

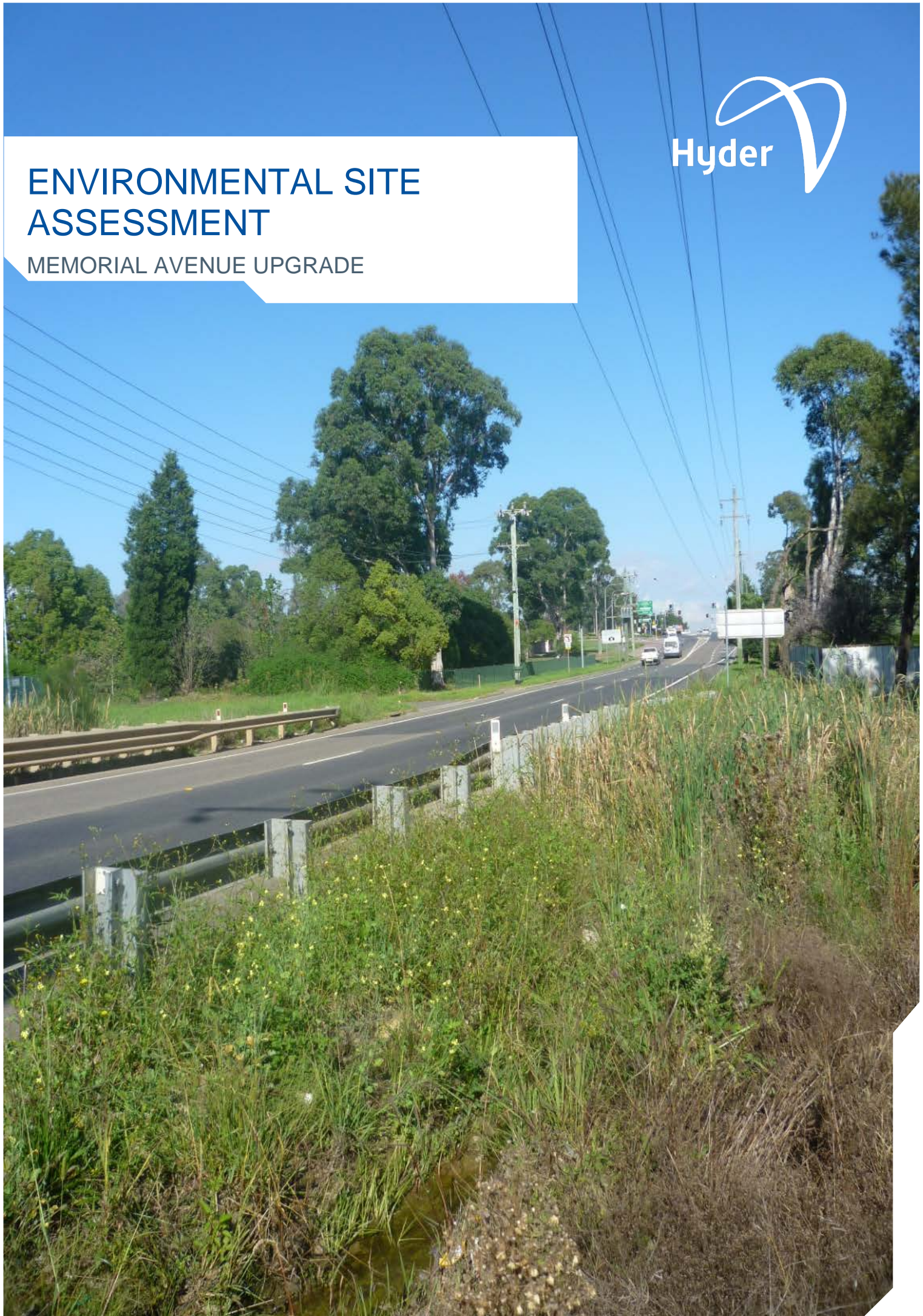
Appendix H

Stage 1 Preliminary Contamination Assessment



ENVIRONMENTAL SITE ASSESSMENT

MEMORIAL AVENUE UPGRADE



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ROADS & MARITIME SERVICES NSW

PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

Memorial Avenue Upgrade

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Report No 1

Date 2nd July 2014

This report has been prepared for Roads & Maritime Services NSW in accordance with the terms and conditions of appointment for Phase 1 Environmental Site Assessment dated 2nd July 2014. Hyder Consulting Pty Ltd (ABN 76 104 485 289) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

EXECUTIVE SUMMARY

Hyder Consulting Pty Ltd (Hyder) has been commissioned by New South Wales Roads and Maritime Service (Roads and Maritime) to undertake a Phase 1 Environmental Site Assessment (ESA) of a site located along Memorial Avenue in Kellyville, New South Wales (NSW). Memorial Avenue is a state arterial road connecting Old Windsor Road in the west to Windsor Road in the East, in the suburb of Kellyville. Roads and Maritime has developed a preliminary concept design to widen Memorial Avenue from a two lane road to a four lane divided road, between Old Windsor Road and Windsor Road.

The purpose of the investigation was to identify potentially contaminating activities which may have occurred on site and that may pose constraints for the future infrastructure development of the site. The investigation was undertaken in general accordance with the relevant Office of the Environment and Heritage guidelines, including the *Contaminated Sites; Guidelines for Consultants Reporting on Contaminated Sites*, and standard industry practice.

As part of the investigation, the following was undertaken:

- A desktop review of available aerial photographs, land title certificates, contaminated sites databases, groundwater, soil and geology databases and relevant available historical reports and documentation as required.
- Development of a Conceptual Site Model (CSM) to outline the framework for identifying how the Site may have become contaminated and how potential receptors may be exposed to contamination either in the present or the future

The site is currently bordered by a mix of low-to-medium residential areas (intermixed with farmland), infrastructure, local centres and public recreation zones. The available information indicates that there is potential contamination risk on the site due to the following:

- **Localised areas of contamination from point sources:** Potential for spills/leaks of fuels, oils and/or chemicals leaching into surface soils, particularly in unpaved areas or where cracks in pavements are present. These also include local Reserves and Parks along Memorial Avenue due to the potential use of pesticides and fertilisers and The Hills Clinic Hospital. Furthermore, former service stations existed at the corner of Memorial Avenue and Windsor Road and 200 metres further south.
- **Activities upstream:** Potential groundwater and waterway contamination issues with regards to the Castle Hill Country Club (Golf course), Industrial and Business areas upstream (south) of the site.
- **Potential imported fill material:** Potential for contaminated fill materials beneath the concrete pavement and existing buildings and infrastructure.
- **Hazardous Building Material:** There is potential that past and present buildings at the site have contaminated hazardous building materials, such as asbestos and lead-based paints.

This Phase 1 ESA found that a potential risk of contamination exists. Therefore, a Phase 2 assessment is recommended to be completed prior to construction. The Phase 2 assessment would confirm levels of site contamination (if any) through collection and analysis of soil and groundwater samples. A hazardous buildings materials survey and asbestos register are also recommended to quantify the potential presence and risks associated with hazardous building materials.

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1 INTRODUCTION

Hyder Consulting Pty Ltd (Hyder) has been engaged by Roads and Maritime to undertake a Phase 1 Environmental Site Assessment to facilitate a Review of Environmental Factors (REF) development proposal for an upgrade to Memorial Avenue, Kellyville, NSW (referred to as “the site”).

Roads and Maritime Services (Roads and Maritime) propose to upgrade about 2.2 kilometres of Memorial Avenue (MR642) between Windsor Road and Old Windsor Road Kellyville (the proposal), as well as intersection upgrades. This would include widening Memorial Avenue with a central median strip along the length to accommodate a possible future upgrade to a six-lane configuration (three lanes in each direction). The proposal is located approximately 35 kilometres north-west of the Sydney Central Business District (CBD).

Memorial Avenue is a State arterial road, which runs in an east-west direction connecting Old Windsor Road in the west to Windsor Road in the east. It links the Blacktown Local Government Area (LGA) and some of its suburbs such as Glenwood, Stanhope Gardens and Parklea with the Hills Shire Council LGA and some of its suburbs such as Castle Hill and Kellyville. The road is located in the suburb of Kellyville within the Hills Shire Council LGA.

Memorial Avenue is located within mainly rural residential land that is in transition to low and medium density urban development and associated urban land uses. The road bisects the new Balmoral Road Release Area (BRRA), identified in The Hills Development Control Plan (DCP) 2012. The proposal is required to cater for future growth arising from increased residential and commercial expansion anticipated in the area.

The purpose of the investigation is to identify any significant constraints to the proposal posed by the presence of areas of contamination across the land that may have been derived from the various past and present land use activities.

This report specifically addresses the *State Environmental Planning Policy 55 – Remediation of Land*.

This assessment has been undertaken in accordance with the requirements of

- *National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPC 2013); and*
- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites (OEH 2011).*

1.1 OBJECTIVES

The objectives of this assessment are to:

- Identify potential on and off-site sources of contamination relating to the current and past activities
- Identify the presence of any significant contamination issues at the site that may pose constraints for future redevelopment of the site
- Provide recommendations for further investigations to confirm and characterise the nature and extent of any contamination, if required.

1.2 SCOPE OF WORKS

The scope of works undertaken for the Phase 1 ESA included the following:

- Desktop study of historical information including a review of available aerial photographs, central online databases and relevant documentation as required
- Review and evaluation of available information to establish the environmental setting of the site, including topography, hydrology, geology and hydrogeology
- Development of a Conceptual Site Model (CSM) to outline the framework for identifying how the site may have become contaminated and how potential receptors may be exposed to contamination either in the present or the future
- Evaluation of the available data in the context of the CSM to identify the potential risk for the identified on and off-site sources of contamination to have impact the site
- Preparation of a Phase 1 ESA report in accordance with the relevant guidelines and standard industry practices outlined by the NSW Office of the Environment and Heritage.

1.3 SITE LOCATION AND IDENTIFICATION

Memorial Avenue is a State arterial road, which runs in an east-west direction connecting Old Windsor Road in the west to Windsor Road in the east. It links the Blacktown Local Government Area (LGA) and some of its suburbs such as Glenwood, Stanhope Gardens and Parklea with the Hills Shire Council LGA and some of its suburbs such as Castle Hill and Kellyville. The road is located in the suburb of Kellyville within the Hills Shire Council LGA.

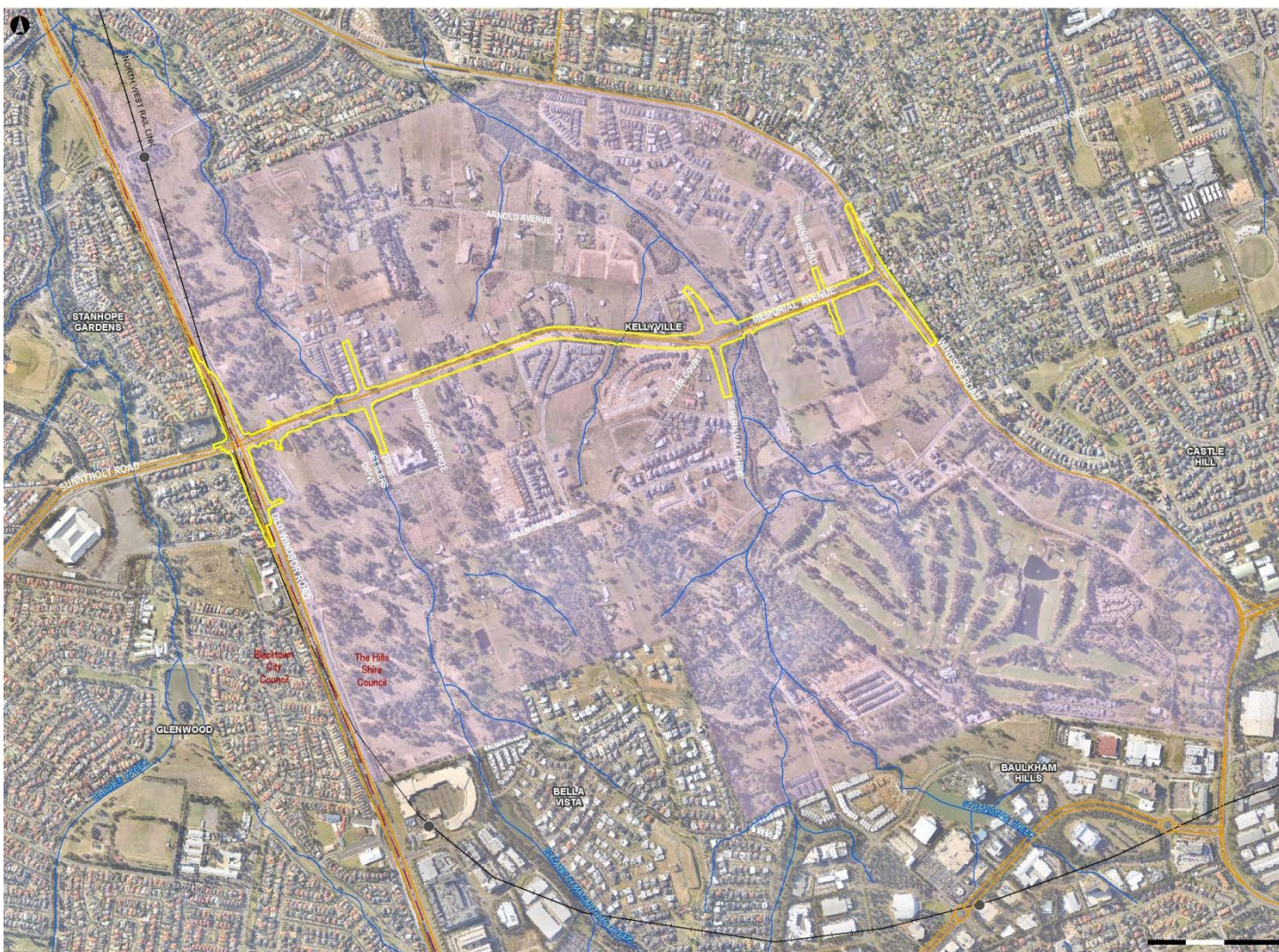


Figure 1 below shows the site boundary and locality.

The site is within the jurisdiction of The Hills Shire Council, Parish of Kellyville and the County of Cumberland.



Figure 1: Site location and boundary

1.4 SITE LAYOUT

Memorial Avenue is a sealed, multi-lane undivided road that extends roughly 2.2 kilometres along Memorial Avenue, between Old Windsor Road and Windsor Road in roughly and east/west direction. The Proposal includes intersection upgrades at Windsor Road between President Road and Wrights Road, and Old Windsor Road for a distance of about 250 metres either side of the intersection. Old Windsor Road is a major road which connects a large portion of north western Greater Sydney, while Windsor Road is a main road connecting many of southern areas of The Hills Districts.

Memorial Avenue intersects with Rouse Hill –Parramatta Transit Way (T-way) at the approach to Old Windsor Road. The future North West Rail Link will cross over Memorial Avenue on a viaduct between the T-way and Elizabeth Macarthur Creek. There are existing intersections with local roads including Arnold Avenue (east), Arnold Ave (west) and Hector Court. These are shown in

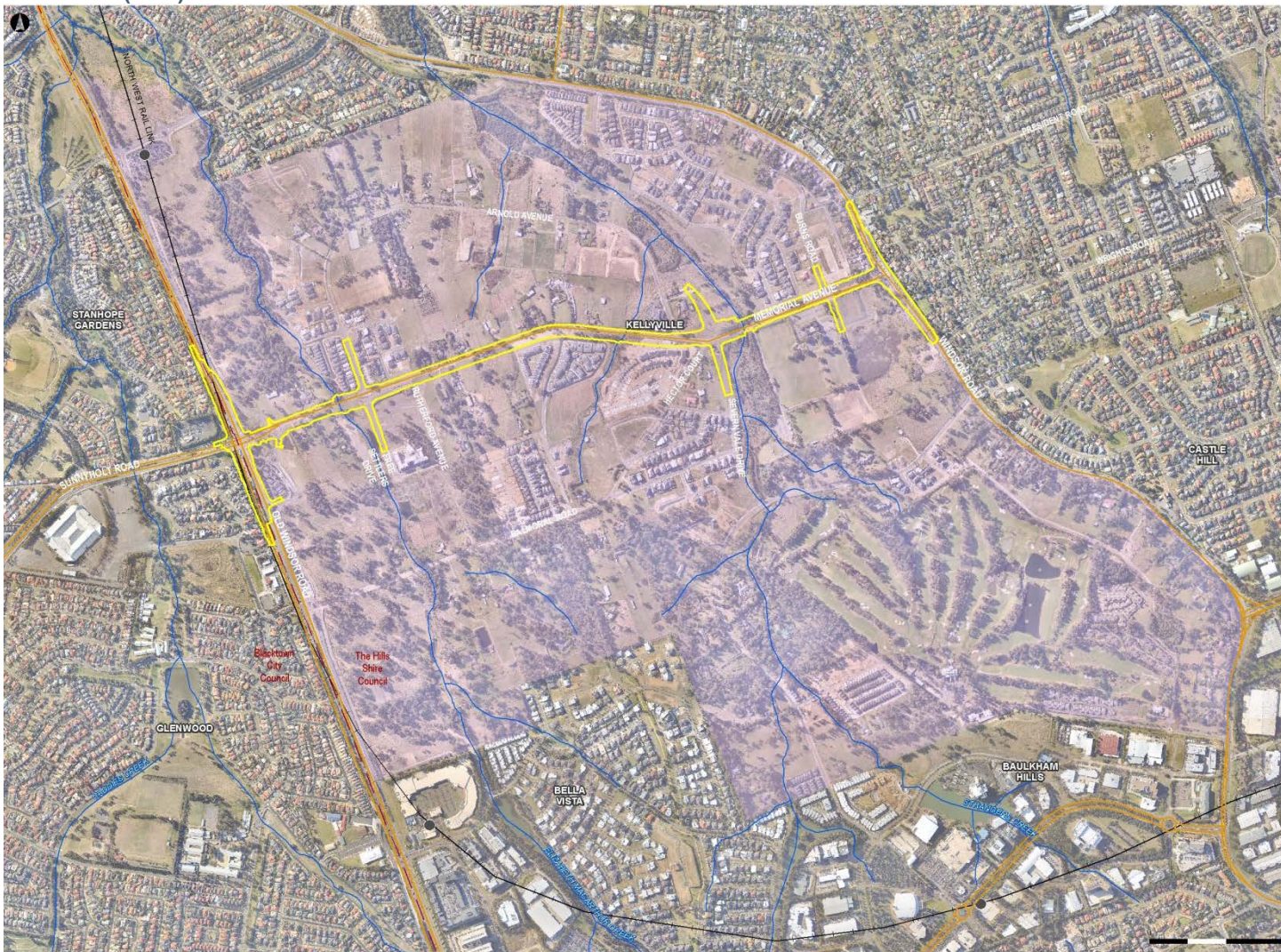


Figure 1 above.

Memorial Avenue crosses Elizabeth Macarthur Creek and Strangers Creek, within the Hawkesbury Nepean River catchment.

1.5 PROPOSED LAND USES

Memorial Avenue is located within mainly rural residential land that is in transition to low and medium density urban development and associated urban land uses. The road bisects the new

Balmoral Road Release Area, identified in The Hills Development Control Plan (DCP) 2012. The proposal is required to cater for future growth arising from increased residential and commercial expansion anticipated in the area.

Non-residential developments in the vicinity include the Hills Clinic (a private psychiatric hospital) and Gracelands Early Education Centre. A 'Woolworths' supermarket is proposed to be built on Memorial Avenue, immediately to the east of Hector Court.

1.6 LIMITATIONS

The findings in this report are based on the preliminary environmental desktop study described in the scope of works. Hyder has performed the services in a manner consistent with the level of care and expertise exercised by members of the environmental consulting profession. No warranties, expressed or implied are made. Hyder's assessment is limited strictly to identifying typical environmental conditions associated with the site. All environmental and contaminated land work is subject to general limitations related to the heterogeneity of the natural environment, variability of contaminant distribution and constraints imposed by the investigation methods utilised.

The results of this assessment are based on a desktop study, information provided by Roads and Maritime and publically available background information. All conclusions and recommendations are the professional opinions of the Hyder personnel involved in the project, subject to the qualifications made above. While normal assessments of data reliability have been made, Hyder assumes no responsibility or liability for errors in any data obtained from external sources, or developments resulting from situations outside the scope of this project.

Specifically, with regard to this report, it should be noted that the scope of works carried out is not intended to include sufficient information to enable completion of a statutory audit of the site, and as such does not include the following:

- Any intrusive soil/groundwater sampling and analysis
- Sampling and analysis of any emissions to air, wastewater discharges or solid and liquid wastes
- Preliminary site visit.

These limitations are to be considered before utilising, or basing decisions on the information presented in this report.

2 SITE HISTORY

The history of the site and surrounding area was obtained from review of the following sources of information:

- Historical aerial photographs
- NSW Department of Finance and Services – Land and Property Information (land title informational and historical land title information)
- Office of Environment and Heritage (notices under *Contaminated Lands Management Act 1997 (CMA)*, *Protection of the Environment Operations Act 1997 (PoEO)* Environment Protection license register, environmental incidents and State Heritage Register).

2.1 PREVIOUS LAND USES

A review of available historic/background information for the site has been undertaken to understand and evaluate potential for on and off-site sources of contamination. Findings of the previous land uses are summarised in the following section.

2.1.1 REVIEW OF HISTORICAL AERIAL PHOTOGRAPHS

Aerial photographs from 1943, 2009 and 2014 have been investigated to determine the historical land uses and are outlined in Table 1 below. Aerial photography was not publicly available for any other years.

Table 1: Review of historical aerial photography

Year	Site description
1943	<p>Almost the entire stretch from Windsor Road to Old Windsor Road bordering Memorial Avenue was cleared agricultural land and the road itself was unsealed and comprised of dirt. There were roughly six residences/farmhouses bordering the road. Small patches of trees were clustered around the crossings of both creeks, but otherwise devoid of mature vegetation and appeared cleared for agricultural purposes/farming.</p> <p>Both Windsor and Old Windsor roads were unsealed in 1943. Barely any trees existed along Windsor Road, although a few residences bordered the road particularly just north of President Road and mainly on the eastern side. Old Windsor Road contained one or two residences along the eastern side, although mainly consisted of cleared land with a few patches of trees.</p>

Year	Site description
2009	<p>The land bordering Memorial Avenue was still mainly cleared agricultural land. However, there were a greater number of residences compared to the 1943 photo, particularly around central and western parts of the road. Mature vegetation appeared more common, particularly around residences and still existing at both creek intersections.</p> <p>In comparison to 1943, significant residential development has occurred along western parts of Old Windsor Road and along the eastern side of Windsor Road, adjacent to the site. Minor sealed roads and a carpark have been constructed adjacent to the site boundary on the eastern side of Old Windsor Road. Along the western side of Windsor Road, adjacent to the site, there has been minor residential development in comparison to 1943.</p> <p>A service station is visible on the border of the site boundary on Windsor Road, opposite Wrights Road. There also appeared to be remnants of a previous service station on the corner of Memorial Avenue and Windsor Road.</p>
2014	<p>Mature vegetation appears to be more abundant, particularly at the crossing of Strangers Creek on the southern side. Significant residential development has occurred resulting in a 50/50 mix of residential areas and cleared agricultural land. There also appears to be more areas cleared for construction or which are currently being constructed. The most significant development either completed or underway has occurred about central and north eastern areas of Memorial Avenue. Development has been very minor if at all along Old Windsor and Windsor roads within the site boundary compared to 1943.</p> <p>The service station which existed on the border of the site boundary on Windsor Road, opposite Wrights Road has been demolished and any fuel tanks/containers appear to have been removed. Remnants of a service station on the corner of Memorial Avenue and Windsor Road still remain unchanged since 2009. A service station on Windsor Road southbound near Presidents Road is evident.</p>

Potential sources of contamination identified from the aerial photograph review in the Memorial Avenue investigation area were three service stations, two former and one existing in the vicinity of Windsor Road.

2.1.2 ADJACENT LAND USE ACTIVITIES/ZONING

The site is relatively large and encompasses a diverse range of land uses. The majority of the site is zoned as SP2 Infrastructure (Classified Road), while the majority of surrounding land is zoned as low and medium density residential. The site is located within the Balmoral Road Release Area with the exception of the western side of Old Windsor Road and the eastern side of Windsor Road. Table 2 below outlines the zoning of the land surrounding the site.

Table 2: Surrounding land use and zoning

Location	Zoning
North	Low density residential (R2), Medium density residential (R3), High density residential (R4), Infrastructure (Stormwater Management) (SP2), and Public recreation (RE1)

Location	Zoning
South	Low density residential (R2), Medium density residential (R3), High density residential (R4), Stormwater Management (SP2 Infrastructure), Public recreation (RE1), Local centre (B2), and Business park (B7)
East	Medium density residential (R3), and Classified Road (SP2 Infrastructure)
West	General residential (R1), Rail corridor (SP2 Infrastructure), and Classified Road (SP2 Infrastructure)

The Hills Local Environment Plan 2012 (LEP) zoning objectives relevant to the site are outlined in Table 3 below.

Table 3: Zoning objectives as outlined by The Hills LEP 2012

Zone	The Hills LEP objectives
R1	<ul style="list-style-type: none"> ▪ To provide for the housing needs of the community ▪ To provide for a variety of housing types and densities ▪ To enable other land uses that provide facilities or services to meet the day to day needs of residents ▪ To enable other land uses that support the adjoining or nearby commercial centres and protect the amenity of the adjoining or nearby residential areas.
R2	<ul style="list-style-type: none"> ▪ To provide for the housing needs of the community within a low density residential environment ▪ To enable other land uses that provide facilities or services to meet the day to day needs of residents ▪ To maintain the existing low density residential character of the area.
R3	<ul style="list-style-type: none"> ▪ To provide for the housing needs of the community within a medium density residential environment ▪ To provide a variety of housing types within a medium density residential environment ▪ To enable other land uses that provide facilities or services to meet the day to day needs of residents ▪ To encourage medium density residential development in locations that are close to population centres and public transport routes.
R4	<ul style="list-style-type: none"> ▪ To provide for the housing needs of the community within a high density residential environment ▪ To provide a variety of housing types within a high density residential environment ▪ To enable other land uses that provide facilities or services to meet the day to day needs of residents ▪ To encourage high density residential development in location that are close to population centres and public transport routes.
RE1	<ul style="list-style-type: none"> ▪ To enable land to be used for public open space or recreational purposes ▪ To provide a range of recreational settings and activities and compatible land uses ▪ To protect and enhance the natural environment for recreational purposes.

Zone	The Hills LEP objectives
B2	<ul style="list-style-type: none"> ▪ To provide a range of retail, business, entertainment and community uses that serve the needs of people who live in, work in and visit the local area ▪ To encourage employment opportunities in accessible locations ▪ To maximise public transport patronage and encourage walking and cycling.
B7	<ul style="list-style-type: none"> ▪ To provide a range of office and light industrial uses ▪ To encourage employment opportunities ▪ To enable other land uses that provide facilities or services to meet the day to day needs of workers in the area ▪ To make provision for high technology industries that use and develop advanced technologies, products and processes.
SP2	<ul style="list-style-type: none"> ▪ To provide for infrastructure and related uses ▪ To prevent development that is not compatible with or that may detract from the provision of infrastructure.

2.2 PREVIOUS INVESTIGATIONS

During the search for all relevant information regarding the preparation of this report, Hyder is not aware of any previous Environmental Site Assessment's (ESA) conducted for the site.

2.3 PLANNING CONTEXT

2.3.1 OFFICE OF ENVIRONMENT & HERITAGE RECORDS

Hyder reviewed publically available New South Wales (NSW) Government databases on 9th July 2014 to determine if the site is subject to any environmental constraints, including a search of the Office of Environment & Heritage contaminated land public record to determine whether any locations at the site were registered under the *Contaminated Land Management Act 1997*.

The results were as follows:

- The site and immediately adjacent properties are not registered on the NSW Environmental Protection Authority (EPA's) contaminated land public record
- The site and immediately adjacent properties are not listed as properties that have been notified to the NSW EPA as potentially contaminated
- The site and immediately adjacent properties do not possess a licence under the *Protection of the Environment Operations Act 1997 (PoEO Act)*.

Table 4 below provides a list of PoEO licences, applications and notices listed on the EPA search register. The closest site identified on the register is approximately 2.1 kilometres to the east of the site.

Table 4: List of past and present PoEO licences, applications and notices within Kellyville

Number	Name	Location	Type	Status	Issued date
11429	Jeff Martin Property Maintenance Pty Limited	12 Stinger Road, Kellyville, NSW 2155	PoEO licence	Surrendered	22-May-01
12154	John Holland Pty Ltd	Kellyville, NSW 2155	PoEO licence	Surrendered	16-Aug-04
10553	Lend Lease Engineering Pty Limited	Stage 2, Kellyville, NSW 2155	PoEO licence	Surrendered	27-Nov-00
1725	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	PoEO licence	Issued	25-May-00
1005308	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	22-Oct-01
1017893	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	26-Jun-02
1018888	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	23-Dec-02
1028459	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	8-Jul-03
1032623	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	21-Nov-03
1032929	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	19-Mar-04
1048125	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	30-Jun-05
1061406	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	29-Jun-06
1074750	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	27-Jun-07
1116044	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	2-Jul-10
1129015	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	27-Jun-11
1504845	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	28-Jun-12
1513714	Sydney Water Corporation	Wrights Road, Kellyville, NSW 2155	s.58 Licence Variation	Issued	9-Jan-14

The EPA register search also identified one pollution and study program for number 1725 at Wrights Road. This site is a Water Recycling Plant located approximately 2.1 kilometres east of the site. The pollution and study program was issued for a review of dry weather leakage monitoring program and pollution reduction program.

There was one former contaminated site listed in the Local Government Area of Baulkham Hills Shire Council-Annangrove Climbers. Annangrove Climbers was subject to a total of three remediation orders due to the presence of Polychlorinated Biphenyls (PCBs) impacted fill materials onsite. Subsequent to successful remediation, the remediation orders were revoked on 3rd October 1995. Annangrove Climbers was located approximately 4.5 kilometres northeast of the site. It is considered sufficiently removed from the investigation area and unlikely to impact the site due to the distance away and being located downstream of the site.

2.3.2 SUMMARY OF SITE HISTORY

In general, the Kellyville area has historically been used for residential, farming, horticultural and livestock purposes. This is reflective of the 1943 aerial photograph and to some extent the 2009. However, the site history information indicates that the majority of the site has changed considerably since 2009 due to population growth.

Based on the available information, the size, location, layout and local setting of the site, it is likely that the historical land use activities have been limited to residential and small-scale agricultural activities. As the population has grown, so too has the number of residences and surrounding infrastructure.

The probability is low that any industrial activities have been undertaken within the site. However, it is possible, that any underground infrastructure for the storage of fuel, oil or other chemicals has been present at the site. This is highlighted particularly at the site of the previous service station located on the corner of Memorial Avenue and Windsor Road and another located approximately 200 metres further south, directly opposite Wrights Road. It should be noted that Hyder could not confirm potential storage of chemicals or presence of underground storage tanks on private land.

Furthermore, farming machinery requiring fuel, oil or other chemicals could also present the risk of contamination.

3 EXISTING ENVIRONMENT

3.1 GEOLOGY

The 1:100,000 Geological Map of the Penrith Region indicates the project area is predominantly underlain by Ashfield Shale of the Wianamatta Group, which is described as dark grey to black claystone-siltstone and fine sandstone-siltstone laminate. Along the western end of Memorial Avenue the Ashfield Shale may be overlain by Quaternary Alluvium, typically comprising fine grained sand, silt and clay. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Soil Resource Information System indicates that soils at the site are predominately light-to-medium clays.

Limitations of these rocks when weathered are that they are moderately-to-highly reactive, have appreciable shrink-swell capacity, low soil fertility and poor soil drainage.

Low lying areas where groundwater is close to the surface are also susceptible to dryland salinity. Groundwater quality can range from fresh-to-highly saline, with the deeper groundwater generally less saline.

3.2 SOILS

The soil landscapes of the Penrith 1:100 000 sheet were mapped by Bannerman and Hazelton (1990). There are two different soil landscapes mapped within the study area: the residual Blacktown soil landscape and the erosional Luddenham soil landscape. The features and location in the study area of the mapped soil landscapes are detailed in Table 5.

Table 5: Soil landscape and location

Soil landscape	Features (Bannerman and Hazelton, 1990)	Location in study area
Blacktown (Residual)	Shallow to moderately deep hardsetting mottled texture contrast soils; red and brown podzolic soils on crests, draining to yellow podzolic soils on lower slopes and drainage lines. On gently undulating rises on Wianamatta Group Shales.	Most of extent of study area in vicinity of Memorial Avenue.
Luddenham (Erosional)	Shallow dark podzolic soils or massive earthy clays on crests; moderately deep red podzolic soils on upper slopes; moderately deep yellow podzolic soils and prairie soils on lower slopes and drainage lines. Landscape is undulating to rolling low hills on Wianamatta Group shales, often associated with Minchinbury Sandstone.	Small section of eastern end of study area in vicinity of Memorial Avenue and Windsor Road.

It should be noted that according to the Acid Sulphate Soils (ASS) Risk Map 1:25,000 for the area, acid sulphate soil materials are an extremely low probability of occurring with low confidence at the site. However, this extremely low risk does not preclude the existence of acid sulphate soils within the investigation corridors.

3.3 TOPOGRAPHY AND HYDROLOGY

The site varies in height with an elevation of between approximately 60 – 84 metres above the Australian Height Datum (AHD). The topography of the site slopes gently towards each creek where topography is lowest (54 – 56 m AHD). The highest elevation is at the intersection of Windsor Road in the east (80 – 84 m AHD) and slightly lower at the intersection of Old Windsor Road in the west (62 – 64 m AHD). Any potentially contaminated sites along Old Windsor Road and Windsor Road could enter the waterways flowing through the site due to the topography.

The site is located within the Cattai Creek subcatchment of the Hawkesbury Nepean Catchment. It is managed by the Hawkesbury Nepean Catchment Management Authority (CMA). The Cattai Creek subcatchment drains areas of new and ongoing development in north-western Sydney in the upper reaches of Cattai and O'Hara's Creeks. Based on an ecological site visit conducted by Hyder, the urbanisation of upstream areas has resulted in increased sedimentation and degradation, with poor water quality as a result of stormwater and sewage treatment plant discharges into creeks.

Three mapped creeklines intersect Memorial Avenue: Elizabeth Macarthur Creek in the west, and Strangers Creek and one of its tributaries in the east of the study area. Both creeks flow northwards. Elizabeth Macarthur Creek is a second order stream using the Strahler stream classification system (Strahler 1952). The two sections of Strangers Creek that traverse the study area are first and second order streams.

The site is currently occupied by mainly existing structures, road base, concrete and paved areas, which would allow potential for stormwater to infiltrate soils at the site. Due to the majority of areas surrounding the site comprising of mostly cleared land with limited vegetation, these are likely to allow stormwater to infiltrate soils. In addition, infrastructure at the site, including stormwater drainage along sections of the existing Memorial Avenue, would direct stormwater into Elizabeth Macarthur Creek in the west, and Strangers Creek and one of its tributaries in the east. It should be noted that sections of the existing Memorial Avenue do not have concrete curb and gutters, which would allow rainwater to flow freely from the road surface into surrounding soils.

Furthermore, any contaminated land upstream of the creeks has the potential to enter the waterways and cause contamination of land at the site.

3.4 GROUNDWATER

The location of groundwater bores (indicated by blue dots) within the vicinity of the site are shown in Figure 2 below.

There are 15 groundwater bores located within a two kilometre radius of the site. Two bores are used for recreational purposes, one for domestic purposes, one for monitoring and all others contained no data. The permanent groundwater table varies considerably around the site and is estimated to be at a depth between 1.6 metres in the southeast (400 metres from the site) - to eight metres just north (250 metres) and west (250 metres) of the site - to 53 metres in the far north (500 metres from the site). The considerable variability of groundwater levels around the site presents the risk of inaccurate measurements and further highlights the need for onsite and technical investigations.



Figure 2: Indicative location of groundwater boreholes within 2 kilometres of the site

4 CONCEPTUAL SITE MODEL

Based on the outcomes of the desktop review, a Conceptual Site Model (CSM) has been developed to outline the framework for identifying how the site may have become contaminated and how potential receptors may be exposed to contamination either in the present or the future. The key elements of the CSM as outlined in the National Environment Protection Council (NEPC) (2013) include:

- Known and potential sources of contamination
- Contaminants of concern
- Mechanism of contamination
- Potentially effected media
- Human and ecological receptors
- Potential for migration
- Exposure pathways

4.1 KNOWN SOURCES OF CONTAMINATION

Table 6 below summarises four contaminated sites near the site. The closest, and most at risk of being impacted during construction are an old service station located on the corner of Windsor Road and Memorial Avenue within the site boundary and another directly next to the site boundary, opposite Wrights Road. However, no records have occurred on the Environmental Protection Authority (EPA) register for the above mentioned sites.

Furthermore, as identified in Table 6, a Caltex service station is located directly opposite the site on the eastern side of Windsor Road, which may be potentially contaminated. Another two service stations which may contain contaminated land are located 80 metres north of the site boundary along Windsor Road and another 70 metres south of the site boundary on Old Windsor Road. Construction will be confined within the site boundary, therefore these sites are unlikely to be directly affected during construction.

Table 6: Current EPA records of contaminated sites notified to the EPA near the site

Site	Address	Activity which caused contamination	S60 received	EPA initial assessment	EPA site management class
Kellyville BP Service Station	19-21 Windsor Road	Service Station	Yes	In progress	A
Kellyville Caltex Service Station	3-5 Windsor Rd	Service Station	Yes	In progress	B
Kellyville Mobil Service Station	Windsor Road	Service Station	Yes	In progress	A
Parklea Caltex Service Station	1190 Old Windsor Rd Near Miami St	Service Station	Yes	In progress	B

In relation to Table 6 above, the EPA has provided a class of each action concerning contaminated land and is summarised below in Table 7.

Table 7: EPA site classification

THE EPA Site Management Class	Explanation
A	The contamination of this site is being assessed by the EPA. Sites which have yet to be determined as significant enough to warrant regulation may result in no further regulation under the Contaminated Land Management Act 1997.
B	The EPA is awaiting further information to progress its initial assessment of this site.

4.2 POTENTIAL SOURCES OF CONTAMINATION

Potential sources of contamination at the site can be summarised into the categories below:

Localised areas of contamination from point sources:

- The proposal may directly impact two former service stations, and potentially impact three current service stations. Potential contaminants at these sites include hydrocarbons, heavy metals and lead associated with service station activities. These may also enter the groundwater table and migrate through the site
- There is the potential for oil/fuel spills from vehicles travelling along the existing road. In addition, the road may have poorly sealed (or unsealed) areas with notable cracks.
- The Hills Clinic Hospital - Any improper disposal of biological, cytotoxic, clinical, chemical and pharmaceutical wastes has the potential to directly affect the site.
- Rutherford and Kellyville Memorial Park on Memorial Avenue - The use of pesticides and herbicides in treatment of grasses and vegetation. Furthermore, line marking paints and oil and fuel from lawn mowing machinery pose a risk of contamination.
- A Business Park located directly adjacent to the site at the intersection of Old Windsor Road could produce potential contaminants that directly affect the site. These may include hydrocarbons, metals, solvents, acids and alkalis.
- Potential imported fill material - Prior to construction of the present infrastructure and buildings, it is possible that fill was used to level the land where necessary, due to the relatively flat topography of the lots directly bordering the site. Any potential imported fill materials from unknown sources may contain contaminants and affect the groundwater and surface soils.

Activities upstream of the site:

- Various land uses fringe the two creeks and one tributary upstream (south) of the site and have the potential to affect land at the site due to waterway and groundwater contamination.
- Approximately 1.6 kilometres to the south of the site are a range of Industrial and Business development areas. Potential contaminants emanating from these areas may include hydrocarbons, metals, solvents, acids, alkalis, refrigerants and antifreeze.
- Approximately 1.25 kilometres to the south of the site are a range of commercial areas. Waste from these areas may not be appropriately stored and present a potential contaminant source. There is also the potential for oil/fuel spills from vehicles within the loading areas. In addition, this area may have poorly sealed (or unsealed) areas with notable cracks.

- Castle Hill Country Club (golf course located 600 metres south of the site) and Kellyville Rotary Park (150 metres west of the intersection at Windsor Road) may use fertilisers, pesticides and herbicides in treatment of grasses and vegetation. Furthermore, line marking paints and oil and fuel from lawn mowing machinery pose a risk of contamination.

4.3 CONTAMINANTS OF CONCERN

The following (but not limited to) potential contaminants of concern have been identified as being associated with the potential contamination sources identified above:

- Volatile organic compounds (VOC), including volatile halogenated compounds (VHC)-potentially from household rubbish from residence along and near Memorial Avenue.
- Petroleum hydrocarbons (Total Petroleum Hydrocarbons (TPH)/Benzene, Toluene, Ethyl-Benzene and Xylenes (BTEX)): Fuels and oils-existing roads and service stations.
- Polycyclic aromatic hydrocarbons (PAH): Fill materials, diesel fuels and oils-service stations.
- Heavy metals, including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc: Potential to have been derived from multiple on and off-site sources of contamination (e.g. service stations), including fill materials, lead-based paints, pesticides and the urban environment (atmospheric fallout).
- Organochlorine Pesticides (OCP): Historical use of pesticides for agricultural and landscaping activities (golf course and farming).
- Asbestos: Potential use of asbestos-containing materials (ACM) in both past and present buildings, including any former residential buildings which have since been demolished.
- Polychlorinated Biphenyls (PCB): Use in transformers and light fittings, also potential contaminant from imported fill materials.

4.4 MECHANISM OF CONTAMINATION

The primary mechanisms for contamination of the site are dependent on the source of contamination. These can be divided into four (4) key categories:

- **Localised point sources:** The use of fertilisers and pesticides on and adjacent to the site throughout history. The potential exists for surface and near surface soils to be contaminated, primarily derived from leaks and spills of materials in this area, including fuels/oils and stored waste products. Furthermore, given the long history of use of the site, there is the potential for the surface soils to have been sprayed with pesticides. Contamination would occur via a top down mechanism (particularly where cracks or unsealed areas are present) and dependant on the types of contaminants released, there is the potential for the contaminants to also migrate into the groundwater table (where it is shallow).
- **Off-site migration:** Any off-site migration of contamination is likely to be via the movement of surface and groundwater from upgradient sources of contamination. The use of fertilisers and pesticides on the golf course and agricultural (current and historical) areas may enter groundwater and the associated waterways and migrate to the site. Commercial and Industrial areas upstream (south) of the site may also generate potential for contamination to enter groundwater and the associated waterways. Furthermore, the potential exists for surface and near surface soils to be contaminated, primarily deriving from leaks and spills of materials in this area, including fuels/oils and stored waste products.

- **Fill materials:** The potential exists for contaminated fill materials to have been used to facilitate the original development of the site and bordering farmland, primarily given the gradient of the land.
- **Hazardous building materials:** The use, maintenance and degradation of hazardous building materials has the potential to release contaminants into the environment, including asbestos, PCBs and lead. Such contaminants are likely to contaminate the surface and near surface soils of the site via a top-down mechanism, although there is the potential for such materials to have been buried following any demolition works where these may have occurred.

It should be noted that based on preliminary desktop investigations, there is potential for underground fuel/oil storage infrastructure to have been historically used at the site. This is in particular reference to the corner of Memorial Avenue and Windsor Road where a previous service station existed prior to 2009 and a former service station on Windsor Road opposite Wrights Road.

4.5 POTENTIALLY AFFECTED MEDIA

Potentially effected media at the site is likely to include:

- Near surface soil and fill materials: Dependent upon the potential leachability of any contaminants that may be present within fill materials and near surface soils, there is the potential for vertical migration of contaminants to have occurred, which may have resulted in an impact to the underlying natural soils.
- Natural soils: From vertical migration of contaminant through the soil profile.
- Groundwater: There is potential for groundwater to be present at relatively shallow levels beneath the site, although, there is uncertainty surrounding the depth at which it lies. Depending on the depth of groundwater, it may have been potentially contaminated by off-site and on-site activities. However, the expected geological conditions to be encountered at the site of silty clay and shale/sandstone bedrock are likely to limit vertical migration of contaminants.
- Waterways (Elizabeth Macarthur Creek, and Strangers Creek and one of its tributaries): Direct runoff into the waterways from contaminated sources both on and offsite.

4.6 HUMAN AND ECOLOGICAL RECEPTORS

The site and surrounding areas are zoned mainly low-to-medium density residential. Development is likely to continue throughout this area as it is zoned as urban release under the Balmoral Road Release Area. Residential receptors are located along the majority of Memorial Avenue and are therefore at a significant risk to potentially contaminated areas.

The current and proposed future development includes infrastructure upgrades that occupy the vast majority of the footprint of the land.

There are sparse patches of remnant vegetation with little connectivity on the site and directly adjacent to the site. However, along the creek banks, particularly where the creeks intersect the site, there are small areas of mature trees. Various small reserves and parks used for public recreation exist along the site

There is a significant risk for workers to come into contact with potentially contaminated soil and/or groundwater during construction, due to unknown areas of fill and a direct impact at the former service station sites, particularly at the former service station located on the corner of Windsor Road and Memorial Avenue. It is anticipated that any contaminated soil/fill materials

would require removal from the site to facilitate the development. Therefore, the primary potential receptors at the site under the future land use setting would be workers during construction and residents living along the site.

In addition, there is also potential for offsite migration of contaminated groundwater (if present).

4.7 POTENTIAL FOR MIGRATION

Contaminants generally migrate via a combination of windblown dusts, rainwater infiltration, groundwater migration and surface water runoff, which are affected by the following:

- **The nature of the contaminants (solid/liquid and mobility characteristics):** The potential contaminants of concern at the site and upstream of the site are likely to be either a solid form (such as heavy metals or asbestos) or liquid form (oils and fuels). There may also be potential for some vaporised contaminants, which have a higher mobility than either solid or liquid contaminants.
- **The extent of the contaminants (isolated or widespread):** The extent of contamination at site could occur within near surface soils, deeper soils and groundwater. Certain areas within the site may have localised point source contamination, particularly around waterway intersections.
- **The location of the contaminants (surface soils or at depth):** There is potential for contaminants to be present at varying soil and groundwater depths depending on their source. Contaminants in fill material is likely to be confined to a thin surface layer, however there is the possibility of contaminants leaching into deeper soil layers either from surface water flows or groundwater flows.
- **The site topography, geology, hydrology and hydrogeology:** There is potential for contamination migration via surface water and infiltration into accessible soils through cracks and defects in the existing road and pathways. There is additional potential that upstream activities may have caused groundwater and waterway contamination.

4.8 MIGRATION PATHWAYS AND EXPOSURE ROUTES

Based on the known and potential contamination issues at the site, exposure pathways are expected to be limited (e.g. to construction workers performing excavation works and potentially local residents). However, more widespread exposure pathways may exist to the long-term residents as a result of surface soil, waterway and groundwater contamination.

Considering the proposed development, where it is anticipated that any contaminated soil/fill materials would require removal from the site to facilitate the development, the primary exposure pathway is considered to be via contaminated soil or groundwater at the site.

4.9 POTENTIAL LOCATIONS AND CONTAMINANTS OF CONCERN

Based on the CSM outlined above, a summary of the potential locations and potential contaminants of concern are presented in Table 8.

Table 8: Potential locations and contaminants of concern

Potential source	Areas of concern	Description	Potential areas of Environmental concern	Likelihood of contamination	Potential contaminants of concern
Localised areas of contamination from point sources	Former service stations on the corner of Windsor Road and Memorial Avenue and directly opposite Wrights Road on Windsor Road.	Potential for spillage/leakages of fuels, oils and/or chemicals; use of pesticides; degradation of hazardous building materials.	Localised areas of near surface soils/fill material and potentially groundwater	Moderate-High	TPH/BTEX, PAH, heavy metals, OCP
Activities upstream of the site	Areas where creeks and tributary intersect Memorial Avenue	Potential for contaminated surface soils and groundwater from upstream activities to migrate on-site.	Surface soils and groundwater	Moderate	Petroleum Hydrocarbons (TRH/BTEX), Heavy Metals
Potential imported landfill	Areas where natural topography has been modified and levelled.	Potential for contaminated fill materials beneath the concrete pavement and existing buildings.	Near surface soils/fill materials across the site	Low – Moderate (unknown presence and source)	Heavy metals, petroleum hydrocarbons (TRH/BTEX), PAH, asbestos, PCB, OCP

Potential source	Areas of concern	Description	Potential areas of Environmental concern	Likelihood of contamination	Potential contaminants of concern
Hazardous building materials	Areas where buildings and infrastructure have been demolished and areas where previous construction has occurred and is currently occurring.	Potential removal of residential buildings since the 1940's may result in hazardous building materials remaining buried on-site.	Near surface soils/fill materials	Low – Moderate	Asbestos, PCBs and lead

5 CONCLUSIONS AND RECOMMENDATIONS

Hyder notes that a number of significant information gaps exist in regards to soil, sediment and groundwater contamination issues potentially affecting sections of the site, particularly where the waterways intersect Memorial Avenue and the previous service station complexes located along Windsor Road. No data were available with respect to concentrations of potential contaminants in the environment and detailed site inspections could not be undertaken.

Consequently, Hyder recommends that a Phase 2 assessment be undertaken. This would include a number of soil samples being collected and analysed for a broad range of potential contaminants to confirm the findings of this Phase 1 Environmental Assessment and to provide an indication of potential waste classification for off-site disposal purposes.

6 REFERENCES

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