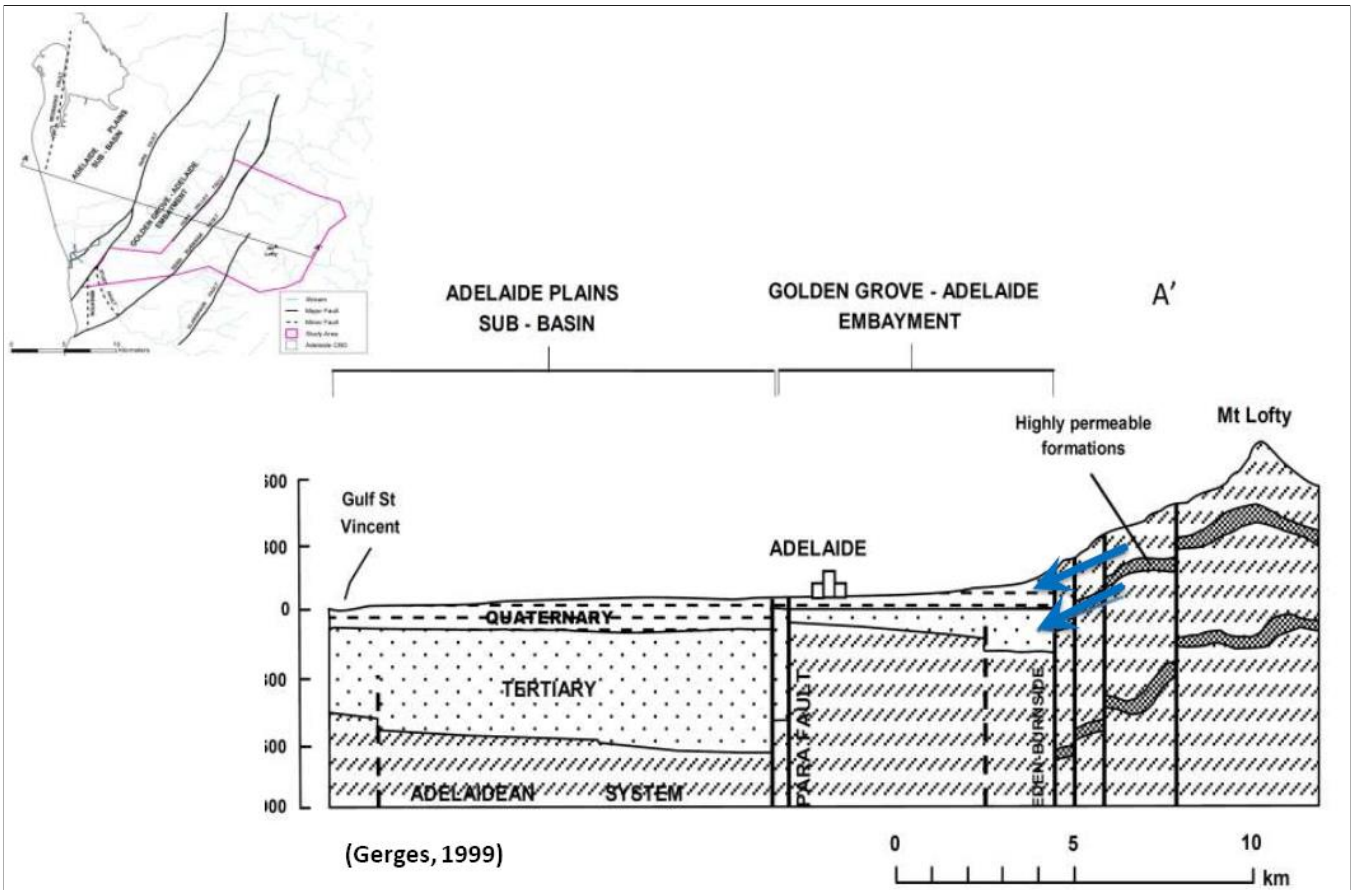


Figure 7 Stratigraphic cross section across the Adelaide Plains (from Gerges 1999)

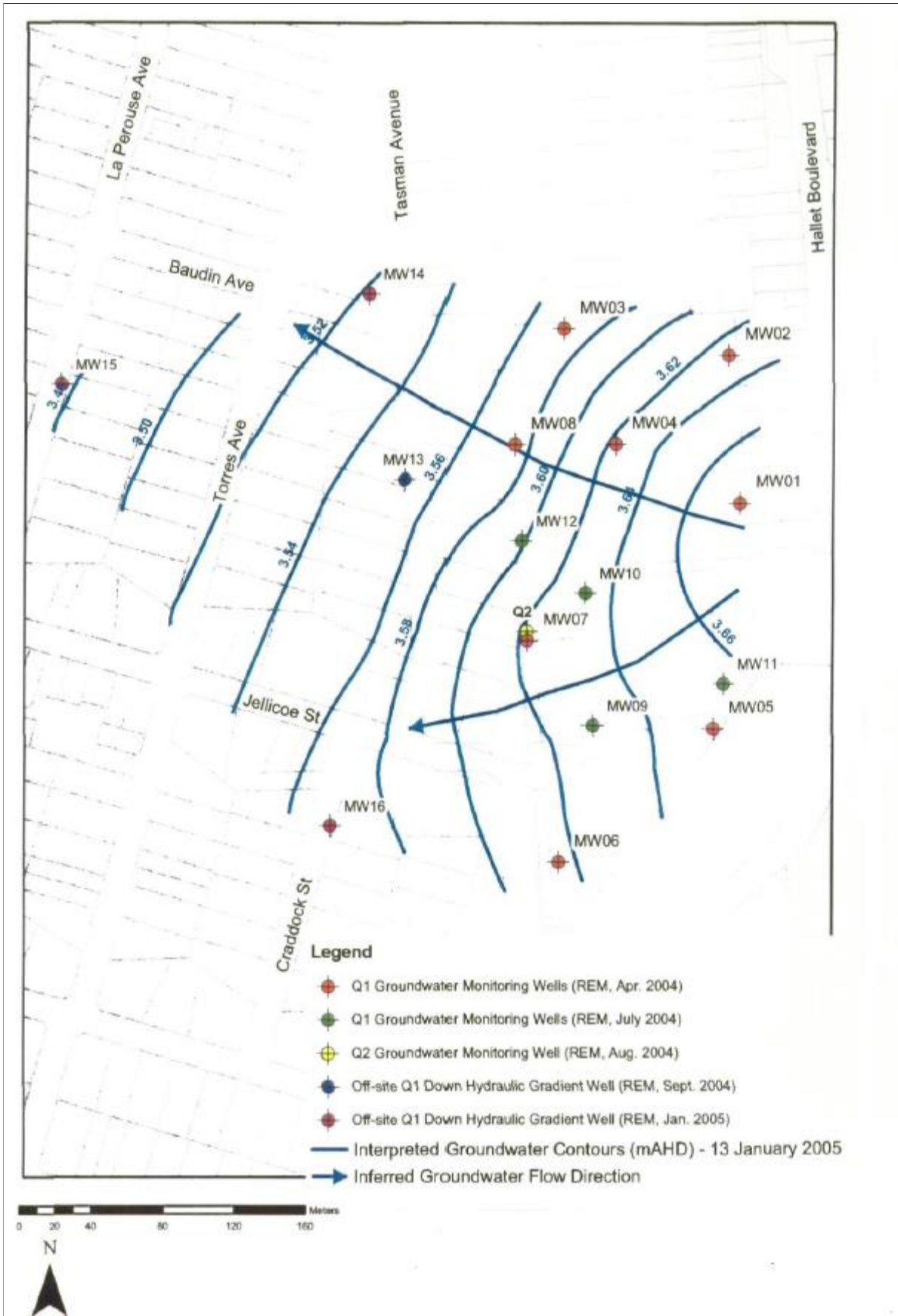


Figure 8 Interpreted groundwater contours and flow direction on and off-site (from REM 2005)

6 References

Journals

DEHAA and Heritage South Australia 1998, *Early Bricks and Brickwork in South Australia*, Department for Environment Heritage and Aboriginal Affairs/Heritage South Australia, Adelaide, viewed 4 December 2014, www.environment.sa.gov.au/files/e15923e7-9ece.../early_bricks.pdf

Doucette WJ, Chard JK, Fabrizio H, Crouch C, Petersen MR, Carlsen, TE, Chard BK and Gorder K 2007, 'Trichloroethylene uptake into fruits and vegetables: three-year field monitoring study', *Environment Science Technology* **41**: 2505–2509.

IARC 1995, 'Dry cleaning, some chlorinated solvents and other industrial compounds', Lyon, *International Agency for Research on Cancer, IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans*, Vol **63**.

Schnabel, WE, Dietz, AC, Burken, JG, Schnoor, JL and Avlarez, PJ 1997, 'Uptake and transformation of trichloroethylene by edible garden plants', *Water Resources* **31**: 816–824.

Schroll R, Beirling B, Cao G, Dörfler U, Lahaniati M, Langenbach T, Scheunert I and Winkler R 1994, 'Uptake pathways of organic chemicals from soil by agricultural plants', *Chemosphere* **28**: 297–303.

US EPA 2011, 'Toxicological Review of Trichloroethylene', *In Support of Summary Information on the Integrated Risk Information System (IRIS)*, US Environmental Protection Agency, EPA/635/R-09/011F.

Reports

ANZECC & ARMCANZ 2000, *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Daly H & Fabris JG 1993, *An environmental study of tributyltins in Victorian waters*, Victorian Environmental Protection Authority, Melbourne, SRS 90/020.

European Commission 2001, *EC Health and Consumer Protection Directorate-General 2001: Opinion of Scientific Committee on Food on the Risk Assessment of Dioxins and Dioxin-like PCBs in Food*, Document CS/CNTM/DIOXIN/20 Final 30 May 2001, EUSC, Brussels.

Sinclair Knight Merz 2009, *Site Audit Report: Lot 3 Moorefield Terrace, Allenby Gardens, South Australia*, prepared by RA Graham, Environmental Auditor, appointed pursuant to the *Victorian Environment Protection Act 1970*.

NEPM 1999, *NEPM HIL Derivation Appendix A6 Chlorinated May 2013*.

UK Environmental Agency 2006, *Evaluation of models for predicting plant uptake of chemicals from soil*, Science Report, SC050021/SR.

US EPA 2005, *Use of field-scale phytotechnology for chlorinated solvents, metals, explosives and propellants, and pesticides*, Status Report, US Environmental Protection Agency, EPA 542-R-05-002.

Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service 1997, *Toxicology profile for trichloroethylene*, Update Statement Report, EPA 542-R-05-002.

Books

Anderson MP and Woessner WW 2002, *Applied groundwater modelling – simulation of flow and advective transport*, Academic Press, San Diego, California, USA.

Websites

Max Colwell Publications, viewed 4 December 2014, www.maxcolwell.net/picture_gallery.htm.

PIRSA, viewed 4 December 2014, [www.pir.sa.gov.au/aghistory/horticulture March 2012](http://www.pir.sa.gov.au/aghistory/horticulture_March_2012).

WHO 2011, *Guidelines for drinking-water quality*, fourth edition, World Health Organization, Geneva, viewed 4 December 2014, http://www.who.int/water_sanitation_health/dwq/chemicals/en/index.html

7 Glossary

Term	Explanation
Audit	Refer to environmental site audit and site contamination audit
Auditor	Refer to environmental site auditor and site contamination auditor
Background concentrations	In relation to chemical substances on a site or below its surface, means results obtained from carrying out assessments of the presence of the substances in the vicinity of the site in accordance with guidelines from time to time issues by the Authority. Refer to the EPA publication, Site Contamination: Determination of background concentrations.
Chemical substances	Any organic or inorganic substance, whether a solid, liquid or gas (or combination thereof), and includes waste
Environmental audit report	<p>A detailed written report that—</p> <ul style="list-style-type: none"> (a) sets out the findings of the audit and complies with the guidelines and standards (in particular, the Environmental Auditor Guidelines for issue of certificates and statements of Environmental Audit) issued by the Victorian EPA; and (b) includes the issue of either a certificate of environmental audit or statement of environmental audit, in the prescribed form, by the environmental auditor who personally carried out or directly supervised the audit.
Environmental auditor	A person accredited under the <i>Victorian Environment Protection Act 1970</i> as an environmental auditor. Since 1 July 2009 South Australia has accredited persons who undertake site contamination audits in SA.
Groundwater contamination	<p>Site contamination of underground water</p> <p>Refer to EPA publication, Site contamination: Assessment and remediation of groundwater contamination (2009)</p>
Groundwater prohibition area	The establishment by the EPA under section 103S of the EP Act.
Land	Land as a physical entity, including land covered by water
Potentially contaminating activity	An activity prescribed in regulation 5 of the EP(SC) Regulations
Remediate	<p>To remediate a site means treat, contain, remove or manage chemical substances on or below the surface of the site as to—</p> <ul style="list-style-type: none"> (a) eliminate or prevent actual or potential harm to the health or safety of human beings that is not trivial, taking into account current or proposed land uses; and (b) eliminate or prevent, as far as reasonably practicable— <ul style="list-style-type: none"> (i) actual or potential harm to water that is not trivial; and (ii) any other actual or potential environmental harm that is not trivial, taking into account current or proposed land uses.

Term	Explanation
Remediation	Has the same meaning as remediate
Site	An area of land (whether or not in the same ownership or occupation)
Site contamination	Exists at a site if: <ul style="list-style-type: none"> (a) chemical substances are present on or below the surface of the site in concentrations above the background concentration (if any); and (b) the chemical substances have, at least in part, come to be present there as a result of an activity at the site or elsewhere; and (c) the presence of the chemical substances in those concentration has resulted in— <ul style="list-style-type: none"> (i) actual or potential harm to the health or safety of human beings that is not trivial taking into account current or proposed land uses; or (ii) actual or potential harm to water that is not trivial; or (iii) other actual or potential environmental harm that is not trivial, taking into account current to proposed land uses.
Site contamination audit report	A detailed written report that— <ul style="list-style-type: none"> (a) sets out the findings of the audit and complies with the guidelines from time to time issued by the EPA; and (b) includes a summary of the findings of the audit certified, in the prescribed form, by the site contamination auditor who personally carried out or directly supervised the audit.
Site contamination auditor	A person accredited under Division 4 of Part 10A of the Environment Protection Act 1993 as a site contamination auditor
Site contamination consultant	A person other than a site contamination auditor who, for fee or reward, assesses the existence or nature or extent of site contamination
Water	<ul style="list-style-type: none"> (a) water occurring naturally above or under the ground; or (b) water introduced to an aquifer or other area under the ground; or (c) an artificially created body of water or stream that is for public use or enjoyment.

Appendix 1 Source site details

Site identification and details (based on the extent of the site at the time the investigations were undertaken)

Source site:	24 Moorfield Terrace, Allenby Gardens (also known as Lot 3 Moorefield Drive, Welland)
Current CT(s):	CT 5124/65 (audited site)
Property description:	Former pug hole, filled with uncontrolled waste
Street address:	24 Moorfield Tce, Allenby Gardens
Local government area:	City of Charles Sturt
Potentially contaminating activity(s):	Historical landfill (pughole) activities

Site ownership

Current (1963–today):	Riverside Park Pty Ltd (formerly Water Garden Village Pty Ltd, formerly UMR Pty Ltd, formerly Freeman Motors Pty Ltd)
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Appendix 2 Site audit report summary by R A Graham (Environmental Auditor)

Background to Environmental Audit

An environmental site audit has been completed in accordance with SA Environment Protection Authority guidelines for the land at Lot 3 Moorefield Terrace, Allenby Gardens, South Australia 5009. The site is approximately rectangular with area of 37,540 m² (3.754 ha), and is in a predominantly residential area with the River Torrens and adjacent linear park on its southern boundary.

The current owner of the audit site is Riverside Park Pty Ltd, which intends to develop residential terrace-style houses and apartments on the site, consistent with Development Application No. 252/2817/04 dated 26 October 2004 and the Provisional Development Plan Consent granted by the City of Charles Sturt on 21 June 2005. Condition 11(b) of that consent requires that 'upon completion of a Council approved remediation program ... an audit report certifying that the site is suitable for the proposed development prepared by an auditor of contaminated land (accredited by the Environment Protection Authority) shall be prepared and provided to the Council'.

In April 2004, Richard Graham of Sinclair Knight Merz was engaged to conduct an environmental audit of the site.

Overview of Site Investigation and Remediation Program

A staged environmental assessment, remediation and validation program was undertaken, in particular by consultants Resource and Environmental Management (REM) and contractors McMahon Services in the period 2004–2008.

The auditor is satisfied that the soil and groundwater assessment and soil remediation and validation program have been undertaken in accordance with accepted industry standards and relevant guidelines and policies, and the requirements of the environmental auditor. The program has adequately characterised the current post-remediation soil quality, groundwater hydrogeology and groundwater quality conditions, and provides adequate information for the purposes of assessing and managing risks to the future medium/high density residential uses of the land and groundwater at the site (and off-site), and for completion of this environmental audit.

Findings of Groundwater Investigation Program

The groundwater assessment program conducted before, during and after the soil remediation program satisfactorily described the site hydrogeology and groundwater contamination conditions, including the delineation of a dissolved phase chlorinated hydrocarbon plume off-site to the west/northwest of the site.

The hydrogeology of the site and vicinity includes a number of Quaternary aquifers in the Hindmarsh Clay Formation, with the Q1 water table being at about 10 mbgl, that is 1–2 m below the base of the pughole. The Q1 gradient and flow direction is to the north-west, away from the River Torrens and towards the Gulf of St Vincent. The groundwater salinity is in the range 1,300–3,200 mg/L, and a number of domestic bores in the area extract groundwater for garden watering.

A total of 25 groundwater monitoring wells were installed on and around the site, to characterise groundwater contamination conditions. Multiple groundwater sampling and analysis events were conducted between 2004–2008, to identify the presence and extent of dissolved phase contamination. No phase-separated hydrocarbons were detected. Dissolved phase contamination with the chlorinated hydrocarbon trichloroethylene (TCE) and its degradation byproducts cis-1,2-dichloroethylene (DCE) and vinyl chloride, and to a lesser extent non-chlorinated petroleum hydrocarbons (TPH) were found in groundwater of the upper (Q1) aquifer at the site and in a plume extending to the northwest up to about 500 m beyond the western site boundary. The chlorinated hydrocarbons and petroleum hydrocarbons appeared to have been historically disposed as wastes into the southwestern part of the pughole. Other less significant groundwater contaminants reported at some locations on the site were ammonia, nitrate and some metals/metalloids. Groundwater in the deeper Q2 aquifer in the source area contained low concentrations of chlorinated hydrocarbons, indicating that relatively minor downward vertical migration of contaminated groundwater has occurred. Concentrations of the

chlorinated hydrocarbons on the site and within the off-site plume exceeded criteria for extractive uses of groundwater. Following these findings, in 2005 the SA EPA and Department of Health imposed a restriction on the use of the existing domestic bores in the affected area.

REM conducted computer modelling of the likely future behaviour of the contaminated groundwater plume and the effect of groundwater remediation options. The modelling predicted that the plume would not expand substantially after removal of the source (being the waste contents of the pughole) and would reduce due to natural attenuation processes to concentrations below the relevant criteria by about 2040–2050. The modelling also predicted a relatively minor reduction in that period to achieve compliance if active groundwater remediation was to be undertaken.

The chlorinated hydrocarbons in groundwater pose a potential risk to human health from volatile contaminants emitted from contaminated groundwater, migrating vertically upward through the soil and entering habitable enclosed spaces. REM conducted an exposure and health risk assessment that demonstrated that groundwater contamination at the site (and off-site) does not pose an unacceptable risk to human health via the volatile migration and air inhalation pathway. No groundwater remediation or site management measures are required to further reduce this risk.

Findings of Soil Investigation, Remediation and Validation Program

The pre-remediation soil investigation found that the pug hole contained a surface fill soil layer 1 to 2 metres thick, over various solid wastes (including brick, concrete, timber, tyres, leather, plastic and metal) in a soil matrix to a depth of about 9 metres below surface level. The pug hole waste and soil contained oily staining and hydrocarbon odours in some areas. The southern (former market garden) area contained a surface fill soil layer about 0.5 m thick over natural clay soils.

The soil investigation information and data was an adequate basis for the preparation of a Remediation Action Plan (RAP) by REM and McMahon Services. The remediation approach was to excavate all soil and waste materials from the pughole, sort and categorise these materials, remove geotechnically unsuitable material (eg tyres, wood and plastic) for off-site recycling or disposal, validate excavated soils and (where necessary) treat contaminated soil on site to a standard suitable for reuse as compacted backfill soil at controlled location/depths on site, and import clean fill material to make up any material deficit. In order to be acceptable for reuse on site, soil or other materials needed to meet both geotechnical standards for engineered compacted backfill, and agreed human health and environmental quality criteria.

The remediation program was conducted over the period 2006–2008. Based on a review of the full documentation generated from the program (including material tracking records, treated and reused soil validation data, excavation walls/base validation data and backfill level survey), the auditor is satisfied that the remediation and validation program was completed in accordance with the RAP and other agreed procedures. Contaminated soil reused as backfill in the pughole excavation was validated to meet agreed quality criteria for specified placement depth intervals. A layer of clean soil has been (or in some parts of the site will be) placed over the contaminated soil layers to prevent exposure of contaminated soil to future site occupants or others. A geofabric layer was placed over remaining potentially contaminated fill at or near site boundaries, where that fill could not be fully excavated or extended beyond the site boundaries.

Pollution Status of Groundwater

The pollution status of the groundwater at the site and in the plume area to the west is summarised below, for protected environmental values (PEVs) of groundwater and contaminants of concern:

- **Aquatic ecosystems:** concentrations of TCE, vinyl chloride, TPH, some metals/metalloids (boron, cadmium, manganese and selenium), ammonia and nitrate in groundwater at and near the site exceed quality criteria for this groundwater PEV. In practice this PEV would be realised at the point of discharge of groundwater to the nearest surface waters to the west of the site. Contaminant concentrations have attenuated so that ecosystem criteria are not exceeded for any contaminant beyond about 300m from the site. Accordingly, groundwater contaminants derived

from this site do not present a significant risk to aquatic ecosystems in the nearest surface waters (Gulf of St Vincent) which is about 8km from the site.

- **Potable water supply:** concentrations of TCE, cis-1,2-DCE, vinyl chloride, TPH, some metals/metalloids (boron, cadmium, manganese and selenium), ammonia and nitrate in groundwater at and (in some cases) down-gradient of the site exceed potable water quality criteria. This use of groundwater is unlikely to occur as the salinity of the Q1 groundwater at this site is too high to be generally acceptable for potable use. Nevertheless, it is concluded that groundwater at the site and for about 500m down-gradient to the west/northwest is polluted and unacceptable for potable water supply.
- **Primary contact recreation and aesthetics:** As for potable water use, chlorinated hydrocarbons and some other contaminant concentrations in groundwater at and down-gradient of the site exceed quality criteria adopted for this groundwater use. Although the groundwater investigation did not report aesthetic impacts (potentially offensive odours) in groundwater with elevated TPH and chlorinated hydrocarbon concentrations, if such impacts were to occur groundwater would not be suitable for primary contact or potable use. Extraction of groundwater for this use (say in a swimming pool or spa) is unlikely (but possible) at the site or at down-gradient properties. It is concluded that groundwater at the site and for about 500 m down gradient to the west/northwest is polluted for primary contact recreation and (potentially) aesthetics.
- **Agriculture (irrigation, including parks and gardens, and livestock water):** objectives for the significant contaminants of concern (TPH and chlorinated hydrocarbons) are not available for this PEV. However, if the groundwater is aesthetically impacted (potentially odorous), it would likely be unacceptable for these uses. Extraction from the Q1 or Q2 aquifers for irrigation is not likely at the site, but the existing tertiary aquifer well is proposed to be retained long term for garden water supply at the site. The risk of contamination of the deep tertiary aquifer is very low. Garden watering is assumed to be the existing use of the licensed domestic bores in the off-site area. Stock water supply is an unlikely use of groundwater in the area.
- **Industrial use:** this use of groundwater is very unlikely in the area, which is predominantly residential. However, in the event that this use was to be realised, the contaminant concentrations (and potentially aesthetics) may make groundwater unsuitable for this PEV. Specific water quality needs for the industrial use proposed would need to be considered at the time. The potential effect of contaminated groundwater on structures (eg building foundations or piles) or sub-surface services has also been considered. The relevant indicators of potentially corrosive conditions (pH, sulphate) do not indicate a significant risk to built structures or other infrastructure at this site. Some hydrocarbon contaminants could potentially damage or permeate through plastic pipes. However, as the depth to groundwater is about 10 mbgl, it is very unlikely that future structures (building foundations, service pipes, etc) will contact groundwater.

In summary, the groundwater in the upper Q1 aquifer at the audit site and within a plume extending up to about 500 m to the north-west is polluted with chlorinated hydrocarbons (TCE, cis-1,2-DCE and vinyl chloride) and to a lesser extent petroleum hydrocarbons. The groundwater is considered to be unsuitable (or potentially unsuitable) for any extractive use including the protected environmental values of potable water, primary contact recreation, aesthetics, agriculture (irrigation or livestock water) and industrial.

Groundwater Clean Up to the Extent Practicable (CUTEP)

Based on the extensive soil remediation program undertaken (including removal of the source of groundwater contamination), and consideration of the technical constraints, costs and limited potential benefits of feasible groundwater remediation options, the auditor concludes that groundwater clean-up has been achieved to the extent practicable.

Site Suitability for Development

The auditor is of the opinion that the post remediation conditions of the site are suitable for the proposed medium/high density residential development, subject to completion of the development in accordance with the proposed development

plans. These further works include clean soil placement to achieve the agreed separation distances between underlying contaminated soil and the final surface levels, construction of service trenches and garden beds and provision of additional capping layers in the form of concrete building slabs and other pavements. The presence of contaminated soils at depth means that the site is unsuitable for more sensitive uses (such as low density residential with multiple site owners) where contaminated site soils may be directly exposed to site occupants as a result of uncontrolled removal or penetration of the capping layers. The auditor is of the opinion that the condition of groundwater at the site (and in the contaminated groundwater plume area to the west/northwest) is unsuitable for any extractive uses, other than sampling during groundwater monitoring, or for remediation in the event that may occur in future.

Future Site Management

Future site management will be undertaken in accordance with a Groundwater Monitoring and Management Plan, a Construction Environmental Management Plan and a post-development Environmental Management Plan (EMP), each of which has been reviewed and (in the case of the GMMP) approved by the auditor. The Construction EMP and post-development EMP will be finalised after completion of the site audit report, to incorporate any relevant conditions of the audit.

Conditions of the Site Audit

The site auditor makes the following statement in relation to the suitability of the site for future use, including conditions that are to be complied with during and following development of the site. The auditor is of the opinion that the site at Lot 3, Moorefield Terrace, Allenby Gardens, SA is suitable for development and use for medium density and high density residential in accordance with the development plans proposed by the site owner Riverside Park Pty Ltd, being the subject of the Provisional Development Plan Consent (to Development Application No. 252/2817/04) granted by the City of Charles Sturt on 21 June 2005.

This statement of suitability is made subject to the following conditions:

- a Future earthworks, filling and construction at the site shall be undertaken in accordance with an approved Construction Environmental Management Plan (being the draft Construction EMP prepared by Resource and Environmental Management Pty Ltd in June 2009, as amended and finalised to be consistent with the recommendations of this site audit report). The site construction works are to include clean soil placement to achieve the agreed separation distances between underlying contaminated soil and the final surface levels, construction of service trenches, and provision of additional capping layers in the form of concrete building slabs, other pavements and clean soil in garden beds, as specified in the Construction EMP;
- b A site contamination auditor accredited by the SA EPA shall confirm in writing to the EPA and the City of Charles Sturt that the construction works have been completed in accordance with the recommendations and conditions of this site audit report and the approved Construction EMP;
- c Management of the site during future (post-development) use shall be in accordance with an approved Environmental Management Plan (being the draft EMP prepared by Resource and Environmental Management Pty Ltd in June 2009, as amended and finalised to be consistent with the recommendations of this site audit report);
- d Groundwater in the Q1 watertable aquifer at the site, and within the groundwater extraction exclusion zone to the west of the site as identified in the GMMP, shall not be extracted for any purpose other than monitoring or remediation (as may be required) until such time as the exclusion zone is removed;
- e Groundwater at the site shall be managed in accordance with the Groundwater Monitoring and Management Plan (GMMP) prepared by Resource and Environmental Management Pty Ltd in March 2009 (as may be amended in accordance with the provisions of that plan). The GMMP contains requirements for a groundwater monitoring program, contingency measures in the event that groundwater conditions change such that trigger levels are exceeded, controls on groundwater extraction and use and a program for review of the GMMP; and

- f Responsibility for implementation of the Construction EMP, post-development EMP and Groundwater Monitoring and Management Plan shall be maintained by the current owner of the site (Riverside Park Pty Ltd), unless otherwise agreed by SA EPA and the City of Charles Sturt.

Appendix 3 Gazettal notice

No. 36

2517



THE SOUTH AUSTRALIAN
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ADELAIDE, THURSDAY, 13 JUNE 2013

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GOVERNMENT GAZETTE NOTICES

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DEVELOPMENT ACT 1993

SECTION 29 (2) (b) (ii) AMENDMENT

Preamble

It is necessary to amend the Port Adelaide Enfield Development Plan dated 15 November 2012.

NOTICE

PURSUANT to Section 29 (2) (b) (ii) of the Development Act 1993, I amend the Port Adelaide Enfield Development Plan dated 15 November 2012, by:

1. Deleting Principle of Development Control 24 within 'Land Division' (General Section).

2. Inserting the following Principle of Development Control within the 'Suburban Neighbourhood Zone' (Zone Section) under the subheading 'Land Division' following Principle of Development Control 27:

Land division resulting in residential allotments should be designed to provide on street car parking that complies with the following:

- (a) a minimum of one car parking space for every two residential allotments
- (b) the on street car parking spaces are located within 50 m of the associated allotments.

3. Relocating the existing Principle of Development Control 25 within 'Land Division' (General Section) into the 'Suburban Neighbourhood Zone' (Zone Section), under the subheading 'Vehicle Parking' following Principle of Development Control 13.

4. Consecutively renumbering Principles of Development Control in both the 'Land Division' (General Section) policies and the 'Suburban Neighbourhood Zone' (Zone Section) following the deletion, insertion and relocation of Principles of Development Control outlined in the instructions 1 to 3.

5. Fix the day on which this notice is published in the *Gazette* as the day on which the Amendment will come into operation.

JOHN RAU, Deputy Premier, Minister for Planning

ENVIRONMENT PROTECTION ACT 1993

Prohibition on Taking Water Affected by Site Contamination

1. ANDREW WALTER PRUSZINSKI, Manager Site Contamination and Delegate of the Environment Protection Authority ('the Authority'), being satisfied that site contamination exists that affects or threatens groundwater and that action is necessary, pursuant to Section 103S of the Environment Protection Act 1993, to prevent actual or potential harm to human health or safety hereby prohibit the taking of groundwater between ground surface (0 m) to 30 m below the ground surface within the area specified in the schedule to this notice ('the Allenby Gardens/Flinders Park Water Prohibition Area'), other than for environmental assessment or environmental monitoring purposes or as approved in writing by the Authority.

The site contamination affecting the groundwater is in the form of chlorinated hydrocarbons which represent actual or potential harm to human health or safety.

This prohibition becomes official upon the gazettal of this notice.

A. PRUSZINSKI, Manager Site Contamination, Environment Protection Authority

SCHEDULE

The Allenby Gardens/Flinders Park Water Prohibition Area

Commencing at the junction of the Suburbs of Allenby Gardens and Flinders Park, 276531E and 6133931N; thence generally south-westerly to the junction of Beatty Street and Mountbatten Terrace; thence generally west north-westerly to the junction of Beatty Street, Holbrooks Road and Hartley Road; thence generally westerly to the junction of Hartley Road and Sturdee Street; thence generally northerly to the junction of Sturdee Street, Collingwood Avenue and Frobisher Avenue; thence generally northerly to the junction of Frobisher Avenue and Grange Road;

thence generally east to the junction of Grange Road, Foster Street and Torres Avenue; thence generally southerly to the junction of Torres Avenue and Charles Street; thence generally easterly to the junction of Charles Street and Hallett Boulevard; thence generally southerly to the junction of Hallett Boulevard and Moorfield Terrace; thence generally westerly to 24 Moorfield Terrace; thence southerly to the River Torrens; thence generally south westerly along the River Torrens to the junction of the Suburbs of Allenby Gardens and Flinders Park to the point of commencement, 276531E and 6133931N.

FISHERIES MANAGEMENT ACT 2007: SECTION 79

TAKE note that the notice made under Section 79 of the Fisheries Management Act 2007, dated 23 January 2013 and published in the *South Australian Government Gazette* dated 31 January 2013, on page 147, being the first notice on that page, referring to the Spencer Gulf Prawn Fishery, is hereby varied such that it will not be unlawful for a person fishing, pursuant to a Spencer Gulf Prawn Fishery Licence to use prawn trawl nets in the areas specified in Schedule 1, during the period specified in Schedule 2, and under the conditions specified in Schedule 3.

SCHEDULE 1

1. The waters of the Spencer Gulf Prawn Fishery that are:

(a) Contained within and bounded by the following co-ordinates: Commencing at latitude 33°18.00'S, longitude 137°49.00'E, then to position latitude 33°18.00'S, longitude 137°35.50'E, then to position latitude 33°24.00'S, longitude 137°37.00'E, then to position latitude 33°24.00'S, longitude 137°57.00'E; and

(b) South of the following co-ordinates: Commencing at latitude 33°29.00'S, longitude 137°18.00'E, then to position latitude 33°29.00'S, longitude 137°28.50'E, then to position latitude 33°31.00'S, longitude 137°28.50'E, then to position latitude 33°37.00'S, longitude 137°26.00'E, then to position latitude 33°37.00'S, longitude 137°28.00'E, then to position latitude 33°32.00'S, longitude 137°30.00'E, then to position latitude 33°29.00'S, longitude 137°30.00'E, then to position latitude 33°29.00'S, longitude 137°34.00'E, then to position latitude 33°38.00'S, longitude 137°34.00'E, then to position latitude 33°46.00'S, longitude 137°44.00'E.

2. Except the waters contained within and bounded by the following co-ordinates, which shall remain closed to fishing:

(a) Commencing at latitude 33°51.50'S, longitude 136°40.00'E, then to position latitude 34°01.00'S, longitude 136°48.40'E, then to position latitude 34°04.00'S, longitude 136°43.00'E, then to position latitude 34°08.00'S, longitude 136°46.70'E, then to position latitude 34°35.00'S, longitude 136°33.00'E, then to position latitude 34°35.00'S, longitude 136°55.50'E, then to position latitude 34°14.00'S, longitude 136°55.50'E, then to position latitude 34°14.00'S, longitude 136°57.00'E, then to position latitude 34°01.00'S, longitude 137°07.00'E, then to position latitude 33°57.00'S, longitude 137°04.00'E, then to position latitude 33°52.00'S, longitude 137°15.00'E, then to position latitude 33°41.00'S, longitude 137°06.00'E;

(b) latitude 34°10.00'S, longitude 137°28.00'E, then to position latitude 34°21.00'S, longitude 137°12.00'E, then to position latitude 34°45.00'S, longitude 137°15.00'E, then to position latitude 34°54.00'S, longitude 137°01.00'E; and

(c) latitude 34°56.50'S, longitude 137°11.00'E, then to position latitude 34°56.50'S, longitude 137°16.00'E, then to position latitude 34°51.50'S, longitude 137°18.00'E, then to position latitude 34°51.50'S, longitude 137°13.00'E.

SCHEDULE 2

From 1830 hours on 7 June 2013 to 0630 hours on 17 June 2013.

SCHEDULE 3

1. The co-ordinates in Schedule 1 are defined as degrees, decimal minutes and based on the Australian Geodetic Datum 1966 (AGD 66).

Appendix 4 Summary of penalties and fees

Penalties

There are a number of offences (and associated expiation fees and penalties) relating to the audit system. Key offences are identified throughout this guideline. A summary of the consequences for relevant division penalties provided in the EP Act is shown in the following table.

Table A1–1 Summary of relevant division penalties

Division	Maximum fine
1	\$60,000
3	\$30,000
4	\$15,000
5	\$ 8,000
6	\$ 4,000

Appendix 5 Summary of geology and hydrogeology in South Australia

The geology of South Australia has had a very distinctive and interesting history over the last 2.7 billion years. South Australia's geological provinces and basins have been shaped by depositional, igneous, orogenic and other alteration events. In South Australia the main geological provinces are the Curnamona Province, Gawler Craton, Musgrave Province and the Adelaide Fold Belt and Stuart Shelf, which includes the Kanmantoo Trough. Within these provinces are the various sedimentary basins, including the Officer Basin, Murray Basin, Gambier Basin, Uley Basin and the Eucla Basin (Cowley 2010).

The South Australian groundwater is known to flow through Precambrian fractured rock and the Palaeozoic, Mesozoic and Cainozoic Era sediments.

Pre-Cambrian and Cambrian

The understanding of groundwater flow mechanisms in fractured rock aquifers of the Mount Lofty Ranges, Northern Adelaide Plains and Kangaroo Island is still developing. Due to the difficulty in understanding groundwater flows and the natural mineralisation in these fracture rock aquifer, groundwater contamination is difficult to characterize. In the Adelaide metropolitan region it is known, however, that groundwater migration is across the Para and Eden–Burnside Faults from the Mount Lofty Ranges to the sedimentary aquifers of the Northern Adelaide Plains, Adelaide Plains and McLaren Vale areas. This groundwater migration provides a significant amount of recharge to the quaternary and tertiary aquifers in these receiving areas (Stewart *et al* 2009). Having said this, the groundwater recharging process in the Mount Lofty Ranges is still not well understood.

Palaeozoic

In central/northern South Australia, deep aquifer systems flow through the Permo-Carboniferous Boorthanna Formation (groundwater abstracted by Prominent Hill Mine) and the Cambrian Andamooka Limestone (groundwater abstracted by Olympic Dam Mine). The Boorthanna Formation is predominantly recharged from northern aquifer systems (Veitch *et al* 2006 and Olympic Dam Draft EIS 2011). The Andamooka Limestone aquifer, however, is recharged predominantly through surface infiltration following significant rainfall events (Olympic Dam Draft EIS 2011). Pressures on these aquifers arise principally from mining abstraction. Mine waste infiltration from mining activities and township irrigation are potentially contaminating activities that may threaten the unconfined Andamooka Limestone.

Mesozoic (Jurassic and Cretaceous)

In central/northern South Australia, the most significant aquifers are the Mesozoic Cadnaowie Formation and Algebuckina Sandstone, which comprise in part the South Australian portion of the Great Artesian Basin. Recharge rates of these aquifers are very low, ranging from 0.1 mm/year to 5 mm/year, with residence times as long as 7,000 years (Veitch *et al* 2006). These Mesozoic artesian aquifers are not susceptible to surface site contamination due to the protection of the partly confining layer of the Bulldog Shale. Pressure on these aquifer systems arise from pastoral and mining abstraction (GABCC 2000).

Cainozoic (Tertiary and Quaternary)

The sediments of the Tertiary basins build deep groundwater aquifers (otherwise known as the T1, T2, T3 and T4 aquifers). These deep aquifers are especially important for the supply of potable water to various market gardens, orchards, vineyards and stock watering in the Northern Adelaide Plains, Clare Valley, McLaren Vale and the Peninsulas, and industries in the Adelaide metropolitan region. The Tertiary aquifers are mostly protected by the overlying layers of widely impermeable confining sediments of the Hindmarsh Clay.

Managed Tertiary aquifer storage and recovery schemes are being increasingly used to 'water proof' an area against low surface water availability during times of drought or low rainfall periods. Managed aquifer storage and recovery is the

process of recharging surface water from created wetland areas into an aquifer for storages and then recovered months later for potable use. Contamination of the Tertiary aquifers could arise from poorly managed aquifer storage and recovery schemes.

Overlying the Tertiary sediments are the shallow, unconfined to semi-confined aquifers of the Adelaide Plains, Kangaroo Island and the Peninsulas, built up by Quaternary sands, gravels and clays, and calcareous sandstones, respectively. Due to the largely unconfined nature of the upper Quaternary aquifers, they can be particularly susceptible to chemical substances entering the groundwater from contaminating activities.

Groundwater within the aquifers of the Quaternary sands is abstracted primarily for market gardens, vineyards and localised domestic use.

Appendix 6 Information provided by SA Health

Fact sheet

Chlorinated solvents in groundwater

Chlorinated solvents include tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride. They are industrial chemicals used widely for metal cleaning and in production of thermoplastics, lacquers, perfumes and polyvinylchloride (PVC) products.

In the past, PCE and TCE were used in dry-cleaning, while TCE was also used in many other applications including: removing caffeine from coffee beans in the production of decaffeinated coffee and as an anaesthetic gas in hospitals.

What happens when chlorinated solvents enter the body or the environment?

If chlorinated solvents are taken into the body, they are metabolised (broken down) and eliminated from the body within days.

In the environment chlorinated solvents break down rapidly in air and surface water but much slower in soil and groundwater. PCE breaks down to form TCE, this in turn forms DCE and vinyl chloride which can then degrade to other chemicals.

How can contact with chlorinated solvents occur if they are in groundwater?

Exposure can occur if contaminated groundwater is extracted and consumed or used in cooking, or used in showers, swimming pools or watering gardens.

If the groundwater is shallow enough and there are sufficient concentrations of these chemicals chlorinated solvent vapours can also sometimes penetrate through the soil and contaminate indoor air.

In the past people were exposed from these chemicals being released into the air near where they lived such as from dry cleaners.

How can chlorinated solvents affect health?

The effects on health of these contaminants depend on a number of factors, such as how long a person has been exposed to the chemical(s), what level of chemical (s) is in air or water, how old the person is and whether there are any other illnesses.

Long-term exposure from these chemicals can be harmful if people are exposed to high enough concentrations over a long period of time, usually many years.

Inhaling or ingesting large amounts of PCE or TCE over short periods of time may make you dizzy or sleepy. Inhaling moderate amounts may also result in headaches.

If large amounts of DCE in air are inhaled over short periods of time (hours), you may feel nauseous, drowsy and tired.

Fact sheet

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Appendix 7 SA Health response minute



Government of South Australia
SA Health

SCIENTIFIC SERVICES PUBLIC HEALTH TOXICOLOGY

Doc #: eA529416
File #: 2009-06489/1

TO: GABRIELLE WIGLEY, SENIOR HYDROGEOLOGIST, SCIENCE & ASSESSMENT DIVISION, EPA

EMMA BRADFORD, ADVISOR SITE CONTAMINATION, SCIENCE & ASSESSMENT DIVISION, EPA

VIA: IAN DELAERE, A/MANAGER, PUBLIC HEALTH TOXICOLOGY, SCIENTIFIC SERVICES, SA HEALTH *24.2012*

RE: ADVICE ON THE PROPOSED WATER RESTRICTION AND PROHIBITION ZONE (WRAPZ), 24 MOORFIELD TCE ALLENBY GARDENS

BACKGROUND

Public Health Toxicology group of the Department of Health (PHT) reviewed the information you provided in support of the introducing the WRAPZ in Allenby Gardens (EPA 05/19891, 60720).

SUMMARY OF ISSUES

It appears that the western to north-western boundary of the proposed WRAPZ was determined based on the mathematical model of the extent of the plume and justified by the non-detect (<LOD) test result from a single groundwater well (MW22).

In May 2008, during an extensive public notification campaign in the nearby suburbs (Woodville South, Beverley, Findon), PHT was notified by a resident that TCE was detected in a domestic bore on Frobisher Avenue, Flinders Park at 6 µg/L. PHT notified EPA of this bore in a minute (DH 00308/0744, Attachment 1) of 4 August 2008 addressed to Greg Hill.

Frobisher Avenue is not included into the proposed WRAPZ. It is located about 120 metres westwards from the proposed WRAPZ boundary and about 200 metres away from the monitoring well MW22.

There may be a substantial number of residential groundwater bores (registered and unregistered) in the area of Flinders Park adjacent to Allenby Gardens and the proposed WRAPZ boundary.

RECOMMENDATIONS

PHT supports that the shallow groundwater in the area of Allenby Gardens/Flinders Park is polluted and is not suitable for residential use.

PHT supports that EPA introduce WRAPZ around the area of contamination.

PHT recommends that EPA reviews the western to north-western boundary of the proposed WRAPZ.

PHT recommends that residential bores in the area bounded by the Grevillea Avenue, Collingwood Avenue, Scott/Westall Avenue and Grange Road are tested to validate the western/north western boundary of the proposed WRAPZ.



Dr Kateryna Babina
Senior Scientific Officer
Public Health toxicology
SA Health

Authorised by Ian Delaere, A/Manager, Public Health Toxicology, DH

02 April 2012

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Appendix 8 Community frequently asked questions

1 How has the groundwater in my area become contaminated?

Groundwater can become contaminated at industrial or commercial sites due to past accepted industrial practices that are now understood to have contaminated the soil at the site and subsequently leached down to the groundwater.

2 I have a groundwater bore on my property. Can I use the bore water for drinking water, fill up the rainwater tank, irrigate the garden, water the lawn, wash down the paths and driveway or use as grey water in the house (eg toilet flushing)?

If you live in a groundwater prohibition area you cannot use your bore water for any use.

If you live in an EPA assessment area, the EPA advises you not to use your bore water for any use.

If you live outside a groundwater prohibition area or an EPA assessment area, the EPA and the Department for Health and Ageing recommend that all groundwater (where use is not prohibited) is tested prior to use.

For further information see: www.health.sa.gov.au/pehs/PDF-files/ph-factsheet-borewater-testing.pdf

3 Where can I get my bore water tested?

If your property is outside a groundwater prohibition area, there are several testing organisations that can undertake bore water testing. The only commercial facility in Adelaide is the Australian Water Quality Centre. Analytical laboratories are also available interstate.

Please ensure that the facility you choose has NATA (National Association of Testing Authorities) accreditation. The cost of water sampling varies and starts at approximately \$250 per sample bottle.

4 I have a groundwater bore that has been tested in the past; can I continue to use it?

If you live in a groundwater prohibition area you cannot use your bore water for any use. Continued use of groundwater within a groundwater prohibition area may draw the groundwater contamination towards your bore.

If you live in an EPA assessment area, the EPA advises you not to use your bore water for any use.

If you live outside a groundwater prohibition area or an EPA assessment area, the EPA and the Department for Health and Ageing that you continue to regularly test your bore prior to use.

For further information see: www.health.sa.gov.au/pehs/PDF-files/ph-factsheet-borewater-testing.pdf

5 I live outside the groundwater prohibition area and use a shallow bore (drilled between 10 and 30 metres), will the groundwater contamination extend to my bore?

The source of the groundwater contamination, the waste material within the pughole, has been removed where practicable. The groundwater contamination is not expected to extend past the boundary of the groundwater prohibition area. The reduction of the concentration of contamination within the groundwater will continue to occur via natural processes over time. However, this is a slow process that can take decades.

6 I have in the past received a letter from the EPA or the Department for Health and Ageing indicating that I live inside an EPA assessment area or in an area where groundwater contamination exists. I have a groundwater bore – will the groundwater contamination affect my bore?

If there is suspected groundwater contamination the EPA and the Department for Health and Ageing has asked private bore owners not to use bore water (groundwater) in the upper aquifers. The nature and extent of the suspected groundwater contamination has to be assessed to determine that groundwater use is of low risk for human health and safety.

7 Can the EPA check the depth and test the quality of my bore water?

The EPA does not undertake testing for this purpose. The use of the upper two aquifers has been prohibited (less than 30 metres). If you think that your bore has been constructed into a deeper aquifer (greater than 30 metres), then you need to confirm the depth.

The EPA and the Department for Health and Ageing recommend that all groundwater (where use is not prohibited) is tested prior to use.

For further information see: www.health.sa.gov.au/pehs/PDF-files/ph-factsheet-borewater-testing.pdf

8 Can the EPA provide information on the geology and hydrogeology of my suburb? I would also like to access documents and reports from the EPA public register.

Geological and hydrogeological information can be obtained from various websites including

- www.minerals.dmitre.sa.gov.au/geological_survey_of_sa/geology
- www.pir.sa.gov.au/wid/regions/mount_lofty_ranges/water_considerations/groundwater

Legislation requires the EPA to have a public register and to make information available for the public to inspect. The EPA public register can be accessed by calling (08) 8204 2004 or, in South Australia, 1800 623 445, emailing epainfo@epa.sa.gov.au or www.epa.sa.gov.au/what_we_do/public_register_directory/site_contamination_index

9 Can the EPA provide information about the consultants and auditors that have been engaged for the groundwater prohibition area, EPA assessment areas and contaminated sites in South Australia?

Legislation requires the EPA to have a public register and to make information available for the public to inspect. The EPA public register can be accessed by calling (08) 8204 2004 or, in South Australia, 1800 623 445 or by email: epainfo@epa.sa.gov.au or www.epa.sa.gov.au/what_we_do/public_register_directory/site_contamination_index

10 I would like to more information regarding groundwater prohibition areas, EPA assessment areas and contaminated sites in South Australia.

Please see the EPA website: www.epa.sa.gov.au/environmental_info/site_contamination

11 Will the EPA provide further information to the community about the ongoing management of the groundwater prohibition area and EPA assessment areas?

The EPA website is continually updated. Please see the EPA website www.epa.sa.gov.au

12 I would like some information on fruit trees and root depths of fruit trees that grow in areas where there is trichloroethylene (TCE) groundwater contamination?

Most fruit trees have shallow root systems where the active root zone for water uptake is generally limited to the upper 0.5 to 1 metre of soil. Some plants, such as grape, vines do extend their root systems down to the water table when rainfall is scarce.

The Department for Health and Ageing has advised the EPA that an assessment of the available literature indicates that the likelihood is low, of fruits and vegetables grown in soil near contaminated groundwater, containing TCE and related compounds at levels that might represent a risk to health. In areas impacted by TCE contaminated groundwater, home-grown vegetables are safe and do not pose an appreciable risk to residents who consume them, provided they are not watered with contaminated groundwater.

13 Do fruit trees and groundwater bores need to be removed from our properties?

Fruit trees and plants do not need to be removed from properties where groundwater contamination exists. Please refer above to Question 11.

Groundwater bores do not need to be decommissioned but can remain in place. However, if your groundwater bore is inside a groundwater prohibition area, it is not to be used.

14 Is there a soil/groundwater vapour issue associated with the contamination arising from the pug hole?

For Allenby Gardens/Flinders Park area, the environmental auditor concluded that;

The groundwater contamination at the site (and off-site) does not pose an unacceptable risk to human health via the volatile migration and air inhalation pathway. No groundwater remediation or site management measures are required to further reduce this [vapour inhalation] risk.

15 Will the groundwater prohibition area boundary change in the future?

Groundwater conditions change very slowly over time. The boundary may be reduced in the future with further groundwater monitoring. No significant changes in the nature and extent of the groundwater contamination are expected for at least 10 years.

16 My property is situated within the 'buffer zone'. Can I be excluded from the groundwater prohibition area?

The 'buffer zone' is a part of the groundwater prohibition area and all properties within the groundwater prohibition area are prohibited from using groundwater.

The buffer zone is designed to prevent the drawing of groundwater and expanding the contamination plume to groundwater extraction.

17 Can the groundwater prohibition area only be applied to people with groundwater bores?

The EPA is unable to determine which properties have a groundwater bore. The *Environment Protection Act 1993* provides the legislative powers to prohibit the taking of contaminated groundwater and establishes a penalty for those who use the bore water within the prohibition area. This legislative mechanism provides a long-term action to ensure that people do not use contaminated groundwater now and into the future.

18 Can the EPA concrete up (decommission) all bores within the groundwater prohibition area?

The EPA is unable to decommission groundwater bores. The *Environment Protection Act 1993* does not provide the legislative powers to require the decommissioning of groundwater bores.

19 Will the EPA collect groundwater data in the future to monitor how the groundwater contaminant plume changes over time?

The EPA is not planning any assessment at this time. However, the groundwater contaminant plume will continue to be monitored by the appropriate person until the plume is shown to be stable.