PRELIMINARY GROUNDWATER ASSESSMENT & MONITORING PROGRAM

PRELIMINARY GROUNDWATER QUALITY REPORT
GROUNDWATER MONITORING PROGRAM
WATER TABLE MONITORING PROGRAM

Proposed Residential Sub-Division

45/49 Warriewood Road, Warriewood, NSW

Report To:

Mikara Developments Pty Ltd C/O

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Report By:

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1 INTRODUCTION

1.1 INTRODUCTION

Archidrome Architects, on behalf of its client Mikara Developments Pty Ltd, is involved in the planning and prospective delivery of a residential sub-division at 45 Warriewood Road, Warriewood, NSW.

The proposed development site is described in 1.2 to 1.5 below.

The proposed development is subject to the regulatory control of the Northern Beaches Council, and relevant NSW Government departments and agencies.

Northern Beaches Council is the consent authority for the development.

Archidrome Architects has engaged NG Child & Associates to undertake an assessment of groundwater quality and behaviour at the site.

Noel Child of NG Child & Associates is an appropriately qualified and experienced consultant to undertake the work required.

His experience and qualifications are summarised in Appendix B.

This report describes the assessment process and timetable and present some preliminary and indicative findings.

1.2 PROPOSED LOCATION

Satellite views and street maps showing the location of the proposed development are provided in Figures 1.1 and 1.2 respectively on the following page.

The direction of north is towards the top of both diagrams.

The site area is shown shaded in blue in both diagrams.

The proposed development site is bounded by Warriewood Road to the north; by prospective or existing residential developments to the east and west, and by Narrabeen Creek to the south and south-west.

The closest major road is Pittwater Road, some 50 metres to the east of the site.

Figure 1.1 – Aerial View of the Proposed Development Site

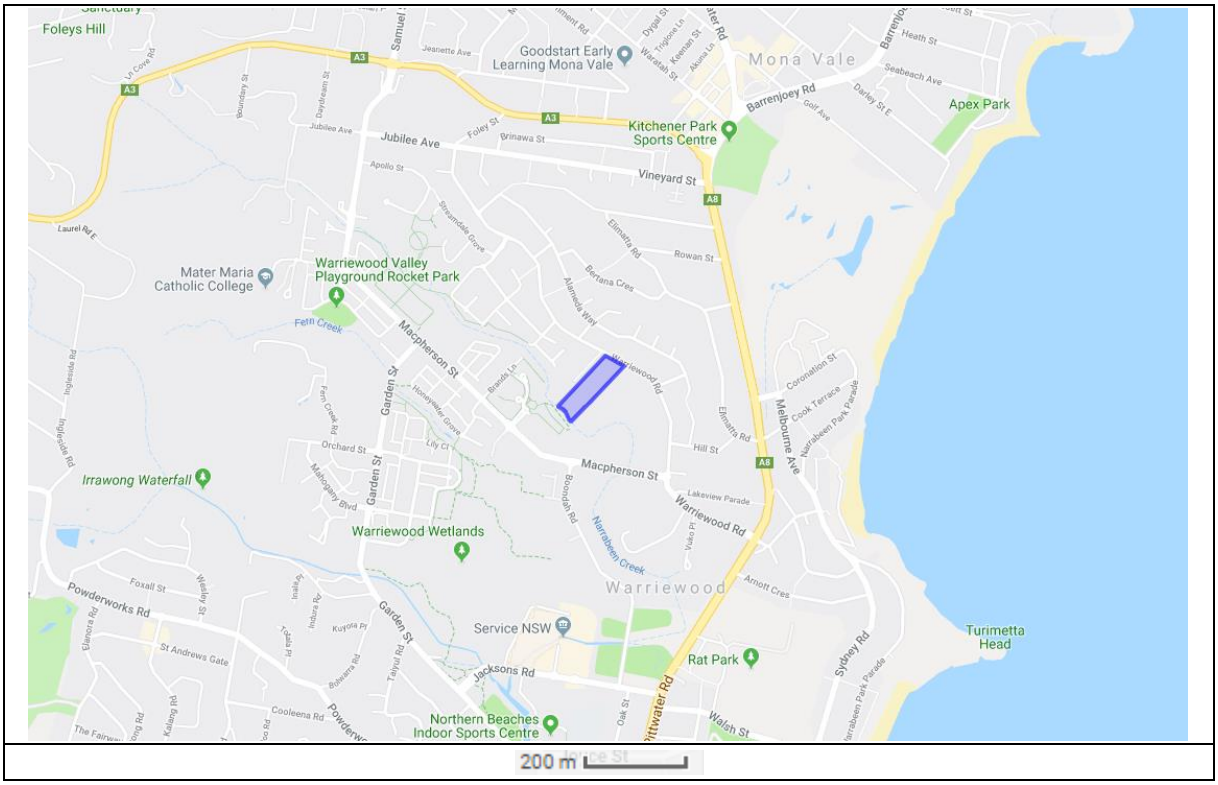


Figure 1.2 – Street Map Showing the Site Location

Views of the site from Warriewood Road, are provided in Figures 1.3 and 1.4, below.

Figure 1.3 – Existing Buildings and Structures on 49 Warriewood Road

Figure 1.4 – Existing Buildings and Structures on 45 Warriewood Road

1.3 ZONING

The zoning of the proposed development site, and surrounding properties, is shown in Figure 1.4, below.

Figure 1.5 – Land Zoning Diagram

The diagram provided in Figure 1.4 is sourced from the current Northern Beaches Local Environment Plan. The site is shown at the approximate centre of Figure 1.4 and is zoned R3 Medium Density Residential.

Immediate surrounding land is also zoned R3 Medium Density Residential, with R2 low density residential land present on the opposite (northern) side of Warriewood Road, and a strip of public recreation land along the creek line bordering the site to the south.

1.4 PROPERTY DETAILS

Survey details of the site are provided for reference in Figures 1.5 and 1.6, on the following pages. The site formally comprises Lots 1 & 2 in Deposited Plan (DP) 349085 and Lot 2 in DP 972209, and is known as 43, 35 & 49 Warriewood Road, Warriewood.

The aggregate site has an approximate area of 21,500 square metres.

1.5 PROJECT DESCRIPTION & PLAN

This proposed development involves a residential subdivision and development.

Site survey details are as follows:

Figure 1.6 Site Survey (Sheet 1 of 2)

Figure 1.7 Site Survey (Sheet 2 of 2)

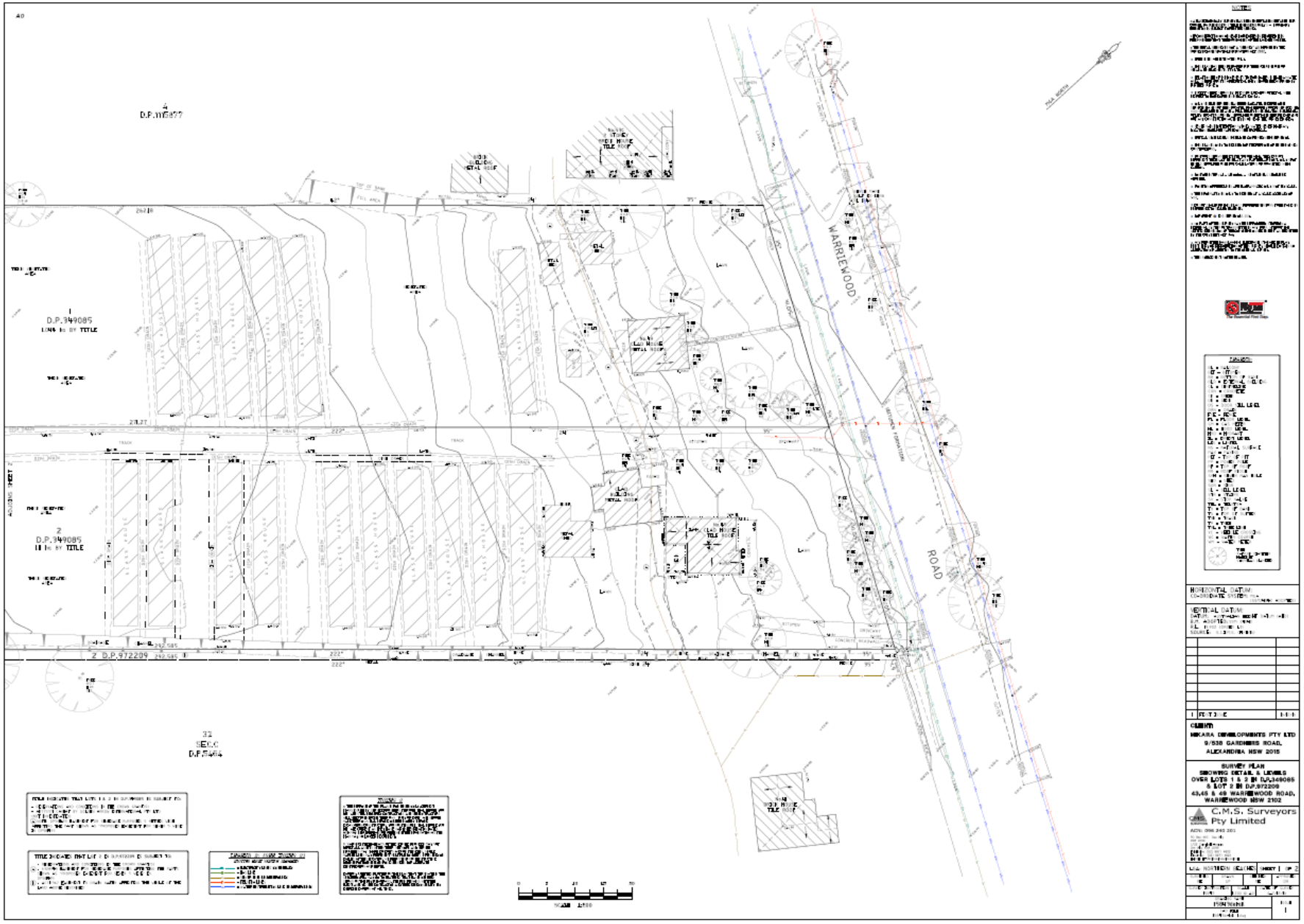


Figure 1.5 – Site Survey (Sheet 1 of 2)

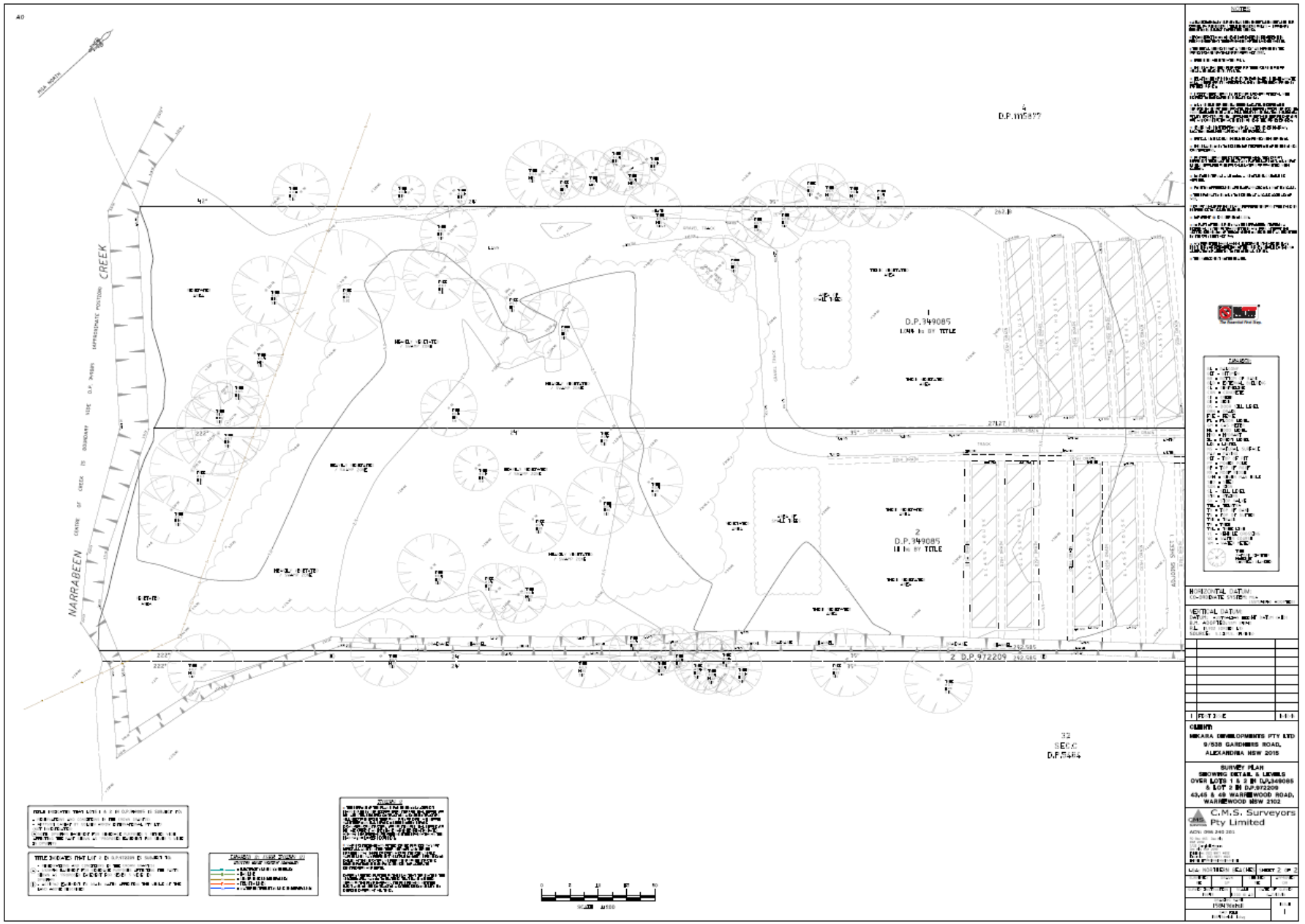


Figure 1.5 – Site Survey (Sheet 2 of 2)

2 ASSESSMENT REQUIREMENTS

2.1 INTRODUCTION

As part of the overall environmental and contamination assessment of the 45/49 Warriewood Road site, an appropriate consideration of groundwater quality and behaviour is required.

2.2 NORTHERN BEACHES COUNCIL REQUIREMENTS

Northern Beaches Council has indicated that it requires two basic considerations of groundwater quality and behaviour at the site.

These are as follows:

2.2.1 Groundwater Level Investigation

Council requires a report on groundwater levels based on six months monitoring of water levels and other data from a minimum of three groundwater monitoring wells to be installed at the site.

Reference is made to Page 11 of the pre-DA meeting notes:

> "*Issues specific to this site Paragraph 2 "Please note: Water level monitoring should be undertaken on a regular basis for a period of six months from monitoring bores installed at the site upslope of the EEC (Endangered Ecological Community). Monitoring results should include a rainfall hyetograph to indicate the sensitivity of groundwater levels to periods of rainfall. A minimum of three bores should be installed to allow triangulation of water levels, determination of the hydraulic gradient and interpretation of flow direction"*

and to Page 17 of the pre-DA meeting notes

> *"Documentation to Accompany the Development Application "Water Table Report".*

2.2.2 Site Works Required

Work required to satisfy Council's requirements will include installation of four groundwater monitoring wells. While three wells are required to determine groundwater flow, the fourth well will be required to satisfy groundwater quality assessment requirements (refer below).

Installation of the groundwater monitoring wells will require a truck mounted mechanical augur, and construction of the four groundwater monitoring wells using appropriate casings, screens and packing materials

Ground water level investigation to satisfy Council's requirement will require fortnightly attendance at the site for a six-month period; measurement of groundwater levels in each well; reconciliation of groundwater levels with rainfall records; calculation of groundwater flows based on a triangulation of monitoring well data, and preparation of an appropriate report.

2.2.3 Groundwater Quality Assessment

Council requires an assessment of groundwater quality and potential groundwater contamination.

This assessment will require groundwater sampling and analysis from the four monitoring wells to be installed at the site.

Reference is made to Page 11 of the pre-DA meeting notes:

> *"Specialist Advice Paragraph 3 "Due to past use of the site for market gardening, particularly 49 Warriewood Road where there large numbers of greenhouses, a groundwater assessment is required. If contaminants are fund above ANZECC guidelines a groundwater management plan should be prepared*".

This additional work requires sampling from the four monitoring wells described above; analysis in a NATA certified laboratory for all broad range of potential contaminants, and preparation of an appropriate report, setting out relevant findings and recommendations.

2.3 TIMETABLE

As indicated above, an overall period of six months will be required to complete the groundwater assessment tasks required by Council.

Results regarding groundwater quality will be available within one month of the installation of the four groundwater monitoring wells.

3 ASSESSMENT GUIDELINES

Groundwater quality guidelines for both fresh and marine water systems are summarised in Table 3.2 below, and on subsequent pages.

Table 3.1 – Groundwater Quality Guidelines

Substance		Groundwater Investigation Levels		
		Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
		(µg/L)	(µg/L)	(mg/L)
Metals and Metalloids				
Aluminium, Al pH>6.5		55	-	-
Antimony		-	-	0.003
Arsenic		24 as As(III) 13 as As(V)	-	0.01
Barium		-	-	2
Beryllium		-	-	0.06
Boron		370[C]	-	4
Cadmium	H	0.2	0.7[D]	0.002
Chromium, Cr (III)	H	-	27	-
Chromium, Cr (VI)		1[C]	4.4	0.05
Cobalt		-	1	-
Copper	H	1.4	1.3	2
Iron, (Total)		-	-	-
Lead	H	3.4	4.4	0.01
Manganese		1900[C]	-	0.5
Mercury (Total)		0.06[D]	0.1[D]	0.001
Molybdenum		-	-	0.05
Nickel	H	11	7	0.02
Selenium (Total)		5[D]	-	0.01
Silver		0.05	1.4	0.1
Tributyl tin (as Sn)		-	0.006[C]	-
Tributyl tin oxide		-	-	0.001
Uranium		-	-	0.017
Vanadium		-	100	-
Zinc	H	8[C]	15[C]	-
Non-metallic Inorganics				
Ammonia[E] (as NH_3-N at pH 8)		900[C]	910	-
Bromate		-	-	0.02
Chloride		-	-	-
Cyanide (as un-ionised Cn)		7	4	0.08
Fluoride		-	-	1.5
Hydrogen sulphide (un-ionised H_2S measured as S)		1	-	-
Iodide		-	-	0.5
Nitrate (as NO_3)		refer to	refer to	50

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L) guideline	(µg/L) guideline	(mg/L)
Nitrite (as NO_2)	refer to guideline	refer to guideline	3
Nitrogen	refer to guideline	refer to guideline	-
Phosphorus	refer to guideline	refer to guideline	-
Sulphate (as SO_4)	-	-	500
Organic alchohols/other organics			
Ethanol	1400	-	-
Ethylenediamine tetra-acetic acid (EDTA)	-	-	0.25
Formaldehyde	-	-	0.5
Nitrilotriacetic acid	-	-	0.2
Anilines			
Aniline	8	-	-
2,4-Dichloroaniline	7	-	-
3,4-Dichloroaniline	3	150	-
Chlorinated Alkanes			
Dichloromethane	-	-	0.004
Trichloromethane (chloroform)	-	-	0.003
Trihalomethanes (total)	-	-	0.25
Tetrachloromethane (carbon tetrachloride)	-	-	0.003
1,2-Dichloroethane	-	-	0.003
1,1,2-Trichloroethane	6500	1900	-
Hexachloroethane	290[D]	-	-
Chlorinated Alkenes			
Chloroethene (vinyl chloride)	-	-	0.0003
1,1-Dichloroethene	-	-	0.03
1,2-Dichoroethene	-	-	0.06
Tetrachloroethene (PCE) (Perchloroethene)	-	-	0.05
Chlorinated Benzenes			
Chlorobenzene	-	-	0.3
1,2- Dichlorobenzene	160	-	1.5
1,3- Dichlorobenzene	260	-	-
1,4- Dichlorobenzene	60	-	0.04

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
1,2,3- Trichlorobenzene	3[D]	-	0.03
1,2,4- Trichlorobenzene	85[D]	20[D]	for individual or total trichlorobenzenes
1,3,5-Trichlorobenzene	-	-	
Polychlorinated Biphenyls (PCBs)			
Aroclor 1242	0.3[D]	-	-
Aroclor 1254	0.01[D]	-	-
Other Chlorinated Compounds			
Epichlorohydrin	-	-	0.1
Hexachlorobutadiene	-	-	0.0007
Monochloramine	-	-	3
Monocyclic Aromatic Hydrocarbons			
Benzene	950	500[C]	0.001
Toluene	-	-	0.8
Ethylbenzene	-	-	0.3
Xylenes	350 (as o-xylene) 200 (as p-xylene)	-	0.6
Styrene (Vinyl benzene)	-	-	0.03
Polycyclic Aromatic Hydrocarbons (PAHs)			
Naphthalene	16	50[C]	-
Benzo[a]pyrene	-	-	0.00001
Phenols			
Phenol	320	400	-
2-Chlorophenol	340[C]	-	0.3
4-Chlorophenol	220	-	-
2,4-Dichlorophenol	120	-	0.2
2,4,6-Trichlorophenol	3[D]	-	0.02
2,3,4,6-Tetrachlorophenol	10[D]	-	-
Pentachlorophenol	3.6[D]	11[D]	0.01
2,4-Dinitrophenol	45	-	-
Phthalates			
Dimethylphthalate	3700	-	-
Diethylphthalate	1000	-	-
Dibutylphthalate	10[D]	-	-
Di(2-ethylhexyl) phthalate	-	-	0.01

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Pesticides			
Acephate	-	-	0.008
Aldicarb	-	-	0.004
Aldrin plus Dieldrin	-	-	0.0003
Ametryn	-	-	0.07
Amitraz	-	-	0.009
Amitrole	-	-	0.0009
Asulam	-	-	0.07
Atrazine	13	-	0.02
Azinphos-methyl	-	-	0.03
Benomyl	-	-	0.09
Bentazone	-	-	0.4
Bioresmethrin	-	-	0.1
Bromacil	-	-	0.4
Bromoxynil	-	-	0.01
Captan	-	-	0.4
Carbaryl	-	-	0.03
Carbendazim (Thiophanate-methyl)	-	-	0.09
Carbofuran	0.06	-	0.01
Carboxin	-	-	0.3
Carfentrazone-ethyl	-	-	0.1
Chlorantraniliprole	-	-	6
Chlordane	0.03[D]	-	0.002
Chlorfenvinphos	-	-	0.002
Chlorothalonil	-	-	0.05
Chlorpyrifos	0.01[D]	0.009[D]	0.01
Chlorsulfuron	-	-	0.2
Clopyralid	-	-	2
Cyfluthrin, Beta-cyfluthrin	-	-	0.05
Cypermethrin isomers	-	-	0.2
Cyprodinil	-	-	0.09
1,3-Dichloropropene	-	-	0.1
2,2-DPA	-	-	0.5
2,4-D [2,4-dichlorophenoxy acetic acid]	280	-	0.03
DDT	0.006[D]	-	0.009
Deltramethrin	-	-	0.04

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Diazinon	0.01	-	0.004
Dicamba	-	-	0.1
Dichloroprop	-	-	0.1
Dichlorvos	-	-	0.005
Dicofol	-	-	0.004
Diclofop-methyl	-	-	0.005
Dieldrin plus Aldrin	-	-	0.0003
Diflubenzuron	-	-	0.07
Dimethoate	0.15	-	0.007
Diquat	1.4	-	0.007
Disulfoton	-	-	0.004
Diuron	-	-	0.02
Endosulfan	0.03[D]	0.005[D]	0.02
Endothal	-	-	0.1
Endrin	0.01[D]	0.004[D]	-
EPTC	-	-	0.3
Esfenvalerate	-	-	0.03
Ethion	-	-	0.004
Ethoprophos	-	-	0.001
Etridiazole	-	-	0.1
Fenamiphos	-	-	0.0005
Fenarimol	-	-	0.04
Fenitrothion	0.2	-	0.007
Fenthion	-	-	0.007
Fenvalerate	-	-	0.06
Fipronil	-	-	0.0007
Flamprop-methyl	-	-	0.004
Fluometuron	-	-	0.07
Fluproponate	-	-	0.009
Glyphosate	370	-	1
Haloxyfop	-	-	0.001
Heptachlor	0.01[D]	-	-
Heptachlor epoxide	-	-	0.0003
Hexazinone	-	-	0.4
Imazapyr	-	-	9
Iprodione	-	-	0.1
Lindane (γ-HCH)	0.2	-	0.01

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)
Propanil	-	-	0.7
Propargite	-	-	0.007
Proparzine	-	-	0.05
Propiconazole	-	-	0.1
Propyzamide	-	-	0.07
Pyrasulfatole	-	-	0.04
Pyrazophos	-	-	0.02
Pyroxsulam	-	-	4
Quintozene	-	-	0.03
Simazine	3.2	-	0.02
Spirotetramat	-	-	0.2
Sulprofos	-	-	0.01
2,4,5-T	36	-	0.1
Tebuthiuron	2.2	-	-
Temephos	-	0.05[D]	0.4
Terbacil	-	-	0.2
Terbufos	-	-	0.0009
Terbuthylazine	-	-	0.01
Terbutryn	-	-	0.4
Thiobencarb	2.8	-	0.04
Thiometon	-	-	0.004
Thiram	0.01	-	0.007
Toltrazuril	-	-	0.004
Toxafene	0.1[D]	-	-
Triadimefon	-	-	0.09
Trichlorfon	-	-	0.007
Triclopyr	-	-	0.02
Trifluralin	2.6[D]	-	0.09
Vernolate	-	-	0.04
Surfactants			
Linear alkylbenzene sulfonates (LAS)	280	-	-
Alcohol ethoxylated sulfate (AES)	650	-	-
Alcohol ethoxylated surfactants (AE)	140	-	-

Table 3.1 – Groundwater Quality Guidelines (continued)

Substance	Groundwater Investigation Levels		
	Fresh Waters[A]	Marine Waters[A]	Drinking Water[B]
	(µg/L)	(µg/L)	(mg/L)

ARMCANZ (2000) for guidance on applying these levels to different ecosystem conditions.

A Investigation levels apply to typical slightly-moderately disturbed systems. See ANZECC &
B Investigation levels are taken from the health values of the Australian Drinking Water Guidelines (NHMRC 2011).

C Figure may not protect key species from chronic toxicity, refer to ANZECC & ARMCANZ (2000) for further guidance.

D Chemical for which possible bioaccumulation and secondary poisoning effects should be considered, refer to ANZECC & ARMCANZ (2000) for further guidance.

E For changes in GIL with pH refer to ANZECC & ARMCANZ (2000) for further guidance.

H Values have been calculated using a hardness of 30 mg/L $CaCO_3$ refer to ANZECC & ARMCANZ (2000) for further guidance on recalculating for site-specific hardness.

It is noted that the full assessment of groundwater quality does not rely solely on a consideration of the groundwater investigation levels summarised in Table 3.1.

Assessment requires consideration of all the issues set out in the document National Environment Protection (Assessment of Site Contamination) Measure 1999 Schedule B1 Guideline on Investigation levels for Soil and Groundwater; and in the various documents provided as part of the 2013 update of the national Environment Protection Measure.

4 PRELIMINARY INDICATIONS

4.1 PRELIMINARY SITE INVESTIGATION

A preliminary assessment of soil quality at the site has been undertaken.

Findings are reported in the associated document:

> *Preliminary Site Investigation: Proposed Residential Sub-Division 45/49 Warriewood Road, Warriewood NSW (NG Child & Associates; Version 1; February 28th, 2020*)

4.2 INVESTIGATION BORES

Soil bores were installed at five locations throughout the site as part of the preliminary site investigation process.

The location of these bores is shown in Figure 4.1 below.

Figure 4.1 – Soil Sampling Locations

Soil bores 4 and 5 were located toward the southwestern or Narrabeen Creek boundary of the site.

These mechanically assisted hand augured bores were installed to a depth of 2.0 metres for soil sampling purposes.

4.3 PRELIMINARY GROUNDWATER SAMPLING

Soil at the bottom of soil bores 4 and 5 was noted to be moist.

The two bores were augured to a further 500 – 1000 mm depth, to allow groundwater to seep into the bore holes.

To provide a preliminary indication of groundwater quality, water samples were:

drawn from bore 4 and 5 using a hand bailer,

filtered in the field using a vacuum filter device;

transferred to 500 ml glass ample bottles;

Labelled WAR-4 and WAR-5 respectively;

stored at less than 4ºC; and

transferred to a NATA certified laboratory for analysis.

4.4 CHAIN OF CUSTODY

Samples were transferred to the laboratory under appropriate chain of custody documentation. A copy is provided for reference at Appendix A.

4.5 LABORATORY ANALYSIS

The two samples were delivered to the NATA certified laboratory Envirolab Services for analysis.

The following analytes were considered:

Volatile Total Recoverable Hydrocarbons (vTRH) – comprising C6 – C10 hydrocarbons plus benzene, toluene, ethylbenzene, xylene and naphthalene.

Semi-volatile Total Recoverable Hydrocarbons (svTRH) - comprising hydrocarbon fractions between C10 and C40.

Polyaromatic Hydrocarbons (PAH)

Organochlorine Pesticide Residues (OCP)

Organophosphorus Pesticide Residues (OPP)

Phenols

and

Heavy Metals – comprising arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.

This is an appropriate range of analytes to assess potential groundwater contamination from a former market garden site.

4.6 LABORATORY RESULTS

Results are summarised in Table 4.1, on the following page, and detailed in the laboratory report provided at Appendix B.

Table 4.1 – Laboratory Results

Substance	Fresh Water Criterion (Units: µg/L)	Marine Water Criterion (Units: µg/L)	Soil Bore 4 (Units: µg/L)	Soil Bore 5 (Units: µg/L)
METALS				
Arsenic (as As III)	24	n/a	<1	<1
Arsenic (as AS V)	13	n/a	<1	<1
Cadmium	0.2	0.7	<0.05	<0.05
Chromium (as Cr III)	n/a	27	<0.5	<0.5
Chromium (as Cr VI)	1	4.4	<0.5	<0.5
Copper	1.4	1.3	0.1	0.2
Lead	3.4	4.4	0.4	0.5
Mercury (total)	0.06	0.1	<0.01	<0.01
Nickel	11	7	1.2	1.3
Zinc	8	15	4.4	4.8
HYDROCARBONS C6-C9 & BTEX				
TRH C_6 - C_9	n/a	n/a	not detected	not detected
TRH C_6 - C_{10}	n/a	n/a	not detected	not detected
vTPH C_6 - C_{10} less BTEX (F1)	n/a	n/a	not detected	not detected
Benzene	950	500	not detected	not detected
Toluene	n/a	n/a	not detected	not detected
Ethylbenzene	n/a	n/a	not detected	not detected
m+p-xylene	200	n/a	not detected	not detected
o-Xylene	350	n/a	not detected	not detected
naphthalene	16	50	not detected	not detected
Total +ve Xylenes	550	n/a	not detected	not detected
HYDROCARBONS C10-C36				
TRH C_{10} - C_{14}	n/a	n/a	not detected	not detected
TRH C_{15} - C_{28}	n/a	n/a	not detected	not detected
TRH C_{29} - C_{36}	n/a	n/a	not detected	not detected
TRH >C_{10} -C_{16}	n/a	n/a	not detected	not detected
TRH >C_{10} - C_{16} less Naphthalene (F2)	n/a	n/a	not detected	not detected
TRH >C_{16} -C_{34}	n/a	n/a	not detected	not detected
TRH >C_{34} -C_{40}	n/a	n/a	not detected	not detected
Total +ve TRH (>C10-C40)	n/a	n/a	not detected	not detected
PAH				
Naphthalene	16	50	not detected	not detected
Acenaphthylene	n/a	n/a	not detected	not detected
Acenaphthene	n/a	n/a	not detected	not detected
Fluorene	n/a	n/a	not detected	not detected
Phenanthrene	n/a	n/a	not detected	not detected
Anthracene	n/a	n/a	not detected	not detected
Fluoranthene	n/a	n/a	not detected	not detected
Pyrene	n/a	n/a	not detected	not detected

Table 4.1 – Laboratory Results (continued)

PAH (continued)				
Benzo(a)anthracene	n/a	n/a	not detected	not detected
Chrysene	n/a	n/a	not detected	not detected
Benzo(b,j+k)fluoranthene	n/a	n/a	not detected	not detected
Benzo(a)pyrene	n/a	n/a	not detected	not detected
Indeno(1,2,3-c,d)pyrene	n/a	n/a	not detected	not detected
Dibenzo(a,h)anthracene	n/a	n/a	not detected	not detected
Benzo(g,h,i)perylene	n/a	n/a	not detected	not detected
Total +ve PAH's	n/a	n/a	not detected	not detected
Benzo(a)pyrene TEQ calc (zero)	n/a	n/a	not detected	not detected
Benzo(a)pyrene TEQ calc(half)	n/a	n/a	not detected	not detected
Benzo(a)pyrene TEQ calc(PQL)	n/a	n/a	not detected	not detected
ORGANO-CHLORINE RESIDUES				
HCB	n/a	n/a	not detected	not detected
alpha-BHC	n/a	n/a	not detected	not detected
gamma-BHC	n/a	n/a	not detected	not detected
beta-BHC	n/a	n/a	not detected	not detected
Heptachlor	0.01	n/a	not detected	not detected
delta-BHC	n/a	n/a	not detected	not detected
Aldrin	n/a	n/a	not detected	not detected
Heptachlor Epoxide	n/a	n/a	not detected	not detected
gamma-Chlordane	0.03	n/a	not detected	not detected
alpha-chlordane	0.03	n/a	not detected	not detected
Endosulfan I	0.03	0.005	not detected	not detected
pp-DDE	n/a	n/a	not detected	not detected
Dieldrin	n/a	n/a	not detected	not detected
Endrin	0.01	0.004	not detected	not detected
pp-DDD	n/a	n/a	not detected	not detected
Endosulfan II	n/a	n/a	not detected	not detected
pp-DDT	0.006	n/a	not detected	not detected
Endrin Aldehyde	n/a	n/a	not detected	not detected
Endosulfan Sulphate	n/a	n/a	not detected	not detected
Methoxychlor	n/a	n/a	not detected	not detected
ORGANO-PHOSPHORUS RESIDUES				
Diazinon	0.001	n/a	not detected	not detected
Dimethoate	n/a	n/a	not detected	not detected
Chlorpyriphos-methyl	0.01	0.009	not detected	not detected
Ronnel	n/a	n/a	not detected	not detected
Chlorpyriphos	0.01	0.009	not detected	not detected
Fenitrothion	n/a	n/a	not detected	not detected
Bromophos-ethyl	n/a	n/a	not detected	not detected
Ethion	n/a	n/a	not detected	not detected

4.7 INDICATIVE DIRECTION OF GROUNDWATER FLOW

The indicative direction of groundwater flow beneath the site is from the northeast to the southwest, as indicated by the red arrow in Figure 4.2, below.

Figure 4.2 – Indicative Direction of Groundwater Flow

The exact direction of groundwater flow will require conformation based on measurements from the four groundwater monitoring well to be installed at the site as part of the formal groundwater investigation process describe din Section 2 of this report.

4.8 SUMMARY OF RESULTS

Heavy metal concentrations in the two samples were low, and significantly lower than relevant groundwater quality and investigation levels summarised in Table 3.1.

5 PRELIMINARY FINDINGS & RECOMMENDATIONS

5.1 PRELIMINARY FINDINGS & LIMITATIONS

The findings of the preliminary groundwater quality analyses described in this report are as follows:

- **Two groundwater samples were obtained from bores installed for soil sampling;**
- **The two bores were located towards the lower or southwestern portion of the site towards the Narrabeen Creek site boundary;**
- **Groundwater at this location can be expected to reflect any leached contamination from the former market garden area which is located up gradient in terms of indicative groundwater flow;**
- **Analysis was conducted for a wide range of contaminants typically associated with former market garden sites; and**
- **No contamination was noted in either of the two samples**

The limitations of these preliminary findings include:

- **The samples were drawn from soil bores rather than structured groundwater monitoring wells; and**
- **Confirmation of these preliminary and indicative findings based on samples drawn from appropriately installed groundwater monitoring wells will be required.**

However, the results are consistent with the soil analyses reported in the associated document *Preliminary Site Investigation: Proposed Residential Sub-Division 45/49 Warriewood Road, Warriewood NSW (NG Child & Associates; Version 1; February 28th, 2020*), and indicate the absence of any serious or significant contamination in the groundwater beneath the site.

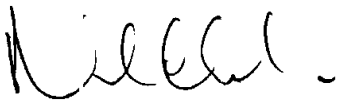
5.2 RECOMMENDATIONS

The recommendations of the preliminary report are:

- **That the four groundwater monitoring wells described in Section 2 of this report are installed; and**
- **That formal groundwater sampling and analysis based on these monitoring wells is undertaken to provide a formal indication of groundwater quality at the site.**

6 LIMITATIONS & AUTHORISATION

This report is based on limited groundwater sampling, as described, and the results are preliminary and indicative only.



Noel Child
Principal
NG Child & Associates
28 February 2020

APPENDIX A

Chain of Custody Document

N G Child & Associates

29 470 953 395

22 Britannia Road
Castle Hill NSW 2154

Consultants in Environmental
Science and Engineering

Telephone: 61-2-9899 1968
Facsimile: 61-2-9899 1797

E-mail: ngchild@canda.com.au
Mobile: 0409 393 024

SAMPLES TO:

ENVIROLAB SERVICES
12 ASHLEY STREET
CHATSWOOD NSW 2067
PH 02 9910 6200

PROJECT: Warriewood Road Preliminary Site Investigation (Page 1 of 1)

	COLLECTION		SAMPLE DETAIL		ANALYSIS REQUIRED
SAMPLE No.	DATE	TIME	TYPE	QUANTITY	
WAR-4	9/1/2020	9:15 am to 3:24 pm	Water	500 ml glass bottle	vTRH; svTRH, PAH, Phenols; 8-Metal Suite; OCP; OPP
WAR-5	9/1/2020		Water	500 ml glass bottle	vTRH; svTRH, PAH, Phenols; 8-Metal Suite; OCP; OPP

COLLECTED BY: N Child		CHAIN OF CUSTODY INITIATED BY: N Child		DATE: 9/1/2020	TIME: 16:00 hrs
TO COURIER BY: N Child		DATE: 10/1/2020	TIME: 0830 hrs	RECEIVED BY:	
SUBMITTED TO LAB BY: Courier		DATE: 10/1/2020	TIME: 09:30 hrs	RECEIVED BY:	
ANALYSED BY:			CHECKED BY:		
REPORT BY:			APPROVED BY:		
REPORT TO NG CHILD & ASSOCIATES	BY:		DATE:	TIME:	

APPENDIX B

Laboratory Report

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 233904

Client Details

Client	**NG** Child & Associates
Attention	Noel Child
Address	22 Britannia Road, CASTLE HILL, NSW, 2154

Sample Details

Your Reference	**45 Warriewood Road, Warriewood Site Investigation**
Number of Samples	2 Groundwaters
Date samples received	9/1/2020
Date completed instructions received	9/1/2020

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	17/1/2020
Date of Issue	17/1/2020

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Long Pham, Team Leader, Metals
Nick Sarlamis, Inorganics Supervisor
Steven Luong, Senior Chemist

Authorised By

Jacinta Hurst, Laboratory Manager

Client Reference: 45 Warriewood Road Warriewood Site Investigation

vTRH(C6-C10)/BTEXN in Water			
Our Reference		233904W-1	233904W-2
Your Reference	UNITS	WAR-4	WAR-5
Date Sampled		9/1/2020	9/1/2020
Type of sample		Water	Water
Date extracted	-	16/1/2020	16/1/2020
Date analysed	-	17/1/2020	17/1/2020
TRH C_6 - C_9	µg/L	<10	<25
TRH C_6 - C_{10}	µg/L	<1	<25
vTPH C_6 - C_{10} less BTEX (F1)	µg/L	<1	<25
Benzene	µg/L	<0.2	<0.2
Toluene	µg/L	<0.5	<0.5
Ethylbenzene	µg/L	<1	<1
m+p-xylene	µg/L	<2	<2
o-Xylene	µg/L	<1	<1
naphthalene	µg/L	<1	<1
Total +ve Xylenes	µg/L	<1	<1
Surrogate Dibromofluromethane	%	106	102
Surrogate toluene-d*	%	103	100
Surrogate 4-BFB	%	90	99

Client Reference: 45 Warriewood Road Warriewood Site Investigation

svTRH (C10-C40) in Water			
Our Reference		233904W-1	233904W-2
Your Reference	UNITS	WAR-4	WAR-5
Date Sampled		9/1/2020	9/1/2020
Type of sample		Water	Water
Date extracted	-	16/1/2020	16/1/2020
Date analysed	-	17/1/2020	17/1/2020
TRH C_{10} - C_{14}	µg/L	<50	<50
TRH C_{15} - C_{28}	µg/L	<100	<100
TRH C_{29} - C_{36}	µg/L	<100	<100
TRH >C_{10} -C_{16}	µg/L	<50	<50
TRH >C_{10} - C_{16} less Naphthalene (F2)	µg/L	<50	<50
TRH >C_{16} -C_{34}	µg/L	<100	<100
TRH >C_{34} -C_{40}	µg/L	<100	<100
Total +ve TRH (>C10-C40)	µg/L	<50	<50
Surrogate o-Terphenyl	%	93	90

Client Reference: 45 Warriewood Road Warriewood Site Investigation

PAHs in Water			
Our Reference		233904W-1	233904W-2
Your Reference	UNITS	WAR-4	WAR-5
Date Sampled		9/1/2020	9/1/2020
Type of sample		Soil	Soil
Date extracted	-	16/1/2020	16/1/2020
Date analysed	-	17/1/2020	17/1/2020
Naphthalene	µg/L	n/d	n/d
Acenaphthylene	µg/L	n/d	n/d
Acenaphthene	µg/L	n/d	n/d
Fluorene	µg/L	n/d	n/d
Phenanthrene	µg/L	n/d	n/d
Anthracene	µg/L	n/d	n/d
Fluoranthene	µg/L	n/d	n/d
Pyrene	µg/L	n/d	n/d
Benzo(a)anthracene	µg/L	n/d	n/d
Chrysene	µg/L	n/d	n/d
Benzo(b,j+k)fluoranthene	µg/L	n/d	n/d
Benzo(a)pyrene	µg/L	n/d	n/d
Indeno(1,2,3-c,d)pyrene	µg/L	n/d	n/d
Dibenzo(a,h)anthracene	µg/L	n/d	n/d
Benzo(g,h,i)perylene	µg/L	n/d	n/d
Total +ve PAH's	µg/L	n/d	n/d
Benzo(a)pyrene TEQ calc (zero)	µg/L	n/d	n/d
Benzo(a)pyrene TEQ calc(half)	µg/L	n/d	n/d
Benzo(a)pyrene TEQ calc(PQL)	µg/L	n/d	n/d
Surrogate p-Terphenyl-d14	%	89	87

Client Reference: 45 Warriewood Road Warriewood Site Investigation

Acid Extractable metals in water			
Our Reference	UNITS	233904W-1	233904W-2
Your Reference		WAR-4	WAR-5
Date Sampled		9/1/2020	9/1/2020
Type of sample		Soil	Soil
Date prepared	-	16/1/2020	16/1/2020
Date analysed	-	16/1/2020	16/1/2020
Arsenic	µg/L	<1	<1
Cadmium	µg/L	<1	<1
Chromium	µg/L	<0.05	<0.05
Copper	µg/L	<0.5	<0.5
Lead	µg/L	<0.5	<0.5
Mercury	µg/L	0.1	0.2
Nickel	µg/L	0.4	0.5
Zinc	µg/L	<0.01	<0.01

Client Reference: 45 Warriewood Road Warriewood Site Investigation

Misc Soil - Inorg			
Our Reference		233904-2	233904-3
Your Reference	UNITS	WAR	WAR
Date Sampled		9/1/2020	9/1/2020
Type of sample		Soil	Soil
Date prepared	-	16/1/2020	16/1/2020
Date analysed	-	16/1/2020	16/1/2020
Total Phenolics (as Phenol)	µg/L	n/d	n/d

Client Reference: 45 Warriewood Road Warriewood Site Investigation

Organochlorine Pesticides in water			
Our Reference		233904W-1	233904W-2
Your Reference	UNITS	WAR-4 9/1/2020	WAR-5 9/1/2020
Date Sampled		Soil	Soil
Type of sample			
Date prepared	-	17/1/2020	17/1/2020
Date analysed	-	17/1/2020	17/1/2020
HCB	µg/L	n/d	n/d
alpha-BHC	µg/L	n/d	n/d
gamma-BHC	µg/L	n/d	n/d
beta-BHC	µg/L	n/d	n/d
Heptachlor	µg/L	n/d	n/d
delta-BHC	µg/L	n/d	n/d
Aldrin	µg/L	n/d	n/d
Heptachlor Epoxide	µg/L	n/d	n/d
gamma-Chlordane	µg/L	n/d	n/d
alpha-chlordane	µg/L	n/d	n/d
Endosulfan I	µg/L	n/d	n/d
pp-DDE	µg/L	n/d	n/d
Dieldrin	µg/L	n/d	n/d
Endrin	µg/L	n/d	n/d
pp-DDD	µg/L	n/d	n/d
Endosulfan II	µg/L	n/d	n/d
pp-DDT	µg/L	n/d	n/d
Endrin Aldehyde	µg/L	n/d	n/d
Endosulfan Sulphate	µg/L	n/d	n/d
Methoxychlor	µg/L	n/d	n/d
Surrogate TCLMX	%	103	101

Client Reference: 45 Warriewood Road Warriewood Site Investigation

Organophosphorus Pesticides in water			
Our Reference		233904W-1	233904W-2
Your Reference	UNITS	WAR-4	WAR-5
Date Sampled		9/1/2020	9/1/2020
Type of sample		Soil	Soil
Date prepared	-	17/1/2020	17/1/2020
Date analysed	-	17/1/2020	17/1/2020
Diazinon	µg/L	n/d	n/d
Dimethoate	µg/L	n/d	n/d
Chlorpyriphos-methyl	µg/L	n/d	n/d
Ronnel	µg/L	n/d	n/d
Chlorpyriphos	µg/L	n/d	n/d
Fenitrothion	µg/L	n/d	n/d
Bromophos-ethyl	µg/L	n/d	n/d
Ethion	µg/L	n/d	n/d
Surrogate TCLMX	%	98	101

APPENDIX C

Noel Child CV

1 PERSONAL DETAILS

Full Name: Noel George CHILD
Profession: Consultant in Environmental Assessment and Management
Date of Birth: 6th December 1946
Nationality: Australian
Experience: > 30 Years
Address: 22 Britannia Road, Castle Hill, NSW, 2154
Contact: **Phone**: 61 2 9899 1968 **Fax**: 61 2 9899 1797 **Mobile:** 0409 393024

2 CAPABILITY AND EXPERIENCE - SHORT SUMMARY

Noel Child is a successful and experienced commercial and technical professional with over 30 years' experience in a variety of senior level appointments and assignments, within both the corporate and private sectors, with a particular focus on strategic, infrastructure and environmental applications.

Noel's experience includes senior management at both the State and National levels in the Australian petroleum industry, and a number of senior consultancies for both government and corporate clients. His record reflects the ability to develop and achieve positive commercial outcomes through effective planning and communication; critical and objective analysis; and quality task completion and delivery at both the personal and team level.

His management responsibilities have included transport, environmental, safety, and general operational activities at a national level, while his formal professional training includes strategic management, environmental, engineering and business disciplines. He has undertaken a number of senior corporate appointments with distinction and been successfully involved in the ownership and operation of a major petroleum distribution and marketing company in regional Australia. More recently, working through his own businesses Environment Australia and NG Child & Associates, he has applied his knowledge and experience in the areas of strategic management, infrastructure development, energy and the environment on a consultancy and contractual basis to a number of private and public-sector clients, both nationally and internationally.

Noel has had post-graduate training in several technical and commercial disciplines, and provides specialised teaching input, by invitation, to post graduate engineering and business management courses conducted by the Faculties of Business and Engineering at Sydney's University of Technology. He has strong affiliations with a number of international corporations and agencies and has worked closely with both the regulators and the regulated in a number of aspects of environmental management, assessment and performance. He has also been recognised as an independent expert on engineering, and environmental issues by the Land and Environment Court of NSW.

Noel has a detailed understanding of environmental engineering and associated processes and has specific experience and expertise in the fields of acoustics, air quality, electromagnetic field assessment, electrolysis and stray current assessment, contaminated site assessment, and liquid and solid waste management. He also provides post graduate teaching input on environmental engineering issues to post graduate courses at the University of Technology, Sydney, and La Trobe and Monash Universities in Melbourne.

3 EDUCATION, QUALIFICATIONS AND AFFILIATIONS

BE, PhD (Chemical Engineering), UNSW, Sydney
Master of Business Studies, University of New South Wales, Sydney
B.Sc. (Hons) Applied Chemistry (Environmental), University of Technology, Sydney
Graduate Diploma (Environmental Engineering and Management), UNSW, Sydney
Qualified Environmental Auditor, Standards Australia
Member, Royal Australian Chemical Institute, 1972/2019
Member, Institution of Engineers, Australia, 1972/2019
Member, Clean Air Society of Australia and New Zealand, 1992/2019
Member, Australian Natural Gas Vehicle Council, 1996/2004
Executive Director, Australasian Natural Gas Vehicles Council, 2003/2004
Visiting Fellow, Institute for Sustainable Futures, UTS, 1995/2002
Research Fellow, Faculty of Civil & Environmental Engineering, UTS, 1996/2019
Research Associate, New York Academy of Sciences, 2000/2019

4 RECENT ASSIGNMENTS & EXPERIENCE

Kaunitz Yeung Architecture (2016) – Electromagnetic field and air quality assessments of a child care centre development project at 60 Dickson Avenue Artarmon NSW.

Australian Consulting Architects (Current) – Electromagnetic, stray current and electrolysis assessments of development projects a Field Place Telopea; Windsor Road Vineyard; Camden Valley way Horningsea Park and others.

Futurespace/Renascent (Current) – Environmental assessment of proposed child care centre development at Waterloo Road Macquarie park and Cleveland Street Strawberry Hills, including general environmental, acoustic assessment, air quality and electromagnetic field assessment.

Thyssen Transrapid Australia (Current) – Adviser on technical and operational issues associated with the development and construction of a high-speed magnetic levitation train systems within the People's Republic of China, and elsewhere, including electrolysis, electromagnetic and stray field effects.

Trumen Corporation (Current) – Environmental assessment, including acoustic and contamination assessment and certification, of mixed use and child care centre development projects at Waine Street Freshwater, Fitzroy Street Marrickville, and at Huntley Street Alexandria, NSW.

Commonwealth Bank (Current) – Environmental assessment, including general, acoustic, air quality, electromagnetic field and wind impact assessment, of a new child care centre development to be located on Level 2 of Darling Park Power 2, Sussex Street, Sydney.

First Impressions Property – Environmental assessment of a proposed child care centre at Ralph Street Alexandria NSW, including Preliminary (Stage 1) Site Contamination Assessment, and Electromagnetic Field Assessment.

LEDA Holdings – Environmental Assessment of a proposed child care centre at 32 Cawarra Road Caringbah NSW, including general environmental, acoustic, air quality and electromagnetic field assessments.

Universal Property Group (Current) – Environmental assessment of a proposed multi building, multi-level residential development at Garfield Street, Wentworthville NSW, including general environmental, site and soil contamination and preliminary geotechnical assessments.

McCormack (Current) – Stage 2, 3 and 4 Environmental Site Assessment of 7,9 & 11 Bayard Street, Mortlake, NSW as part of the process of assessing the site for medium density residential development and obtaining a site audit statement confirming the suitability of the site for this purpose. Work inclusive of the assessment of all relevant environmental impacts.

Gundagai Meat Processors (Current) – Review and enhancement of solid and liquid waste processing and management systems at GMP's Gundagai abattoir, including the on-site treatment of waste streams from meat processing and other operations.

Campbelltown City Council (Current) – Peer review of acoustic assessments submitted to Campbelltown City Council regarding assessment of the acoustic impacts of developments including a major truck maintenance facility and the expansion of Macarthur Square shopping centre, including the conduct of noise measurements.

Brenchley Architects (2009 - Current) – Acoustic assessments of proposed residential and commercial developments at Elizabeth Street Sydney; Spit Road Mosman, Botany Road Waterloo, Cranbrook Street, Botany and Bellevue Hill Road, Bellevue Hill NSW.

BJB Design (2009 - Current) – Acoustic, air quality and odour assessments of residential and commercial developments at Botany Road, Botany and Cranbrook Street Botany.

Bovis Lend Lease (Current) – Environmental assessment of a major development site at Darling Walk, Darling Harbour NSW, including a detailed review of air quality, electromagnetic field and acoustic issues for review by the NSW Department of Planning.

Penrith City Council (2012/13) – Preparation of the Penrith City Council response to the NSW Government Long Term Transport Plan, including consideration of transport and associated environmental issues affecting the Penrith Local Government Area.

Harry Azoulay & Michael Bell Architects (2012) – Assessment of the environmental impacts on and from a proposed child care and early learning centre at Chatswood, NSW. Assessments lodged with and adopted by Willoughby City Council.

Wollondilly Shire Council (2012) – Preliminary environmental assessment and review of the development of a second Sydney airport at Wilton, including a preliminary assessment of acoustic impacts.

White Horse Coffee (2011) – Air quality and odour assessment regarding a boutique coffee roasting and drying operation at 7/3-11 Flora Street, Kirrawee, and NSW.

Sydney Skips & Galaxy Waste (Current) – Environmental assessment of a proposed waste recycling facility to be located on a potentially contaminated site at Stephen Road, Botany, NSW, including a detailed review of all relevant engineering and environmental issues, and the preparation of relevant documentation including assessment reports for review by Botany City Council.

Michael Bell Architects & Clients (2004 to Current) – Assessment of the environmental impacts, including acoustic impacts, associated with various child care centre applications in suburban Sydney, and the Sydney CBD, including the development of plans for the management and control of such impacts.

ABC Learning Centres Pty Ltd (2005 - Current) – Provision of professional services re the environmental assessment of prospective child care centre developments, including issues relating to acoustics, air quality, odour, soil, and groundwater contamination.

NSW Roads & Traffic Authority (2004 to Current) – Review of international technologies, systems & applications in relation to the treatment of motor vehicle exhaust emissions and associated air pollution within and discharged from road tunnels, in accordance with the conditions of approval for the M5 East Motorway

Federal Airports Corporation (1995/1996) – Preliminary environmental and ground transport studies for the proposed Sydney West Airport, including consideration of all relevant environmental issues.

Isuzu-GM (2003 to Current) – Representations to Environment Australia and the Department of Transport and regional Services regarding the emission performance standards of Japanese sourced medium and heavy natural gas trucks, with the aim of having the current Japanese emission standard accepted within the Australian design Rule 80 series of vehicle emission standards.

City of Sydney (2005 - 2007) – Assessment of air quality and odour issues associated with a proposed redevelopment of craft studios and associated facilities at Fox Studios, Moore Park, Sydney, and review of air quality monitoring stations in the Sydney CBD area, in part as a basis for monitoring the air quality and potential health cost impacts of transport congestion and modes.

Warren Centre for Advanced Engineering, University of Sydney (2000 to 2003) – Contribution to the report "Sustainable Transport for Sustainable Cities", a major government and private enterprise funded study into the future sustainability of transport in Sydney and adjoining regions, including in particular a review of associated environmental issues. Study received the 2003 Bradfield Award for Engineering Excellence from the Australian Institute of Engineers.

United Kingdom Department of the Environment (1994) – Contribution to the development of revised environmental guidelines for air, soil and groundwater water quality.

United States Environmental Protection Agency (1994) - Contribution to an international team developing strategies for the control and management of air pollution in seven major US cities.

5 CORPORATE EXPERIENCE

NG Child & Associates

- **1992--Present**, Managing Principal - Responsible for all aspects of the conduct of a private engineering and environmental consultancy, including administration, marketing, team coordination and technical and professional delivery.

Western Fuel Distributions Pty Limited, Australia

- **1984-92** Managing Principal. - Responsible for all aspects of the management and development of one of the largest private petroleum distributorships then operating in Australia, with a peak annual sales volume of 70 million litres, turnover of $30 million per annum, a direct staff of thirty, and a network of some 40 retail and wholesale agency outlets. This position included direct personal accountability for all aspects of storage, distribution and environmental performance.

Caltex Oil Australia Limited

- **1982-84** General Manager, Marketing and Operations. Responsible for the management and operation of Caltex Australia's marketing, storage, warehousing, distribution, environmental and safety functions, including seaboard terminal and marine operations.
- **1980-82** National Consumer Marketing Manager. Responsible for Caltex Australia's national consumer, industrial and distributor marketing activities.

Golden Fleece Petroleum Limited

- **1977 - 1980** Manager Operations, NSW. Responsible for the overall management of the distribution, warehousing, seaboard terminal and lubricant production activities of Golden Fleece Petroleum in New South Wales, including environmental, occupational health and safety matters.

Esso Australia Limited

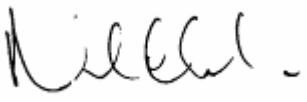
- **1976-77** SA Manager, Marketing and Operations. Responsible for all aspects of the management of Esso's petroleum, lubricant and LPG storage, distribution and marketing throughout South Australia.
- **1975-76** Refinery Manager. Responsible for all engineering, operational and environmental aspects of the joint Esso/Mobil refinery at Port Stanvac in South Australia.
- **1975** Manager, Process Operations, Port Dixon Refinery, Malaysia. Six-month special assignment at the Esso Petroleum Refinery, Port Dixon, Malaysia.
- **1971-75** Senior Analyst, Logistics and Corporate Strategy Departments, Esso Sydney Head office.

6 SOME REPORTS & PUBLICATIONS

- **High Speed Rail – Benefits for the Nation,** Keynote address at the UNSW Institute of Environmental and Urban Studies International High-Speed Rail Seminar, August 2013.
- **High Speed Trains in Australia: Connecting Cities and Energising Regions**; with the Hon Peter Nixon AO, October 2010.
- **Sydney's High Residential Growth Areas: Averting the Risk of a Transportation Underclass**, World Transport & Environmental Forum, Reims France, June 2006.
- **The M5 East Road Tunnel: Implications for Ventilation, Air Quality and Emission Treatment Systems**, International Road Transport and Tunneling Forum, Graz Austria, May 2006.
- **Transport Fuels in Australia: The Folly of Australia's Increasing Reliance on Imported Crude Oil**, Submission to the Australian Senate Rural and Regional Affairs and Transport Committee Inquiry into Australia's Future Oil Supply and Alternative Transport Fuels, February 2006.
- **The Japan 2003 CNG Emission Standard & the Emission Performance of the Isuzu 4HF-1-CNG: The Case for Acceptance under ADR80**. Submission on behalf of Isuzu GM Australia to the Commonwealth Department of Transport and Regional Services, June 2004.
- **M5 East Freeway: A Review of Emission Treatment Technologies, Systems and Applications**, NSW RTA and NSW Department of Planning, April 2004.
- **Future Directions: Challenges & Opportunities in the Australian CNG Vehicle Industry**, ANGVC, December 2002
- **High Speed Rail in Australia: Beyond 2000** (with the Hon Peter Nixon), November 2000
- **Review of Options for the Treatment or "Filtration" of Tunnel Gases and Stack Emissions**, City of Sydney. January 2003
- **A Comparative Analysis of Energy and Greenhouse Performance: Austrans Ultras Light Rail System**, Bishop Austrans Limited, January 2003
- **Engineering and Environmental Aspects of Enclosing the Cahill Expressway Cutting**, City of Sydney, May 2001.
- **M5 East Motorway: Proposed Single Emission Stack at Turrella – Review of Air Quality Impacts and Consideration of Alternative Strategies**, Canterbury City Council, February 1999

7 PERSONAL & PROFESSIONAL REFERENCES

- The Hon Peter Nixon AO, Former Federal Transport Minister
- John Black, Professor Emeritus of Civil & Transport Engineering, University of NSW
- Mr Stephen Lye, Development Manager, Trumen Corporation, Sydney.
- Mr Peter Han, Project Director, Commonwealth Bank, Sydney
- Mr Michael Bell, Principal, Michael Bell Architects, Sydney.
- Mr Barry Babikian, Brenchley Architects
- Mr Luke Johnson, Assistant General Manager, Wollondilly Shire Council
- Mr Bernie Clark, Chief Executive, Thyssen Australia
- Mr Alan Ezzy, Former Chairperson, NSW Flood Mitigation Authority.
- Professor Vigid Vigneswaran, Faculty of Civil & Environmental Engineering, University of Technology, Sydney.
- Mr Merv Ismay, General Manager, Holroyd City Council, Sydney NSW
- Dr Jack Mundey, Past Chairman Historic Houses Trust, Environmentalist
- Alex Mitchell, Journalist



Noel G Child
28 February 2020

ATTACHMENT A
Client Reference List

Acre Woods Childcare Pty Ltd
Australian Commonwealth Environmental Protection Agency
Australian Consulting Architects
Australian Federal Airports Corporation
Australian Federal Department of Transport and Regional Development
Bovis Lend Lease
Brenchley Architects
Campbelltown City Council
Canterbury City Council, Sydney, NSW
Commonwealth Banking Corporation
Environment Protection Authority of NSW
Exxon Chemical
Fairfield City Council, Sydney, NSW
First Impressions Property
FreightCorp, Sydney, NSW
Futurespace
GM - Isuzu
Guangxi Environment Protection Bureau
Gundagai Meat Processors
Hong Kong Department of the Environment
Hornsby and Ku-ring-gai Councils, Sydney, NSW
John McCormack
Kaunitz Yeung Architecture
LEDA Holdings
Michael Bell Architects
Minter Ellison
Mobil Oil Australia Associated
NSW Roads & Traffic Authority
Ove Arup & Partners
Qantas Airways
Queensland Ports Corporation
Renascent
Salibeau Pty Ltd
Shell Australia
Sinclair Knight Merz
Skouras and Mabrokardatos
Southern Sydney Regional Organisation of Councils (SSROC)
State Rail Authority of NSW
Stephen Davidson Property Investments
Sydney Skips & Galaxy Waste
The City of Sydney
The Western Sydney Alliance of Mayors
Thyssen Krup Transrapid Australia
Tom Howard QC
Trumen Corporation
UK Department of the Environment
United States Environment Protection Agency
University of Technology, Sydney
Warren Centre for Advanced Engineering, University of Sydney
Waverley Council, Sydney, NSW
Western Sydney Parklands Trust
Wollondilly Shire Council