Sampling, Analysis and Quality Plan (SAQP): Preliminary Environmental Site Assessment, Portion of Barton Park Occupied by Former St George Soccer Stadium, Banksia, New South Wales.

Prepared for MODE Design Corp Pty Ltd.

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List of Abbreviations

Units of Measure

%	per cent
ug L^{-1}	Micrograms per Litre
ug m^{-3}	Micrograms per Cubic Metre
ha	Hectare
km	Kilometres
m	Metre
m AHD	Metres Above Australian Height Datum
m BGL	Metres Below Ground Level
m BTOC	Metres Below Top of Casing
mg kg^{-1}	Milligrams per Kilogram
mg L^{-1}	Milligrams per Litre
mg m^{-3}	Milligrams per Cubic Metre
mm	Millimetre
ppm	Parts Per Million
ppb	Parts Per Billion

General

ABC	Added Background Concentrations
ACL	Added Contaminant Limit
ACM	Asbestos Containing Materials
ADWG	Australian Drinking Water Guideline
AEC	Areas of Environmental Concern
AF	Asbestos Fines
AGST	Above Ground Storage Tank
AHD	Australian Height Datum
ALS	Australian Laboratory Services Pty Ltd
ANZECC	Australian and New Zealand Environment and Conservation Council
APHA	American Public Health Association
ASS	Acid Sulphate Soils
ASSMAC	Acid Sulfate Soils Management Advisory Committee
BGL	Below Ground Level
BOD	Biochemical Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene and Total Xylenes
CLM Act	NSW Contaminated Land Management Act, 1997
CMPC	Conceptual Model of Potential Contamination
COC	Chain of Custody
CoPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
CT	Contaminant Threshold
DA	Development Application
DAC	Data Acceptance Criteria
DCP	Development Control Plan
DNAPL	Dense Non-Aqueous Phase Liquid
DP	Deposited Plan
DQI	Data Quality Indicator
DQO	Data Quality Objectives
DSI	Detailed Site Investigation
EIL	Ecological Investigation Levels
EMP	Environmental Management Plan
EOH	End of Hole

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EPA	Environment Protection Authority
EPA Act	Environmental Planning and Assessment Act, 1979
EQL	Environmental Quantitation Limit
ESA	Environmental Site Assessment
ESL	Ecological Screening Level
FA	Fibrous Asbestos
FID	Flame Ionisation Detector
GIL	Groundwater Investigation Level
GPS	Global Positioning System
HIL	Health Based Investigation Levels
HSL	Health Screening Levels
IAA	Interim Audit Advice
LCS	Laboratory Control Sample
LEP	Local Environment Plan
LFG	Landfill Gas
LNAPL	Light Non-Aqueous Phase Liquid
LOR	Limit of Reporting
ML	Management Limits
NATA	National Association of Testing Authorities
ND	Not Detected
NEPC	National Environmental Protection Council
NEHF	National Environmental Health Forum
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NL	Not Limiting
NSW	New South Wales
OCP	Organochlorine Pesticides
OEH	Office of Environment and Heritage
OPP	Organophosphorous Pesticides
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PID	Photo-ionisation Detector
POEO Act	Protection of the Environment (Operations) Act, 1997
PQL	Practical Quantitation Limit
PSI	Preliminary Site Investigation
PSH	Phase Separated Hydrocarbon
PSP	Project Safety Plan
QA/QC	Quality Assurance and Quality Control
RL	Reduced Level
RPD	Relative Percentage Difference
RSL	Regional Screening Level
SAC	Site Assessment Criteria
SAQP	Sampling, Analysis and Quality Plan
SAR	Site Audit Report
SAS	Site Audit Statement
SCC	Specific Contaminant Concentration
SCEW	Standing Council on Environment and Water
SILs	Soil Investigation Levels
sPOCAS	Suspension Peroxide Oxidation – Combined Acidity and Sulfate
SPT	Standard Penetration Test
SVOC	Semi-Volatile Organic Compounds

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SWL	Standing Water Level
TCLP	Toxicity Characteristics Leaching Procedure
TD	Termination Depth
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
TRH	Total Recoverable Hydrocarbons
TV	Trigger Value
USEPA	United States Environment Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
VOCCs	Volatile Organic Chlorinated Compounds
WHS	Work Health and Safety
--	On tables is 'not calculated', 'not measured', 'no criteria' or 'not applicable'

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1. Introduction

Bayside Council (Council) is the manager of the open space referred to as Barton Park as shown on Figures 1 and 2. The site has been the subject of a series of environmental assessments culminating in the development of a Long-Term Management Plan (LTSMP) for ongoing use of the site for recreational/open space land use (Edison, 2020a). The LTSMP is based on an assessment of environmental conditions at Barton Park as presented in a report by Edison (2020b). The LTSMP contains provisions for the management of environmental impacts (landfill gas, groundwater and surface water) arising from legacy landfills at Barton Park.

In its' role as manager of Barton Park, Council has developed a Master Plan for the southern portion of the site (Annexure 1) consisting of the following elements (Figure 3):

- Demolition of the existing grandstand and associated buildings;
- Construction of a new sporting amenities building, including public amenities, change rooms, canteen and storage;
- Construction of a new tiered seating area suitable for a minimum of 400 people with shade structure;
- Construction of four (4) turf playing fields;
- Construction of four (4) multi-purpose synthetic courts and supporting infrastructure;
- Off leash dog area;
- Playground or natural play area;
- Carparking and vehicular access driveways;
- Improvements to the public domain, including footpaths, paving, landscaping and street furniture;
- Shared pathway/cycleway;
- Passive recreation opportunities including lookouts, picnic areas, seating and fitness.

MODE Design Corp Pty Ltd (MODE) has been engaged by Council to undertake design works necessary to implement the masterplan

Past environmental studies (Edison, 2020b) have not assessed conditions within the area occupied by the former St George Soccer Stadium (the St George site, Figures 2 and 3). It is known from works around the periphery that the site is underlain by legacy waste landfill. Landfill gas and leachate impacts around the perimeter of the former St George Soccer Stadium site have been documented in past reports (Edison, 2020b; 2020c, 2020d, 2020e, 2020f, 2020g, 2020h). The Master Plan concept involves removing the stadium and fill mounds around the perimeter of the soccer field (the perimeter mounds). Accordingly, an assessment of soil/fill underlying the former soccer field and perimeter fill mounds is required to assess the suitability of the material for beneficial reuse on the broader site and to identify remediation/management requirements associated with same. This Sampling, Analysis and Quality Plan (SAQP) provides a detailed specification for a Preliminary Environmental Site Assessment (PESA) of the former St George Soccer Stadium site.

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2. Objectives and Scope of Work

The aim of the PESA is to assess whether or not the St George site is suitable, or can be made suitable, for the proposed recreational open-space land use. A further objective is to provide a preliminary classification of material within the perimeter mounds for off-site disposal in accordance with EPA (2014) waste guidelines.

The objectives of this SAQP are as follows:

- Identify data gaps in site history;
- Define objectives of the investigation;
- Define Data Quality Objectives (DQOs);
- Provide a detailed scope of works;
- Specify methods for field investigations and laboratory testing;
- Define a detailed Quality Assurance and Quality Control (QA/QC) programme;
- Outline data validation and reporting requirements.

The scope of works includes the following:

- Preparation of a detailed SAQP;
- Preparation of a Project Safety Plan (PSP) that identifies foreseeable hazards associated with the proposed site works and measures to be employed to manage or remove the associated risks;
- Collection of ten (10) near-surface soil samples from the former St George Soccer Field to provide a preliminary assessment of the site on the basis that further sampling would be carried out as necessary during site works;
- Excavation of up to ten (10) test pits into perimeter mounds around the former St George Soccer field to provide a preliminary assessment of material contained therein. Collection of two (2) samples from each test pit;
- Analysis of samples from the soccer field (10) and perimeter bund test pits (20) for the following parameters: asbestos; heavy metals and metalloids (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg); Total Recoverable Hydrocarbons (TRH); monocyclic aromatic hydrocarbons (BTEX); Polycyclic Aromatic Hydrocarbons (PAHs); Organochlorine Pesticides (OCPs); Organophosphate Pesticides (OPPs) and total Polychlorinated Biphenyls (PCBs);
- Implementation of a Quality Assurance and Quality Control (QA/QC) programme consisting of the following: blind replicates at a rate of 1/10 samples; inter-laboratory duplicates at a rate of 1/20 samples; one (1) trip blank and trip spike per batch; one (1) rinsate blank per batch. For groundwater the QA/QC programme will consist of one (1) split replicate, one (1) trip blank and one (1) trip spike.
- Preparation of a report on work undertaken.

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3. Information and Environmental Setting

3.1 Site Identification and Description

Barton Park (also referred to in previous investigations as the Cooks Cove Southern Precinct (CCSP)) consists of the following areas (Figure 2):

- Area C: Land located north of Spring Street Drain, west of the Cooks River and Muddy Creek, east of Eve Street and south of the M5 east motorway easement;
- Area D: Land located south of the Spring Street Drain, west of Muddy Creek, west of former St George Soccer Stadium, east of Arncliffe Market Garden and north of Bestic Street;
- Area D1: Area incorporating former St George Soccer Stadium, bounded by Muddy Creek to the east, Bestic Street to the south, and Area D to the west;
- Area E: Southern portion of Riverine Park bound by Spring Street Drain to the south, Spring Street Wetland to the east and West Botany Street to the west.

The legal descriptions for each area are provided below (Annexure 2):

Area C (approximately 30 ha comprising):

- Part of Lot 1 (north of Spring Street Drain), Deposited Plan (DP) 576148;
- Part of Lot 100 DP 1133869;
- Lot 6 DP 1050923;
- Part of Lot 1 DP 665481;
- Part of Lot 1 DP 219126;
- Part of land referred to in Crown Plan (CP) 12437-3000.

Area D (approximately 13 ha):

- Part of CP 12437-3000 (south of Spring Street Drain);
- Part of Lot 1 DP 576148 (south of Spring Street Drain);
- Part of Lot 100 DP 1133869;
- Part of Lot 1 DP 514811.

Area D1 (approximately 6.3 ha comprising):

- Part of Lot 1 DP 576148 (south of Spring Street Drain);
- Part of Lot 7303 DP 1148740 (south of Spring Street Drain);
- Part of Lot 100 DP 1133869;
- Part of land referred to in CP 7979-3000.

Area E (approximately 1.9 ha):

- Part of Lot 1 DP 665481;
- Part of Lot 1 DP 219126.

The site is zoned for recreational/open-space land use and Special Uses (F6 Corridor) under Sydney Regional Environmental Plan 33 - Cooks Cove (2004 No 397).

Barton Park is located in the Local Government Area (LGA) of Bayside Council and has an area of 49.3 hectares.

The St George site occupies part of Lot 100 in DP 1228008 and has an area of approximately 2.2 ha as shown on Figure 3.

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3.2 Site Description

In past environmental studies, Barton Park has been divided into four (4) broad areas (C, D, D1 and E) as described below (CES, 2017a).

The land bound by Spring Street Wetland, Spring Street Canal, M5 tunnel and the Cooks River has been historically referred to as Area C. Most of Area C is occupied by a former landfill mound (Figure 2). The former landfill extends to the banks of the Spring Street Wetland in the west and M5 tunnel in the north. The former landfill batters slope towards the Cooks River and Spring Street Canal. The former landfill mound on Area C is predominantly covered with grass used for sporting activities (golf range, soccer and baseball fields). The site is uneven due to differential settlement of the underlying waste material. The batters of the former landfill are landscaped with shrubs, trees and mulch on the ground surface. Low-lying land in the south-east corner of the site along Muddy Creek/Cooks River is covered with shrubs. There is a tarred road from West Botany Street with a works depot at the end. There is also a depot/compound for the M5 Motorway in the north-east corner of Area C along the Cooks River. The Spring Street Wetland is tidal and connected to Spring Street Canal. Both the wetland and canal are fully drained of water at low tide.

The land bound by Spring Street Canal, Muddy Creek, Bestic Street and Landing Light Wetlands/market gardens has been referred to as Areas D and D1. The former landfill covers most of the site with batters sloping towards each site boundary. With the exception of the former, disused St George Soccer Stadium which is constructed on a raised fill mound on the former landfill, the top of the former landfill mound is grassed and used for passive recreation. The site is uneven due to differential settlement of the underlying waste material. Batters of the former landfill mound are grassed (southern portion) or vegetated with shrubs (northern portion). The Landing Light Wetland is located in the north-west portion of the site. The wetland is tidal and is connected with Spring Street Canal by a concrete pipe. The level of the pipe allows shallow water depth to be retained within the wetland at low tide.

Area E is a rectangular, grassed park (Riverine Park/Firmstone Gardens) between West Botany Street, Spring Street Wetland and Spring Street Canal to the west, east and south respectively. Riverine Park/Firmstone Gardens extends north beyond the boundary of Area E. The site surface is uneven. The surface is covered with grass and there are small trees along the boundary. The batter to Spring Street Wetland is covered with trees.

The St George site consists of a disused, central soccer field surrounded by fill mounds to the north, east and south. The perimeter bunds measure approximately 400 m in length, 30 m in width with an average height of approximately 2 metres (triangular section with apex 4 metres above surrounding ground level). These dimensions equate to a volume of approximately 25,000 to 30,000 m^3. There is a disused, concrete stadium building on the western side of the soccer field. The roof of the stadium has been removed. Access to the site is restricted by secure, locked fences.

3.3 Geology and Hydrogeology

The *Sydney 1:100,000 Geological Series Map* describes the underlying natural lithology as consisting of silty to peaty quartz sand, silt and clay. Ferruginous and humic cementation occurs in places, in addition to common shell layers. This material is most likely to be of alluvial origin, deposited as sub-aerial and sub-aqueous component of the Cooks River delta. The natural deposit has been reworked significantly in the last century as part of river diversion works. These works would have involved significant dredging operations (CES, 2001a). Waste landfills have been constructed over the natural sediments (Figure 2).

Based on past borehole logs presented in the site suitability report (Edison, 2020b), the generalised stratigraphic sequence for the site is as follows:

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- Cover soil over waste (former landfill areas): Silty sand to sandy cover soil ranging from 0.1 to 2.7 m thickness over waste material;
- Waste (mounds) consisting of compacted municipal waste material including rubber, cloth, wood, glass, plastic, metal, fabric, ceramic, ash, construction/demolition waste and organic matter;
- Areas to the periphery of the waste mounds are underlain by reworked alluvial sediments associated with historical diversions/re-alignments of the Cooks River/Muddy Creek with surface fill material;
- Natural alluvial/estuarine sediments consisting of fine to medium-grained, loose sands to coarse-grained dense sands, black/brown peat and soft to dense clays.

Groundwater associated with filled land and underlying unconsolidated sediments is unconfined. The regional direction of groundwater flow is towards the Cooks River (CES, 2017a). Spring Street wetland, Spring Street Drain and the Landing Light Wetland are local groundwater sinks along with Cooks River and Muddy Creek.

A map showing registered groundwater extraction bores within 200 m of the site boundary is provided in the report on site suitability (Edison, 2020b). Notably, there are no registered groundwater extraction bores on the site (GW111316 is a monitoring bore). A site inspection by Edison and enquiries with Bayside Council did not identify any unregistered extraction bores on the site. There are five (5) registered groundwater bores on residential properties to the west (hydraulically upgradient) of the site and four (4) bores to the south-east on the opposite side of Muddy Creek.

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4. Site History

The site history if summarised as follows (Maunsell, 2001):

- The site was used as a market garden until early in the twentieth century;
- Parts of the site were used as a sewage farm serving south and western Sydney for approximately 40 years commencing in the late nineteenth century;
- The sewage farm was decommissioned in the 1940s and filled with waste by Rockdale Council;
- Following completion of landfill operations (1940s-1980s), the site was covered with soil, grassed and converted into a series of sports fields.

Since 2001 the site has been the subject of a series of proposals seeking consent to redevelop the site as a golf course. No substantial changes have been made to the site since 2001 other than the closure of the St George soccer stadium.

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5. Summary of Past Reports

Past reports on the Barton Park site are divisible into those completed prior to and following the issuance of the Site Audit Statement (SAS) KJL144 by Zoic dated August 2016.

5.1 Reports Issued Prior to Site Audit Statement

5.1.1 Maunsell McIntyre, 2001, Site History Geotechnical and Contamination Issues

Maunsell McIncyre was commissioned to undertake a review of geotechnical and contamination issues in association with a Master Plan for the broader Cooks Cove site. The report states that the site was used for the disposal of night soil from the late nineteenth century until the early-mid twentieth century. Thereafter the site was '*reclaimed by various filling materials, including mixed fill from unknown origins in Sydney, and garbage refuse placed by Rockdale Council'.*

The presence of aging waste mounds at the site has been documented since at least 2001 in relation to the Cooks Cove project.

5.1.2 CES Phase I Environmental Site Assessment (2001a)

Consulting Earth Scientists (CES) prepared a Preliminary Environmental Site Assessment (PESA) for the broader Cooks Cove site on behalf of the project proponent at the time, Trafalgar Properties Pty Ltd. Nine (9) boreholes (BH101 – BH109) were drilled as part of the PESA on the broader Cooks Cove project site. Of these boreholes, three (3) (BH101, BH102, BH103) were drilled on Area C in the CCSP.

In respect to the landfills in Areas C and D, CES notes that waste has been placed directly on alluvial sediments with no evidence of leachate or gas management systems. CES further notes the presence of methane at concentrations exceeding the Lower Explosive Limit (LEL) on landfill Area C. Furthermore, evidence of the pressurisation of landfill gas in the boreholes is also noted. No groundwater wells were installed as part of the PESA.

5.1.3 CES Report on Wetland Water Sampling (2001b)

CES collected one (1) round of samples to characterise water quality in the Spring Street and Landing Light Wetlands. These tidal waterbodies are located immediately adjacent to the landfills in Areas C and D and are connected with the Cooks River. The report notes indicators that the embankment of the Area C landfill extends to the edge of the Spring Street Wetland. Seepage points were noted in the base of the embankment on a falling tide.

Based on the ammonia (74 mg L^{-1}) concentration taken at low tide and physical observations indicating a likely hydraulic connection between the Area C landfill and the Spring Street Wetland, the report concludes that the water body was impacted by landfill leachate. Notably, partial contributions from the *in situ* degradation of organic matter and possible contributions from off-site sources were also identified. The report concludes that '*while the leachate poses potential risk to the aquatic ecosystem, no threats to users of the site are envisaged under the proposed development concept involving no direct or indirect recreational contact'.*

5.1.4 Golder Associates Interpretative Report on Contamination Investigation (2002)

Golder Associates (Golder) excavated 10 test pits, drilled 13 boreholes and advanced 10 soil gas spikes at the site. A complete site plan showing the location of Golder sampling points is not available.

With respect to the waste mounds, the Golder report re-affirms that the waste has not been capped in a manner that is consistent or compliant with relevant EPA guidelines for landfill construction. The Golder report further re-affirms that the landfills are un-lined and are not fitted with leachate or gas controls.

Ammonia concentrations in groundwater monitoring wells ranged up to 301 mg L^{-1}. Concentrations in Spring Street Wetland (1.87 and 0.78 mg L^{-1}) were '*well below the level recorded by CES (74 mg L^{-1})*'.

With respect to landfill gas, Golder reports that methane levels in all gas spikes adjacent to houses were below the nominated investigation level of 1.5% volume. In contrast, levels within the landfills ranged from 10% to 77% methane by volume.

The Golder report re-affirms that groundwater in and around the waste landfills is impacted with leachate (as indicated by ammonia concentrations). The Golder report further indicates that there is landfill gas present in the waste landfills, but that gas is not present adjacent to residential houses at levels above the nominated investigation level. Notwithstanding the results of the investigation, Golder does note, however, that *'there is some risk of lateral migration to houses at Firmstone Gardens and Eve Street'.*

5.1.5 CES Report on Additional Soil, Groundwater and Landfill Gas Assessment, Area C (2008a)

CES completed the following scope of works on Area C:

- Drilling of 51 soil sampling boreholes (CBH601 – CBH651);
- Installation of 10 groundwater monitoring wells in selected boreholes (CMW601-606 with nested wells in CMW604, CMW606, CMW608, CMW609);
- Installation of landfill gas monitoring wells at 12 locations (CLG601 – CLG612). Conduct one (1) round of monitoring from each well;
- Completion of surface-gas survey involving the measurement of concentrations of combustible gases (in methane equivalents) 5 cm above the site surface on a grid pattern;
- Analysis of trace Volatile Organic Compound (VOC) concentrations in one (1) round of soil-vapour samples from two (2) wells (CLG609, CLG611) with highest methane concentrations.

CES reports that the waste material in Area C is up to 8 m thick and overlies natural alluvial soils. Results indicated that groundwater was impacted with ammonia, heavy metals and petroleum hydrocarbons. Along the southern boundary, groundwater was impacted with ammonia to a depth of at least 16 m below ground level (bgl). The report notes an outward direction of groundwater flow from the landfill towards the Cooks River, Spring Street and Eve Street wetlands.

CES notes that '*the results of the groundwater monitoring programme carried out … indicate that there may be obligations to report … under the Contaminated Land Management Act 1997'.* The report recommends that legal advice be sought in relation to this matter. It is noted that, since the date of the CES report, the EPA (2015) has clarified the circumstances arising in a duty to report and that the amendment of the subsequent CLM Act no longer makes reference to the term 'significant risk of harm'.

Results of surface and sub-surface gas monitoring indicate that the rate of landfill gas generation and gas flux through the landfill cover layer is low. The report also notes that the cover soil varied in composition, thickness and permeability and does not form a suitable capping layer.

The investigation confirmed the presence of landfill gas within the landfill and inferred the off-site migration of leachate-impacted groundwater. The report also re-affirms that the landfill has not been properly closed (capped).

5.1.6 CES Report on Additional Soil, Groundwater and Landfill Gas Assessment, Area D (2008b)

CES completed the following scope of works on Area D:

- Drilling of 40 soil sampling boreholes (DBH801 – DBH840);
- Installation of nine (9) groundwater monitoring wells in selected boreholes (DMW802, DMW803, DMW806, DMW808) including nested wells at DMW803 (A/B/C), DMW806 (A/B/C) and DMW808 (A/B);
- Installation of landfill-gas monitoring wells at four (4) locations (DLG801, DLG812, DLG813 and DLG814). Conduct one (1) round of monitoring from each well;

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- Completion of surface-gas survey involving the measurement of concentrations of combustible gases (in methane equivalents) 5 cm above the site surface on a grid pattern;
- Analysis of trace Volatile Organic Compound (VOC) concentrations in one (1) round of soil vapour samples from two (2) wells (DLG804, DLG813) with the highest methane concentrations.

As with Area C, CES reports that the waste material overlies natural alluvial soils. Monitoring results indicate that groundwater is impacted with leachate indicators, namely ammonia, petroleum hydrocarbons and specific Volatile Organic Compounds (VOCs), particularly in the inferred downgradient direction. The report further notes that impacted groundwater is present near the site boundary and is likely to be migrating off site.

In relation to landfill gas, the report notes that landfill gas is present within the waste mass at concentrations one (1) order of magnitude greater than the Lower Explosive Limit (5% v/v). However, landfill gas had not accumulated under pressure and was not measured in the surface-gas survey. The results were interpreted as an indication that gas is not being generated at a high rate or is dissipating through the cover layers at a flux equivalent to the generation rate.

The investigation confirmed the presence of landfill gas within the landfill and inferred the off-site migration of leachate-impacted groundwater. The report also re-affirms that the landfill has not been properly closed (capped).

5.1.7 CES Report on Additional Soil, Groundwater and Landfill Gas Assessment, Area E (2008c)

CES completed the following scope of works on Area E:

- Drilling of 21 soil sampling boreholes (EBH1001-1013, EBH301, ELG1001-1004, EMW1001-1004);
- Installation of four (4) groundwater monitoring wells in selected boreholes (EMW1001-1004);
- Installation of landfill gas monitoring wells at four (4) locations (ELG1001-1004). Conduct one (1) round of monitoring from each well;
- Completion of surface-gas survey involving the measurement of concentrations of combustible gases (in methane equivalents) 5 cm above the site surface on a grid pattern;
- Analysis of trace Volatile Organic Compound (VOC) concentrations in one (1) round of soil-vapour samples from two (2) wells (ELG1002, ELG1004) with the highest methane concentrations.

CES reports that the waste material is up to 4 m thick and overlies natural alluvial soils. Monitoring results indicate that groundwater is impacted with ammonia, petroleum hydrocarbons and specific Polycyclic Aromatic Hydrocarbons (PAHs), particularly in the inferred downgradient direction. The report further notes that impacted groundwater is present near the site boundary and is likely to be migrating off site.

In relation to landfill gas, the report notes that landfill gas is present within the waste mass at concentrations one (1) order of magnitude greater than the Lower Explosive Limit (5% v/v). However, landfill gas had not accumulated under pressure and was not measured in the surface-gas survey. The results were interpreted as an indication that gas is not being generated at a high rate or is dissipating through the cover layers at a flux equivalent to the generation rate.

The investigation confirmed the presence of landfill gas within the landfill and inferred the off-site migration of leachate-impacted groundwater. The report also re-affirms that the landfill has not been properly closed (capped).

5.1.8 CES Remediation Action Plans, Area C, D, E (2008d; 2008e; 2008f)

Separate Remediation Action Plans (RAPs) were developed for Areas C, D and E outlining the following scope of works:

- Installation of an engineered capping layer over the former landfills;
- Implementation of a Long-Term Site Management Plan (LTSMP) detailing requirements for ongoing monitoring and maintenance;

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- Construction of a soil-bentonite cut off wall around the landfill in Area C;
- Placement of a Clean Soil Barrier (CSB) on parts of Area C not within the landfill footprint;
- Placement of a gas barrier and passive drainage system under proposed buildings and structures to be built on landfilled waste.

Pursuant to the RAPs, the EPA-accredited Site Auditor (Mr Frank Mohen) issued a series of Site Audit Statements (SAS) stating that the site can be remediated to a standard suitable for the proposed open-space land use.

The RAPs have not been implemented.

5.1.9 CES Report on Surface Water Sampling (2008g)

CES conducted further investigations to assess potential off-site impacts of groundwater on the adjacent surface-water bodies. The following scope of works was undertaken:

- Summarise existing data;
- Estimate the volume of groundwater discharging into the water bodies from Areas C, D, E;
- Collection and analysis of water samples from surface-water bodies.

The report concludes that groundwater flowed outwards from the former landfills in a radial pattern and discharges into the surface-water bodies (wetlands and Spring Street Canal). Estimates of groundwater discharge rates into surface-water bodies were estimated to be: 35.5 m^3 day^{-1} from Area C; 14.3 m^3 day^{-1} from Area D; and 2 m^3 day^{-1} from Area E. Exceedances of water-quality criteria for ammonia and petroleum hydrocarbons occurred only at low tide, indicating dilution of leachate-impacted groundwater by tidal flushing.

The results re-affirm the off-site impacts of leachate-impacted groundwater on the surface-water bodies adjacent to the former landfills.

5.1.10 CES Environmental Monitoring - Area C (2010)

The following scope of work was completed in order to assess whether leachate-impacted groundwater from the landfill in Area C was likely to pose a significant risk to surrounding and receiving surface waters:

- Review existing groundwater and surface-water data collected in Area C from 2001 to 2008;
- Map seepage points around the boundary of the landfill and estimate the volume of groundwater discharging from same;
- Sampling and analysis of groundwater from existing monitoring wells on Area C;
- Sampling and analysis of bottom sediments from Spring Street Canal, Muddy Creek and Cooks River.

The report concludes that ammonia is likely to be the only compound which could be impacting on surface waters. The report further concluded that, although groundwater on Area C was impacted by landfill leachate, the impact on surface-water were minimal.

The work undertaken re-affirms that groundwater on Area C is impacted with landfill leachate and that impacts on surface water are temporally transient. That is, consistent with earlier reports, surface-water impacts occur at low tide and are diluted by diurnal tidal flushing. These results also reflect the low volume of groundwater discharged from the former landfills.

5.1.11 CES Groundwater Monitoring, Area D and Area C (2013a)

CES monitored eight (8) existing wells at the site boundary adjacent to receiving waters: Cooks River for Area C and Muddy Creek for Area D. The monitoring was undertaken to characterise the quality of groundwater discharging into the receiving waters.

CES concluded:

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- While ammonia concentrations were elevated in groundwater on Area C, '*concentrations are consistent with previous groundwater monitoring and are not considered to be significantly impacting on the overall quality of the Cooks River*';
- '*Groundwater quality in Area D/Area D1 has been identified as being below the relevant screening criteria, similar to an up-gradient surface water quality sampling location, or not considered to represent a significant risk to the water quality of Muddy Creek (or Cooks River)*'.

5.1.12 CES Review of RAPs and Environmental Data for Revised Development Proposal (2013b)

CES reviewed the RAPs (Section 5.1.8) in the context of a revised development proposal for the CCSP. Recommendations are as follows:

- Area C: Remediation by means of secure capping and either of the following in place of the cut-off wall contemplated in the preceding RAP:
    - Monitored Natural Attenuation (MNA);
    - Enhanced Natural Attenuation (ENA); or
    - The construction of a Permeable Reactive Barrier (PRB).
- Area D: This part of the site was expanded to include land occupied by the St George Soccer Stadium. CES recommended that a new RAP be prepared combining the original Area D and the additional land (D1);
- Area E: Utilise existing RAP with minor amendments;
- Site Management Plans: Develop SMPs to account for ongoing maintenance of remediation infrastructure;
- Acid Sulfate Soils (ASS): Prepare ASS Management Plans.

The review of the RAPs did not recommend any specific requirements with respect to off-site landfill gas or groundwater impacts.

5.1.13 CES SAQP for Preliminary Stage 2 Environmental Site Assessment Area D1 (2015)

CES prepared a detailed Sampling, Analysis and Quality Plan (SAQP) for a preliminary Stage 2 Environmental Site Assessment (ESA) on Area D1.

5.1.14 CES Area D1 Preliminary Stage 2 ESA and Area C Groundwater Monitoring Event (2016a)

The ESA was conducted generally in accordance with the SAQP. The objectives were as follows:

- Assess the suitability of D1 for the proposed use (public open space);
- Assess whether or not the site (current form) is adversely impacting on the surrounding (off site) environment;
- Conduct an additional round of groundwater sampling on Area C to compare and asses temporal changes in groundwater quality.

CES concludes that ground conditions in Area D1 were comparable to those encountered in Area D. CES concludes that leachate-impacted groundwater was likely to be migrating off site and discharging into the Cooks River and Muddy Creek. The rate of landfill gas generation and the quantity of gas present were assessed as being low.

The data re-affirm the presence of landfill gas within the waste mass in addition to the off-site migration of leachate-impacted groundwater into surface water bodies.

5.1.15 CES RAP Areas C, D, D1 and E (2016b)

CES prepared a RAP for Areas C, D, D1 and E consisting of the following items:

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- Pilot Trial Study to determine the suitability of an interception trench (pump and treat), hydraulic control (reverse hydraulic gradient) or PRB for the management of leachate-impacted groundwater;
- Site capping and application of a growing medium (landscaping layer) over the site;
- Placement of a gas drainage layer under proposed buildings and structures;
- Groundwater remediation programme;
- Ongoing gas and groundwater monitoring programme focused on the site perimeter.

The RAP did not contemplate the active management of potential off-site landfill gas impacts.

The RAP has not been implemented.

5.1.16 Zoic Site Audit Report and Statement - Cook Cove Stage 1 (Areas C, D, D1, and E) (2016)

The Site Audit Statement states that the site can be made suitable for use as public open space (park, recreational/open space, playing field) subject to the following conditions:

- Preparation of a Landfill Gas Management Plan;
- Development of a landfill gas conceptual site model to identify potential pathways to sensitive receptors now and into the future. Furthermore, a SAQP is to be prepared that outlines the works required to characterise these pathways with reference to NSW EPA Ground Gas Guidelines;
- A baseline ecological survey of the Landing Light Wetlands is to be carried out and considered in the SAQP for the groundwater remediation Pilot Trial Study (PTS);
- A SAQP for the PTS should be prepared and reviewed by the Site Auditor;
- A Detailed Design RAP is to be prepared following the results of the PTS and landfill-gas monitoring.

5.2 Reports Issued pursuant to Site Audit Statement

5.2.1 CES SAQP - Landfill Gas Southern Precinct (2017b)

The SAQP details a scope of works required to '*complete a landfill gas assessment along the western and southern site boundary of the Southern Precinct … to identify any landfill gas migration that may occur after the completion of the landfill cap construction.'*

Consistent with data provided in the preceding sections, Section 1 of the SAQP notes that *'a review of the previous data … indicated that although gas concentrations were elevated within the waste mass, there was no evidence of gas accumulation and pressure (based on the low flow rates detected) and as such a low risk to the off-site residential receptors'.*

The scope of works outlined in the SAQP is as follows:

- Installation of 18 gas monitoring bores to the level of groundwater arranged 50 metres apart. Eight (8) boreholes were located along the southern boundary and 10 were located along the northern boundary;
- Completion of four (4) rounds of monitoring in the proposed and existing three (3) wells.

5.2.2 CES SAQP - Pumping Tests and Leachate Treatment Pilot Trial, Southern Precinct (2017c)

The SAQP details the scope of works associated with the completion of aquifer pumping tests and leachate treatment plant trials. The scope of works outlined in the SAQP is as follows:

- Drilling of pumping wells (2) and observation wells (12);

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- Conduct two (2) aquifer pumping tests;
- Test the operation of an Aerobic Digestion Biological Treatment (ADBT) plant during the pumping test.

5.2.3 CES Draft Preliminary Environmental Site Assessment, Spring Street Wetland (2017d)

CES conducted a Preliminary ESA (PESA) on the Spring Street Wetland. The boundary of the study site (area 1.2 ha) generally corresponds with the high-water mark of the wetland. The wetland was not assessed in any of the previous investigations. The scope of works is as follows:

- Review historical and background information;
- Drill 10 hand auger holes and four (4) sediment samples;
- Collection of surface-water samples from three (3) locations.

Consistent with earlier reports, photographs presented in the report show waste material in the banks of the wetland indicating that the waste was placed to the edge of the water body. The photographs also note visible seepage from the landfill batter and associated indicators of leachate impact.

The report concludes that the wetlands were '*constructed recently (between 1991 and 2000) using former landfill leachate and stormwater control measures to create the base topography for the wetlands*'. The report further concludes that '*the site is not suitable to be classified as an area of ecological significance and requires remediation to improve its ecological/environmental status'.* The report recommends that the wetlands be removed and capped.

The PESA makes no reference to potential landfill-gas impacts in the wetland and states that ammonia concentrations in surface water do not exceed the nominated site assessment criterion.

5.2.4 CES Leachate Management System, Pilot Trial Report (2017e)

The works outlined in the corresponding SAQP (Section 5.2.1) were executed by CES.

The report confirms outward groundwater flows from the former landfills. The report states that '*it is unlikely that there is a hydraulic connection between the leachate and the underlying natural groundwater'.* While the results of pumping tests may support this assertion, the statement is inconsistent with past results of groundwater monitoring in nested wells on Area C that indicate natural alluvium is impacted with leachate (Section 5.1.5). To clarify, there is no leachate barrier or collection system in the base of the former landfills (such a barrier would form an aquitard or aquifuge separating groundwater in the waste and underlying alluvium). While there may be differences in the hydraulic conductivity of the waste and alluvium, borehole logs and monitoring results indicate an hydraulic connection between leachate and underlying natural groundwater.

The report also notes that no drawdown in the wetlands was detected during the pumping tests. The report concludes that a '*leachate treatment remediation system is feasible for remediation of the leachate/impacted groundwater at the site'.* While the extraction and treatment of leachate and impacted groundwater may be a feasible option to reduce outflows from the site, the environmental benefits to be gained are questionable. In support of this argument it is noted that Spring Street Wetland and Drain are flushed dry by diurnal tides, bed sediments in the waterways are a likely contributor of ammonia to surface water and the ultimate receiving waterways (Muddy Creek/Cooks River) are highly degraded as a result of urban runoff. Additionally, lowering water levels within the former waste mass has the potential to increase landfill gas emissions and landfill gas generation rates.

5.2.5 CES Draft Detailed Design Remediation Action Plan, Southern Precinct (2017a)

The Draft Detailed Design Remediation Action Plan (DDDRAP) is intended to replace prior RAPs prepared for the site.

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The scope of remediation works outlined in the document includes:

- Capping of former landfills;
- Placement of gas drainage and barrier under proposed buildings;
- Placement of a clean soil barrier outside the landfill footprint;
- Construction of a leachate management system consisting of a series of pumping wells and an on-site treatment plant.

A Site Management Plan (SMP) is also specified in the DDRAP to define restrictions for the site in addition to monitoring and maintenance requirements for the leachate management system infrastructure.

Other than gas barriers and drainage layers under proposed (future) site buildings, the DDRAP recommends '*no management of landfill gas … due to the absence of pressured gas accumulation of detectable surface gas emissions'.*

Gas and soil-vapour risks to off-site residential properties are the subject of a separate on-going assessment by Edison.

It is noted that potential risks associated with hazardous ground gases on the site have not been assessed in accordance with EPA (2019) guidelines.

5.2.6 CES Baseline Landfill Gas Assessment Report, Southern Precinct (2017f)

The report is summarised as follows:

- Landfill gas studies were conducted in the Southern Precinct generally in accordance with a scope of works outlined in a Sampling, Analysis and Quality Plan (SAQP) prepared by CES (2017b);
- The aim of the works was to '*complete a landfill gas assessment along the western and southern site boundary of the Southern Precinct … to identify any landfill gas migration that may occur after the completion of the landfill cap construction*.'
- The following scope of works was completed:
    - Installation of 18 gas monitoring bores arranged 50 metres apart. Eight (8) boreholes were located along the southern boundary and 10 were located along the northern boundary;
    - Completion of five (5) rounds of monitoring in the new and existing three (3) wells.
- CES (2017a) divided the boundary of the Southern Precinct into 10 segments (A to J);
- Gas Screening Values (GSV) and Characteristic Situations (CS) as per EPA (2019) guidelines have been re-calculated by Edison in the site suitability report (Edison, 2020b). The resultant level-2 risk assessment is comparable with that of CES (2017g) other than a designation of CS 2 which was applied where either methane concentrations exceeded 1% or carbon dioxide concentrations exceeded 5% regardless of the CS determined by GSV as per EPA (2019) guidelines;
- Conclusions are as follows:
    - Low or very low risk from landfill gas exists along the northern and eastern boundaries (Boundary Segments A, B, E, H and I) and along the central internal Boundary Segment J;
    - Low risk from landfill gas migration has been identified to residential properties on the southern boundary of the site (Boundary Segment G);
    - Moderate to low risk from landfill gas migration has been identified on the western boundary (Boundary Segments C and F) due to the presence of housing in close proximity to the site;
    - Moderate risk from landfill gas migration has been identified on the western boundary (Segment Boundary D) due to the close proximity of housing <u>and waste</u> to the site boundary.

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5.2.7 CES Surface Water Sampling 2017 Report, Southern Precinct (2017g)

CES completed a programme of surface-water sampling to characterise *'heavy metal concentrations in surface water bodies surrounding the site, and assess the possibility that elevated concentrations of boron within the leachate could be sourced from saline intrusion from nearby water bodies'*. Samples were collected from 10 locations (high and low tide) and analysed for concentrations of heavy metals.

In relation to the matter of boron concentrations arising from saline water intrusion, the report concludes in the negative.

The document does not add any significant additional information in regard to the objectives of this report.

5.3 Assessment of Site Suitability (Edison, 2020b)

Edison (2020b) assessed the suitability of the site for ongoing use as recreational/open space (including associated maintenance). Data from past studies were consolidated and reviewed in this report to create a dataset that can be used to assess the suitability of the site for the use as described. This validated dataset was used as a basis to assess the suitability of the site for ongoing recreational/open-space land use.

Data from the following key documents were used to address the objective of this report:

1. Consulting Earth Scientists, 2008a: *Report on Additional Soil, Groundwater and Landfill Gas Assessment.* Report ID: CES050706-BCC-16-F - Area C. 4 August 2008;
2. Consulting Earth Scientists, 2008b: *Report on Additional Soil, Groundwater and Landfill Gas Assessment.* Report ID: CES050706-BCC-19-F - Area D. 5 August 2008;
3. Consulting Earth Scientists, 2008c: *Report on Additional Soil, Groundwater and Landfill Gas Assessment.* Report ID: CES050706-BCC-20-F - Area E. 5 August 2008;
4. Consulting Earth Scientists, 2008g: *Report on Surface Water Sampling.* Report ID: CES050706-BCC-28-D. 12 November 2008;
5. Consulting Earth Scientists, 2010: *Environmental Monitoring - Area C.* Report ID: CES050706-BCC-29-F. 9 June 2010;
6. Consulting Earth Scientists, 2013a: *Re: Groundwater Monitoring, Area D and Area C, Cooks Cove Development, Arncliffe.* Report ID: CES130608-BP-AF. 18 October 2013;
7. Consulting Earth Scientists, 2016a: *Area D1 Preliminary Stage 2 Environmental Site Assessment and Area C Groundwater Monitoring Event Report, Cooks Cove, Bestic Street, Banksia, NSW.* Report ID: CES130608-BP-AJ. 12 February 2016;
8. Consulting Earth Scientists, 2017f: *Baseline Landfill Gas Assessment Report, Southern Precinct, Cook Cove Development, Banksia NSW. Prepared for Cook Cove Inlet Pty Ltd.* Report ID: CES130608-BP-BD. 9 November 2017.

Based on a thorough evaluation of source documents, the data presented in the key documents was considered to be of suitable quality to satisfy the objective of the report with the exception of Area D where supporting documents had not been provided for review. Consequently, data for Area D as reported in CES (2008b) is treated as having low reliability. Notwithstanding, groundwater, surface-water and landfill-gas data in subsequent reports (CES, 2008g; CES, 2010; CES, 2017f) were considered sufficient to satisfy the objective of the report with respect to Area D.

The site is mostly (80-90%) occupied by former municipal waste landfills placed over alluvial sediments associated with the Cooks River and Muddy Creek. The landfills have been constructed without engineering controls to manage leachate or gas impacts associated with leaching or degradation of deposited waste. The waste has been covered with a thin veneer of cover soil of varying thickness and permeability. Based on borehole logs the generalised site stratigraphy consists of:

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- Cover soil over waste (former landfill areas): Silty sand to sandy cover soil ranging from 0.1 to 2.7 m thickness over waste material;
- Waste (mounds) consisting of compacted municipal waste material including rubber, cloth, wood, glass, plastic, metal, fabric, ceramic, ash, construction/demolition waste and organic matter;
- Areas to the periphery of the waste mounds are underlain by reworked alluvial sediments associated with historical diversions/re-alignments of the Cooks River/Muddy Creek with surface fill material;
- Natural alluvial/estuarine sediments consisting of fine to medium-grained, loose sands to coarse-grained dense sands, black/brown peat and soft to dense clays.

Concentrations of heavy metals exceeded the Site Assessment Criteria (SAC) for recreational/open-space land use in some samples of cover soils. The potential for the presence of Asbestos Containing Materials (ACM) in cover soil and waste is also acknowledged. Additionally, exceedances of the nominated SAC occurred in samples of buried waste material. Under a scenario of ongoing recreational/open-space land use, management measures are required with respect to the potential risk to users of the site from contact with exposed cover soils (concentrations exceeding the SAC) and, potentially, exposed waste materials in the event that cover soils are eroded.

Groundwater at the site is unconfined, occurring within the waste mass and underlying alluvium. Groundwater is impacted with constituents derived from anoxic and anaerobic waste degradation (primarily ammonia) and is hydraulically connected to the surrounding surface-water bodies resources, namely: Spring Street Wetland; Spring Street Drain/Canal; Cooks River; Muddy Creek and the Landing Lights/Riverine Park Wetlands. The estimated quantity of impacted groundwater (and therefore contaminant loading) discharging to surface-water bodies is small relative to the volume of the diurnal tidal prism. Furthermore, the receiving waterways are substantially degraded as a result of urban runoff and organic-rich bed sediments, particularly in the wetlands, and are also likely to constitute a source of ammonia at low tide. On these bases, the risks arising from ammonia-impacted groundwater to baseflows in surface-water bodies are considered to be low. The likelihood of potential human contact with impacted groundwater is low due to the configuration of the discharge zone to receiving surface-water resources. Any management measures implemented to address ammonia impacts on surface-water systems must consider potential impacts on landfill-gas production and migration as well as loading of the waste mass. Measures should be implemented to minimise leachate generation by improving drainage and reducing infiltration.

Elevated concentrations of methane, derived from anaerobic waste degradation, are present within the waste mass. Off-site impacts on residential receptors are the subject of separate investigations by Edison and are not considered within the report. Methane is not accumulating under significant pressure within the waste mass, likely due to poor compaction on placement and the thin, relatively porous cover soils. Trace Volatile Organic Compounds (VOCs) have been detected at low concentrations within the waste mass (*e.g.*, Benzene, toluene and chlorobenzene and 1,2,4 trimethyl benzene). Methane has been detected in some buildings on the site albeit at low concentrations. Management measures are required with respect to potential landfill-gas emissions and exposure under a scenario of ongoing recreational/open-space land use.

Triggers that may give rise to a requirement to notify the Environment Protection Authority (EPA) under Section 60 of the *Contaminated Land Management Act 1997* (EPA, 2015) have been considered. It was concluded that notification is not required with respect to landfill provided that '*management measures are in place to control gas entry into buildings or in ground services'.* Concentrations of ammonia in groundwater and surface water may trigger a technical duty to report on the following basis: groundwater quality on the site is impacted by landfill leachate at low tide; leachate-impacted groundwater is migrating off the site; measurable water-quality impacts are reported in the surface-water system adjoining the site at low tide. However, based on the transient nature of surface-water impacts, contributions from natural

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sources and the degraded condition of the waterways, the impact of ammonia on the aquatic ecosystem is considered to be low.

Management measures are required to mitigate potential human-health risks associated with waste fill, cover soil with heavy metal concentrations above the SAC and hazardous ground gases within the site. Subject to the development and implementation of a robust Site Management Plan with a documented programme of ongoing monitoring and maintenance, it is concluded that the site can be made suitable for ongoing recreational/open space land use. The management plan should address the following:

- Measures to reduce leachate generation in the waste mass without affecting the rate of landfill-gas production and migration. Measures should be implemented to improve site stormwater drainage;
- Ensure that adequate soil cover is maintained to prevent potential human contact with impacted cover soil, buried waste material and landfill gas (and associated trace compounds) in buildings and service conduits;
- Ensure that grass cover is maintained to minimise human contact with impacted cover soils;
- Implement measures to monitor and manage potential landfill-gas (and associated trace compounds) accumulation in buildings and buried service conduits;
- Implement a robust process for the management of maintenance and upgrade works to the site;
- Implement a programme of ongoing environmental monitoring.

The following data gaps require assessment in the implementation of the management plan:

- The location of service trenches and in-ground structures has not been accurately identified or mapped;
- Area D data are preliminary only as no tables or supporting documents have been provided to Edison for review. One (1) additional round of groundwater and surface-water monitoring is recommended to characterise groundwater and surface-water quality at the site (Areas C, D, D1, E);
- The area occupied by St George Stadium has not been assessed (except for some gas accumulation monitoring in buildings). An assessment of this area is required prior to any re-development programme;
- Groundwater flow contours require validation for Area C as data on the altitude of well collars have not been provided in past documents. Groundwater wells should be surveyed, and updated groundwater flow contours should be plotted based on updated monitoring data;
- With the exception of studies around the site boundary (CES, 2017f), an assessment of risks associated with hazardous ground gases in accordance with EPA (2019) have not been undertaken for the site. One (1) initial round of monitoring from existing wells within the site should be undertaken to assess hazardous ground-gas impacts in accordance with EPA (2019) guidelines;
- Surface-gas survey data is preliminary only as tabulated raw data has not been provided. One (1) round of surface-gas emission monitoring should be undertaken to set a baseline dataset for the LTSMP;
- Soil-vapour data (VOCs in soil vapour) is preliminary as only one (1) round of sampling using Tedlar bags has been undertaken. One (1) round of sub-slab soil vapour monitoring should be undertaken to assess poetical impacts in buildings on the site;
- Potential off-site landfill-gas and soil-vapour impacts to adjoining residential properties are the subject of a separate assessment by Edison and are not considered further in the report.

5.4 Long-Term Site Management Plan (Edison, 2020a)

The Long-Term Site Management Plan (LTSMP) was prepared in response to the recommendations of the site suitability report summarised in Section 5.3. The LTSMP provides guidance on:

- Information on Contaminants of Potential Concern (CoPC);
- Measures to reduce landfill leachate generation rates by improving site drainage;
- Measures to ensure that adequate soil cover is maintained to prevent potential human contact with impacted cover soil, buried waste material and landfill gas (and associated trace compounds) in buildings and service conduits;
- Measures to ensure that grass cover is maintained to minimise human contact with impacted cover soils;
- Measures to monitor and manage potential landfill gas (and associated trace compounds) accumulation in buildings and buried service conduits;
- Specific responsibilities and obligations of relevant parties for administering the LTSMP, including a robust process for the management of maintenance and upgrade works to the site;
- Environmental monitoring requirements including trigger levels for further action developed with reference to guidelines endorsed by the Environment Protection Authority (EPA).

5.5 Monitoring Undertaken Pursuant to LTSMP

Monitoring specified in the LTSMP (Section 5.4) has been completed by Edison (2020a, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h)The results of monitoring confirm the landfill gas, groundwater and surface-water impacts described in past reports (Section 5.1 and 5.2).

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6. Conceptual Site Model

A Conceptual Site Model (CSM) is a representation of site-related information regarding contamination sources, receptors and exposure pathways (NEPC, 2013). The development of a CSM is a dynamic process; the data gathered at each stage of the investigation are used to refine the CSM and inform decisions regarding further investigation or management.

The CSM presented below has been prepared with reference to guidelines endorsed by the EPA, specifically NEPC (2013).

6.1 Assumptions and Data Gaps

Data gaps are as follows:

- The area occupied by the St George site has not been assessed;
- Fill mounds surrounding the former soccer field on the St George site have not been assessed.

6.2 Contaminants of Potential Concern (CoPC)

The following Contaminants of Potential Concern (CoPC) have been identified:

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Period	CoPC	Phase/State	On site[2]	Off site[2]
Market Garden[1]				
<1900s	• Heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn); • OCPs (Aldrin, Dieldrin, DDT and degradation products).	• Primarily sorbed on soil; • Primarily sorbed on soil.	Y Y	N N
Sewage farm				
1900s - ~1940s	• Pathogens (human waste); • Organic matter (human waste); • Nutrients (human waste); • Bio gas (primarily methane)	• Pathogens (bacteria, viruses, etc); • Solid; • Solid and dissolved; • Vapour and dissolved	Y Y Y U	N N N N
Landfilling				
~1940s - ~1980s	• Petroleum hydrocarbons; • Heavy metals; • PAHs; • OCPs/OPPs; • PCBs; • Asbestos; • Ammonia; • Landfill gas (primarily methane) • Volatile Organic Compounds (VOCs)	• Separated, dissolved, vapour; • Sorbed and dissolved; • Primarily solid phase in waste; • Primarily sorbed on soil; • Primarily sorbed on soil; • Solid and airborne particles; • Dissolved in ground/surface-water; • Vapour and dissolved; • Vapour, sorbed and dissolved.	Y Y Y Y Y Y Y Y Y	Y Y U N N N Y Y Y
Open space				
1978 - ongoing	• Aesthetics; • PACM on bare soil and from dumping; • Herbicides; • Landfill gas (primarily methane); • VOCs • Landfill leachate impact (ammonia, organic loading).	• Bare soil on site surface; • Solid; • Sorbed on soil; • Vapour and dissolved; • Vapour, sorbed and dissolved; • Dissolved. Surface water and groundwater.	Y Y Y Y Y Y	N N N Y Y Y
Note 1: EPA (2005). Note 2: Y means 'yes'; N means 'no'; U means 'unlikely.'				

6.3 Sources, Nature and Extent of Potential Contamination

The majority of the site is occupied by former municipal waste landfills placed over alluvial sediments associated with the Cooks River and Muddy Creek. The landfills have been constructed without engineering controls to manage leachate or gas impacts associated with leaching or degradation of deposited waste. The waste has been covered with a thin veneer of cover soil of varying thickness and permeability.

The waste masses at the site interface either directly or indirectly with the following tidal surface-water resources: Spring Street Wetland; Spring Street Drain/Canal; Cooks River; Muddy Creek and the Landing Lights/Riverine Park Wetlands. These water bodies are variously degraded as a result of urban development.

Groundwater at the site is unconfined and occurs with the waste mass. Groundwater is impacted with constituents derived from anaerobic waste degradation (primarily ammonia) and is hydraulically connected to the surrounding surface-water bodies. Low-reliability estimates of the quantity of impacted

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groundwater (and therefore contaminant loading) discharging to surface-water bodies are small relative to the volume of the diurnal tidal prism.

The waste mass contains organic matter. Elevated concentrations of methane, derived from anaerobic waste degradation, is present within the waste mass.

6.4 Exposure Pathways, Potential Receptors and Qualitative Risk Assessment

Exposure pathways and potential receptors are considered below along with a qualitative assessment of risk.

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Exposure Pathway	On site	Off site	Potential Receptors	Risk
Human Health				
Soil:				
Incidental ingestion and dermal contact	✔		Workers and visitors	Areas of bare soil pose a potential risk with respect to exposure to cover soil and exposed waste material. Concentrations of CoPC in cover soil were mostly below the SAC for open space/recreational use indicating that potential risks are low provided that adequate grass cover remains in place. Concentrations of CoPC in waste material exceed the SAC. This exposure pathway is complete only if workers intersect waste material without appropriate PPE.
Inhalation of dust and PACM fibres	✔	✔	Workers, visitors and adjoining residents	Maintenance activities (*e.g.* lawn mowing) have the potential to generate dust and exposure to CoPC. Asbestos cement fragments have been identified at the site surface. Inappropriate management methods have the potential to generate asbestos fibres from the identified fragments.
Groundwater and Surface-Water:				
Dermal contact with impacted groundwater and surface water	✔	✔	Persons exposed to impacted water at the site boundary and in waterways	Access to the groundwater discharge interface at the site boundary is difficult and limited (steep banks or muddy wetland/channel beds at low tide). Therefore, access to impacted groundwater discharge zones is considered to be unlikely.
Ingestion of marine life		✔	Ingestion of marine life impacted	The entire Cooks River and tributaries is subject to a ban on fishing for consumption (https://www.dpi.nsw.gov.au/fishing/closures/location-closures/botany-bay-and-georges-river). The ban attests to the generally degraded state of the receiving waterway.
Soil Vapour and Landfill Gas:				
Accumulation of combustible/explosive components of landfill gas (methane) in buildings and service conduits		✔	Users of buildings associated with sporting facilities constructed over waste or impacted groundwater	Initial data shows low levels of methane in site buildings. The risk is considered to be low on the basis of this data and subject to ongoing monitoring. Off-site risks to residential receptors are the subject of a separate and ongoing assessment by Edison.
Inhalation of VOC vapours in enclosed spaces (buildings)	✔	✔	Users of buildings associated with sporting facilities constructed over	Concentrations of VOCs in site buildings have not been assessed, however, based on the generally low methane concentrations the associated risk is expected to be low. Off-site risks to residential receptors are the subject of a separate and ongoing assessment by Edison.

			waste or impacted groundwater	
Ecological				
Soil:				
Direct contact and uptake by terrestrial flora and fauna (assumed to extend to 2 m depth)	✔		Terrestrial flora and fauna within the root zone.	The waste material is impacted with concentrations of heavy metals, TRH and PAHs above the SAC. The site is an urban park with minimal plantings. Ecological risks to terrestrial flora and fauna are expected to be low.
Surface Water and Groundwater:				
Exposure to impacted groundwater migrating off site		✔	Aquatic flora and fauna in receiving water bodies	Groundwater at the site is impacted by landfill leachate at levels above the SAC (heavy metals, naphthalene and ammonia). While it is necessary to undertake additional investigations to determine the extent of off-site groundwater impacts, considering the degraded state of receiving water bodies, diurnal tidal flushing and relatively small quantity of groundwater discharge relative to the tidal prism, the risks to ecological receptors therein is considered to be low.
Exposure to impacted groundwater discharging into surface-water bodies	✔	✔	Aquatic flora and fauna in receiving water bodies	Spring Street Wetland in particular is heavily degraded with bed sediments expected to be a contributor to ammonia impacts in surface water at low tide. Surface-water impacts are temporally transient due to diurnal tidal flushing of the waterways. Considering that the waterways are significantly degraded and subject to ongoing impacts from urban runoff, the risk to aquatic flora and fauna associated with the site is considered to be relatively low.

7. Data Quality Objectives

7.1 Step 1 – State the Problem

Former landfills at the site have been constructed without any environmental management (leachate, landfill gas) and has not been properly closed. A series of extensive environmental studies have been conducted at the site, the findings of which have been validated by recently-completed monitoring programmes (Edison 2020a, 2020b, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h). The area occupied by the former St George site has not been investigated in past studies. Consequently, while it is known that the former waste landfill extends under the St George site, the quality of cover soils and fill in perimeter mounds is not known and cannot be ascertained from the results of past studies.

The results of the field and laboratory programme outlined herein will support the development of remediation/management requirements for the former St George site with reference to the existing, approved LTSMP for the broader Barton Park site (Edison, 2020a).

7.2 Step 2 – Identify the Decisions

The decisions to be made based on the results of the investigation are as follows:

1. Is there sufficient information on the distribution and characteristics of groundwater and soil-vapour to properly characterise groundwater and soil-vapour quality at the site;
2. Does the dataset adequately characterise the site for the purpose of assessing the suitability of the site for the current (and proposed) land uses and (if required) remedial options;
3. Is the dataset sufficient to enable the preparation of defensible RAP for the site;
4. Is there sufficient data to classify waste *in-situ* for off-site disposal or beneficial reuse;
5. Have potential off-site sources been investigated sufficiently;
6. Are the data reliable?

7.3 Step 3 – Identify Information Inputs to the Decision

Inputs into the decision are as follows:

1. Existing data;
2. Land use;
3. Appropriate NSW EPA made or endorsed guideline documents;
4. Experienced environmental consultants;
5. Geological data and information relevant to subsurface structures;
6. Hydrogeological data;
7. Geo-referencing of sampling point location by surveying each borehole location;
8. Concentrations of Contaminants of Potential Concern (CoPC) in different fill/soil types;
9. Concentrations of CoPC in groundwater;
10. Observations regarding the presence of potential chemical residues including staining, odours and discolouration of the soil media;
11. Observations on the presence of different fill materials, such as: general refuse (metal, plastic, glass *etc.*), timber, ash, slag and ACM;
12. Observations relating to the potential presence of light non-aqueous phase liquid/dense non-aqueous phase liquid (LNAPL/DNAPL), odours and discolouration of the groundwater and surface water during purging and sample collection;
13. Assessment of the nature, level and distribution of impacts on soil and groundwater;
14. Quality Assurance and Quality Control (QA/QC) data.

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7.4 Step 4 – Define the Boundaries of the Study

The boundary of the St George site is shown on Figure 3. The St George site occupies part of Lot 100 in DP 1228008, has an area of approximately 2.2 ha and is shown on Figure 3.

The vertical extent of the study is defined as follows:

- Surface soil characterisation: 0-100 mm;
- Perimeter bund characterisation: top of bunds to surrounding ground level.

The temporal boundary of the assessment is defined as the time between commencement and final sample collection.

7.5 Step 5 – Develop a Decision Rule

The decision rules for this investigation are as follows:

1. If it is determined that the data generated through this investigation are reliable and adequately characterises groundwater and soil-vapour conditions at the site, the data will be compared against the adopted Site Assessment Criteria (SAC);
2. If the data meets the adopted SAC, then the site will be considered suitable;
3. If the data do not meet the adopted SAC, then further investigations or the development of a RAP will be recommended as a basis for making the site suitable. Further investigations may include:
   - Additional soil or groundwater sampling points to delineate impacts;
   - Analysis of soil and/or groundwater for additional analytes/CoPC;
   - Undertaking soil-vapour investigations; and/or
   - Undertaking a human health and/or ecological risk assessment to assess site suitability and, if not suitable, assess the requirement for remediation and/or management.

If it is determined that the data generated through this investigation are not reliable and/or do not suitably characterise the site, then further investigations may be recommended prior to comparison against the SAC.

7.6 Step 6 – Specify Acceptable Limits on Decision Errors

Acceptable limits on decision errors must be applied based on the Data Quality Indicators (DQIs) pertaining to precision, accuracy, representativeness, comparability and completeness. The limits on decision errors for the study are as follows:

1. Incorrectly deciding that levels are below an assessment criterion (Type I error). The consequence of this error is that there may be a conclusion that material conforms to a lower waste classification than is actually the case. A Type I error rate of 5% is nominated for the study;
2. In applying statistical analysis of a data set (where applicable/sufficient data set exists):
   - Exclude any individual sample with a concentration that exceeds 250% of SAC. This data point is to be regarded as an 'outlier';
   - Test that assume a normal distribution will only be used if the coefficient of variance is less than 1.2;
   - The standard deviation of a sample population will not exceed 50% of the Alignment assessment criteria.
3. A robust quality assurance and quality control (QA/QC) programme will be implemented with appropriate sampling and analytical density to satisfy the objective of the study.

Decision errors may result in:

1. Basing decisions on unreliable data and consequently making incorrect decisions regarding land use suitability;

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2. Basing decisions on unreliable data and inappropriately defining a remedial or management strategy.

The Data Quality Indicators (DQIs) are described in Section 11 while the adopted SAC are described in Section 10.

7.7 Step 7 – Optimising the Design for Obtaining Data

The purpose of this step is to identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs. To ensure that the design satisfies the DQOs, a comprehensive Quality Assurance and Quality Control (QA/QC) plan will be implemented as described in Section 11.

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8. Sampling Programme

The following sampling programme has been designed to meet the objectives defined in Section 2. The site area is shown on Figure 3.

Planned sampling locations are provided in Table 1 and the planned analytical programme is provided in Table 2.

8.1 Soil and Fill

8.1.1 Sampling Pattern

With reference to EPA (1995) *Sampling Design Guidelines* a minimum of 32 sampling points, arranged on a square grid, is required to a site with area of 2.2 ha. The objective of the sampling pattern is to detect circular hotspots on Stages 6A and 6B respectively with a diameter of approximately 32.6 m. As the characteristics of the underlying landfill waste mass are well understood from past studies (Section 5) a lower sampling density consisting of twenty (20) points is considered sufficient to satisfy the objectives listed in Section 2. The sampling programme consists of ten (10) surface-soil sampling points on the former soccer field and ten (10) test pits excavated into the fill mounds.

A summary of the proposed sample locations and an analytical programme are provided in Tables 1 and 2 respectively. The sampling locations are shown on Figure 3 with the precise locations to be determined during fieldwork and verified by site survey. The proposed sampling points are arranged to allow access around site features and structures.

Soil sampling test pits proposed under this SAQP are designated with the prefix *TP1xx* while surface-soil sampling locations are designated *SS2xx*.

8.1.2 Depth Intervals of Sampling

Surface-soil samples will be collected using a decontaminated stainless steel trowel directly into laboratory-supplied glass jars with Teflon-lined lids. Samples will be collected from 0-100 mm depth.

Test pits into the perimeter fill mounds will be with an hydraulic excavator or back hoe. Test pits will extend from the apex of the mound to the surrounding ground level.

It is proposed to sample collect two (2) samples from each test pit and one sample from each surface-soil sampling location.

8.1.3 Method of Sampling Collection

Test pits will be excavated using an hydraulic excavator or backhoe. Undisturbed samples will be collected directly from the wall of test pits or, when depths exceed 1 m, directly from excavator bucket. Care will be taken to collect samples from the fresh excavation faces as recommended by NEPC (2013).

Boreholes will be drilled with a hydraulic drilling rig using solid flight augers. Undisturbed samples will be collected with the aid of decontaminated Standard Penetrometer Test (SPT) or push tube sampler.

Care will be taken to ensure that representative samples are obtained from the depth required and that the integrity is maintained, particularly when dealing with potentially volatile and semi-volatile components. When collecting duplicates, samples to be analysed for volatiles will not be mixed, rather they will be placed directly into sample jars.

Samples will be collected in accordance with documented Edison procedures by experienced staff. Soil jars must be filled to the rim with no headspace remaining to minimise the potential for loss of volatile components prior to analysis.

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Samples of soil and fill will be transferred from the decontaminated SPT sampler into laboratory-supplied sample jars with Teflon-lined lids for chemical analysis using a decontaminated stainless-steel trowel or a new pair of disposable latex or nitrile gloves. If required, samples for the sPOCAS and foreign matter tests respectively will be transferred into laboratory-supplied plastic bags using a new pair of disposable latex or nitrile gloves.

Fragments of visible Potential Asbestos Containing Materials (PACM) have not been reported in past studies or in the site inspection conducted by Edison. On this basis, the likelihood of asbestos impacts at the site is considered to be low. It is therefore proposed to adopt the following approach to the investigation of asbestos impacts: Trained field staff to inspect excavator spoil or drill cuttings and samples for the presence of PACM. If no PACM is identified, then selected samples are to be submitted for laboratory analysis as a precautionary measure. Should field staff observe PACM on site, then the procedure outlined by NEPC (2013) is to be adopted to properly characterise the nature, level and extent of PACM impacts.

NEPC (2013) outlines the following procedure for the assessment of bonded Asbestos Containing Material (ACM) impact in granular soils (*e.g.,* sand):

1. A minimum of 10L of sample is required for asbestos analysis. It is intended to collect samples for asbestos analysis from solid auger flights in order to yield sufficient sample volume. It is planned to either drill 'twin' holes adjacent to the primary sampling points or to collect asbestos samples from different levels in the fill strata to those collected for chemical analysis;
2. Samples should be weighed on site and passed through a 7 mm sieve. Material retained in the sieve is to be examined for bonded ACM and/or suspect material;
3. Identified bonded ACM and Friable Asbestos (FA) should be weighed (and suspect materials assumed to contain asbestos) and documented to assist with calculating asbestos soil concentrations in accordance with the procedure outlined in Schedule B1 of NEPC (2013) guidance;
4. Suspect materials should be forwarded to analytical laboratory for analysis in accordance with AS 4964-2004.

For cohesive soils, samples are to be disaggregated and inspected. In the absence of visible fragments of bonded ACM, samples of soil will be collected and submitted for the determination of asbestos fines as a precautionary measure.

8.1.4 Decontamination Procedures

In order to minimise potential cross-contamination of the boreholes, drilling tools used to advance boreholes will be thoroughly cleaned between sampling points (set-ups) using a pressure washer or potable water supply.

SPT and sampling tools and equipment will be washed between sample locations using Decon 90 (or other phosphate-free detergent) followed by adequate rinsing with potable water. To check the adequacy of the decontamination protocol, rinsate samples will be collected for analysis. All samples will be collected with new disposable latex or nitrile gloves.

8.1.5 Sample Containers

For chemical analysis, soil sample containers (Table 3) will comprise glass with a Teflon lined lid and be supplied by either the primary or secondary laboratory. The jars will be completely filled with soil, sealed, labelled with the job number, date, unique sampling point identification and depth.

8.1.6 Method of Sample Storage and Handling

The full soil jars will immediately be placed in a cooler box with ice or ice bricks. The objective is to chill

samples to a temperature of approximately 4°C. At the end of each day the samples in the cooler box will be transported to the Edison office where more ice or ice bricks will be added until delivered to the laboratory (within one (1) day).

Alternatively, samples may be dispatched to the laboratory from the field.

8.1.7 Sample Logging and Documentation

A log will be completed during drilling or test pitting by a qualified and trained environmental scientist or engineer. The borehole log records the following data:

- Location details: Edison Project ID, Borehole/test pit identifier and coordinates, date commenced, date completed, drill company, drill rig;
- Sample number and depth;
- Sample type;
- Soil classification, colour, consistency or density, odour and moisture content;
- Depth of boring/excavation;
- Drill bit/excavator bucket refusal;
- Method of drilling/excavation;
- Depth of first encountered free water;
- Presence or absence of odour or potential Asbestos-Containing Materials (ACM).

A copy of a blank test pit log is provided in Annexure 3.

While on site, the supervising engineer/scientist will be required to fill out a copy of 'Edison Sample Register' which documents:

- Time of sample collection;
- Weather;
- Unique sample identification number;
- Sample type;
- Sample location and depth.

A blank 'Edison Sample Register' is provided in Annexure 3.

All samples, including QA samples, will be transported to the primary and check laboratories under Chain-of-Custody (COC) procedures and maintained in a chilled cooler. The COC will detail the following information:

- Site identification;
- The sampler's name;
- Nature of the sample;
- Collection time and date;
- Analyses to be performed;
- Sample preservation method;
- Departure time from site;
- Dispatch courier(s).

8.1.8 Reinstatement

Test pits will be reinstated to surface levels by backfilling with excavated soils. All attempts will be made to place spoil in the test pits in an order relative to depth (*that is*, deeper cuttings will be placed in pits first, shallow cuttings will be placed in boreholes last).

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9. Analytical Plan

9.1 Choice of Analytes

9.1.1 Soil

The soil analysis programme consists of (Table 2):

- One (1) sample will be collected from each surface-sampling location
- Two (2) samples will be collected from each test pit;
- Fill samples will be analysed for the following parameters: asbestos; heavy metals and metalloids (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg); Total Recoverable Hydrocarbons (TRH); monocyclic aromatic hydrocarbons (BTEX); Polycyclic Aromatic Hydrocarbons (PAHs);
- Surface soil samples will be analysed for concentrations of: asbestos; heavy metals and metalloids (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg); Total Recoverable Hydrocarbons (TRH); monocyclic aromatic hydrocarbons (BTEX); Polycyclic Aromatic Hydrocarbons (PAHs); Organochlorine Pesticides (OCPs); Organophosphate Pesticides (OPPs) and total Polychlorinated Biphenyls (PCBs).

9.1.2 Laboratory

Edison plan to use either Eurofins, SGS or Envirolab Services Pty Ltd (or equivalent) for the analytical programme. The analytical laboratories for the project are to be certified by the National Association of Testing Authorities (NATA) for all methods and EQLs specified in this SAQP.

9.2 Analytical Methods

9.2.1 Soil

Soil samples will be analysed in accordance with USEPA and APHA approved analytical methods as described in Table 4.

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10. Site Assessment Criteria

Proposed Site Assessment Criteria (SAC) are defined and discussed below from guidelines most recently endorsed by the EPA.. In cases where the SAC account for soil texture, values for coarse-grained soil have been selected because cover soils over waste material generally have a sandy texture as noted in the site inspection by Edison.

10.1 Soil

10.1.1 Aesthetics

With reference to NEPC (2013), '*aesthetic issues generally relate to the presence of low-concern or non-hazardous inert foreign material (refuse) in soil or fill resulting from human activity*.' Aesthetic issues may also arise from the discolouration of soil from inert chemical waste or residual odour.

An assessment of aesthetic consideration would arise in the following circumstances (NEPC, 2013):

- Highly malodorous soils or extracted groundwater;
- Hydrocarbon sheen on surface water;
- Discoloured chemical deposits or soil staining with chemical waste other than of a very minor nature;
- Large monolithic deposits of otherwise low-risk material (*e.g.*, gypsum as powder, plaster board or cement kiln dust);
- Presence of putrescible refuse;
- Soils containing buried animal waste.

There are no specific numeric guidelines for the assessment of aesthetic impacts. NEPC (2013) note that '*higher expectations for soil quality would apply to residential properties with gardens compared with industrial sites*'. General assessment considerations include (NEPC, 2013):

- *'That chemically discoloured soils or large quantities of various types of inert refuse, particularly if unsightly, may cause concern to site users;*
- *The depth of the materials, including chemical residues, in relation to the final surface of the site;*
- *The need for, and practicality of, any long-term management of foreign material.'*

Further to the above, NEPC (2013) note that the presence of small quantities of non-hazardous inert materials and residues with low odour that will decrease over time may not be of concern or limit site use in most cases. Furthermore, while sites with large quantities of well covered inert materials that pose no health hazard (*e.g.,* brick fragments and cement waste) are generally of low concern, care should be used for assessing sensitive land uses where large quantities of fill and demolition rubble are present.

10.1.2 Health Screening Level (HSL) for Asbestos Soil

NEPC (2013) defines the following terms when assessing the significance of asbestos impacts in soil:

- Bonded Asbestos Containing Material (bonded ACM): Asbestos bound within a matrix such as cement or resin that is in sound condition, although may be broken or fragmented. The terms are restricted to material that cannot pass a 7 mm square sieve;
- Fibrous Asbestos (FA): Friable asbestos material defined as degraded ACM that can be broken or crumpled by hand pressure. Includes severely weathered cement sheet, insulation products and woven asbestos material;
- Asbestos Fines (AF): Includes free fibres, small fibre bundles and fragments of ACM passing a 7 mm square sieve.

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Health Screening Levels (HSLs) for asbestos in soil are contained in Table 5 (NEPC, 2013). Criteria for FA, AF and surface ACM are common across all land uses. The 'Recreation C' criteria for bonded ACM are appropriate for use on the site.

10.1.3 Health Investigation Levels (HILs) for Soil Contaminants

Health Investigation Levels (HILs) are scientifically based, generic assessment criteria designed to be used in the first stage (Tier 1 or 'screening') of an assessment of potential risks to human health from chronic exposure to contaminants (NEPC, 2013). They are conservative and based on a reasonable worst-case scenario for specific land-use settings.

HILs are not intended to be clean-up levels (NEPC, 2013). Rather, HILs establish the concentration above which further investigations are required to inform decisions as to the requirement for remediation or management measures. Importantly, NEPC (2013) notes that levels slightly in excess of the HILs do not imply unacceptability or that a significant health risk is likely to be present. Exceeding a HIL means 'further investigation needed', not 'risk is present, clean-up required'.

NEPC (2013) contains HILs for the following land-use categories:

- HIL A. Standard residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake, no poultry), includes children's day care centres, preschools and primary schools;
- HIL B. Residential with minimal opportunities for soil access, includes dwellings with fully and permanently paved yard space such as high-rise buildings and flats;
- HIL C. Includes developed open space such as parks, playgrounds, playing fields (*e.g.*, ovals), secondary schools and footpaths. Does not include undeveloped public open space which should be subject to a site-specific assessment where appropriate;
- HIL D. Commercial/industrial includes premises such as shops, offices, factories and industrial sites.

HILs are contained in Table 6 (NEPC, 2013). The Recreation C criteria is appropriate for use on the site.

10.1.4 Ecological Screening Levels (ESLs) for Petroleum Hydrocarbon Compounds

Ecological Screening Levels (ESLs) are presented in NEPC (2013) for TRH fractions F1, F2, F3, F4, BTEX and benzo(a)pyrene. The ESLs are intended to be used as a Tier 1 tool to assess impacts from these compounds on terrestrial ecosystems. ESLs apply from the surface to a depth of 2 m below the finished surface/ground level, which corresponds to the root zone and habitation zone for many species (NEPC, 2013).

ESLs have been derived for coarse and fine soil textures and are based on 'fresh contamination' (NEPC, 2013) for the following land uses:

- Areas of ecological significance;
- Urban residential and public open space;
- Commercial/industrial.

The ESLs for coarse-grained soils and urban residential/public open space land use will be applied for the site assessment.

ESLs for petroleum hydrocarbon compounds are presented in Table 7.

10.1.5 'Management Limits' for Petroleum Hydrocarbon Compounds

In addition to consideration of HSLs and ESLs for petroleum hydrocarbon compounds, the following matters are to be considered:

- Formation of observable light non-aqueous phase liquids (LNAPL);

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- Fire and explosion hazards;
- Effects on buried infrastructure.

Management limits are intended to address the issues listed above (NEPC, 2013) for residential/park/open-space and commercial/industrial land uses. Furthermore, 'management limits' are provided for coarse and fine-textured soil (NEPC, 2013).

The following site-specific factors are to be considered in determining the maximum depth to which the 'management limits' are to be applied:

- Depth of basements;
- Position of buried services;
- Depth to groundwater.

It is noted that the 'management limits' are less relevant at operating industrial sites with limited/no sensitive receptors in the potentially impacted area.

Risks identified by means of an exceedance of the 'management limits' may be addressed by further investigations or management actions.

The 'management limits' for coarse-grained soils and residential, parkland and public open space land use will be applied for the site assessment.

'Management limits' for petroleum hydrocarbon compounds are presented in Table 8.

10.1.6 NEPC (2013) Soil Vapour Health Screening Levels (HSLs) for Petroleum Hydrocarbons

Soil vapour HSLs for petroleum hydrocarbons were developed to be protective of human health by determining the '*reasonable maximum exposure for a range of situations'* (NEPC, 2013), noting that health concerns arising from petroleum hydrocarbons occur as follows:

- Inhalation of vapours from contaminant sources;
- Direct contact with impacted soils and groundwater.

HSLs have been developed for:

- Benzene, toluene, ethylbenzene and xylenes (BTEX);
- Total Recoverable Hydrocarbons (TRH) in the following carbon number ranges (fractions): F1 (C_6-C_{10}); F2 (>C_{10}-C_{16}); F3 (>C_{16}-C_{34}); F4 (>C_{34}-C_{40});
- Naphthalene.
  Note:
  - BTEX results should be subtracted from TRH C_6-C_{10} results for comparison with the HSL for F1;
  - Naphthalene results should be subtracted from TRH >C_{10}-C_{16} results for comparison with the HSL for F2.

HSLs have been derived for a range of land uses. Values for residential use (HSL-A, HSL-B) are the same as they are based on the same exposure conditions (time spent indoors) (NEPC, 2013). Importantly, selection of the relevant HSL is based on the ground floor land use. The HSL-D values for commercial/industrial use are to be applied for multi-storey buildings where basements are used for non-residential uses or at ground level (NEPC, 2013).

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Furthermore, HSLs have been derived for different soil types (sand, silt, clay). The recreational/open-space HSLs C for sandy soils are the appropriate SAC.

HSLs for petroleum hydrocarbons are presented in Table 9.

NEPC (2013) guidelines permit the adjustment of HSLs to account for biodegradation under the following conditions:

- Oxygen concentrations greater than 5% in soil vapour at 1 m depth below the surface immediately adjacent to a concrete slab;
- A maximum slab width of 15 m with oxygen access on both sides of the slab. (A distance of 7-8 m from exposed soil at the slab edge is considered the maximum under-slab penetration distance for oxygen).

Under the conditions described above, the following biodegradation factors can be applied to adjust the vapour intrusion HSLs:

- Biodegradation factors are not to be applied for depths of less than 2 m;
- A factor of x10 for depths to source of 2 m to <4 m;

A factor of x100 for depths to source of 4 m and greater where the vapour source concentration (groundwater) is 100 mg L^{-1} or less.

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11. Quality Plan

Fieldwork will be undertaken by experienced staff in accordance with documented Edison procedures. Field and laboratory QA/QC requirements compliant with National Environment Protection Council (NEPC, 2013) guidelines are outlined below.

11.1 Field QA/QC Programme

Field QA/QC for this project consists of the collection and analysis of blind replicates, split samples, rinsate samples, trip spikes and trip blanks. Collection frequencies for QA/QC samples are summarised in Table 10.

11.1.1 Environmental Samples

Environmental samples or field samples are the representative samples collected for analysis to determine aspects of their chemical composition.

11.1.2 Blind Replicate Samples

Blind replicate samples are provided by the collection of two (2) environmental samples from the same location. These samples are collected, preserved, stored, transported, prepared and analysed in an identical manner. As a minimum, the results of analyses on the blind replicate sample pair are assessed by calculating the Relative Percentage Differences (RPD) between the results. The RPD is calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeds the value adopted for any analytes, additional investigation will be required, or justification provided for not conducting additional investigation.

While the rate of blind replicates varies between projects, the following strategy is generally adopted. Blind replicate samples will be collected at a rate of one (1) duplicate for every 10 environmental samples. For smaller batches of between five (5) and 10 environmental samples one (1) replicate sample will be collected for each batch. Blind replicates may be used for batches of less than five (5) samples subject to project requirements.

11.1.3 Split Samples

Split samples, otherwise known as 'inter-laboratory duplicates', provide a check on the analytical proficiency of the laboratories. Split samples are collected from the same location. Split samples must be taken from the same location as the blind replicate, thus becoming a triplicate sample. However, split samples are not taken as often as blind replicates. Split samples will generally be collected at a rate of one (1) split sample for every 20 environmental samples or 5% of samples. For small batches split samples are collected subject to project requirements.

Spilt samples (triplicates) are preserved, stored, transported, prepared and analysed in an identical manner to environmental samples.

11.1.4 Rinsate (Equipment) Samples

Rinsate (equipment) blanks consist of pre-preserved bottles filled with laboratory-prepared water that has been passed over decontaminated field equipment. Rinsate blanks are prepared on site, labelled with a unique Edison sample identification number and transported to the principle laboratory for analysis as regular environmental samples. The purpose of rinsate blank is to assess the efficiency of decontamination procedures.

For inorganic compounds and semi-volatile organic compounds (SVOCs), rinsate water must consist of milli-Q water (distilled tap water passed through a resin de-ioniser). This water is unsuitable for the analysis of volatile organic compounds (VOC) due to the inclusion of volatiles in the milli-Q water. Only purged water is to be used for volatiles (VOC) rinsate blanks. This water is produced at the laboratory by purging spring water that has not been adulterated by VOCs as with tap water. Purged water is unsuitable for the production of rinsate samples for inorganics due to the presence of trace levels of inorganic compounds.

While the number of equipment blanks varies between projects, the following strategy is generally adopted (Table 10): a rate of one (1) rinsate blank for each field collection (>5 samples). Rinsate sampling will be subject to project requirements for smaller batches (<5 samples).

One (1) rinsate blank will be prepared for each field collection day where non-disposable sampling equipment (*e.g.,* hand auger, stainless steel trowel or knife) are used.

11.1.5 Trip Blanks

Trip blanks consisting of pre-washed bottles containing distilled or de-ionised water and appropriate preservatives or laboratory-prepared sand blank containing acid-washed quartz sand are supplied by the analytical laboratory. The role of trip blanks is to detect potential contamination during sample transport. These samples reside in transport vessels during sampling activities and are not opened in the field. Typically, one (1) trip blank is submitted with each batch of samples. Trip blanks are analysed at the laboratory as regular samples or only for volatile organic compounds, as deemed appropriate.

11.1.6 Laboratory-Prepared Trip Spikes

Laboratory-prepared VOC spikes consisting of distilled, de-ionised water or sand spiked with known concentrations of BTEX should be included in QA/QC programmes where light fraction TPH, BTEX and other VOCs concentrations are being measured. Laboratory-prepared VOC spikes should be included at a rate of one (1) per sample batch. These samples are submitted for BTEX analysis with resulting concentrations compared with the concentrations of the known additions. The purpose of these samples is to monitor VOC losses during transit.

11.2 Laboratory QA/QC Programme

The reliability of test results from the analytical laboratories is monitored according to the QA/QC procedures used by the primary laboratory. The QA/QC programme employed by the primary laboratory specifies holding times, extraction dates, method descriptions, Chain of Custody (COC) requirements, analysis, PQLs and acceptance criteria for the results. Laboratory QA/QC requirements undertaken by ALS are based on NEPC (2013) requirements and are outlined below.

11.2.1 Laboratory Duplicate Samples

Laboratory duplicates provide data on analytical precision for each batch of samples. Where required and in order to provide sufficient sample for analysis of laboratory duplicate, two (2) batches of samples are collected at the first site listed on the Chain of Custody form. This is done in order to ensure that sufficient sample is collected.

Laboratory duplicates are performed at a rate of one (1) duplicate for batches of 6-14 samples with an additional duplicate for each subsequent 10 samples.

11.2.2 Laboratory Control Samples

Laboratory control samples consist of a clean matrix (de-ionised water or clean sand) spiked with a known concentration of the analyte being measured. These samples monitor method recovery in clean samples and can also be used to evaluate matrix interference by comparison with matrix spikes. Laboratory control samples may be certified reference materials.

11.2.3 Surrogates

For organic analyses, a surrogate is added at the extraction stage in order to verify method effectiveness. The surrogate is then analysed with the batch of samples. Percent recovery is calculated.

11.2.4 Matrix Spike

A matrix spike consists of samples spiked with a known concentration of the analyte being measured, in order to identify properties of the matrix that may hinder method effectiveness. Samples are spiked with

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concentrations equivalent to five (5) to 10 times the PQL. Percent recovery is calculated.

11.2.5 Method Blanks

Method blanks (de-ionised water or clear sand) are carried through all stages of sample preparation and analysed at a rate of approximately 10%. Analyte concentrations in blanks should be less than the stated PQL. Reagent blanks are run if the method blank exceeds the PQL. The purpose of method blanks is to detect laboratory contamination.

11.3 Data Acceptance Criteria

The QA/QC Data will be assessed against the Data Acceptance Criteria (DAC) provided in Table 11. If data does not meet the DAC then the following steps will be taken:

- Request that the laboratory re-check or re-run the analysis on the sample;
- Inspect the samples for anomalies that may have caused the failure;
- If necessary, undertake additional sampling and analysis;
- Qualify data. For example, data may be used for screening purposes only.

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12. Reporting

The proposed programme outlined in this SAQP, including field and laboratory methods and results, will be reported in accordance with the requirements of guidelines adopted by the NSW EPA and with reference to EPA (1997) and NEPC (2013).

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14. Limitations of this Report

This report has been prepared for use by the client who commissioned the works in accordance with the project brief and based on information provided by the client. The advice contained in this report relates only to the current project. A competent person should review all results, conclusions and recommendations before being used for any other purpose. Edison Environmental & Engineering Pty Ltd (Edison) accepts no liability for use of interpretation by any person or body other than the client. This report must not be reproduced except in full and must not be amended in any way without prior approval by the client and Edison.

The extent of sampling and analysis has been undertaken to target areas of potential environmental concern and to provide site coverage with sampling, where possible, targeting specific soil strata from where contamination is considered most likely to occur based on knowledge of site history and visual inspection. This approach has been adopted in order to maximise the probability of identifying contaminants, however, the approach may not identify contamination that occurs in unexpected locations or from unexpected sources.

Furthermore, soil, rock and aquifer conditions are variable, resulting in potential for the heterogeneous distribution of contaminants across the site. Contaminants have been identified at discrete locations, however, conditions between sample locations have been inferred based on estimated geological and hydrogeological conditions and the nature and extent of identified contamination. Boundaries between zones of variable contamination are generally unclear and have been interpreted based on available data and professional judgement. The accuracy with which subsurface conditions have been characterised depends on the frequency of sampling, field and laboratory methods and the uniformity of the substrate and is therefore limited by the scope of works undertaken.

This report is based on sampling from borehole locations placed to target potential areas of environmental concern and to provide site coverage. This report does not provide a complete assessment of the environmental status of the site and is limited to the scope defined therein. Should information become available regarding conditions at the site including previously unknown sources of contamination, Edison reserves the right to review the report in the context of the additional information.

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FIGURES

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N

Rev	Description	By	Date
A	Original issue	AL	9/11/17
B	Revision	AL	16/12/19

Legend:

Boundary of Barton Park

Boundary of Adjoining Residential Areas

Scale:

Figure 1: Site Location
Datum: Google Earth Pro

Client: Bayside Council

Project: Barton Park

Project ID: E17011-CU

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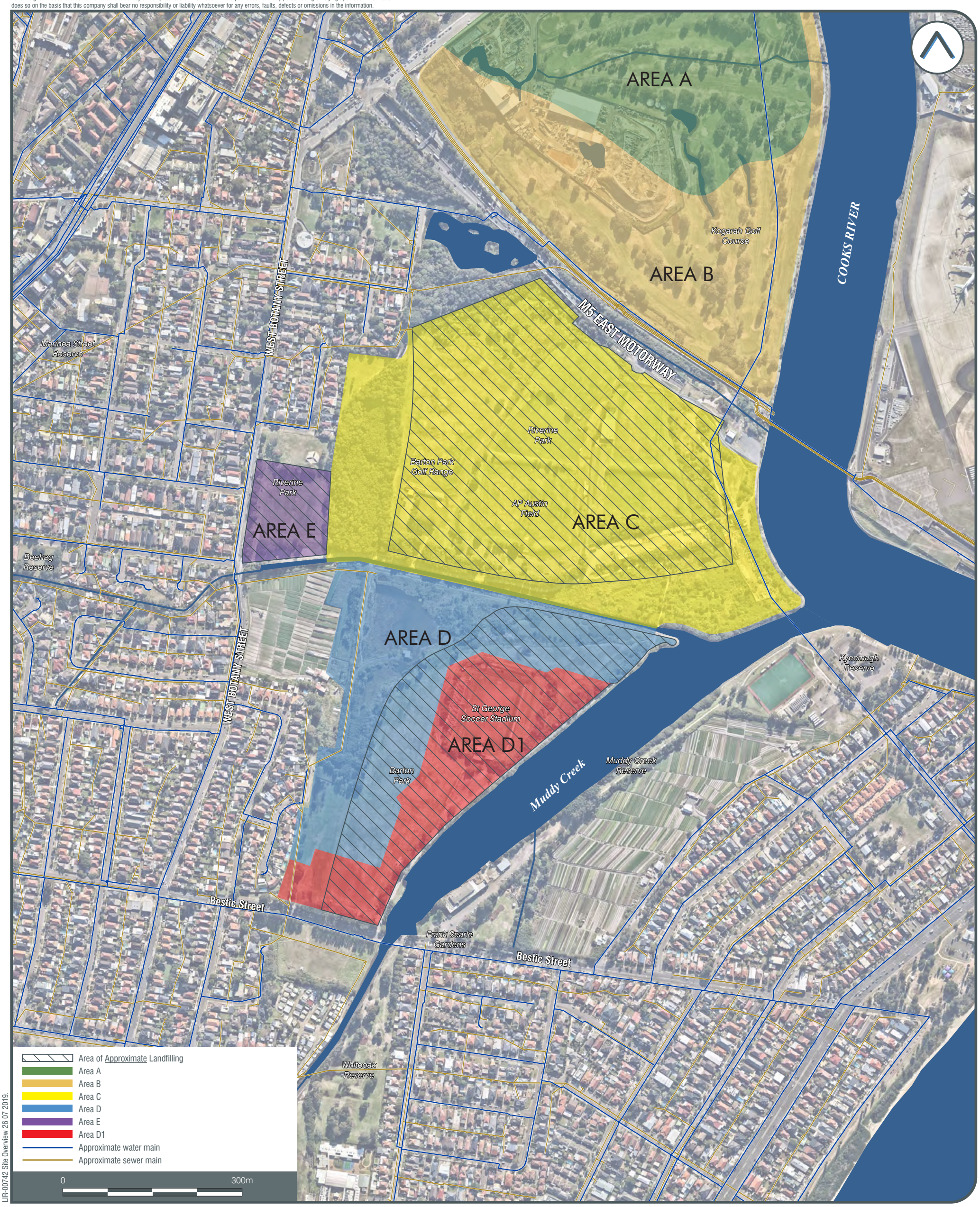

LIR-00742 Site Overview 26 07 2019.

SITE OVERVIEW

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FIGURE 2

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LIR-01260 F1 Area D Proposed Test Pit Locations 21 08 2020

BARTON PARK, AREA D AND D1: PROPOSED TEST PIT LOCATION

Client: Bayside Council

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FIGURE 3

TABLES

Table 1: Planned Sampling Locations				
Sampling location	**Matrix[1]**	**Sampling pattern**	**Location rationale**	**Sampling Method**
TP111-TP110	SO	Grid pattern along perimeter fill mounds	Characterisation of fill perimeter fill mounds.	Excavator test pit. Sample fresh face.
SS211-SS210	SO	Grid pattern on former soccer field	Characterise surface soil thickness and quality on former soccer field.	Grab sample.

Notes:
1. Sample matrix codes: SO – soil; GW – groundwater; GS – gas; LC – leachate.

Table 2: Planned analytical programme			
Matrix	**No sampling points**	**CoPC**	**Number of environmental samples**
Fill/Soil Test Pits	10	Two (2) samples of fill from each test pit will be analysed for the following parameters: asbestos; heavy metals and metalloids (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg); Total Recoverable Hydrocarbons (TRH); monocyclic aromatic hydrocarbons (BTEX); Polycyclic Aromatic Hydrocarbons (PAHs).	20 (2 samples/borehole)
Surface soil	10	Surface soil samples will be analysed for concentrations of: asbestos; heavy metals and metalloids (As, Cd, Cr, Cu, Ni, Pb, Zn, Hg); TRH; BTEX; PAHs; OCPs; OPPs and total PCBs.	10

Table 3: Containers, preservation requirements and holding times - soil				
Parameter	**Container**	**Preservation**	**Maximum holding time**	**Colour code**
Acid extractable metals and metalloids[1]	250 mL glass	4°C	6 months	N/A
Mercury	250 mL glass	4°C	28 days	N/A
TRH/BTEX	250 mL glass	4°C, zero headspace	14 days	N/A
PAHs, Phenols	250 mL glass	4°C	14 days [1]	N/A
OCPs, OPPs, PCBs	250 mL glass	4°C	14 days	N/A
SPOCAS	Re-sealable plastic bag	Frozen	N/A	N/A
Asbestos	Sealed plastic bag	Nil	N/A	N/A
pH, EC	250 mL glass	4°C	7 days	N/A
Foreign matter	6 kg plastic bag	N/A	N/A	N/A
Note 1: Extraction within 14 days. Analysis within 40 days.				

Table 4: Analytical schedule, parameters, EQLs and methods – soil/fill			
Parameter	**Unit**	**EQL**	**Method note**
Metals and metalloids in soil			
Arsenic[1]	mg kg^{-1}	1	USEPA 200.7
Cadmium[1]	mg kg^{-1}	1	USEPA 200.7
Chromium[1]	mg kg^{-1}	1	USEPA 200.7
Copper[1]	mg kg^{-1}	1	USEPA 200.7
Mercury[2]	mg kg^{-1}	0.1	USEPA 7471A
Nickel[1]	mg kg^{-1}	1	USEPA 200.7
Lead[1]	mg kg^{-1}	1	USEPA 200.7
Zinc[1]	mg kg^{-1}	1	USEPA 200.7
Total Recoverable Hydrocarbons (TRH) and BTEX in soil			
TRH F1 C_{6-10}	mg kg^{-1}	25	USEPA 8015B
TRH F2 $>C_{10-16}$	mg kg^{-1}	50	USEPA 8015B
TRH F3 $>C_{16-34}$	mg kg^{-1}	50	USEPA 8015B
TRH F4 $>C_{34-40}$	mg kg^{-1}	100	USEPA 8015B
Benzene	mg kg^{-1}	0.2	USEPA 8015B
Toluene	mg kg^{-1}	0.5	USEPA 8015B
Ethylbenzene	mg kg^{-1}	1	USEPA 8015B
m&p-xylene	mg kg^{-1}	2	USEPA 8015B
o-xylenes	mg kg^{-1}	1	USEPA 8015B
napthalene	mg kg^{-1}	1	USEPA 8207 SIM
Organic compounds in soil			
PAHs	mg kg^{-1}	0.5-1.0	USEPA 8207 SIM
Phenols (speciated)	mg kg^{-1}	0.2-2.0	USEPA 200
OCPS	mg kg^{-1}	0.05-0.2	USEPA 8081A
OPPs	mg kg^{-1}	0.05-0.2	USEPA 8081A
Total PCBs	mg kg^{-1}	0.1	USEPA 8081A
Miscellaneous			
Asbestos	g kg^{-1}	0.1	Polarised light microscopy
pH	pH units	0.1	APHA 2510B
EC	uS cm^{-1}	1	APHA 2510B
TCLP extraction	N/A	N/A	USEPA 1311
SPOCAS	% or mol H^+ $tonne^{-1}$	0.001-0.01	Ahern *et al* (1998)

Note 1: Acid extractable metals by ICP-AES.
Note 2: Total recoverable mercury.

Table 5: Screening Levels (HSLs) for asbestos in soil (NEPC, 2013)[1]				
Form of asbestos	**Residential A[2]**	**Residential B[3]**	**Recreation C[4]**	**Commercial/Industrial D[5]**
Bonded ACM	0.01%	0.04%	0.02%	0.05%
FA and AF (friable asbestos)[6]	0.001%			
All forms of asbestos	No visible asbestos for surface soil			

Notes:

1. Source: NEPC (2013), Schedule B1, Table 7.
2. Residential A: Residential with garden/accessible soil. Also includes children's day care centres, preschools and primary schools.
3. Residential B: Residential with minimal access to soil. Includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.
4. Recreation C: Includes public open space such as parks, playgrounds, playing fields (*eg*, ovals), secondary schools and un-paved footpaths.
5. Commercial/Industrial: includes premises such as shops, offices, factories and industrial buildings.
6. The screening level of 0.001% w/w asbestos in soil for FA and AF only applies where FA an AF are quantified by gravimetric procedures. This screening level is not applicable to free fibres.

Table 6: Health Investigation Levels (HILs) for soil contaminants (NEPC, 2013)				
Chemical	Health-based investigation levels (mg/kg)			
	Residential A	Residential B	Recreational1 C	Commercial/ industrial D
Metals and Inorganics				
Arsenic	100	500	300	3000
Beryllium	70	100	100	500
Boron	5000	40000	20000	300000
Cadmium	20	140	100	800
Chromium (VI)	100	500	240	3000
Cobalt	100	600	300	4000
Copper	7000	30000	20000	250000
Lead[3]	300	1200	600	1500
Manganese	3000	8000	9000	40000
Methyl mercury[4]	7	30	10	200
Mercury (Inorganic)	200	600	400	4000
Nickel	400	900	800	4000
Selenium	200	1500	700	10000
Zinc	8000	60000	30000	400000
Cyanide (free)	250	400	350	2000
Polycyclic Aromatic Hydrocarbons (PAHs)				
Carcinogenic PAHs (as BaP TEQ)	3	4	3	40
Total PAHs	300	400	400	4000
Phenols				
Phenol	3000	50000	45000	250000
Pentachlorophenol	100	150	140	700
Cresols	400	5500	4700	27000
Organochlorine Pesticides				
DDT+DDE+DDD	260	700	400	4000
Aldrin and dieldrin	7	10	9	50
Chlordane	50	100	80	560
Endosulfan	300	460	400	2000
Endrin	10	20	20	100
Heptachlor	7	10	9	50
HCB	10	20	15	85
Methoxychlor	400	550	500	2700
Mirex	10	20	20	100
Toxaphene	20	35	30	170
Herbicides				
2,4,5-T	700	1000	900	5000
2,4-D	1000	2000	1400	9500
MCPA	700	1000	900	5000
MCPB	700	1000	900	5000
Mecoprop	700	1000	900	5000
Picloram	5000	8000	6500	37000
Other Pesticides				
Atrazine	360	550	500	3000
Chlorpyrifos	170	400	300	2000
Bifenthrin	600	900	750	4000

Other Organics				
PCBs	1	2	2	8
PBDE Flame Retardants Br1- Br9)	1	2	2	10

Table 7: ESLs for TPH fractions F1 – F4, BTEX and benzo(a)pyrene in soil				
Chemical	**Soil texture**	**ESLs (mg/kg dry soil)**		
		Areas of ecological significance	**Urban residential and public open space**	**Commercial and industrial**
F1 C_6-C_{10}	*Coarse / Fine*	125*	180*	215*
F2 >C_{10}-C_{16}		25*	120*	170*
F3 >C_{16}-C_{34}	*Coarse*	-	300	1700
	Fine	-	1300	2500
F4 >C_{34}-C_{40}	*Coarse*	-	2800	3300
	Fine	-	5600	6600
Benzene	*Coarse*	10	50	75
	Fine	10	65	95
Toluene	*Coarse*	10	85	135
	Fine	65	105	135
Ethylbenzene	*Coarse*	1.5	70	165
	Fine	40	125	185
Xylenes	*Coarse*	10	105	180
	Fine	1.6	45	95
Benzo(a)pyrene	*Coarse*	0.7	0.7	0.7
	Fine	0.7	0.7	0.7

Notes:
1. ESLs are of low reliability except where indicated by * which indicates that the ESL is of moderate reliability.
2. '-' indicates that insufficient data was available to derive a value.
3. To obtain F1, subtract the sum of BTEX concentrations from C6-C10 fraction and subtract naphthalene from >C10-C16 to obtain F2.

Table 8: Management Limits for TPH fractions F1–F4 in soil			
TPH fraction	**Soil texture**	**Management Limits[1] (mg/kg dry soil)**	
		Residential, parkland and public open space	**Commercial and industrial**
F1[2] C_6- C_{10}	*Coarse*	700	700
	Fine	800	800
F2[2] >C_{10}-C_{16}	*Coarse*	1000	1000
	Fine	1000	1000
F3 >C_{16}-C_{34}	*Coarse*	2500	3500
	Fine	3500	5000
F4 >C_{34}-C_{40}	*Coarse*	10 000	10 000
	Fine	10 000	10 000

Notes:
1. Management limits are applied after consideration of relevant ESLs and HSLs
2. Separate management limits for BTEX and naphthalene are not available hence these should not be subtracted from the relevant fractions to obtain F1 and F2.

Table 9: Soil HSLs for vapour intrusion (mg/kg)													
	HSL A & HSL B Low – high density residential				HSL C recreational / open space				HSL D Commercial / Industrial				
Chemical	0 m to <1 m	1 m to <2 m	2 m to <4m	4 m+	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	0 m to <1 m	1 m to <2 m	2 m to <4 m	4 m+	Soil saturation concentration (Csat)
SAND													
Toluene	160	220	310	540	NL	NL	NL	NL	NL	NL	NL	NL	560
Ethylbenzene	55	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	64
Xylenes	40	60	95	170	NL	NL	NL	NL	230	NL	NL	NL	300
Naphthalene	3	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	9
Benzene	0.5	0.5	0.5	0.5	NL	NL	NL	NL	3	3	3	3	360
F1[9]	45	70	110	200	NL	NL	NL	NL	260	370	630	NL	950
F2[10]	110	240	440	NL	NL	NL	NL	NL	NL	NL	NL	NL	560
SILT													
Toluene	390	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	640
Ethylbenzene	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	69
Xylenes	95	210	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	330
Naphthalene	4	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	10
Benzene	0.6	0.7	1	2	NL	NL	NL	NL	4	4	6	10	440
F1[9]	40	65	100	190	NL	NL	NL	NL	250	360	590	NL	910
F2[10]	230	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	570
CLAY													
Toluene	480	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	630
Ethylbenzene	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	68
Xylenes	110	310	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	330
Naphthalene	5	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	10
Benzene	0.7	1	2	3	NL	NL	NL	NL	4	6	9	20	430
F1[9]	50	90	150	290	NL	NL	NL	NL	310	480	NL	NL	850
F2[10]	280	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	NL	560

1. Notes (Source, NEPC, 2013, Schedule B1, Table 1A(3):
2. Land use settings are equivalent to those described in Table 1A(1) Footnote 1 and Schedule B7. HSLs for vapour intrusion for high

Table 9: Soil HSLs for vapour intrusion (mg/kg)				
	HSL A & HSL B **Low – high density residential**	**HSL C** **recreational / open space**	**HSL D** **Commercial / Industrial**	

density residential assume residential occupation of the ground floor. If communal car parks or commercial properties occupy the ground floor, HSL D should be used,

3. The key limitations of the HSLs should be referred to prior to application and are presented in Friebel and Nadebaum (2011b and 2011d).
4. Detailed assumptions in the derivation of the HSLs and information on how to apply the HSLs are presented in Friebel and Nadebaum (2011a and 2011b).
5. Soil HSLs for vapour inhalation incorporate an adjustment factor of 10 applied to the vapour phase partitioning to reflect the differences observed between theoretical estimates of soil vapour partitioning and field measurements. Refer Friebel & Nadebaum (2011a) for further information.
6. The soil saturation concentration (Csat) is defined as the soil concentration at which the porewater phase cannot dissolve any more of an individual chemical. The soil vapour that is in equilibrium with the porewater will be at its maximum. If the derived soil HSL exceeds Csat, a soil vapour source concentration for a petroleum mixture could not exceed a level that would result in the maximum allowable vapour risk for the given scenario. For these scenarios, no HSL is presented for these chemicals and the HSL is shown as 'not limiting' or 'NL'.
7. The HSLs for TPH C6-C10 in sandy soil are based on a finite source that depletes in less than seven years, and therefore consideration has been given to use of sub-chronic toxicity values. The >C8-C10 aliphatic toxicity has been adjusted to represent sub-chronic exposure, resulting in higher HSLs than if based on chronic toxicity. For further information refer to Section 8.2 and Appendix J in Friebel and Nadebaum (2011a).
8. The figures in the above table may be multiplied by a factor to account for biodegradation of vapour. A factor of 10 may apply for source depths from 2 m to <4 m or a factor of 100 for source depths of 4 m and deeper. To apply the attenuation factor for vapour degradation, a number of conditions must be satisfied. Firstly the maximum length of the shorter side of the concrete slab and surrounding pavement cannot exceed 15 m, as this would prevent oxygen penetrating to the centre of the slab. Secondly, measurement of oxygen in the subsurface is required to determine the potential for biodegradation. Oxygen must be confirmed to be present at >5% to use these factors.
9. For soil texture classification undertaken in accord with AS 1726, the classifications of sand, silt and clay may be applied as coarse, fine with liquid limit <50% and fine with liquid limit>50% respectively, as the underlying properties to develop the HSLs may reasonably be selected to be similar. Where there is uncertainty, either a conservative approach may be adopted or laboratory analysis should be carried out.
10. To obtain F1 subtract the sum of BTEX concentrations from the C6-C10 fraction.
11. To obtain F2 subtract naphthalene from the >C10-C16 fraction.

Table 10: Frequency of Field QA/QC sampling					
Environmental samples	**Blind replicate**	**Split sample**	**Rinsate Blanks**	**Trip spike**	**Trip blank**
0 – 5	Subject to project requirements				
5 - 10	1	0	1	1/batch	1/batch
10 – 15	1	1	1		
>15	10%	5%	1		

Table 11: QA/QC Compliance Assessment		
QA/QC Sample Type	**Method of Assessment**	**Acceptable Range**
Field QA/QC		
Blind Replicates and Split Samples	The assessment of split replicate is undertaken by calculating the Relative Percent Difference (RPD) of the replicate concentration compared with the original sample concentration. The RPD is defined as: $RPD = 100 \times \frac{\lvert X_1 - X_2 \rvert}{Average}$ Where: X_1 and X_2 are the concentration of the original and replicate samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 5 times the EQL) • 0 – 75% RPD (When the average concentration is 5 to 10 times the EQL) • 0 – 50% RPD (When the average concentration is > 10 times the EQL)
Blanks (Rinsate and Trip Blanks)	Each blank is analysed as per the original samples.	Analytical Result < EQL
Laboratory-prepared Trip Spike	The trip spike is analysed after returning from the field and the % recovery of the known spike is calculated.	70% - 130%
Laboratory QA/QC		
Laboratory Duplicates	Assessment as per Blind Replicates and Split Samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 4 times the EQL) • 0 – 50% RPD (When the average concentration is 4 to 10 times the EQL) • 0 – 30% RPD (When the average concentration is > 10 times the EQL)
Surrogates Matrix Spikes Laboratory Control Samples	Assessment is undertaken by determining the percent recovery of the known spike or addition to the sample. $\% \text{ Recovery} = 100 \times \frac{C - A}{B}$ Where: A = Concentration of analyte determined in the original sample; B = Added Concentration; C = Calculated Concentration.	70% - 130% (General Analytes) 50% - 130% (Phenols) 60% - 130% (OP Pesticides) If the result is outside the above ranges, the result must be < 3x Standard Deviation of the Historical Mean (calculated over past 12 months)
Method Blanks	Each blank is analysed as per the original samples.	Analytical Result < EQL

Note: *EQL = Laboratory Estimated Quantitation Limit (PQL) or the minimum detection limit for a particular analyte.*

ANNEXURE 1:
Master Plan for Southern Portion of the Site (Developed by Council)

DRAFT

BARTON PARK MASTERPLAN

DRAFT FOR EXHIBITION APRIL 2020

Bayside Council
Serving Our Community

Rev	Date	Description	Prepared By	Reviewed By	Approved By
A	17.04.2020	Draft for review			

Exported on 17/04/20

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1. Introduction and Vision for Barton Park

This masterplan sets the VISION for the long term development of Barton Park. The masterplan contains four planning zones.

The Masterplan will address a range of issues including:

- The need to demolish some amenities and facilities;
- The need to upgrade sporting and recreation facilities to meet the needs of the growing community;
- Barton Park's location near population growth centres in Arncliffe, Banksia and Wolli Creek.

Bayside Council at its meeting of 11 March 2020 resolved

- That Council endorses the draft Barton Park Masterplan for public exhibition.
- That public exhibition of the draft Barton Park Masterplan be undertaken for a period of 28 days.
- That the activities as per the Community Engagement Plan are commenced.
- That a future report be prepared for Council's consideration in relation to submissions received during the public exhibition period.

Due to the outbreak of the Coronavirus crisis it is not possible to undertake the face to face Community Engagement Strategies originally planned for this project. An extended period of exhibition will now be undertaken with comments to be received until Tuesday 26 May 2020.

Council has developed the following objectives and design principles for the Draft Barton Park Masterplan

- Provide playing fields and other sporting facilities for active recreation to meet sporting group and user needs
- Improve amenity and lighting to meet user groups and regulatory requirements
- Upgrade site conditions in accordance with the opportunities identified in the Environmental Management Plan.
- Improve interface with Landing Lights Wetlands and other adjacent open space
- Improve landscape and biodiversity outcomes through increased plantings
- Identify integrated movement network with connections to adjacent areas
- Increase safety using Safety by Design (CPTED) principles

Council has installed signs in the park to notify park users of the draft masterplan. These public information boards are included on the pages that follow.

This report provides background information that has been considered in the development of the draft Barton Park Masterplan.

Figure 1.1 - Aerial photo of Barton Park (source: google earth)

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2. Background

2.1. Current Site Context

Barton Park is located at 88-96 Bestic Street, Banksia to the west of Sydney Airport (Kingsford Smith Airport) and 10km south of the Sydney CBD, extending between Spring Street Drain on the north, Bestic Street on the south, and West Botany Street and Eve Street on the west and Muddy Creek on the east (Figure 2.1 - Location Plan)

The site is approximately 19 ha in size, zoned RE1 and is comprised of Lot 1 DP 576148, and Road Reserve owned by Bayside Council, a small square owned by Crown Land for controlled by Sydney Airport for operational requirements and the remainder owned by Department of Planning (part Lot 100 DP1133869), Roads and Maritime No, 88 Bestic Street (DP400546) and Crown (Lot 100 DP1228008). The Barton Park site is entirely within State Regional Environmental Plan 33 (Cooks Cove SREP33).

Banksia is a residential area comprised of mostly low density dwellings and some unit development. The site is 1km from Banksia Train Station and town centre, 1 km to the foreshore of Cook Park in Kyeemagh, is adjacent the banks of Muddy Creek within the Rockdale Wetlands Corridor identified as part of Sydney Green Grid recreational open space and wetlands. The Rockdale Town Centre and Brighton-Le Sands are both approximately 1.5km away. The end of the airport runway is only 600 metres away.

Barton Park has road access from Bestic Street connecting to arterial roads West Botany Road to the west and General Holmes Drive to the east, as well as from adjacent residential streets to the west. The site is serviced by a north south shared path that is well used by cyclists commuting to the airport and beyond.

2.2. Historical Context

The traditional owners of the area are the Aboriginal Peoples of the Eora Nation including the Gamaygal, Gwegal, Bidjigal and Gadigal Clans and collectively they are known as the "water people".

Prior to European settlement, the Bayside Local Government area was comprised of coastal, wetland, waterway and bushland environments that sustained the Eora Nation with plentiful resources to support a rich culture.

Banksia was named after Joseph Banks, a botanist with James Cook who visited Botany Bay in 1770. The suburb was heavily timbered until the late nineteenth century with residential development beginning once the railway line was developed in the 1880s.

Between 1895 and 1899, The Southern and Western Suburbs Ocean Outfall Sewer (SWOOS) was constructed for the disposal of sewage from much of Southern Sydney. It stretched from Marrickville to Rockdale. The sewage from this system flowed to a sewage farm located at present-day Barton Park. The extensive tract of open space including Barton Park, Firmstone Gardens, Riverine Park and Landing Lights Wetland is a significantly disturbed landscape with areas of it used for a Sewerage Farm servicing Sydney for 30 years until 1916. The sewerage farm which was 200 acre in size was Sydney's earliest attempt at purifying sewage in the hope of beating the major sanitary problems of the era. The system is of considerable historical and scientific significance as one of the early sewers to service the southern, western and Illawarra suburbs of Sydney.

The secondary function of the Sewage Farm was to utilise the manure value of the sewage to produce much-needed vegetables for the household table. In the late 1890s, the Sewage Farm was extended to allow for the disposal of the sewage from the Western Suburbs, and by the turn of the century, the Sewage Farm was in crisis. There was too much sewage on too little land, and the establishment was unanimously disliked by Councils and residents. By then, government priorities were changing, and following parliamentary investigations between 1906 and 1908, the decision was made to transfer the sewage to a new ocean outfall at Long Bay.

In 1916 the SWSOOS was extended to Long Bay ocean outfall. The whole of the sewage of Cooks River and Wolli Creek valleys now drains to this outfall. The three brick barrels, which are encased in concrete, are an excellent example of the oviform brick construction method of the time, which have provided continuous service for over 100 years.

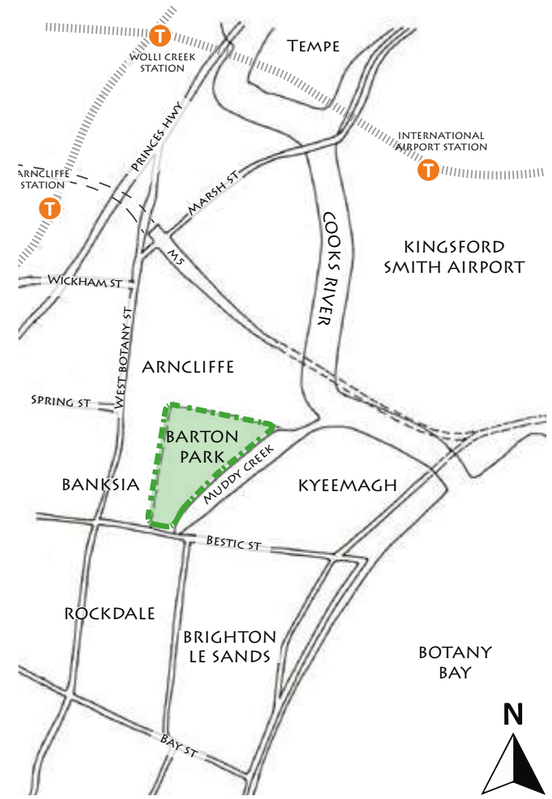

Figure 2.1 - Location Plan

This area was then extensively sand mined for civil projects and later as recently as the late 1970s it was used as a council landfill site. Barton Park has relatively limited recreational facilities that do not match its enormous potential to serve the growing community of Bayside in a prime position along the foreshore of Muddy Creek.

The history of the site is evident in its altered landform, disturbed vegetation and poorly developed infrastructure. There is little remaining of it former vegetation and no evidence of past use by traditional owners yet nature has opportunistically developed alternative habitats that thrive and are now highly valued in the Landing Lights Wetland and the enriched soils continue to support the adjoining heritage listed market gardens.

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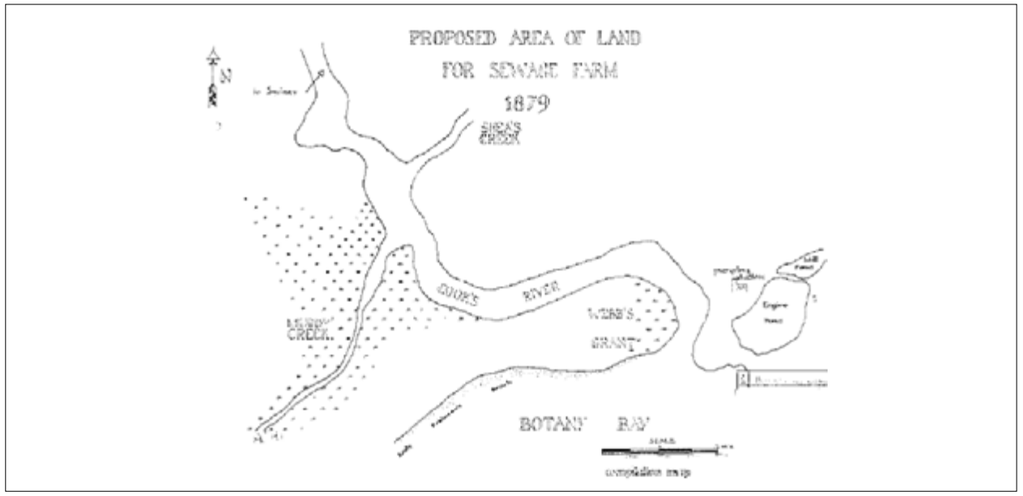
2.3. Historical Park Development

Barton Park was first gazetted as a park 10 June 1977 as a reserve bounded by Muddy Creek, Spring Street Canal and Bestic Street and Eve Street at Banksia.

The plan dated 1879 shows the extent of sewerage farms impacting the low lands of Barton Park.

YEAR 1879



YEAR 1943

The aerial photo taken in 1943 shows the original landform before the site was mined for sands used in Council construction of roads and other civil assets. The aerial shows that the adjacent Market Gardens in West Botany Street and across Muddy Creek are in operation. The Spring Street Canal also exists at that time as does significant residential development in the area. However, the generally denuded landscape is evidence of its industrial use as a sewage farm prior to 1916.

Figure 2.2 - The map shows the original Cooks River alignment and proposed realignment of Cooks River.

YEAR 1965

The aerial photo in the 1960s shows that the landform is already significantly disturbed. Muddy Creek and the mouth of the Cooks River have been substantially changed and are full of fishing boats.

By this time the site was operated as a land fill site for council operations. The crossing to Riverine Park is already established.

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By 1977 some of the hard fill mounds and ponds which are now known as the Landing Lights Wetland are also visible. The site was also substantially artificially raised with hard fill to stabilise the site which was subject to combustion fires collapse. Three buildings have also been built, one near the mounds associated with the main field, a second building made out of containers halfway between Bestic St and the mounding and a third building in the Landing Lights Wetland. The construction of the stadium started in 1976.

The stadium opened to the public on 5 March 1978 to become one of Sydney's most popular football stadiums. The grandstand was not completed until 1979 and subsequently hosted international matches for the Socceroos and Young Socceroos and finals for Sydney based matches attracting large crowds for big events for over 10,000 people.

YEAR 1977

The stadium was privately funded by the former club, St George Budapest who were in the National Soccer League (NSL) when first grade soccer started being played in Sydney. The stadium and field are evident in the 1989 aerial photo.

In 1988 bicentennial funding was made available for various council projects including a large salt marsh project near the Spring Street Canal.

YEAR 1989

The 2000 aerial shows the extensive grass cover across the site which is used for sport fields. The Barton Park cycleway is also evident on the eastern side, providing the north/south connection.

YEAR 2000

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There is little change in the park with the exception of the gravel carpark created to the south of the main field. The roof is still on the stadium at this point in time.

YEAR 2011

There is little change except that the stadium roof has been removed due to structural failure. The structure remains but the building is closed off to the public due to concerns for public safety. The grounds continue to be operated by the St George Soccer Club.

YEAR 2018

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2.4. Existing Facilities

The park is dominated by active recreation:

- St George Football Stadium includes: fenced grandstand, buildings & spectator mounds
- Other sports fields and lighting
- Barton Park Cycleway along the banks of Muddy Creek connecting to Riverine Park
- Landing Lights Wetland
- Overland flow path from Bestic Street to the wetlands

Figure 2.3 - Existing Site

1: Football field and St George football stadium with the damaged roof structure

2: Lack of vegetation management in the area around the Landing Lights Wetland.

3: Peaceful waterview of Landing Lights Wetland with lush green backdrop

4: Existing Barton Park Cycleway. Photo shows aged bitumen surface and overgrown vegetation both sides of the cycleway.

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5:Bestic Street Main Entrance

6:Poor pedestrian access from Bestic Street

7: Vehicle road and shared path resulting in user conflicts

8: Informal gravel carparking

9: View of the back of St George Football Stadium

10: Aged shelter and seating set

11: Informal pathway through the Mangrove forest south of the Landing Lights Wetland

12: Existing boardwalk near the Landing Lights Wetland is in poor condition.

13: Rain causes surface flooding at an open area near the residential zone

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St George Football Stadium

The current lease between Council and St George Football Club is for the use of the area known as the St George Soccer Stadium which is the complex defined by security fences and includes the remains of the large grandstand (the roof was removed in 2012/2013 due to safety concerns), Senior sports fields including lighting and part of the spectator mounding. The subject buildings shown in green on the map were demolished in 2019 due to safety concerns arising from structural defects and included the entry building and adjoining amenities block. The lease with St George Football Club is due to expire in February 2022.

Sports fields and lighting

There are two senior grass covered sports fields that do not form part of the St George Soccer lease but are permitted annually to St George Football Club.

These fields are served by outdated lighting on wooden poles, an informal gravel carpark and an amenities building constructed from storage containers that do not provide adequate facilities for the community.

Figure 2.4 - Map showing buildings demolished in 2019

Barton Park cycleway along Banks of Muddy Creek connecting to Riverine Park

The shared path starts from Bestic Street in the south passing over the Spring Street drain to Spring Street and Banksia/ Rockdale to the West, or continuing north-bound to Riverine Park and under the M5 to provide off-road bicycle links to Wolli Creek, Sydney Airport and the CBD.

The path is subject to regular inundation due to the proximity to Muddy Creek and its tidal influence and flood prone location. The path way is not separated from vehicle access to the gravel carpark that services the St George Stadium. Users must ride this section of shared path cautiously to avoid conflict with vulnerable users and vehicles.

The asphalt surface is uneven and is reaching the end of its serviceable life but otherwise provides an excellent north/south link through public open space in a prime location along the foreshore.

Landing Lights Wetland

Landing Lights Wetlands is 4.9ha (approx.) and incorporates a low lying area of modified bushland, heavily disturbed bushland, planted, weedy and built environments.

The reserve occurs within soil landscapes mapped as 'Warriewood' as well as 'Disturbed' (Chapman and Murphy 1989). The reserve is bounded to the north by a channelized tributary of Muddy Creek, just prior to Muddy Creek entering the Cooks River, known as the Spring Street Drainage Channel. There is a swale running approximately north near the western boundary leading towards a standing body of saline water. Weeds occurring in the wetter lower lying areas are dominated by Juncus acutus. Weeds dominating higher areas are more varied and include Kikuyu, Green Cestrum, Lantana, Hydrocotyle bonariensis and Acacia saligna. Core bushland within the reserve is in poor to good condition.

Native species diversity is generally low. However the local communities associated with estuarine environments typically show a low species diversity compared to other local non-estuarine communities. Estuarine areas in the locality are also potentially dynamic, sometimes making identification of depauperate estuarine vegetation difficult. Bushland condition declines around the edges of the reserve and downstream from the exotic species infestations adjacent to the stormwater outlets.

Overland flow path from Bestic Street to the wetlands

This section of parkland is dominated by grass covered undulated land with a few scattered trees. It is bound to the west by the rear fences of private backyards however there is a generous opening to the residential area at the intersection of Oakleigh Avenue and Eve Street.

Park infrastructure is limited in this area to low log fencing. The entry to the path is unmarked and not supported with pathways or other park facilities.

This section of Barton Park is regularly flooded by overland flow and holds water that seeps into the Landing Lights Wetland. The batter of the former land fill site to the east impedes views across the site which once would have been relatively flat to the banks of Muddy Creek.

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2.5. Management and Maintenance

Maintenance of Barton Park is primarily undertaken by Bayside Council.

Routine Park Maintenance

The parks staff undertake a range of routine park maintenance activities including mowing, litter collection, broad acre mowing of the outer fields and herbicide spraying.

Seasonal improvements are undertaken of the sports fields including

- Aerating
- Fertilising
- Top-dressing
- Turf repairs
- Filling uneven surfaces
- Turf weed control
- Line marking fields

Inside Stadium Field

The lease holder conducts mowing and detail maintenance of the stadium facilities. However Council does provide assistance with engaging contractors to top-dress field (with the cost borne by the user group) and watering.

Bush Regeneration

To protect the Landing Lights Wetland site Council has begun undertaking significant weed control and vegetation removal which has continued since 2016. These works have included the removal of Grey Mangroves (Avicennia marina), Casuarinas species and Acacia species within and adjacent to the main wetland. Removal has occurred to protect the existing salt-marsh from being invaded by trees and shrubs that should not exist in this area and to open up the site to ensure it continues to provide important habitat for threatened and migratory coastal birds.

Works that have been completed include:

- Treatment of the weed species Juncus acutus along the boardwalk and within the saltmarsh area
- Removal of mangroves within the wetland and Spring Street Drain
- Removal of Casuarinas growing adjacent to Spring Street Drain
- Treatment of woody weeds such as Mickey mouse plant (Ochna serrulata), Green Cestrum (Cestrum parquii) and Golden wattle (Acacia saligna)
- Treatment of the fast-growing vines, Coastal Morning Glory/Mile-a-minute (Ipomoea cairica), Turkey
- Rhubarb (Acetosa sagittata) and highly invasive groundcover Hydrocotyle bonariensis
- Replanting with native species using community volunteers along the boardwalk
- Removal of rubbish that was blocking the pipe outlet of the wetland

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2.6. Adjoining Land Uses

Adjacent public open space

Riverine Park is located on the northern banks of the Spring Street Drain and can be accessed by cyclists and pedestrians via a small bridge near the mouth of the drain adjoining Muddy Creek. The access off West Botany Street allows vehicle access to the southern boundary of Riverine Park, the Landing Lights Wetland and Barton Park. Riverine Park is complementary open space to Barton Park and shares a similar history in terms of its development.

Lance Studdert Reserve is located on Bestic Street opposite Barton Park on the eastern banks of Muddy Creek. It has cycleway connection to the Kyeemagh Boat Ramp Reserve and contains the buildings once associated with the Brighton Fishermans Club, community gardens, playground, carpark and open space adjacent the Kyeemagh Market Gardens.

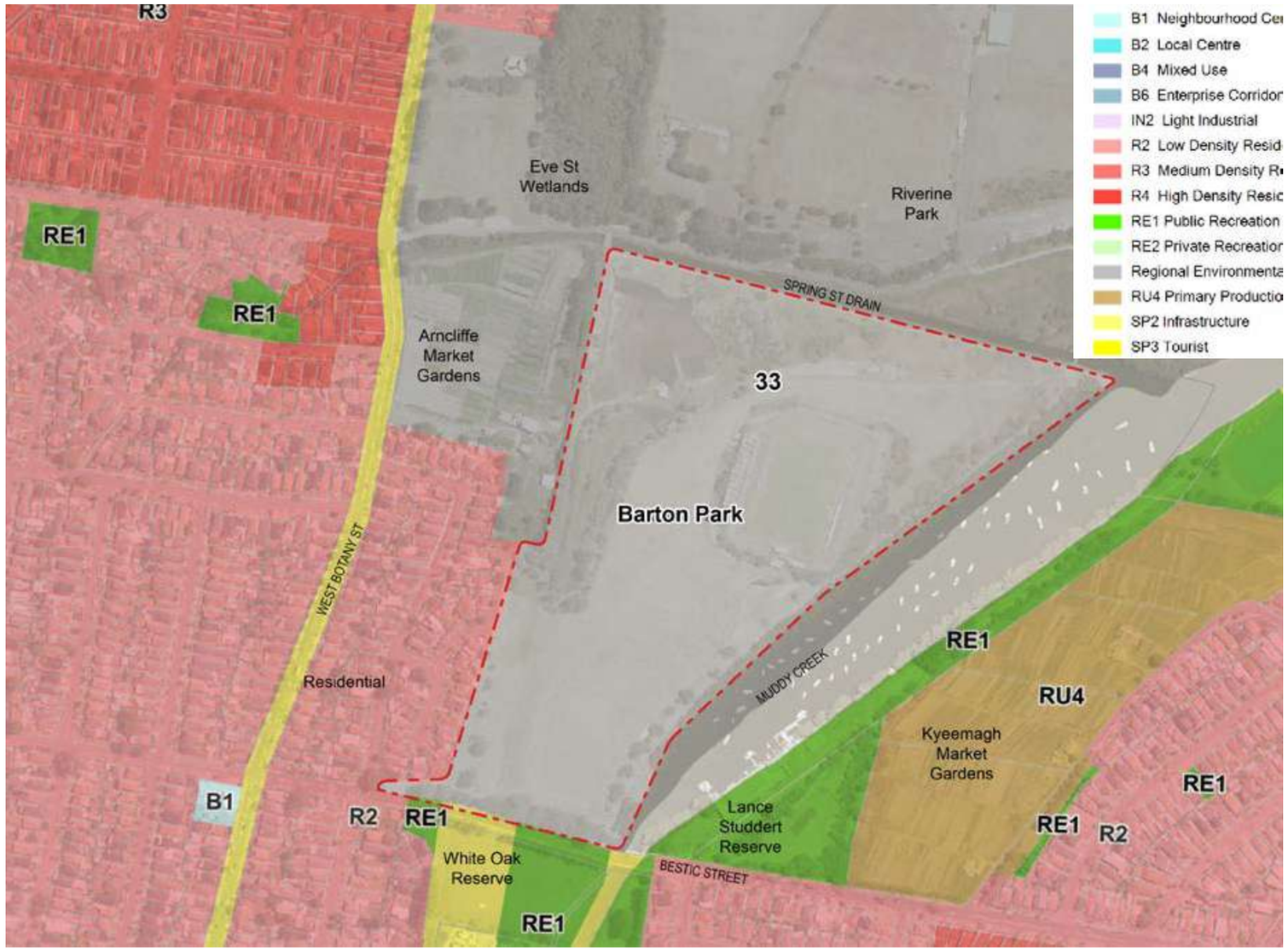

Figure 2.5 - Adjoining land use map

Arncliffe Market Gardens (also known as West Botany Street Market Gardens, Rockdale Market Gardens, Banksia Market Gardens and Chinese Market Gardens) – 212 West Botany Road, Banksia

The market gardens are located on Crown Land that is on the State Heritage Register.

The Statement of Significance states that the Arncliffe Chinese Market Gardens are of high significance for their association with the Chinese community and their demonstration of a continuous pattern of land usage since the late nineteenth century. They are one of only three such surviving market gardens in the Inner Sydney region and one of few similar surviving examples in the Sydney Metropolitan Region.

The site demonstrates prolonged and continuous use as a market garden. The site was first occupied as market gardens in 1892 by Sung Kuong War, Lee How and Sin Hop Sing. A 1930 aerial photograph shows the site still occupied as a market garden. Market gardens such as this played an important role in food production for the local and regional community, particularly during the Great Depression and Post and Inter-War periods. For much of the Great Depression, Chinese market gardens were the only source of vegetables for urban dwelling Australians.

The site consists of a market garden, under production, and an associated fibro building, in poor condition. The site has some archaeological potential associated with its use as a market garden. The garden is divided into small strips, each of which has a different type of produce under cultivation.

Figure 2.6 - The Arncliffe Market Gardens in 1895. (Source: Rockdale Library Photographic Collection).

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Residential Land

Land zoned as residential (R2) adjoins Barton Park on the western side. This small pocket of residential land is bound by West Botany Street, Bestic Street and the market gardens with local residential streets including Highclere Avenue and Eve Street.

Unfortunately, most of the residences do not take advantage of their position adjacent to the open space and turn their backs onto the parkland with high boundary fences.

Sydney Water Assets

Muddy Creek Channel between Bestic Street and the Cooks River.

Sydney Water own and are responsible for the Muddy Creek storm water channel (SWC) which is a brick and concrete channel draining a catchment approximately 6.2km2 running for approximately 4.3km through the catchment draining to the Cooks River estuary. Sydney Water has commenced the design process for a naturalisation program for the section upstream of Bestic Street into the upper Muddy Creek catchment. Downstream of Bestic Street adjacent Barton Park the channel has been dredged and widened to form a tidal basin.

The channel conveys stormwater flows from Forest Road / Croydon Road Bexley to the Cooks River / Botany Bay. On the downstream eastern bank there is the former Brighton Fisherman's Club on Crown Land which provided safe harbour moorings for small watercraft and also has a boat ramp from the parking area. In 1994 Council undertook a project to address high quantities of siltation in the channel which caused boats to be grounded at low tide and prevented boats from travelling to the Cooks River / Botany Bay. Council undertook a major dredging project to remove a large quantity of material from the channel, constructed small islands along the western side of the channel into which were planted mangrove seedlings obtained locally and also constructed a large silt basin opposite the former club to collect sediment from the upstream Sydney Water concrete lined open channel. This basin has been cleaned twice since 1994. This pocket islands have since thrived and have propagated with mangroves now lining both sides of the Channel.

Council has responsibility for maintenance and ownership of assets such as the jetties, pontoons, slipways, and retaining structures.

Council owns water quality devices in the waterway and other associated drainage assets.

The moorings in the waterways are leased directly from NSW government.

Spring Street Drain through Barton Park (Council owned)

The brick and concrete lined open stormwater channel was constructed in the 1930's as part of a Public Works initiative to provide employment during the Depression. It conveys stormwater flows from a catchment approximately 2.7km2 from Forest Road / Wolli Creek Road Bexley to Muddy Creek / Cooks River / Botany Bay. The existing Channel is in very poor condition due to concrete cancer, subsidence of the subbase and jacking by plants growing in the drain. At its downstream end in Muddy Creek Council has constructed a silt basin designed to collect sediment that flows along this channel to prevent silting of Muddy Creek. To date this basin has been cleaned out on two occasions. This channel may be suitable for naturalisation potentially retaining the concrete channel floors and reconstructing the revetment walls with sandstone battered walls which can then be planted with plants endemic to the local area.

Roads

Barton Park may be accessed from Bestic Street connecting to West Botany Street to the West and beyond to the Princess Highway (State road) at Rockdale. To the east Bestic Street connects to General Holmes Drive (State Road) at Kyeemagh.

An access also exists off West Botany Street adjacent the Market Gardens.

Both Bestic Street and West Botany Street have regional road status and are controlled by Council.

Figure 2.7 - Year 1989 aerial photograph

Figure 2.8 - Year 2000 aerial photograph shows extension of bank of Muddy Creek. This has effectively added reclaimed land to the banks of Barton Park

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2.7. Biodiversity, Ecology and Tree Canopy

Landing Lights Wetland (also known as Riverine Park Wetlands), is an environmentally significant natural area. The site contains some of the last remaining saline wetlands on the Cooks River and includes vegetation identified as threatened under NSW legislation

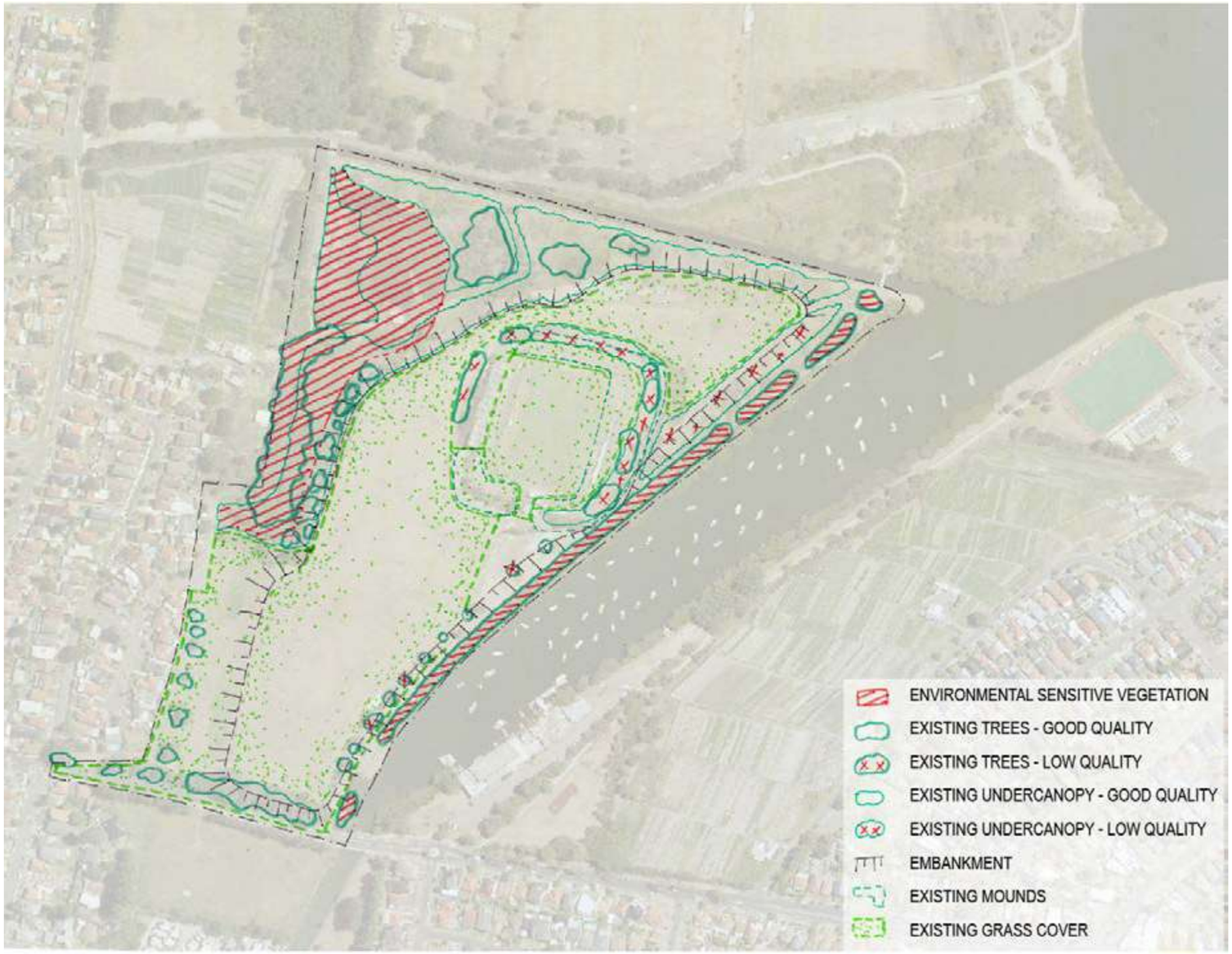
- Saltmarsh: identified as an endangered ecological community;
- Reedland and Mangroves: identified as significant vegetation

The wetland provides habitat to a number of threatened Australian coastal bird species and migratory birds from as far away as Siberia, who visit during the warmer months to feed and fatten up before returning to the Northern Hemisphere to breed. With the significant urban development that has occurred along the Australian coast, Landing Lights Wetland is one of the few suitable sites in Botany Bay that can provide this important habitat. Critical species are:

- Migratory birds (threatened species: the Terek Sandpiper, Broad-billed Sandpiper, Great Knot, Sanderling, Black-tailed Godwit and the Lesser Sand Plover)
- The Green and Gold Bell frog (GGBF, listed as Endangered under the Threatened Species Conservation Act 1995).

Muddy Creek is an important tributary of the Cooks River. There remains significant Mangrove (Avicennia marina) forest and riparian vegetation adjacent to the banks of Muddy Creek. Mangroves are protected in New South Wales (NSW) under the Fisheries Management Act 1994 due to their importance as habitat for fish and fish breeding environments. Mangroves also protect foreshore land by absorbing the energy of tidal currents and storm-driven wind and wave action, creating a natural breakwater that helps stop erosion.

Barton Park has tree canopy covering approximately 20-30% of the site however the quality varies significantly and large amounts of this vegetation consists of woody weed and invasive species that are not endemic to the area.



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2.8. Heritage and Conservation Assets

There are three properties near Barton Park that are identified as Heritage Items in Schedule 5 Environmental Heritage of the Rockdale Local Environmental Plan 2011 (Rockdale LEP). These properties are also on the State Heritage Register as having significance for the people of NSW under the Heritage Act 1977 (NSW).

The Arncliffe Market Gardens are also listed in the Heritage Schedule of the Sydney Regional Environmental Plan and in Schedule 3 of Sydney Regional Environmental Plan No 33 – Cooks Cove (SREP 33).

Suburb	Item Name	Address	Property description	Significance	SHR
Arncliffe	Southern and Western Suburbs Ocean Outfall Sewer (SWOOS) Western Main Carrier	11 & 13a Marsh St	Lot 17, DP 1069479; Part Lot 5, Lot 9 & Lot 10 DP1050923	State	01647
Banksia	Arncliffe Market Gardens	212 West Botany Street	Lot 1, DP 514811	State	01395
Kyeemagh	Kyeemagh Market Gardens	2A, 2B, 2D and 2E Occupation Road	Lots 2, 3 & Part Lot 4 DP 171133; Lot 4, DP 529923	State	01393

Barton Park is not in itself listed as a heritage item. However, it has a legacy of continued use as a public reserve since 1930 when according to Ron Rathbone Rockdale Council purchased 89 acres from the Water Board for 5 pounds per acre for the purpose of recreational purposes. This was in conjunction with other acquisitions from adjacent land owners and set about reclamation works in 1932 "to convert a low lying mosquito infested wasteland into the St George Sporting Complex". Philip Geeves also describes the acquisition of 120 acres of the then disused North Brighton Sewage Farm.

Rathbone also wrote that "The naming of such a large sporting facility generated considerable controversy" Some of the aldermen favoured retaining the name, St George Sporting Complex, while others believed it should be named after Alderman George Barton, Mayor of Rockdale, the man who had inspired the project in the first instance. When it was put to the Council to decide, the voting was four all with four aldermen absent. Alderman Barton then used his casting vote to name the complex after himself.

The adjoining Landing Lights Wetlands are evidence of sand mining activities undertaken by the council during the mid 20th century where a rich and vibrant wetlands now exists.

The wetlands and Barton Park are not considered to have any Aboriginal Site Sensitivity.

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2.9. Climate Change

The Report by BMT WBM "Botany Bay Western Foreshore Coastal Hazard Risk Assessment and Management Options Study completed in 2013 provides a discussion of the geomorphology and coastal processes of Botany Bay and the surrounding study area followed by a risk based assessment of coastal hazard and their consequence. The study considered coastal inundation due to high water levels during storms resulting in inundation into rivers, creeks, drains connecting with the ocean and permanent inundation due to sea level rise. Sea level rise was calculated to increase 0.4m by 2050, and 0.9m by 2100 above 1900 mean sea level. That was widely accepted as competent scientific opinion based on reports by IPCC (2007) and CSIRO (2007) for NSW in the absence of other suitable recommendations although these figures are no longer prescribed by the NSW State Government.

The low lying areas within Barton Park are subject to inundation as a consequence of sea level rise.

The importance of protecting and regenerating coastal ecosystems

Blue carbon refers to the carbon captured by the world's coastal ecosystems, which are predominantly made up of seagrasses, mangroves and salt marshes. Blue carbon ecosystems play an important role in climate change mitigation as they store carbon dioxide up to 40 times faster than inland forests due to an ability to store large amounts of carbon in their soils and for far longer than terrestrial systems. It is estimated four times more carbon is sequestered in Australian soil beneath marine ecosystems over a given area than in other environments.

Other than storing large amounts of carbon, mangroves, tidal marshes and seagrasses are critical ecosystems, supporting coastal water quality, healthy fisheries, and coastal protection against floods and storms.

However, large areas of blue carbon ecosystems have been lost due to land reclamation, clearing, pollution and severe weather events. Tidal salt marshes cover roughly 140 million hectares of Earth's surface, this is roughly half of their historical area and this area is continuing to decrease at a rate of 1-2% per year.

Coastal ecosystems are big carbon sinks so when they are degraded or destroyed. They emit large amounts of carbon. Experts estimate that as much as 1.02 billion tons of carbon dioxide are being released annually from degraded coastal ecosystems.

2.10. Hydrology and Flooding

Barton Park is located in the Spring Street and Muddy Creek sub-catchment.

The topography of the catchment is relatively flat with the upper reaches of the Muddy Creek catchment generally sloping in a south-easterly direction with the lower reaches draining north east towards the Cooks River. Muddy Creek is a small tributary of Cooks River.

The Spring Street Drain has a peak elevation of 55.5m AHD with the catchment draining eastwards. The catchment is a highly modified landscape, comprising medium to high-density residential and commercial developments. It also includes major infrastructure assets where raised above the natural ground level, restrict surface flows from west to east. The topography of the former land fill site impedes natural drainage which acts as a barrier for natural water flows from the west and exacerbates the impact of tides and flood waters along the banks of Muddy Creek along the east.

There are two relevant flood studies for this area including:

1. Cooks River Flood Study, MWH and PB, 2009 Sydney Water commissioned this report to determine baseline conditions of the Cooks River Catchment to enable the design of naturalisation options to be considered as part of their ongoing asset renewal program.

2. Spring Street Drain, Muddy Creek and Scarborough Ponds Catchments 2D Flood Study Review, BMT WBM, 2017 this study was commissioned by council to understand the existing flood behaviour and to establish the basis for floodplain management activities.

Figure 2.9 - Cooks River Catchment

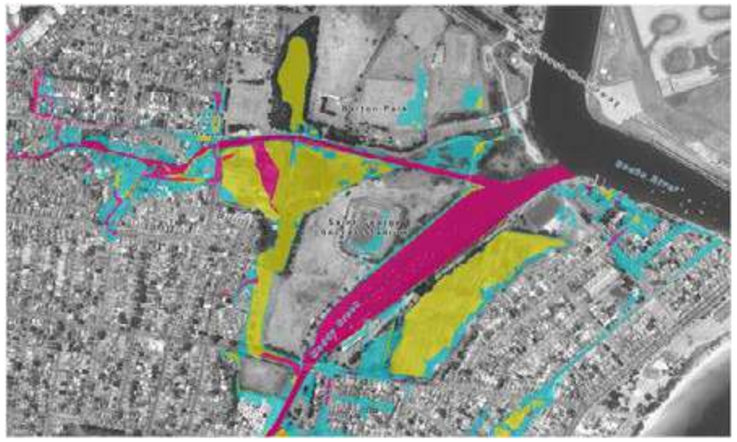

Figure 2.10 - Hydraulic Categories within Lower Muddy Creek

Figure 2.11 - Extent of 1:100 Year flood of Lower Muddy Creek Catchment

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2.11. Access and Transport Links

Barton Park has the benefit of community access from a number of defined pathways. The access road from Bestic Street leads to Barton Park soccer fields services an informal gravel carpark and is well-utilised by both recreational and commuting bicycle riders as an off-road coastal (mangrove) cycling path.

Barton Park can also be accessed from the north via an entry off West Botany Street through Riverine Park by vehicle, bicycle and pedestrian.

There is opportunity to improve the quality of these paths for the recreational benefit and safety of riders and pedestrians. Currently the embankment does not have any formal pathways through it.

2.12. Key Stakeholders

The St George Stadium complex is a fenced area leased to the St George Football Association. The existing Lease is due to expire in February 2022.

Sydney Airport has tenure over site AD4 – Utilities Reservation Zone" for special uses within the Landing Lights Wetland. See section 2.15. Key Consideration – Close proximity to Kingsford Smith International Airport The remainder of the site is not otherwise leased or licensed to any specific user group.

2.13. Visual and Spatial Impact

The landscape is still considered by some to be a wasteland having been significantly disturbed since the mid 19th century with vast tracks of it used for a Sewerage Farm that serviced Sydney for 30 years until 1916. The subsequent sand mining for council civil projects and later as a council landfill site.

As the topography is significantly altered the site is not easily understood by those that do not understand its past resulting from industrial beginnings.

The highly valued wetlands are the result of previous sand mining activities. The heritage listed Market Gardens continue to benefit from Sewage Farm deposits that have enriched the soil artificially.

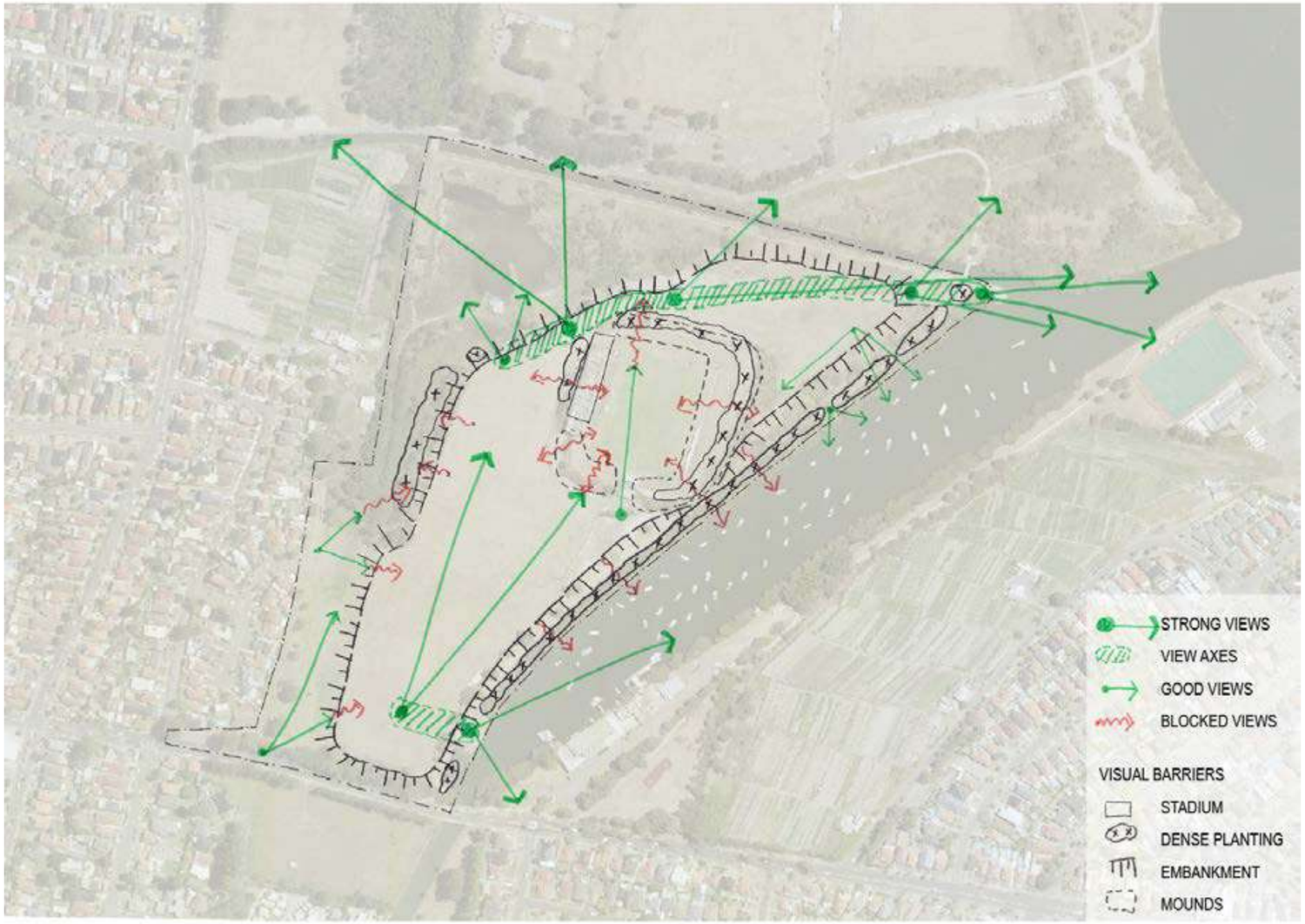
The poor quality of tree canopy and vegetation that is dominated by weeds is the result of poor land management practices over long periods of time.

The Mangrove Forest is also the result of neglected land management practices and is now heavily blocking site lines to the water with only two openings along the cycleway which is adjacent to the waterway.

There is little remaining evidence of former dune and woodland vegetation and it is unlikely to be any remaining evidence of past use by traditional owners.

Today the site is dominated by the vast monoculture of grassland required to contain the disturbed soils below with limited interruptions to the long views which are artificially directed upward to the northern part of the site.

The altered elevation provides advantageous sweeping views at the northern extreme towards the airport and across to the Landing Lights Wetlands, Market Gardens, Spring Street Drain, Muddy Creek, Cooks River, and residential areas of Arncliffe and Banksia.



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2.14. Key Consideration – Close proximity to Kingsford Smith International Airport

Close proximity to Sydney Airport impacts the height of structures, the style and intensity of lighting that can be provided within the Masterplan area as well land use constraints. The National Airport Safeguarding Framework (NASF) applies to all airports in Australia and affects planning and development around airports including development activity that might impact operational airspace and/or affect navigation of aircraft.

The NASF is comprised of 8 guidelines (refer Figure 2.12) with an additional guideline relating to Public Safety Areas (PSA) proposed to be finalised in the near future. Some of these guidelines impact development and design outcomes within Barton Park.

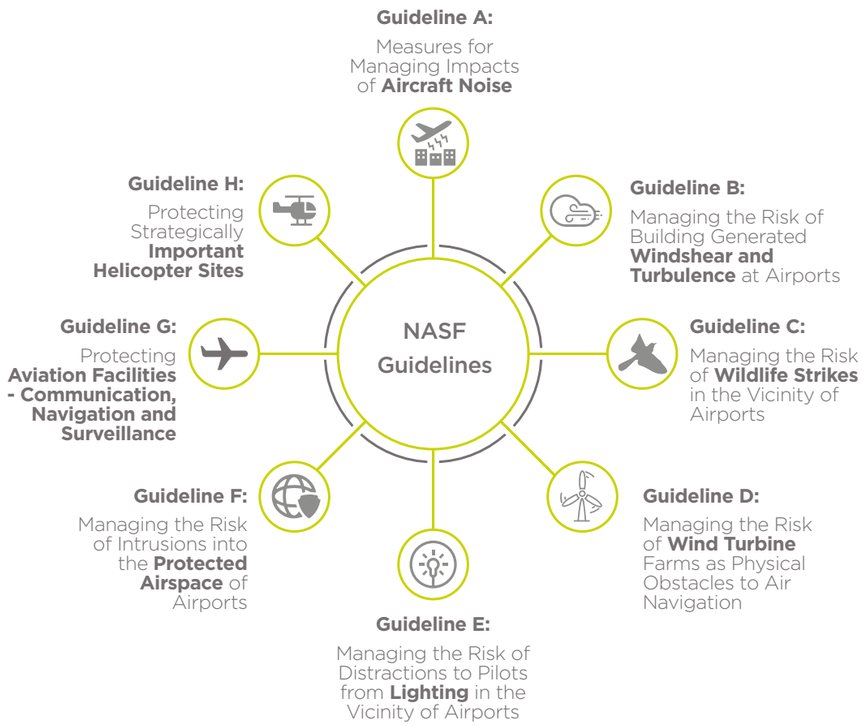

Figure 2.12 - NASF Guidelines (source: Sydney Airport Master Plan 2039)

Obstacle Limitation Surface (OLS)

The OLS is defined by international specifications, as adopted by CASA. It defines the airspace surrounding an airport that must be protected from obstacles to ensure aircraft flying in good weather during the initial and final stages of flight, or in the vicinity of the airport, can do so safely. Figure 2.13 Mapping of OLS (Gap analysis between OLS and AHD contours) identifies the constraints of the OLS as it impacts the heights of structures to under 10m in some sections of the park that can be constructed within Barton Park.

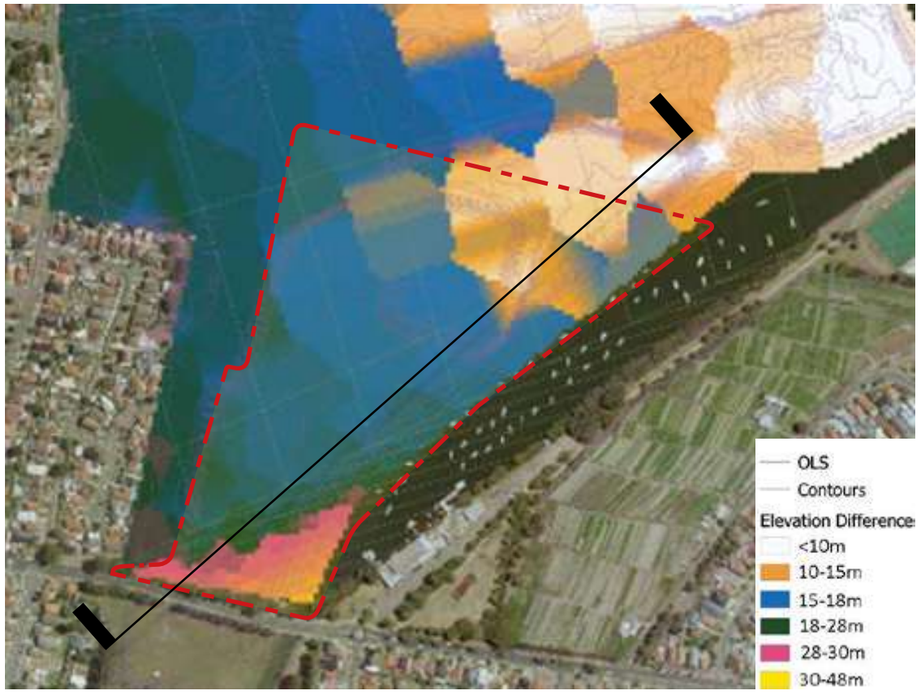

Figure 2.13 - Mapping of OLS (Gap analysis between OLS and AHD contours

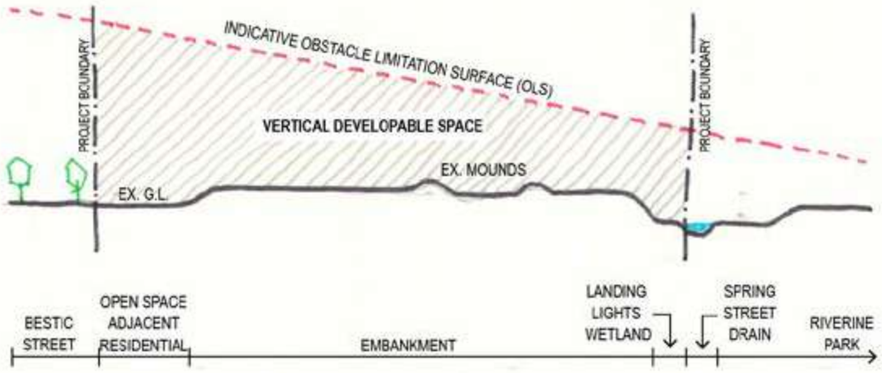

Figure 2.14 - Indicative Section - Vertical Developable Space

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Sydney Airport – Utilities reservation

The Sydney Airport Masterplan 2039 (Figure 2.15) identifies a very small parcel of land as an "AD4 – Utilities Reservation Zone" within Barton Park south west of the M5 East Motorway. This is within the Landing Lights Wetland. This parcel accommodates special uses of the airport.

Public Safety Areas (PSA)

Public Safety Areas are implemented at airports to protect the safety of the public from aviation activities and accidents. Barton Park is within the accepted zones of 1,000 metres before the runway on approach or within 500 metres beyond the runway on departure. These zones are generally accepted standards set by the International Civil Aviation Organisation (ICAO).

Lighting near the airport

CASA has the authority under the Civil Aviation Regulations 1988 to control ground lights where they have the potential to cause confusion or distraction from glare to pilots in the air. Design Guidelines have been prepared to assist lighting designers and installation contractors to determine the location and permitted intensities of ground lights within a six kilometre radius of an airport. Sports field lighting and street lighting require careful consideration.

The intensity of reflected sunlight may also be considered under the regulatory regime.

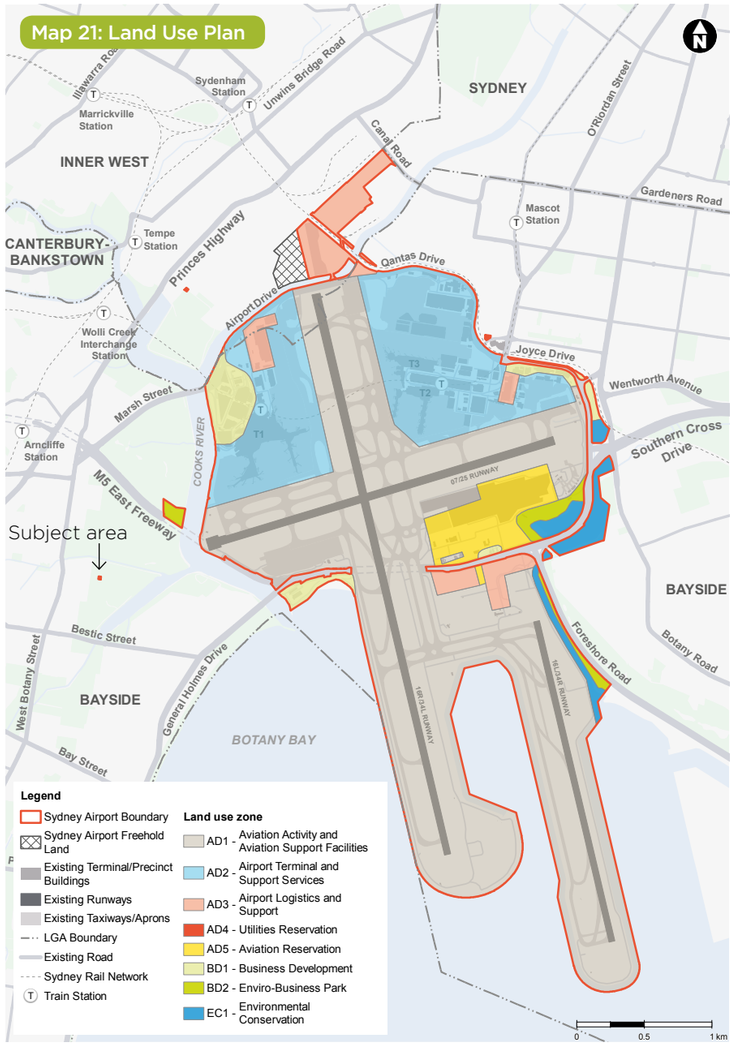

Figure 2.15 - Airport Utilities Reservation Map (Note AD4 in Landing Lights Wetland) (source: Sydney Airport Master Plan 2039)

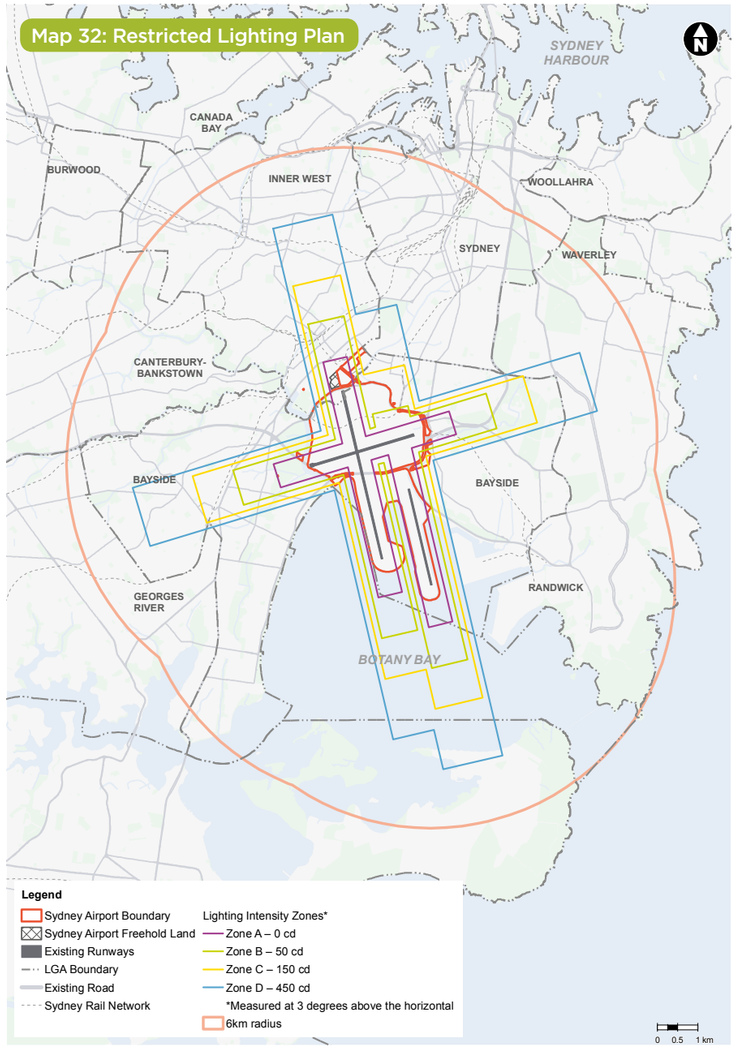

Figure 2.16 - Sydney Airport Lighting Constraint Plan (source: Sydney Airport Master Plan 2039)

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2.15. Key Consideration - Historical landfill Site

The use of the site as a sewage farm, sand mine and an uncontrolled fill site means that the legacy of contamination must now be carefully managed and monitored.

A Long Term Management Plan (LTMP) has been prepared for the site. This Plan provides guidance on:

- Contaminants upon the land
- Measures to reduce landfill leachate generation rates by improving site drainage
- Measures to ensure appropriate soil cover is maintained
- Measures to monitor and manage landfill gas
- Responsibilities and obligations of relevant parties to administer the Long Term Management Plan
- Robust processes for the management, maintenance and upgrade works to the site.
- Sets out environmental monitoring requirements

The NSW Environment Protection Authority (EPA) has reviewed the LTMP and have concluded that the site will not require regulation, provided the LTMP is implemented.

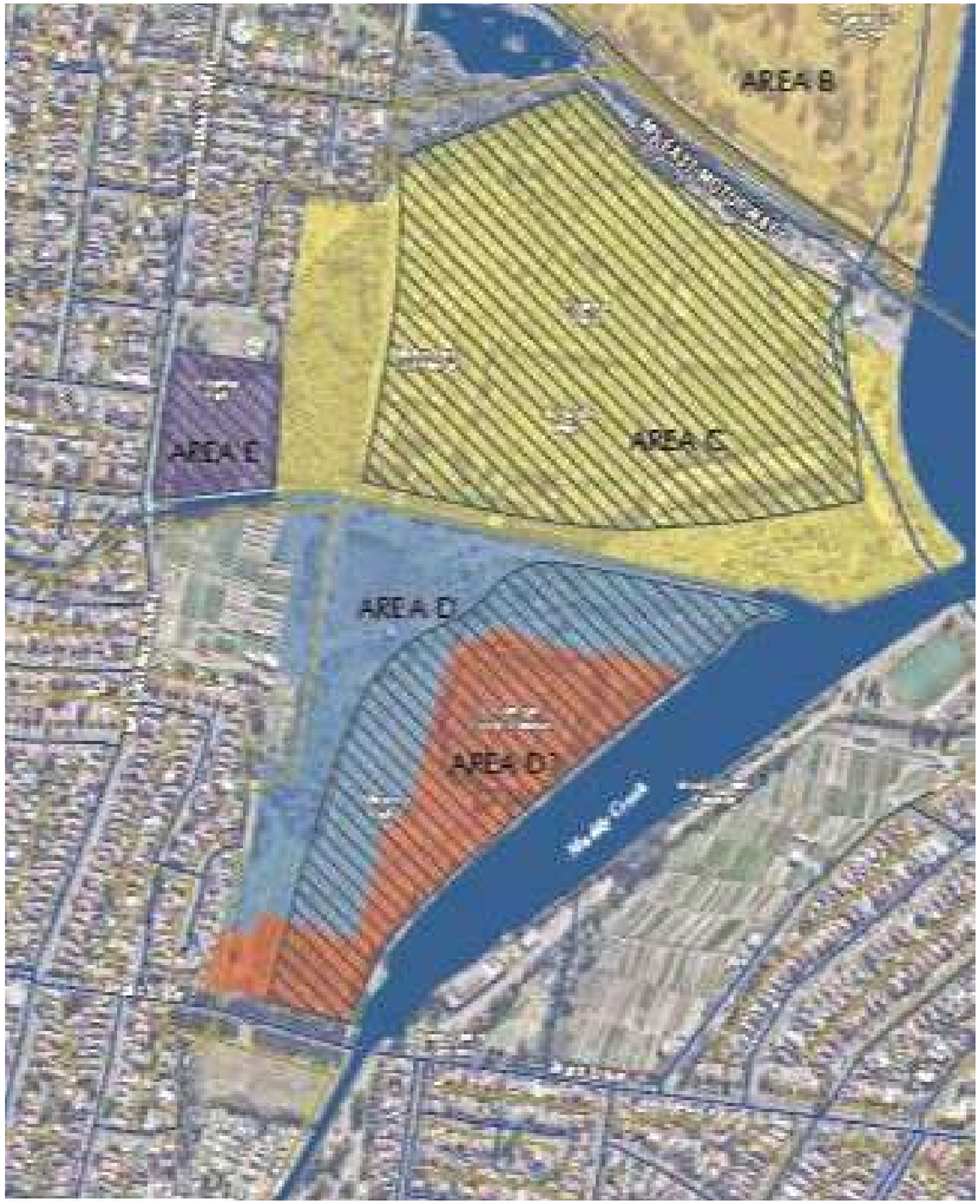

Figure 2.17 - Hatched Areas subject to historical land fill

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3. Planning Framework

Sydney Green Grid

The Sydney Green Grid is an integral part of the Greater Sydney Regional and District Plans. Green space is a key liveability factor in urban areas that is made up of a network of green space that connects town centres, public transport hubs and major residential areas. The Green Grid is the State Government's green infrastructure policy that promotes sustainable development while maximising quality of life and well-being. Specifically the Green Grid promotes the linkages between open space within the wider public realm through enhancing creek corridors, transport routes, suburban streets, footpaths and cycleways.

The Sydney Green Grid document identifies 4 major zones in the Bayside Local Government Area.

Barton Park is within the group identified as CD.1.12 Rockdale Wetlands with the dominant grid layer identified as "ecological". This group of projects have a very high conservation value extending from the Cooks to the Georges River along Muddy Creek, through Eve Street Wetlands, Spring Creek Wetlands, Landing Light Wetland, Patmore Swamp, Scarborough Park Ponds and through to Sans Souci. Opportunities include wetland restoration, education, interpretation and an improved pedestrian and cyclist environment.

It is also described as a very important recreational corridor with a significant amount of active sports grounds and facilities, cycle and walking trails.

The Green Grid framework aims to protect and enhance this important hydrological and ecological asset and create a connected open space corridor for walking, cycling and urban greening along the F6 corridor from the airport to the Sans Souci and beyond the LGA to Sutherland.

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Sydney Regional Environmental Plan No. 33 (Cooks Cove)

Barton Park is within Sydney Regional Environmental Plan No. 33 (Cooks Cove) (the SREP 33) and is zoned as 'Open Space' & 'Special Use' under that instrument.

The Cooks Cove SREP 33 was gazetted on 25 June 2004. Clause 2 articulates the aims of the plan that are relevant to the Barton Park masterplan.
(f) to provide open space for a range of recreational uses
(g) to provide good public access through the Cooks Cove site and along the Cooks River foreshores,
(h) to enhance the Botany Bay to Homebush Bay regional cycleway and pedestrian/cycle network
(i) to protect environmentally significant wetlands and the habitat of the endangered Green and Golden Bell Frog
(j) to establish vegetated riparian areas along the Cooks River and Muddy Creek foreshores
(k) to provide vegetated riparian buffers around the Marsh Street, Eve Street Spring Creek and Landing Lights Wetlands.

It is noted that as the area subject to the Barton Park Masterplan is under the care, control and management of Council. Clause 8 of State Government Planning Policy (Infrastructure) 2011 prevails over SREP 33. Division 12 of Part 3 and the implementation of the draft masterplan is permissible.

The objectives for the Open Space Zone include:
(a) to provide for active sporting and recreational land uses and club facilities, and
(b) to provide public access along the Cooks River and Muddy Creek foreshores, and
(c) to protect significant wetland areas within the Cooks Cove site and along the Cooks River foreshores, and
(d) to provide for facilities that are ancillary to the recreational use of public open space, and
(e) to provide vegetated riparian areas to enhance biological connectivity along the Cooks River and Muddy Creek foreshores,
(f) to protect and enhance the habitat of the Green and Golden Bell Frog established within Cooks Cove.

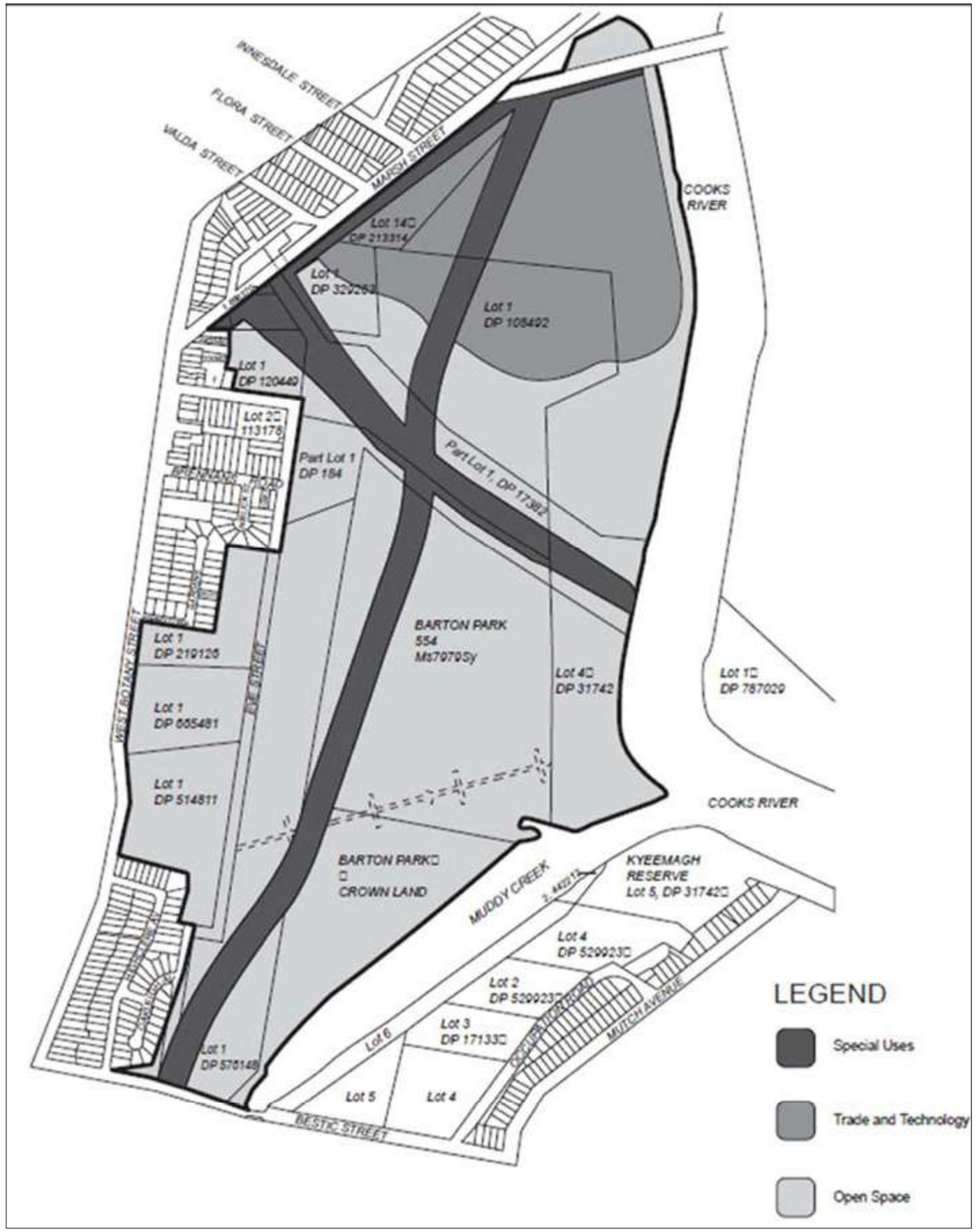

Figure 3.1 - Current zoning map of the Cooks Cove Precinct, under the Cooks Cove SREP

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M6 Reserved Corridor traverses Barton Park

The instrument includes a “Special Uses Zone’ that includes:
- South West Sydney Ocean Outfall Sewer (SWOOS)
- M5 Corridor
- M6 Corridor (traverses Barton Park) as indicated by red hatch in figure 3.2

Environmental sensitivity & flood

Under the SREP 33 there are associated requirements for the development of:

- Wetlands Environmental Management Plan
- Soil and Water Management Plan Map
- Green and Golden Bell Frog Management Plan
- Environmental management
- special requirements
- Development of Flood prone land with low lying area generally impacted by 1:100 year flood in accordance with the relevant flood studies for Spring Street and Muddy Creek.
- Heritage Assessments and impact statements

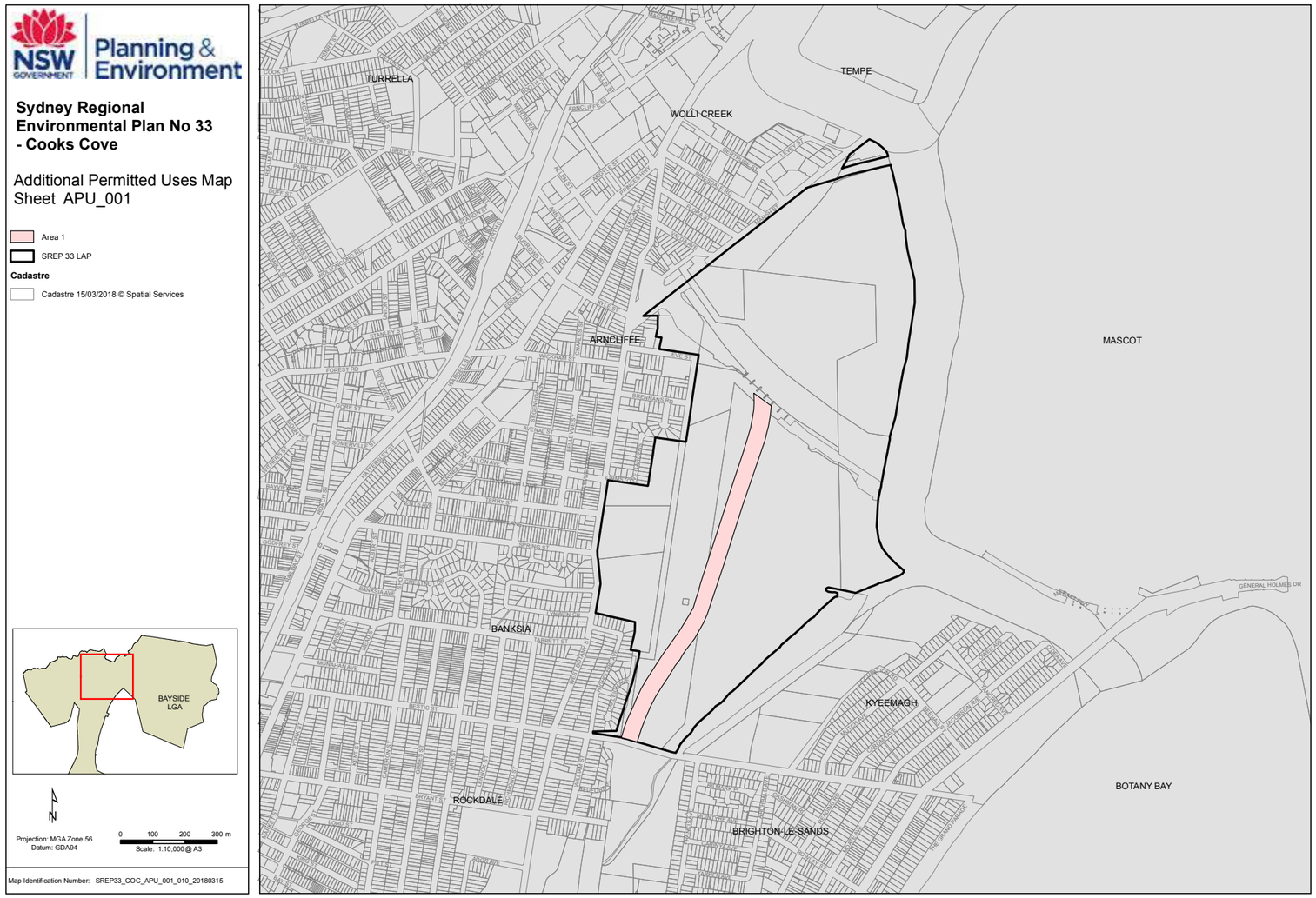

Figure 3.2 - Sydney Regional Environmental Plan No 33 - Cooks Cove

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State Environmental Planning Policy (Coastal Management) 2018

Section 5 of the Coastal Management Act 2016 provides that the coastal zone means the area of land comprised of the following coastal management areas

- the coastal wetlands and littoral rainforests area,
- the coastal vulnerability area,
- the coastal environment area,
- the coastal use area. This area is mapped and shows that Barton Park is affected by SEPP Coastal Management 2018

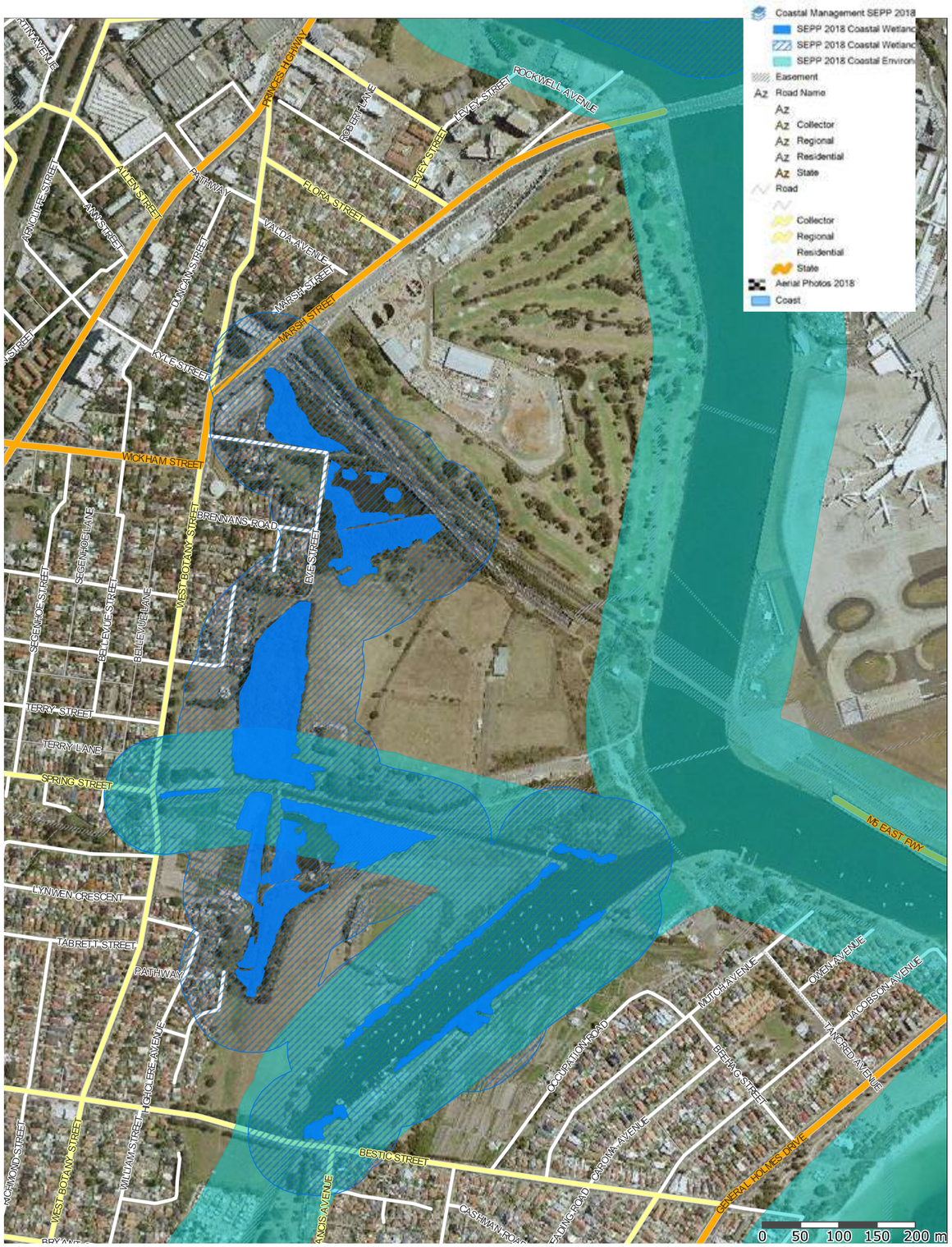

Figure 3.3 - SEPP Costal Management

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Plan of Management Community Lands and Open Spaces 2015

Barton Park has several categories of land as identified in the former Rockdale City Council Plan of Management Community Lands and Open Spaces. This plan provides high level planning controls and opportunities framework for the development of Barton Park. All of Barton Park is Community Land see Section 6.1 of the Plan of Management for details regarding Permitted Use in all categories. In addition Barton Park is also identified in the plan as having the following open space categories:

- Wetland and Water Courses –
- Current and Future Permitted Uses · Sports Grounds –Current and Future Permitted Use

Wetland and Water Courses - Current and Future Permitted Uses									
Locality / Water Course	Park Name / Wetland	Current Use (refer to current Asset Management Plan for condition)				Future			
						Permitted Purposes	Permitted Development		Scale and Intensity of Permitted Use / Development
		Land	Vegetagion	Buildings	Improvements	Land	Buildings	Improvements	
	Barton Park	Passive Recreation Bush generation, regeneration and endemic planting	Mangrove Forest Swamp Paperbark Scrub	International Airport Building	Access road	Passive Recreation activities and events Active transport links to and through open space, but NOT where it will have a negative impact on ECCs, threatened flora and threatened fauna habitat or significant negative impact on environmentally sensitive areas Environmental restoration works	International Airport Building No new buildings where it will have a negative impact on ECCs, threatened flora and threatened fauna habitat or significant negative impact on environmentally sensitive areas	Access road Passive Recreation - furniture, landscape, etc, Active transport Infrastructure Play equipment / space, Landscaped, Park furniture, Shared path, Car park Bush regeneration, re-vegetation and endemic planting	Access road

Sports Grounds - Current and Future Permitted Uses						
Precinct	Park Name	Current Use (refer to current Asset Management Plan for condition)		Future		
				Use	Permitted Purposes	Scale and Intensity Use / Development
Barton Park	Barton Park	Land	Active Recreation - Soccer	Active Recreation	Related to active recreation needs - Sportsground amenities, park furniture, stormwater harvesting and/or mitigation development Large cultural events / activities e.g festivals Affected by Cooks Cove Development SEPP	Appropriate scale and intensity developments to the size for the active open space area and the sites necessities for the level (local) Subject to REP No. 33 - Cooks Cove
		Building	Sports Amenities Building	Sports Amenities Building		
		Improvements	Lighting, Irrigation and/or Drainage, Car Park	Lighting, Sportsground levelling and resurfacing, irrigation and/or drainage		
	St George Soccer Stadium	Land	Active Recreation - Soccer	Active Recreation		
		Building	Sports Amenities Building	Sports Amenities / Stadium		
		Improvements	Lighting, Irrigation and/or Drainage, Car Park	Lighting, Sportsground leveling and resurfacing, irrigation and/or drainage		

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Biodiversity Strategy 2014 – A strategy for the Natural Assets of the City of Rockdale

This strategy provides high level goals and targets to guide the development of open spaces with an emphasis on restoration and protection and enhancement of natural areas, improvement of waterway quality and creation of linkages along corridors of open space.

The strategy identifies the following priorities for Landing Lights Wetlands in conjunction with nearby Marsh Street Wetlands, Eve Street Wetlands and Spring Street Wetlands:

- Provide foraging and roosting habitat for a range of migratory and non-migratory shorebirds and small bush birds.
- Marsh/Eve Street Wetlands is known habitat for the threatened Green and Golden Bell Frog.
- Potentially constrained by proximity to Sydney Airport (given attraction to birds)
- Comprise of a sequence of threatened estuarine and freshwater vegetation assemblages and coastal saltmarsh.
- Function as important wetland links in the Wetlands Biodiversity Corridor.
- M5 and neighbouring market gardens.
- Within Landing Lights wetland coastal saltmarsh are currently heavily impacted by the weed species Juncusacutus and are being out-competed by more dominant mangroves.

Figure 1: Vegetation communities

Figure 2: Endangered ecological communities and known and potential habitat for threatened flora

Figure 3: Known and potential habitat for threatened fauna and shorebirds

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Bayside West Precinct Plan 2018

This Plan sets out strategic land use and infrastructure planning to guide the future transformation of the Bayside West Precincts. The Plan will inform future changes to the planning controls to enable the rezoning of the Arncliffe and Banksia Precincts, through future amendments to the Rockdale Local Environmental Plan 2011 (LEP 2011).

The Bayside West Precinct identifies the importance of open space that is accessible, functional and adaptable to different stages of life for local residents and is reliant on provision to be provided by the large parks in Cooks Cove including Barton Park and to improve connections for pedestrians and cyclists.

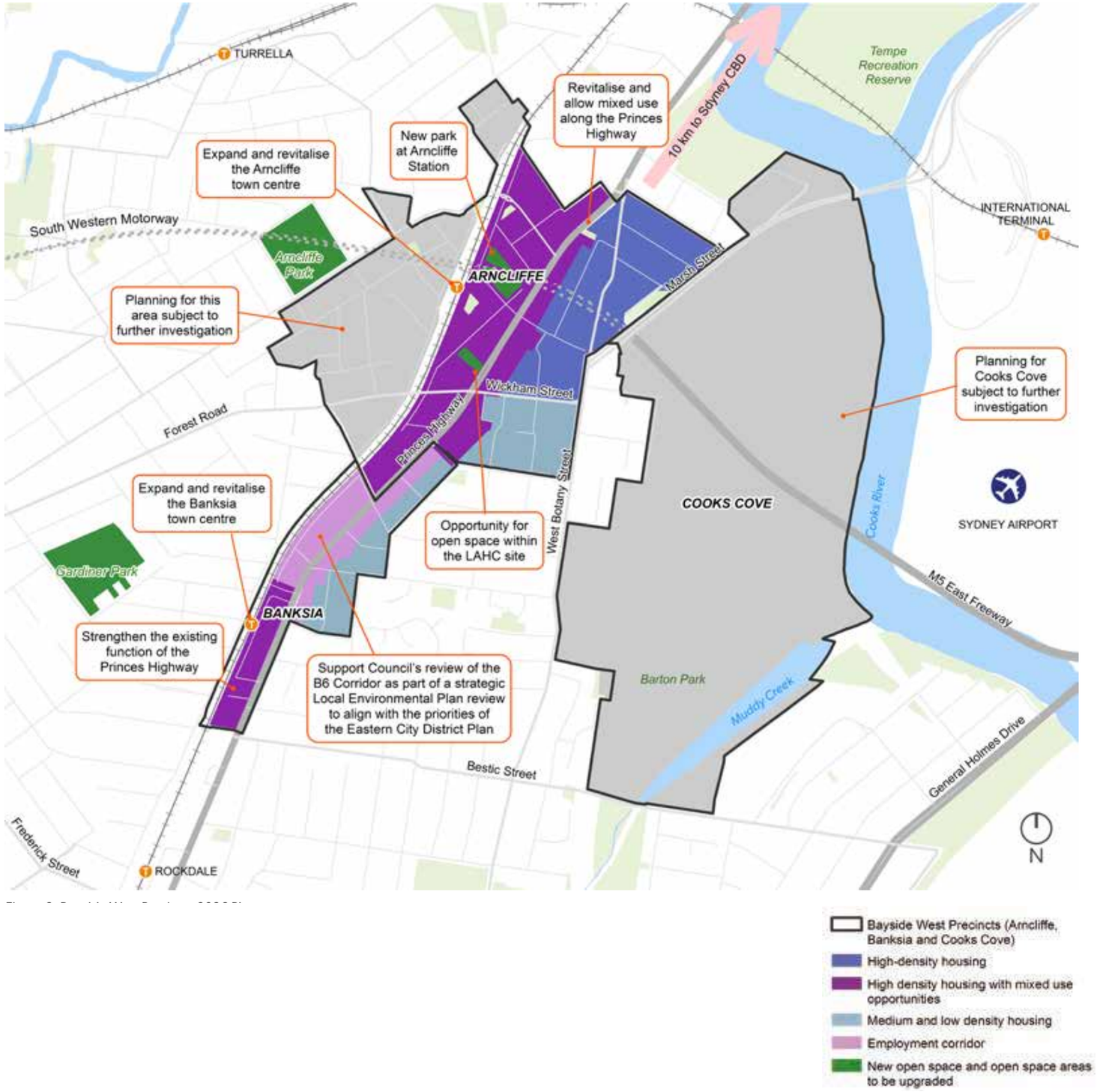

Figure 3.4 - Bayside West Precincts 2036 Plan

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4. Key Design Opportunities

4.1. Key Opportunities - Access & Connection

Currently there is poor access into and though Barton Park except for the the existing north/south route.

- Creation of formal routes and wayfinding signage using standards developed for use in Bayside Council.
- Enhance the already existing north/south route.
- Remove conflicts between vehicles and vulnerable users such as cyclists and pedestrians
- Improve safety for increased usage by cyclists and pedestrians in a shared environment.
- Creation of a pathway hierarchy to provide enjoyable routes for all users through and around the park and to the waterfront.
- Create opportunities for better east/west connections
- Improve links to the broader network to connect to local transport nodes including Arncliffe station and Wolli Creek Station.
- Potential to link to the rest of Rockdale Wetland Corridor. Enhance Barton Park Cycleway, which is part of the popular Bay-to Bay cycle network
- Improve access and pedestrian access in the Landing Lights Wetland including boardwalks through otherwise inaccessible areas.
- Provide areas of parking situated to service a range of recreation options and to provide disabled access in the most suitable locations.

4.2. Environment and Water zones 2,3,4

The rich ecological resources of the Landing Lights Wetland and Muddy Creek Foreshore :

- Extend/enhance the wetland and vegetated environment to areas heavily impacted by overland flow in Zone 3 to improve water quality entering the Landing Lights Wetland.
- Improve the quality of vegetated areas. An opportunity exists to remove extensive areas of weeds including woody and noxious species. The works will primarily involve reconstruction rather than regeneration of vegetation including the protection of some large canopy trees.

Remediate the heavily disturbed land with planting, especially canopy trees using endemic species.
Improve pedestrian access and promote complementary activities such as the development of an educational route, art trail and/or heritage interpretation route.
Provide spaces that encourage passive recreation focuses on bird watching and enjoyment of locations adjacent water bodies
Introduction of rocks/boulders in swale areas to encourage exploration and water play
The foreshore of Muddy Creek has been allowed to become enclosed by a mangrove forest due to lack of maintenance over a long period of time. Whilst mangroves are protected there is a good case for selective removal to improve view corridors and public safety.
Opportunity to create freshwater ponds to create detention for freshwater species such as the Green and Golden Bell Frog.
The Spring Street Drain is part of the Riverine Park area however there are opportunities for naturalisation of the southern banks adjoining Barton Park.
Promotion of park as a wetlands park and nature reserve.

4.3. Key Opportunities - Open Space & Recreational Uses

- Creation of sporting fields and activities that take advantage of the available flat mildly undulating land above flood level. Environmental management is to ensure grassed cover at all times
- Upgrade sporting facilities to meet the demands of increasing population in the catchments
- Provision of higher standard of sports fields including lighting and drainage.
- New sporting facilities to be supported with new amenities to the high standard Bayside Council has provided in other parks such as Scarborough Park to provide facilities for organised sport as well as casual users.
- Removal of some mounds will allow the provision of multi-purpose courts.
- Provision of facilities to serve casual users such as play spaces, exercise hubs, picnic tables, seating
- Provision of lighting throughout the park to create safe access and usage to support night time use.

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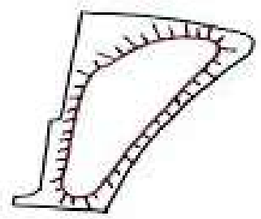
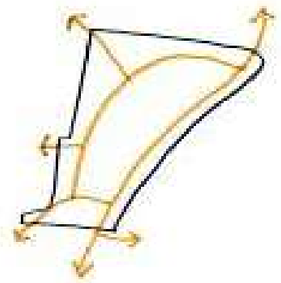
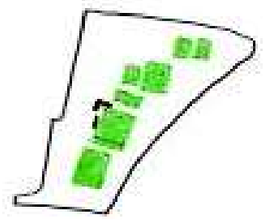
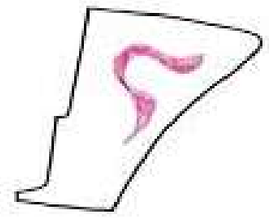
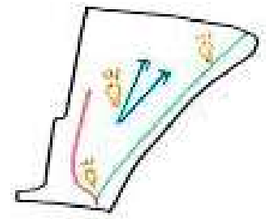
5. Principles and Strategies

Design Principles	1. PROTECT ENVIRONMENTAL QUALITY	2. RESPECT SITE CONTEXT	3. CONNECTIVITY WITHIN & BEYOND	4. SPORTS & COMPETITION	5. ACTIVE LIFESTYLES	6. SAFETY FOR ALL
Design Strategies	Expand the ecological communities to enhance their viability and protection Protect places with ecological value Improve landscape quality in all Zones Improve connections to Landing Lights Wetlands Reconstruct natural environments Regenerate native vegetation Improve water quality Allow community access and interaction Manage use and limit dog access in vulnerable ecological areas Harness the effects of flooding for the benefit of the environment Educate the community on why its valuable	Respect site history & topography Design responds to modified environment Incorporate land management measures to limit impacts from past contamination Recognise context of site in the early development of industrial Sydney Interpret the site history in the context of the adjoining heritage and civil assets	Connect to broader active transport network Improved access and parking within in the park A hierarchy of access for cohesiveness and legibility An inclusive path system to provide opportunities for a range of users in terms of ages and abilities Reinforce access to the site by providing a sense of arrival and destination	Upgrade sports fields and facilities for active recreation to meet sporting group and user needs Improve amenity and lighting to meet compliance and best practice standards Provide for growing community demand Encourage sport participation	Provide opportunities for diverse recreational participation Provide recreation for a range of ages and abilities Dynamic passive recreational corridor linking facilities and features. Opportunity for heritage, environmental or art trail Create places of interest and delight Promote health and fitness within the local area with various routes possible as circuits of various lengths Create places for relaxation, viewing, contemplation and socialising Design areas to shelter so park can be used in hot weather or inclement weather	Adopt Safety by Design (CPTED) principles to ensure that users are safe and also feel safe when in the park Lighting along path, road and parking network Allow safe access to the water Mitigate the effects of flooding to protect the community Encourage high levels of use to promote the sense of safety for users Improve site surveillance by opening up site lines and avoid hidden areas New facilities are designed to meet current compliance codes as a minimum and where possible enhanced best practice

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6. Functional Zoning

The Masterplan area has been divided into four zones.

Zone 1 – Active & Passive Park Zone

- Extensively grassed area on top of the old land fill embankment.
- Least impacted by flooding, generally undulating sloping from the high point in the northern part of the site to the lowest point in Bestic Street.
- Design is constrained by limitations of airport proximity and is development is restricted by Obstacle Limitation Surface (OLS), Public Safety Area (PSA) and M6 corridors. This zone is generally suitable to cater for the increasing sports and recreational demands in the LGA.

Zone 2 – Foreshore Environment Zone

- A narrow strip of land adjacent the Muddy Creek foreshore.
- Zone 2 is impacted by flooding, tidal and sea-level rise.
- Opportunity for environmental and landscape improvements

Zone 3– Open Space Adjacent Residential

- A low lying grassed area between residential area, the embankment and Landing Lightings Wetland.
- Subject to flood and occasionally tidal backwash. Partially within M6 Reserved Corridor.
- Investigate options for passive recreation, opportunities for habitat creation and integration with other zones

Zone 4 – Landing Lights Wetland

- A low lying wetland area with large salt marsh area between the embankment and Spring Street Drain
- Subject to flood and airport operational restrictions
- Suitable for passive recreational use especially for bird watching

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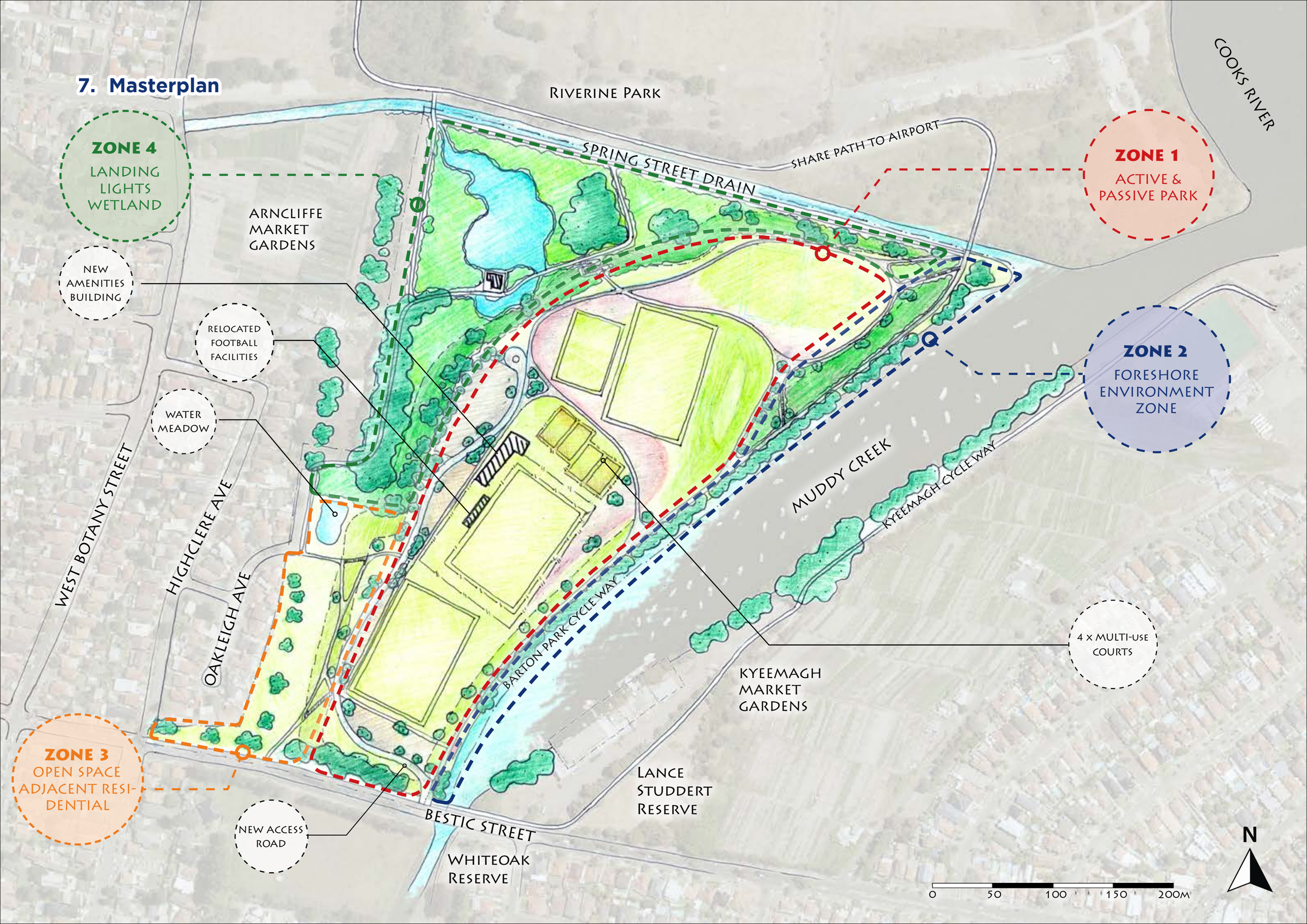
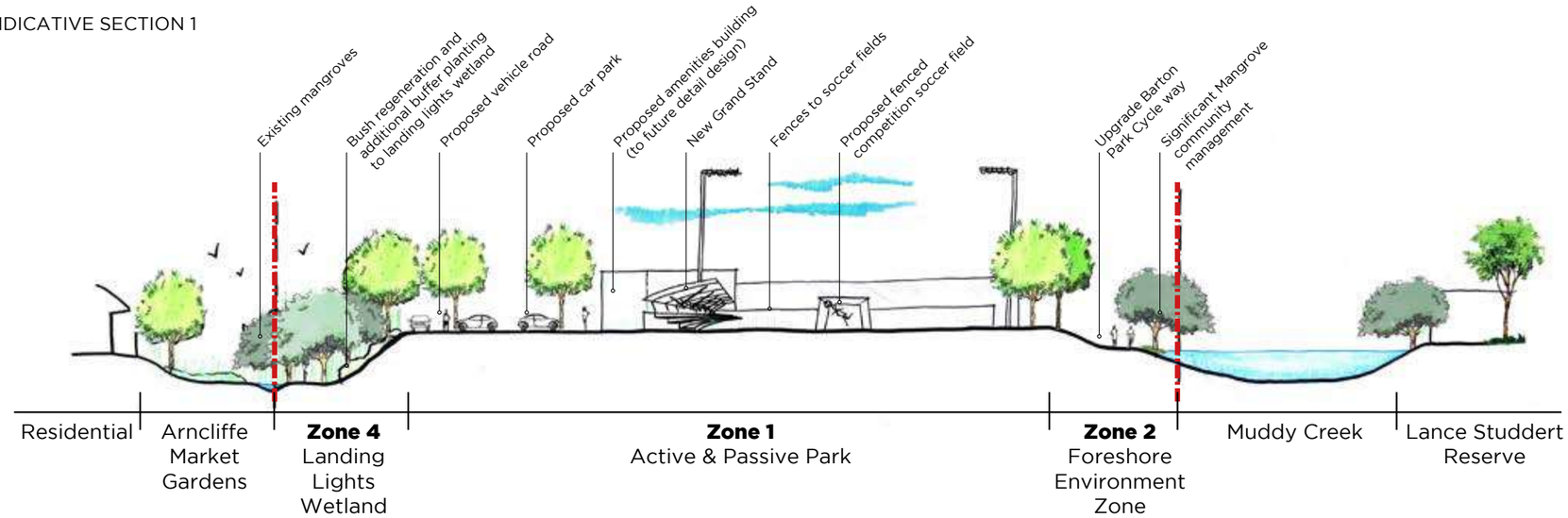
7. Masterplan

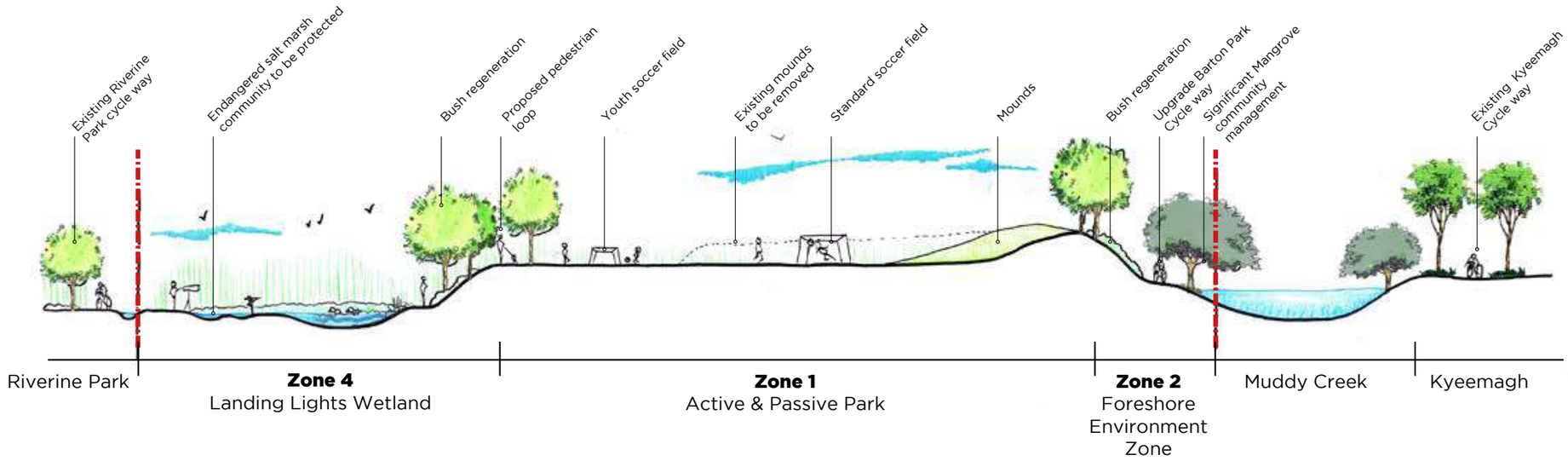


7.1. Landscape Sections

INDICATIVE SECTION 1



INDICATIVE SECTION 2



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8. Landscape Design Frameworks

8.1. Access and Circulation

Access to park:

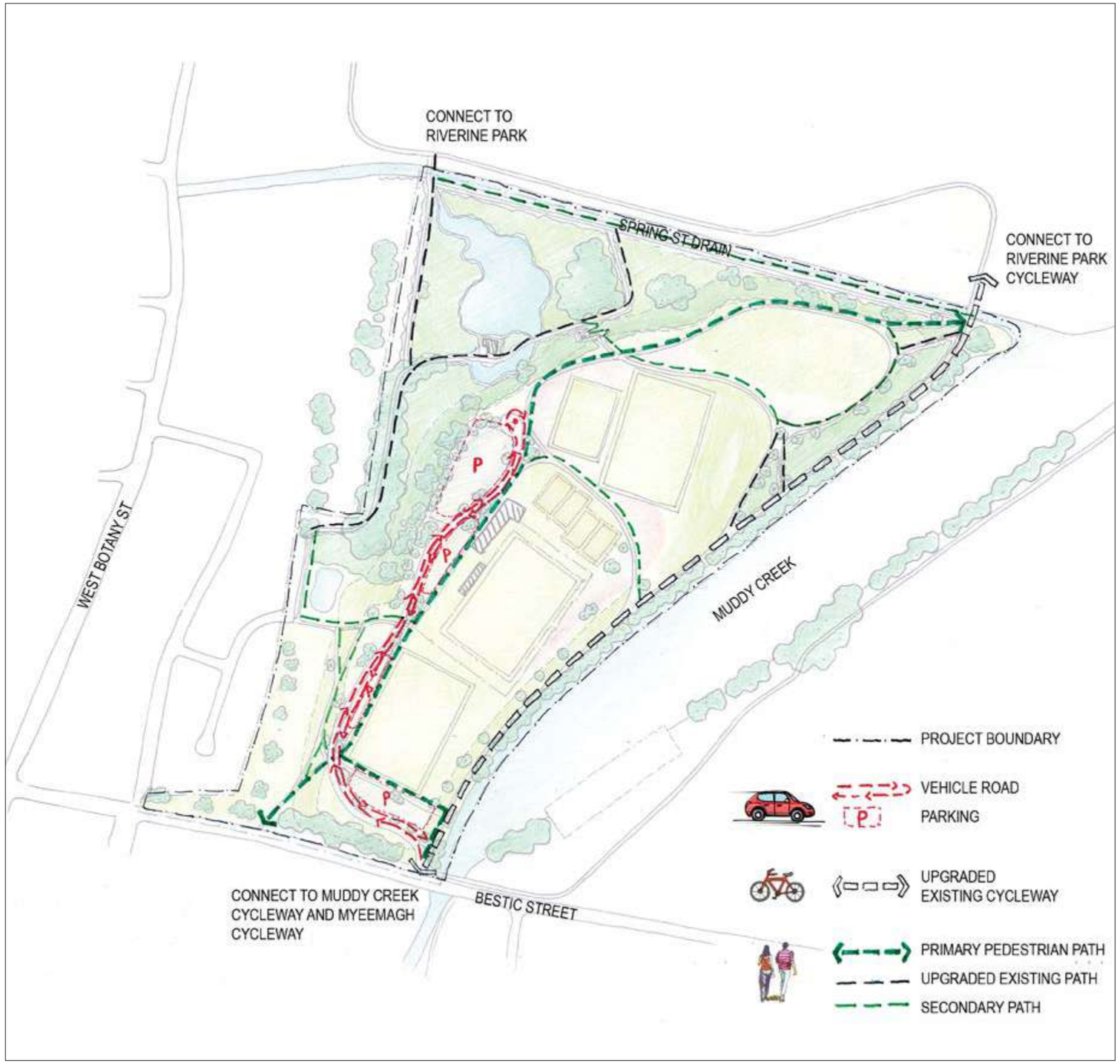
- Existing vehicle entrance location to be improved
- Create a sense of arrival
- Separate vehicle entry from vulnerable users and provide separated shared path. One close to the bus stop on Bestic Street and one from residential area in Eve Street.

A hierarchy of access

- Vehicle road meanders within M6 Reserved corridor and links major sports fields and amenities building.
- Upgrade existing cycleway into a safe shared pathway that runs alongside the Muddy Creek foreshore.
- Primary pedestrian path provides complimentary access alongside the new road and connects to north/south shared path connecting to Riverine Park to the north and south to Bestic Street
- Secondary paths to provide internal connections east/west and between facilities connecting 4 zones.
- Opportunity to integrate interpretative, heritage, educational or art trail into network
- A safe path system
- Path network to meet Australian Standards for universal access
- Separate vehicle access from vulnerable users to reduce conflicts.
- Clearly line marked areas for cyclists and pedestrians to manage user conflicts
- Provide a high standard of lighting along pathways

Improved Parking:

- Provide parking at regular locations along the new vehicle road
- Provide good access to new facilities with shade and lighting



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8.2. Natural Environment

Protect and enhance natural resources

- Protect environmentally sensitive environments
- Enhance and extend sensitive zones to create buffer to Landing Lights Wetland, particularly to protect from increased nutrient loads
- Protect trees in good health and of high ecological value
- Develop a vegetation management plan and remove woody and noxious weeks to allow for reconstruction of long term ecology
- Undertake bush regeneration especially to stabilise embankment slopes and to connect habitat zones including species found in Coastal Saltmarsh and Swamp Oak Floodplain Forest.

Improve water quality

- Mitigate impacts of flooding by harnessing overland flow into detention facilities such as water meadows or bio-retention at overland flood path to improve water quality through natural filtration of flood waters entering Landing Lights Wetland
- Water meadows/biodetention of fresh water arising from stormwater will create habitat for frogs including the Green and Golden Bell Frog.
- Arrested flood waters reduces erosion and slows down sedimentation of drainage channels and waterways and protects properties upstream.

8.3. Recreation and provision for future generations

- Implement high standard of sporting and recreation facilities to provide for a range of ages and abilities
- Provide a home for St George Football Club including grandstand
- Enhanced recreational route with upgraded shared pathway including lighting to connect the north/south route through Barton Park from Riverine Park to White Oak Reserve.
- Pedestrian routes to connect east/west and north/south within and beyond Barton Park with a range of options to suit the growing community needs.
- Opportunities to enjoy the natural outdoor environment in the context of its past industrial history adjacent the growing vibrant city.
- A place for socialising, competition, relaxation, contemplation, and recreation for today's and future generations of Bayside.

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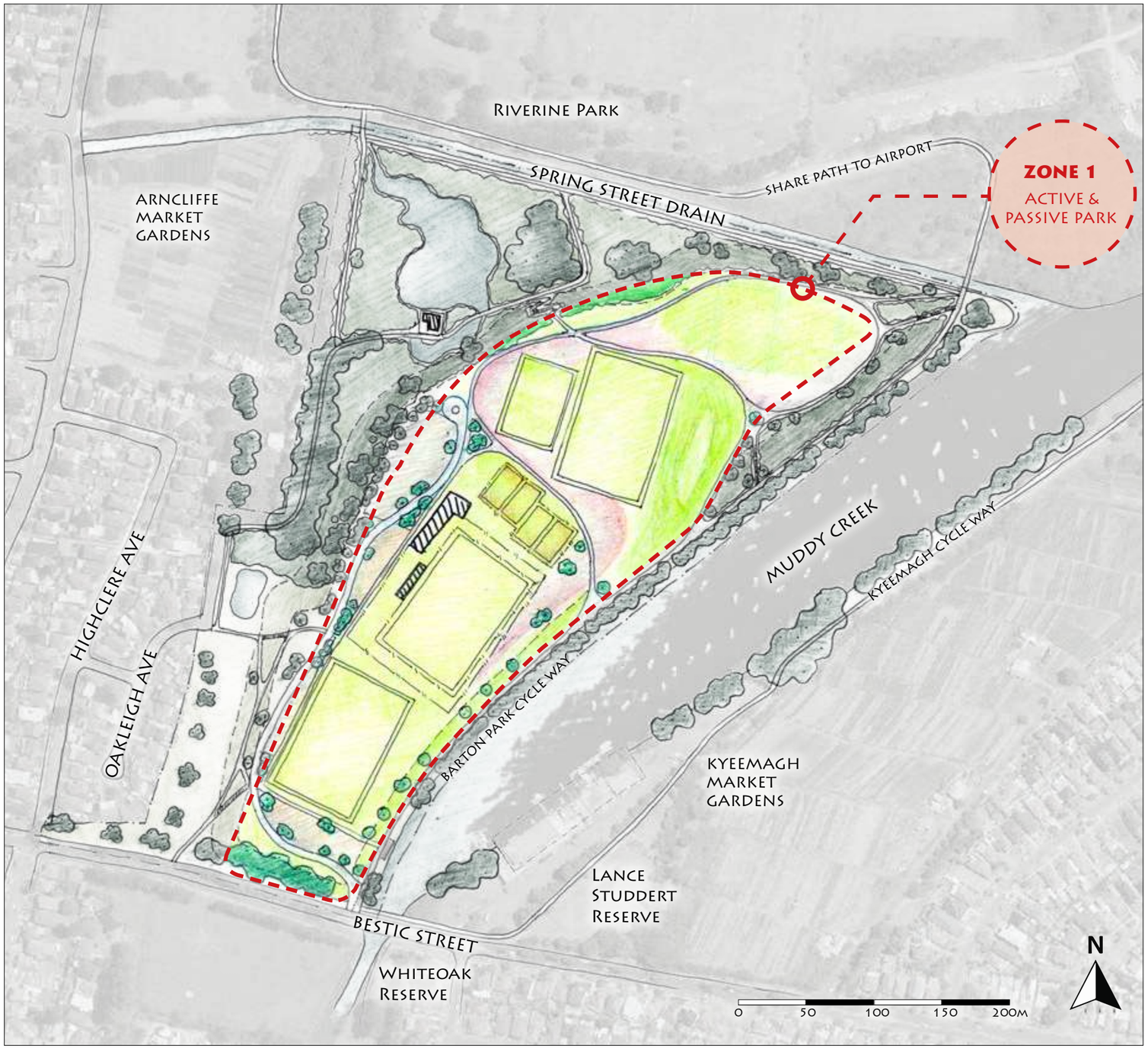
8.4. Zone 1 – Active & Passive Park



Zone 1 – Active & Passive Park Zone

- Extensively grassed area on top of the old land fill embankment.
- Requires demolition of substantial structures associated with St George Football Stadium including grandstand, buildings and some portions of spectator mounds.
- Demolition of some of the existing mounds will open the long views across the park to the long views of the city beyond Wolli Creek and east to the airport and west to Arncliffe over the wetlands. This will also improve passive surveillance within the park
- This zone may sustain a range of recreational facilities including:
    - New home for St George Football Stadium including grandstand
    - Amenities building to serve the sports fields, multi-use courts and casual users of the park.
    - Grassed sports fields of various sizes
    - Multi-use synthetic courts
    - Exercise hubs
    - Picnic and seating areas for socialising
    - Potential for other facilities such as playground and viewing areas
    - Tree lined access road and associated parking
    - Network of pathways to service facilities and recreational routes within the park

- Long term contamination management works will require careful consideration during the design and construction phases to ensure longevity of structures. Design considerations include the nature of drainage, limitations on depths and type of excavation, location of services, materials selection and structural considerations. In the long term maintenance of grass cover in this area is critical.

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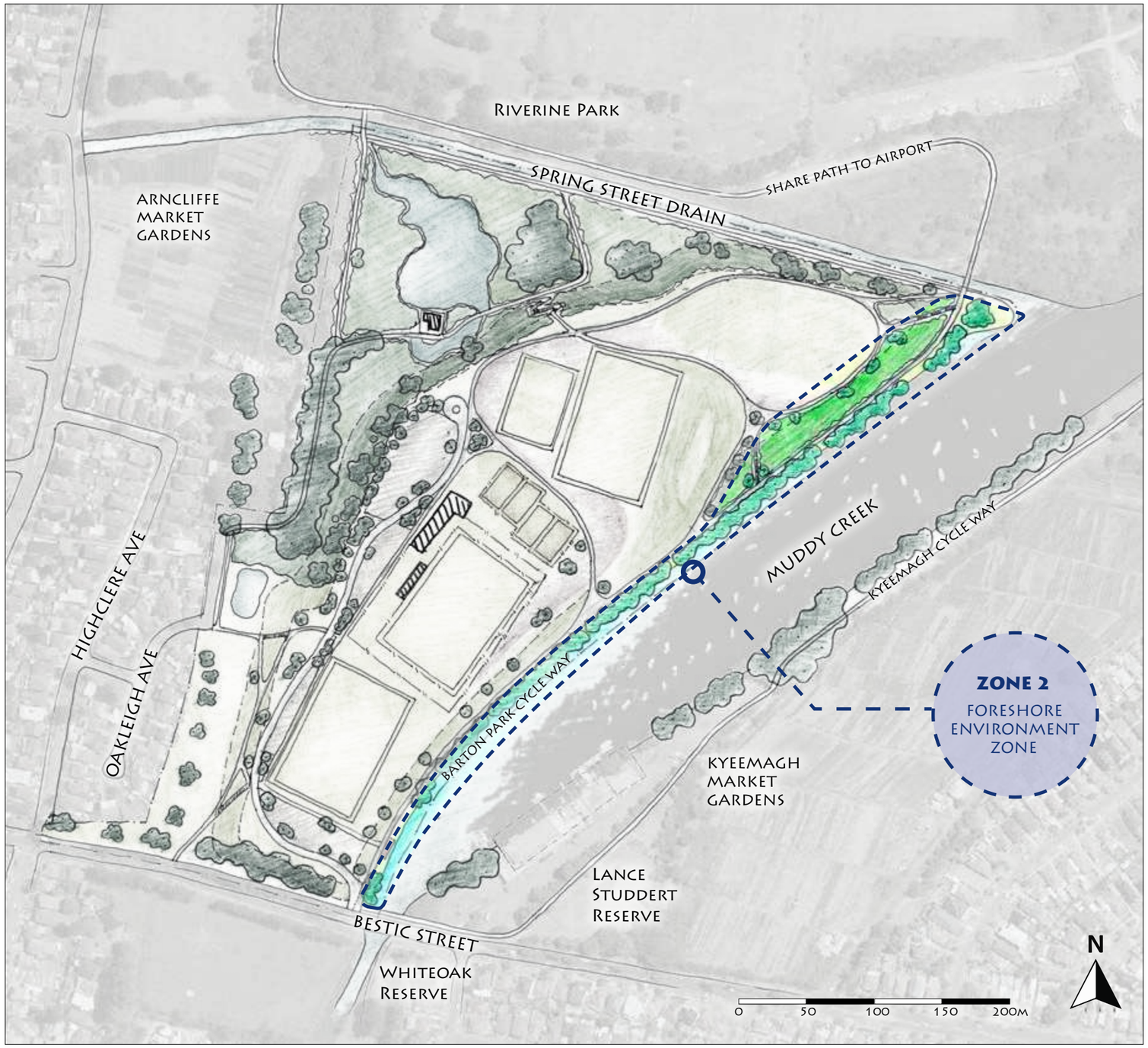
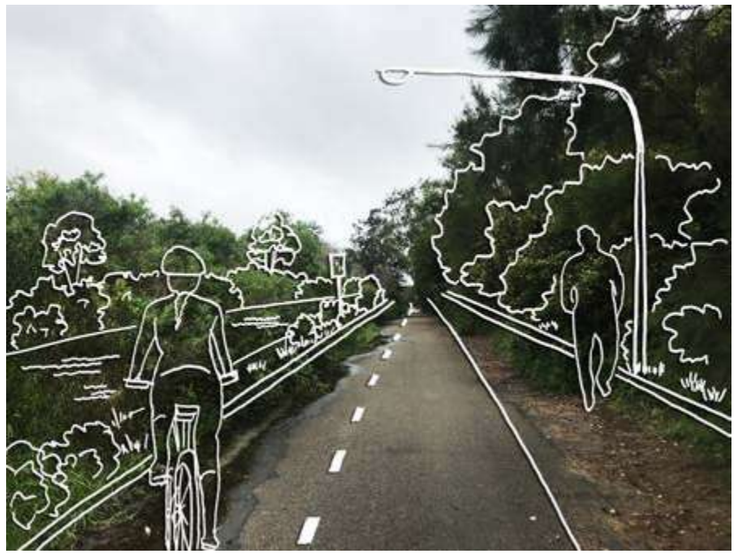
8.5. Zone 2 – Foreshore Environment Zone



Zone 2 – Foreshore Environment Zone

- Travels through existing environmentally significant mangrove forest along Muddy Creek, an existing cycleway - part of (Homebush) Bay to (Brighton) Bay cycle network, and past a steep batter of land fill abutting the north-west section of the cycleway.
- Opportunity to upgrade to a shared pathway as part of recreational route including lighting connecting to Riverine Park to the north and White Oak Reserve to the south as part of the Rockdale Wetlands corridor.
- Visual connection to Muddy Creek is possible with selective thinning of the mangroves with opportunities to stop along the route for relaxation and contemplation and enhanced cyclist experience.
- The improvements will create a destination within Barton Park including seating and lookouts as well as servicing the north/south route as part of the broader recreational route.
- Vehicle access will be restricted to service vehicles only to improve safety for vulnerable users.



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8.6. Zone 3 - Open Space Adjacent Residential

Zone 3– Open Space Adjacent Residential

- The proposal will explore flood management options in this area to improve water quality draining into Landing Lights Wetland and to mitigate the impacts of flood waters
- Improve pedestrian connections to Zone 1 Active and Passive Zone and Zone 4 Landing Lights Wetland

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8.7. Zone 4 – Significant Environmental Sensitive – Landing Lights Wetland

Zone 4 – Landing Lights Wetland

- Environmentally significant wetland to be protected as it is favoured by migratory birds including Threatened Species.
- Must exclude dogs from this sensitive environment
- Opportunity to enhance public access over boardwalk and to create areas of relaxation and contemplation
- Opportunities for inclusion as part of environmental, heritage, art, educational trail.

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9. Funding strategy

Council has a range of funding sources that may be used to deliver this significant project.

The list below provides an indication of how the project could be funded.

- Special Rates Variation (SRV) is currently collected for area covering Barton Park. This funding is available to fund replacements of existing infrastructure with modern equivalent.
    - Sporting infrastructure, buildings, stadium seating, road and parking but not drainage infrastructure. Irrigation of stadium field including tanks. Fencing around stadium and stadium infrastructure. All signage & wayfinding. Some park pathways, furniture and playground.
- Council collects contributions from developments that generate additional demand and growth of infrastructure such as recreational facilities. These funds are collected under Section 7.11 and S7.12 of Environmental Planning & Assessment Act, 1979 (EP&A Act). This could include:
    - Fitness stations, pathways, park furniture, playground, off leash dog facilities, new types of fencing, irrigation of other fields including tanks.
- Council also collects a Special Variation Rate (SRV) specifically for enhancing community safety. Examples of projects that can be funded are: Pedestrian lighting, and pathways
- Council will also pro-actively seek assistance from other government agencies to help achieve the vision for Barton Park. Various possibilities include:
    - Metropolitan Green space Grants
    - Environmental Grants for interface with wetland areas eg. Lookouts, interpretation, bush regeneration etc
    - Sport and Recreation grants
    - Water quality grants
    - Coastal grants
    - vegetation management grants
    - art and education grants

Barton Park - preliminary schedule of works

ZONE 1 Active and Passive Park	Standard	Size	Qty	Unit	Potential Funding source
Football field incl. drainage & irrigation Fields 1, 2, 3	Fifa	68x105 m	3	item	SRV
Mini fields - Field 4	Youth 10 x 2 or 1 x Senior field	45x60 m	2	item	SRV
Football field - Field 5	Youth 10	45x60 m	1	item	SRV
Water supply tanks	Extent to be confirmed	100,000 litres	2	item	TBC
Field lighting - stadium	200 lux	Pole max 18m	6	poles	SRV
Field lighting - training	50-100 lux	Pole max 18m	6	poles	SRV
Stadium score board & screen	To be confirmed	TBC	1	item	TBC
Stadium fencing - low internal, two pedestrian gates & 1 vehicle acces	Metal fence	1.0 m tall	374	l m	SRV
Stadium fencing - high boundary, two pedestrian gates & 1 vehicle access	Security type	1.8 m tall	465	l m	SRV
Concrete path around fence	Concrete	1 m wide	465	l m	SRV
Hard stand around buildings	Extent to be confirmed	131 long x 20 m wide	2620	sq m	SRV
Grandstand seating	400 seats		1	item	SRV
Amenities building including public toilets, change rooms, canteen	Standard Bayside + 30%	TBC	1	m	SRV
Synthetic multi-use courts including fencing	To be confirmed	TBC	4	item	SRV / S7.11
Internal road including lighting	2 lanes x 3m	620	6	l m	SRV
Turning area including lighting	Cul de sac	Approx 10 m wide	1	sq m	SRV
Carparking & number of spaces including lighting	To be confirmed	7400	TBC	sq m	SRV / S7.11
Primary paths including lighting	To be confirmed	1.5-2.5m wide	960	l m	S7.11 & other
Secondary path (lighting to be investigated)	To be confirmed	1.2-1.8 m wide	1000	l m	S7.11 & other
Exercise hubs	To be confirmed	To be confirmed	2-4	item	S7.11 & other
Viewing platforms	To be confirmed	To be confirmed	TBC	item	S7.11 & other
Playground	To be confirmed	To be confirmed	1	item	S7.11 & other
Off leash dog area	To be confirmed	To be confirmed	1	item	S7.11 & other
Wayfinding, signage and interpretation	To be confirmed	To be confirmed	TBC	item	SRV / S7.11
Bush regeneration areas	Extent to be confirmed	To be confirmed	TBC	sq m	Grants

ZONE 2 Foreshore environment including coastal wetland zone	Standard	Size	Qty	Unit	Potential Funding source
Upgrade of existing active transport route	Concrete	4 m wide	650	l m	SRV & grants
Lighting along route	To be confirmed	TBC	TBC	item	SRV & grants
Bush regeneration areas	Best practice	Approximate	4750	sq m	Grants
Passive recreation opportunities including lookouts, picnic areas,					

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10. Next steps

The draft Barton Park Masterplan will be exhibited for 6 weeks until Tuesday 26 May 2020.

The Covid-19 (Coronavirus) situation has meant that council has not been able to undertake face to face community engagement activities.

Display boards are located in several locations on the site. Letters will be sent to adjacent residents and stakeholders including St George Football Club, Sydney Airport, Sydney Water and the operators of the Arncliffe Market Gardens.

We will continue to refine the Masterplan. We will develop a staging plan and funding strategy for the long term implementation plan of approximately 10 years.

Investigations such as detail survey and geotechnical will commence soon specifically in the areas identified for large structures such as buildings and grandstand.

Budget to deliver design and documentation will be proposed in the City Projects Program 2020-2021.

The results of the Have Your Say process and feedback received will be reported to Council in mid 2020

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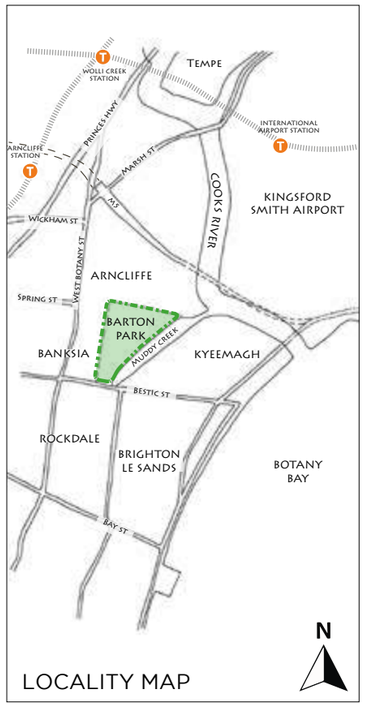
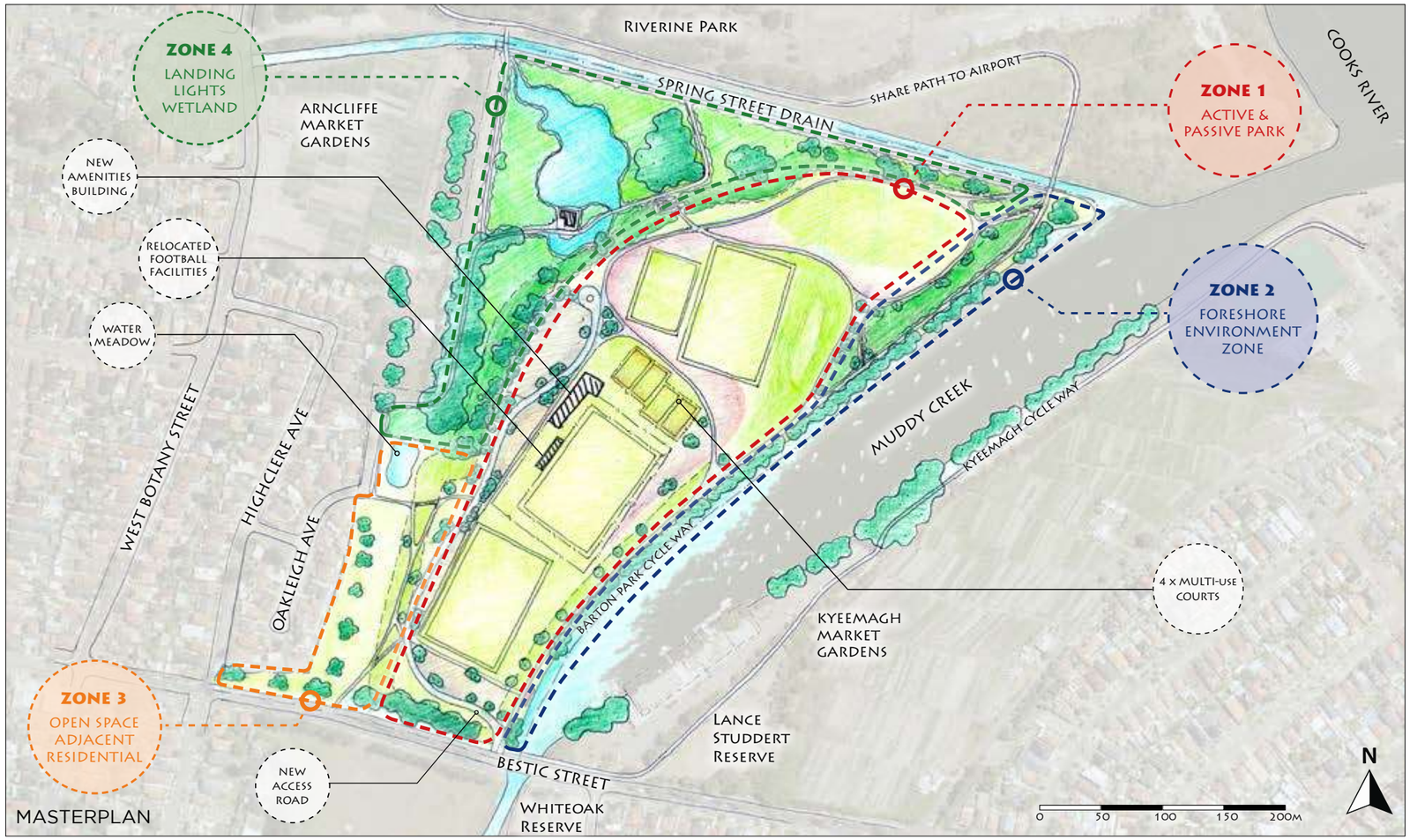
12. Appendix A

Community consultation board





HAVE YOUR SAY

www.haveyoursay.bayside.nsw.gov.au

We have prepared a draft Masterplan for Barton Park. We will be implementing Zones 1 & 2 first then Zones 3 & 4. Your feedback will help us to develop the detail design and set the priorities.

For more information and to Have Your Say please visit our website on https://haveyoursay.bayside.nsw.gov.au/

Comments will be received until **Tuesday 19 May, 2020**.

Phone: 1300 581 299
Email: council@bayside.nsw.gov.au
Web: www.bayside.nsw.nsw.gov.au

Objectives

- Provide playing fields and other sporting facilities for active recreation to meet sporting group and user needs
- Improve amenity and lighting to meet user groups and regulatory requirements
- Upgrade site conditions in accordance with the opportunities identified in the Environmental Management Plan
- Improve interface with Landing Lights Wetlands and other adjacent open space
- Improve landscape and biodiversity outcomes through increased plantings
- Identify integrated movement network with connections to adjacent areas
- Increase safety using Safety by Design (CPTED) principles

Zone 1 – Active & Passive Park

This area is best suited to provide high quality sporting and passive recreation. The zone includes opportunities to:

- relocated St George Football facilities
- upgraded turf sports fields
- 4 x multi-use synthetic courts
- new amenities building & grand stand
- potential for passive recreation facilities
- new park road and parking areas to service the new facilities
- pedestrian path networks & viewing areas
- the removal of sections of mounds to improve the spatial quality of the site & better integrate the sporting facilities

Zone 2 – Foreshore Environment Zone

This area is located adjacent the banks of Muddy Creek and provides a significant north/south connection of open space. The zone includes opportunities to:

- upgrade the recreational pathway for pedestrians and cyclists
- provide lighting along the foreshore of Muddy Creek for improved safety and user amenity
- Make strong connect through to Riverine Park to the north and Whiteoak Reserve to the south as part of the Rockdale Wetlands Corridor
- separate vulnerable users such as pedestrians and cyclists from vehicles to remove conflicts
- activate the foreshore of Muddy Creek taking advantage of its waterside location

Zone 3 - Open Space Adjacent Residential

Open Space adjacent residential This area is best suited for passive recreation, pedestrian connectivity and environmental management. The zone includes opportunities to:

- improve pedestrian connections from Bestic Street and adjoining residential areas to adjoining zones 1 and 4
- improve visual and park amenity
- improve water quality to the Landing Lights Wetland where this land drains by introducing a water meadow to take advantage of the overland flow
- improve vegetation management

Zone 4 – Significant Environmental Sensitive – Landing Lights Wetland

This area encompasses the Landing Lights Wetland including a significant salt marsh habitat that provides habitat for migratory birds including Threatened Species. This zone includes opportunities for:

- improved passive recreation
- conservation of high environmental quality
- upgrade of boardwalks and access
- greater access to the valuable educational resource for the community

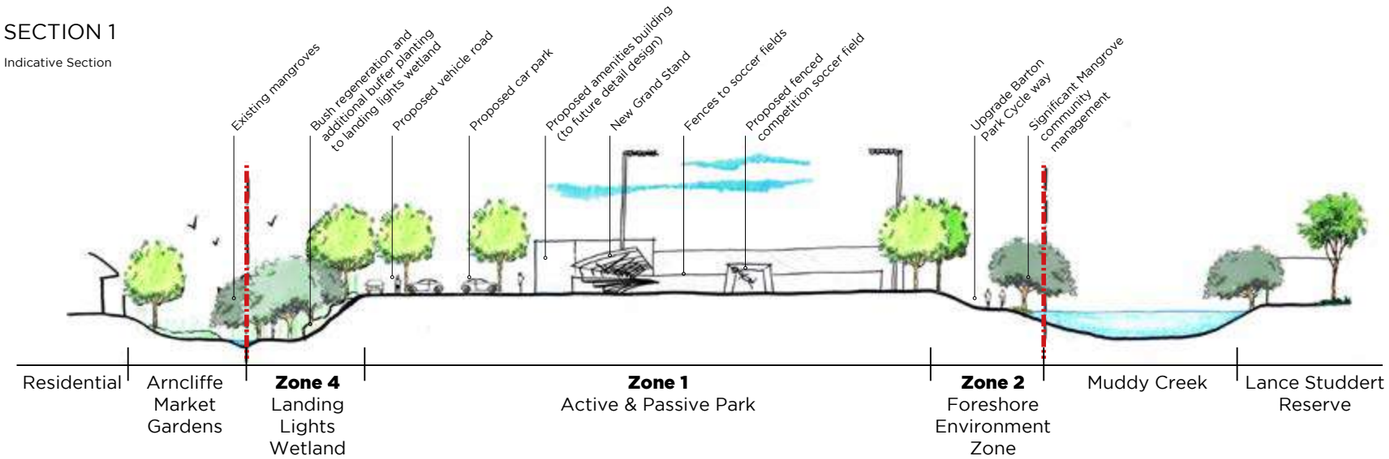
Barton Park, Banksia - Draft Masterplan

Bayside Council
Serving Our Community

Exported on 17/04/20

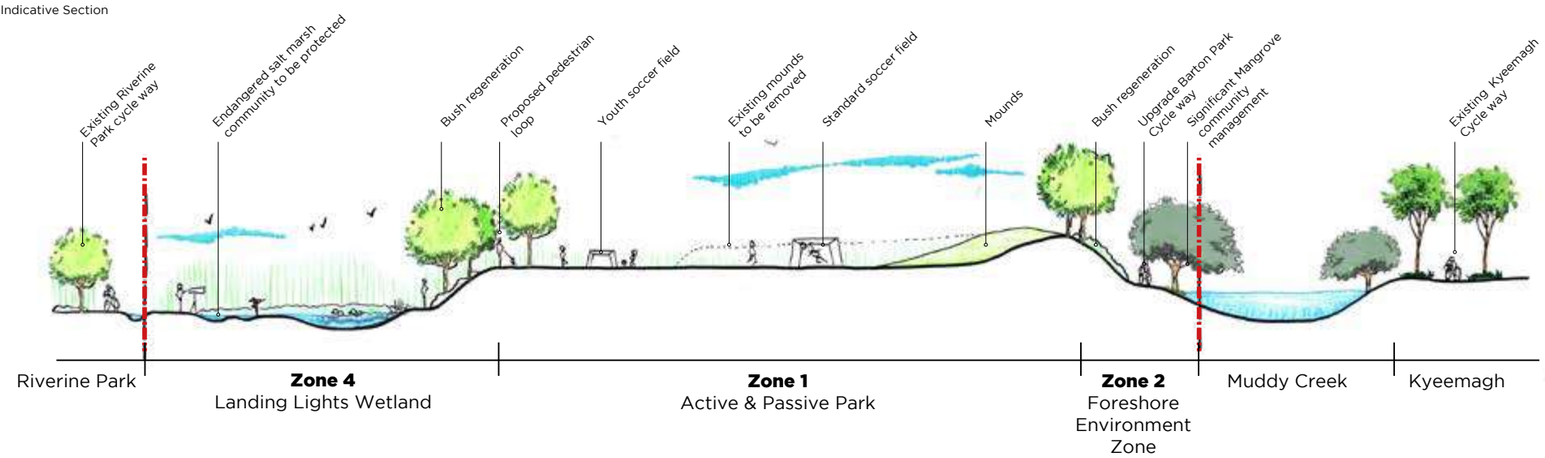
SECTION 1

Indicative Section



SECTION 2

Indicative Section



SPORTS FIELDS

MULTI-USE SYNTHETIC COURTS

GRANDSTAND

PEDESTRIAN PATH

SHARED PATH

Precedent image only, detail to future design

Barton Park, Banksia - Draft Masterplan

Bayside Council
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13. Appendix B

Photos and articles provided by Rockdale Library Local History Librarian

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BARTON PARK, ROCKDALE.

BIG RECLAMATION SCHEME.

The Rockdale Municipal Council is carrying out, without assistance from the Government, a reclamation scheme which will considerably enhance the value of property in that area, as well as providing a public park of 120 acres on a self-supporting basis.

For years the sewerage farm area has been the prolific breeding ground of mosquitoes and other pests. That land was secured from the Water Board at a cost of £885. Tenders were invited for the reclamation, one of the conditions being that the contract charges would be met by deferred payments. Six firms tendered for the work, the successful tenderer being Mr. A. T. Keirle, Manly, at £12,721, payment to be 25 per cent. of the cost as the work proceeds, the balance to be spread over a period of 15 years, annual outstanding balances to carry interest at the rate of 5 per cent. per annum.

The filling-in will vary from an inch to three feet. More than 300,000 cubic yards of material will be used. This will be obtained from the banks of the Muddy Creek rivulet. The reclamation will be so carried out that this stagnant swamp will be converted into a splendid sheet of clear water, which, in future, will be the venue of many aquatic sports. The top soil for the reclaimed land is being laid by the Rockdale council, so as to provide sporting facilities for Rockdale and Arncliffe in the near future.

The council has named the area to be reclaimed Barton Park, in honour of the present mayor (Alderman E. G. Barton). The reclamation is being supervised by Mr. T. Gifford, on behalf of the council. The park land will lend itself to a beautification scheme, there being an area 100 feet wide, on the opposite side of the lake, where trees and gardens could be planted.

ROCKDALE

Its Beginning and Development

By

PHILIP GEEVES and JAMES JERVIS

(Revised 1986 by Alderman R. W. Rathbone)

THE COUNCIL OF THE MUNICIPALITY OF ROCKDALE

It should also be explained that Sydney's expanding suburbs were then plagued by a whole variety of unpleasant odours from the "noxious trades" mentioned briefly in a previous chapter. These consisted mainly of boiling down offal, grinding bones in bone mills, tanning and treatment of fleeces, and fellmongering. Boiling down was the commonest for, in an age of candles, the tallow chandler was often a tycoon. Such enterprises were widespread in the metropolitan area, in fact twenty municipalities submitted a petition to the Premier requesting governmental action. In 1890 Rockdale could boast 45 market gardens, 22 dairies, 5 boiling-down establishments, a tannery and fellmongery, and a slaughteryard. Some of these had probably moved into the district in the pious hope that their odours would commingle with those of the sewage farm and so pass unnoticed. However, gross objection was taken by residents who endeavoured to goad Council into stern action. The Bucknell family at Arncliffe set the pattern by launching a prosecution against a "noxious" neighbour. . . . "Alderman Judd deprecated the existence of the establishment, and said that the smell got in the houses, hung to the drapery, and upon a foggy morning it came like a cloud." Probably the most overworked man in the district was Council's Inspector of Nuisances, Mr W. Williamson.

By an odd circumstance, a leading alderman was involved in the business of boiling down, and made it a point of honour to fight for his industry against the combined voices of his confrères: "He for one, would not prosecute or persecute. All the industry wanted was a place to go and erect their establishments and, as for the business being dangerous to health, he denied it. He thought as a man he was a fair specimen, and he had slept by the side of a digester for years."

As the months went by, worthy families were threatening to move from the district and a few had already done so. A petition signed by almost a hundred leading Arncliffe citizens urged Council into action. As a result, a prosecution was launched against McNamara's boiling-down works at Arncliffe, resulting in a verdict and costs for Council. The wealthy McNamara ceased operations for a short time, only to begin again later at the same place. Another prosecution was threatened. Meanwhile, a meeting of ratepayers was convened in the Town Hall to discuss the general question of noxious trades. It was a packed house, in every sense of the term. The ratepayers found themselves outnumbered by angry proprietors and employees of noxious trades from every district about Sydney. In one of the rowdiest meetings on record, the Mayor, aldermen and ratepayers were shouted down by the "invaders", and the meeting closed by passing a resolution calling on the Government to set aside a specific area of Sydney for the operation of noxious trades. Incidentally, one of the official suggestions for the location was the Kurnell headland, but this proposal was sternly combated by local interests.

Meanwhile the nuisance from the sewage farm continued unabated for many years. Official complaints on a high level had become so general that in 1905 an attempt was made to treat the sewage by a less objectionable method, but already the question of an ocean outfall was under consideration. Ten years later it was complete. On 14th September 1916 the last junction was connected to the ocean outfall and from that date the sewage farm ceased to operate. Eventually the whole of the land, except a small portion carrying the main sewers, was disposed of in the manner indicated on page 114.

On this land sprang up farms, homes and extensive sporting areas. The Kyeemagh Polo Ground, the Sydney headquarters of the New South Wales Polo Association, was later to give its name to a flourishing new suburb. It was here, too, that Alderman E. G. Barton devoted his mayoral term to the reclamation of 120 acres of low-lying, swamp land; today, Barton Park is a tribute to his efforts.

As for noxious trades, their disabilities were largely overcome by advances in chemistry and technology, plus the tendency for tallow and soap making to come under the control of a few big firms. An industrial drift towards Botany and Waterloo centralized most of these operations in those areas. And just as Hercules diverted a river to cleanse the Augean stables, so the later diversion of Cook's River has practically removed the landmarks by which to locate the old sewage farm.

and by 1932 there were 131 camps and humpies constructed from all manner of second hand materials in the area. At one time the North Brighton sand hills gave shelter to nearly 400 persons. Because there were no services whatever, outbreaks of gastro enteritis and outbursts of lawlessness were common and the Council was urged to move the campers. Realising, however, that these unfortunate people had nowhere else to go, the Council formed the residents into an Unemployed Campers League to bring some order to the administration of the camp and provided it with running water and a sewage collection service. The last of the camps was not removed until 1947 when the Commonwealth Government, as part of the extension of Sydney Airport after the Second World War, diverted Cook's River through the area.

The economic stringencies of the Depression era severely curtailed the Council's ability to undertake its normal works and improvements programmes but by skilfully channelling the aid money it received into projects which would be of lasting benefit to the municipality many valuable improvements were, nevertheless, effected. During these years Scarborough Park, still then a primeval tidal swamp, was drained and filled, the artificial lakes created and the area developed as one of the most important sporting venues in the St George District while 120 acres of the now disused North Brighton Sewage Farm were acquired, raised and provided with 23 cricket wickets and opened as Barton Park. But the Council's lot was never an easy one.

Not only was the municipality subjected to almost continual rain throughout the 1930's which resulted in a series of floods sweeping away bridges and inundating large areas of low lying land—especially in the Scarborough Ward, but an exceptionally high tide during one of these downpours caused Cook's River to break its banks cutting the Princes Highway and flooding large areas of Arncliffe to a depth of four feet. This followed hot on the heels of the most serious health hazard the municipality had so far experienced.

In March, 1931 the Water Board announced that it intended to divert 25 million gallons of untreated raw sewage into Cook's River and Botany Bay while it repaired the leaking and overloaded western outfall sewer carrier. For nearly six months the Bay was sickeningly discoloured and the beaches at North Brighton and Ramsgate were heavily polluted. The stench was so appalling that in December, 1931 at the height of the swimming season the Council had to close the new Brighton Baths.

In an attempt to restore their popularity and at the same time raise funds for the unemployed, the Council decided to organize a huge carnival at Brighton which featured a re-enactment of the landing of Captain Cook with the Mayor, Alderman E. G. S. Barton in the role of Cook, a beauty contest to select "The Pearl of the Pacific" and an ill-fated parachute jump in which the parachutist landed on a fence at Sandringham instead of in the Baths at Brighton. Despite these mishaps the exercise was an unqualified success raising over £700 and providing a week's work for 125 unemployed men. To mark the occasion the Council produced a film entitled "In the Days of Captain Cook". Having not seen the light of day for nearly 40 years this epic of the silent screen was rediscovered in the tower of the Town Hall during the Council's Centenary Celebrations in 1971 and re-issued with appropriate musical accompaniment to delight all who have subsequently seen it.

Throughout this difficult period in the municipality's history the one great diversion which took people's minds off their troubles was the district's pre-eminence in sport. For more than half a century the St George District has had a reputation for producing outstanding sportsmen and there is no doubt that many of these champions were nurtured and developed on the playing fields of Rockdale. At some time or other the St George Baseball Team whose home ground was at Bexley Oval, the St George Hockey Team which operated from Gardiner Park, tennis heroes like John Bromwich, Vivian McGrath and Arthur Huxley, all of whom trained on the Illawarra Lawn Tennis Association Courts at Rockdale have reigned supreme in their field. It is worthy of note that during the 1930's and 1940's the Illawarra Lawn Tennis Association was the largest tennis organization in the world. But it was in cricket, more than in any other sport that the district

conducted an extensive immunisation programme as a result of which the scourge of diphtheria was removed from the municipality and the incidence of poliomyelitis dropped from 24 cases in 1950 to nil in 1957. Rockdale was one of the first Councils in the State to introduce the Sanivan method of garbage collection with a fleet of enclosed garbage vehicles in which the waste matter was compacted before it was disposed of. Much of this garbage was used to reclaim the areas of open space previously acquired and to convert them into useable playing fields or passive recreation sites. The most spectacular of these projects was along the beachfront at Botany Bay.

The beachfront from Kyeemagh to Ramsgate consisted of sand dunes 15 to 20 feet high. They were not only unsightly but in strong winds the sand frequently blew across the roadway into the front gardens of houses and sand blown under their tiled roofs caused the ceilings to sag and collapse. To eliminate these undesirable conditions and to improve the appearance of the area, the council proposed a scheme which involved the removal of the sand to approximately 20 feet below road level, the filling of the void with compacted garbage and the levelling and beautifying of the surface. As a consequence the area is no longer unsightly, there are no sanddrifts to endanger traffic or property and residents and passing motorists now enjoy a view of the Bay which previously was obscured by barren sandhills. It is estimated that in excess of 50,000 people use the amenities of the beachfront on a hot weekend in summer. Household garbage was also used to raise the level of the tide and water affected Barton Park. Between 1950 and 1955 the Council provided additional bathing enclosures at Kyeemagh, Ramsgate and Dolls Point but during these years the hand of the Council could be seen everywhere.

It acquired and redeveloped the old Arncliffe School of Arts as the Coronation and Elizabeth Halls; it established municipal tennis courts in Bexley Road; it developed then leased the bowling greens at Bexley to the Bexley Bowling Club; it further developed and improved the Bexley Golf Course. It provided playing areas at Gilchrist Park, Evatt Park and Donnan's Reserve and set aside Stotts Reserve as an area for native Australian trees and plants and it undertook the progressive improvement of Cahill Park at Arncliffe to make it one of the most attractive recreation areas in Sydney.

Ultimately its years of endeavour were recognised. The most covetted award any Council can receive is the A. R. Bluett Award—given each year to the most progressive Council in the State. In May, 1951 the Council learned it had been selected for the award because of its previous year's work. In order to fittingly celebrate this event it decided to provide the Mayor with a robe and chain of office which were worn for the first time on 28th November, 1951 at the official presentation of the award. The Council also produced a film for the occasion entitled "Achievement in Service" and commissioned Mr Philip Geeves—a councillor of the Royal Australian Historical Society—whose grandmother, Mary Ann Geeves had given Rockdale its name, to write an official history of the district.

insulator production, tin foil cutting and the processing of horse hair for upholstery purposes at Irwin and Davis's factory in Hill Street, were just a few of the undertakings but surely one of the most unusual was D. Little and Company's leadlighting and stained glass works in Barden Street.

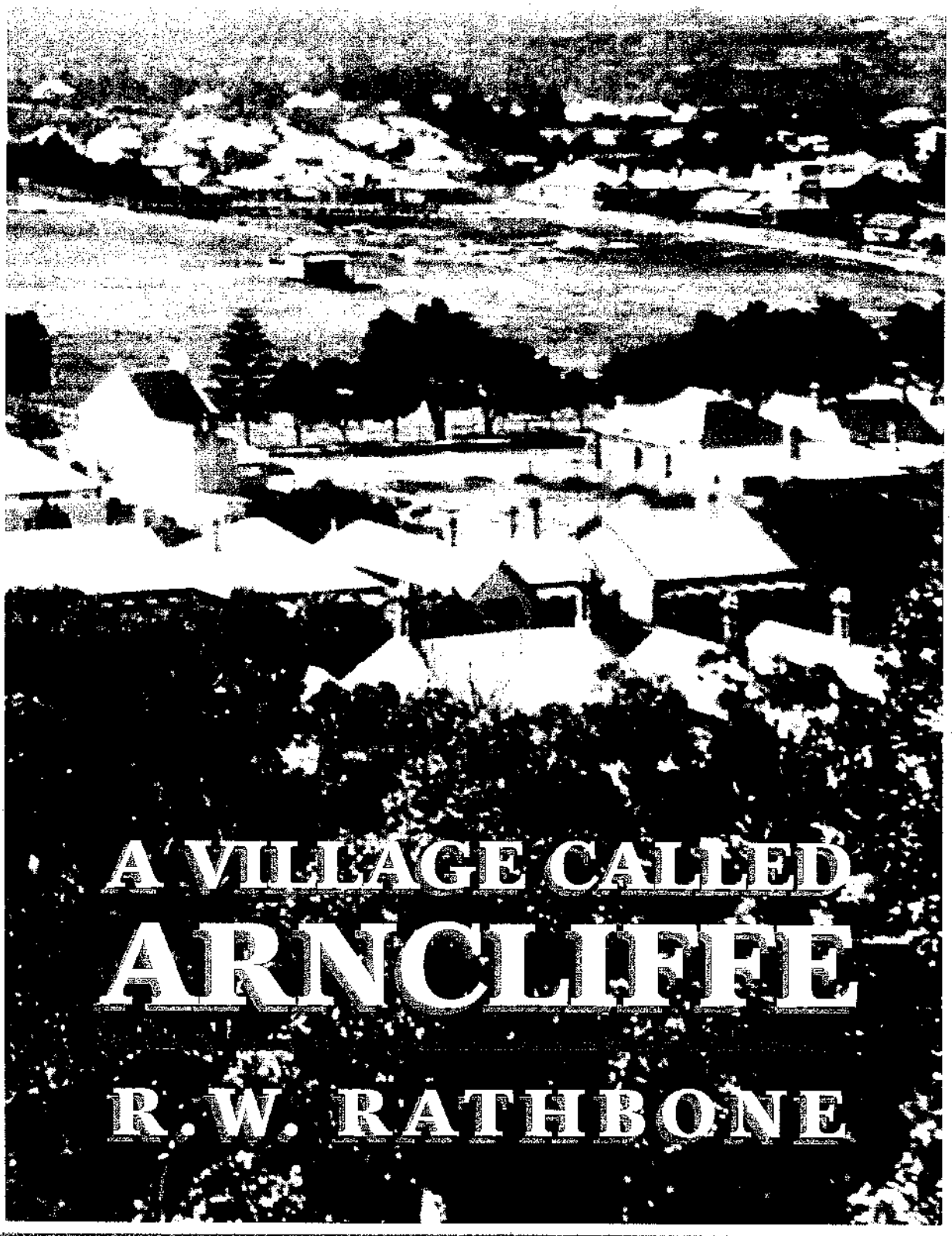
It was during these years that a number of the most significant open space areas in Arncliffe were developed. The most important of them was Barton Park. When the Arncliffe Sewage Farm was closed down in 1916, the land on the eastern side of Muddy Creek was sold or leased to the North Brighton Golf Club and the N.S.W. Polo Association, but the portion on the western side of the creek remained largely vacant. In 1930, Rockdale Council approached the Water Board with an offer to purchase 89 acres of the land for recreational purposes. The Board agreed to sell at £5 per acre and with a further 33 acres which the Council was able to acquire from adjoining landowners, it set to work to convert a low lying mosquito infested wasteland into the St. George Sporting Complex. Reclamation began in 1932, and ultimately twenty-two concrete cricket wickets were laid down on the area.

The naming of such a large sporting facility generated considerable controversy. Some of the aldermen favoured retaining the name, St. George Sporting Complex while others believed it should be named after Alderman George Barton, Mayor of Rockdale, and the man who had inspired the project in the first instance. When it was put to the Council to decide, the voting was four all with four aldermen absent. Alderman Barton then used his casting vote to name the complex after himself.

Between 1933 and 1935, Hopetoun Park was upgraded and renamed Gardiner Park in honour of long serving Alderman E.J. Gardiner and the landscaping of this picturesque park dates from that period. The development was, unfortunately, marred by the accidental death of ganger William Crossling who was fatally injured by a rock fall during the park's reconstruction.

Fourteen acres of land off Lorraine Avenue, most of which is now included in the Bardwell Valley Golf Course, was also acquired. Much of the area was rough and uneven but a section along the Lorraine Avenue frontage was filled and developed as a children's playground and called Silver Jubilee Park to commemorate the silver jubilee of King George V's accession to the throne.

The most important acquisition during the 1930s was the land now known as Cahill Park. Once an inlet from Cooks River backed by a tidal swamp covered in mangroves, the area was used as a dump for spoil taken from the river when it was dredged between 1898 and 1919. Despite the filling, it was



A VILLAGE CALLED ARNCLIFFE

R. W. RATHBONE

Removing the Stain: The Botany-Rockdale Sewage Farm, Sydney, NSW

COLLEEN CALLAGHAN

This study of Sydney's only sewage farm is concerned with a significant aspect of the urban process. Introduced as state of the art ideology during a short-lived phase of dynamic urban development in the late 1880s, it operated only thirty years before being superceded by the newer technology of ocean outfall disposal - a policy only now recognised as having far greater long term problems. The writer proposes that the lack of surviving visual evidence of this experiment in recycling human waste was part of a deliberate policy to erase it from urban memory. This research was carried as part of a BA Honours program.

The Botany-Rockdale Sewage Farm was a socio-environmental experiment which was formulated in response to the critical sanitary problems in the 1870s. Sanctioned by contemporary ideologies, it employed home-grown empiricism to mutate imported technology into an indigenous enterprise. It was Sydney's only sewage farm, and the earliest, major, government-funded project which attempted to purify, and to utilise, human waste products. The timespan of the Sewage Farm coincided with a period of dynamic urbanisation. During this period, a new ideology of sewage management was introduced. This was in ideological opposition to that which had motivated the formation of the Sewage Farm, and was based on cost-efficient, technolo-emphatic sewage schemes for large-scale urban problems. For a time the Sewage Farm operated as a small self-contained cog serving as a component of the larger, urban machine. Ultimately it was destroyed by the large-scale system, and was closed in 1916; a scant thirty years after it had been opened.

Since the Sewage Farm closed, the Water Board has published two official histories which encompass the water supply, sewerage and drainage works in the Sydney metropolitan area.[1] These histories do not provide an historical synthesis of sewage treatment, and it is apparent that selective historiographic processes have been employed to emphasise specific ideological messages. The Sewage Farm is only briefly mentioned, and emphasis is placed on later ideological developments in sewage technology e.g. the cost and size of the system, how the system works; and constructional difficulties overcome in its production. This historiographic method enforces the existing order, and at the same time, allows the influence of the present to be felt in the perceived past.[2] As a result, the Sewage Farm and the cultural ideologies which validated its establishment have become historically disenfranchised.

The site of the former Sewage Farm has been intensely modified, and all distinguishing landmarks have been eradicated. The surviving physical evidence is scattered, disparate, and insulate – a ruined corner of a building, a cluster of introduced trees, and a raised earthern platform. These physical remains are anonymous objects, which provide no visual mnemonic to trigger any remembrance of the Sewage Farm. They regain their original integrity only when they are translated into the composite of the total archaeological site. Mark Leone contends that our conceptions of the past are constrained by the past that survives;[3] and the past, in the direct physical form of the Sewage Farm, and indirectly in the ideologies of sewage management that it embodied, has not survived. Like its literary analogue, the Sewage Farm has become physically disenfranchised.

It is evident from the historiographic process used in the official histories of the Water Board that in order to reinforce the progressive nature of later ideological developments in sewage technology it was necessary to devalue the historical significance of the Sewage Farm. It is probable that a rationale of a similar nature can be applied to explain the intense modifications to the archaeological site, as well as the absence of any prominent physical evidence pertaining to the Sewage Farm. This paper therefore proposes the following hypothesis: to reinforce the validity of later ideological developments in sewage technology which disposed of urban sewage by ocean outfall, it was the preferred policy of the Water Board to diminish the physical evidence which distinguished the site of a government-funded Sewage Farm which had employed resource-management and anti-pollution to dispose of urban sewage.

To test the validity of this hypothesis the industrial archaeological site of the Sewage Farm will be examined within a broad historical intepretive construct in order to gain an understanding of the purpose of the Sewage Farm and the ideologies which led to its establishment; the broad-scale ramifications of the later ideological developments in sewage technology which ultimately led to the Farm's closure; and the ensuing partition of, and modifications to, the lands on which the Sewage Farm was situated. The archaeological site and its remains will be located and identified, and examined against relevant documentary evidence. No detailed survey is presented, nor was any excavation undertaken.

DOCUMENTARY SOURCES

There are four main sources for the historical understanding of the Sewage Farm. Each presents a separate argument, and facts are manipulated to suit the purposes of the particular vested interest. Therefore none can be taken at face value.

First: the Annual General Reports of the Water Board were prepared for the Legislative Assembly and tend to accentuate positive aspects of the operation and ignored or glossed over negative aspects. These Reports are the only documents which provide consecutive accounts of

the yearly activities at the Sewage Farm.

Second: the Minutes of Evidence 1875 relate to the Sydney City and Suburban and Health (SCSSH) Board's inquiry into the best means of disposing of Sydney's sewage. They detail the appalling sanitary conditions in the city and suburbs, and a pragmatic attitude to human waste which spanned the class spectrum from judges, to Chinese market gardeners.

Third: the Minutes of Evidence 1906-1908 relate to the Parliamentary Standing Committee on Public Works Inquiry into a Scheme of Sewerage for the Illawarra Suburbs. Among those who gave evidence were the manager of the Sewage Farm who outlined the Farm's physical limitations, operating difficulties, future prospects and other matters, as well as officials and private individuals from neighbouring suburbs who commented upon local attitudes to the sewage farm, and to sanitary/medical matters in general. None of this material is included in any secondary source.

Fourth: the two official histories of the Water Board, which do not present an historical synthesis of sewage or sewage treatment, and the Sewage Farm is only briefly mentioned. Instead, they emphasise and chronicle the technological achievments involved in the metropolitan sewage networks, from point of entry to point of disposal.

It is not possible to confront these historical sources with detailed archaeological evidence. Nevertheless, when viewed as a total archaeological component the site itself illuminates the contradictions and misrepresentations in the documentary sources.

PROPOSED SEWERAGE SCHEMES FOR SYDNEY

The SCSSH Board was appointed in 1875 to inquire into, and report on, the best means of sewage disposal for the city and suburbs.[4] Board members included scientists with a knowledge of physical and natural sciences, medical professionals involved in the public health arena, and civil engineers. The latter belonged to a new class of professional men attaining prominence in governmental matters involving civic planning and administration, who relied on science and technology to solve the problems created by mass urban living.[5] The Board's investigations revealed that there was a critical sanitary situation in the city and suburbs, and that the problem of providing adequate water supplies and efficient sewerage systems had assumed metropolitan proportions.[6] Current medical ideology held that most diseases were either directly, or indirectly, attributable to the gaseous stenches, or miasmas, emitted by putrifying matter, and the Board considered the greatest health risk to the community came from the 'the immediate and palpable evil' generated by commonly used cesspits.[7] These were virtual on-site storage depots for human excreta, and it was not unusual for a common cesspit straddled by three or four privies, to be shared by the inhabitants of several houses as well as by the the patrons of commercial establishments. The removal of such waste products to some remote location was, *ipso facto*, essential for 'the public good'.

Two sewerage systems were recommended for the city and suburbs. Both cut across Municipal boundaries, and both were capable of being controlled by a single overriding authority.[8] They were to be water-carriage systems; with watertight, underground sewerage mains for transport; and with final disposal points as far removed from human habitation as possible. The first system proposed to intercept the sewage entering Port Jackson through sewers built during the 1850s, and divert it into a tunnel for discharge via ocean outfall at Ben Buckler Point near Bondi.

The second system proposed to sewer the southern slopes of the city, which had an estimated population of only 20 000.[9] These slopes formed the watershed of the north side of Botany Bay, and included portions of Surry Hills, Redfern, Newtown and other suburbs. Although Sydney's geographicial position made ocean outfall the most effective and cost-efficient method of sewage disposal, the SCSSH Board was aware that the Government would not approve the expense of constructing a second ocean outfall to service an area with such a small population. They therefore recommended that the sewage from the southern slopes be intercepted and collected in a similar manner to the Northern system, and disposed of at Botany. There the sewage would undergo a form of land treatment to purify the effluent and render it 'harmless' before discharge into Botany Bay. At the same time, the manurial value of the sewage would be utilised to produce vegetable crops for sale, the revenue from which would be used to offset running costs.[10]

This latter proposal was simply an extension of a relatively common domestic activity. A lack of embarrassment towards the functions of the body and its byproducts made it culturally acceptable for home, and market gardeners, to improve the poor quality soil in Sydney by fertilising their gardens and vegetable crops with liquid sewage, 'soup' from boiling-downs, or dried blood. The Board also knew from their investigations of English and European sewage farms that 'the most surprising fertility'[11] had resulted from irrigating raw sea sand with sewage, and they were of the opinion that the same results could be achieved at Webb's Grant. The soil was light and sandy, it could be easily cleared, and with proper management and the application of night soil, Sydney's mild winters would allow 'a luxuriant growth of a great variety of useful plants [to] be maintained here throughout the year'.[12]

Webb's Grant, the site chosen for the Sewage Farm, was a 120 ha (300 acres) tongue-shaped tract of land on the southern side of the mouth of Cook's River (Fig.1). It was almost uninhabited. It was an accessible place of deposit, and 'however much then the city and suburbs may extend, it may be made to remain for indefinite period almost isolated... [with] no possibility of any watercourse being polluted'.[13] The northern side of the river was mainly occupied by small market gardens, generally run by Chinese. These establishments provided most of Sydney's garden produce, and as settlement spread and land use became more intensified, they had gradually been pushed to unwanted areas on the periphery of the city. The Botany Swamps, at that time the source of Sydney's water supply, were also on the northern side of the river. In the 1850s a series of dams had been created along the Lachlan Stream. An engine pond was excavated, and an engine house constructed to pump water to Paddington Heights.[14]

THE BOTANY SEWAGE FARM 1880-1889

In 1889 the Metropolitan Water and Sewerage Act Amendment was passed by Parliament, and all existing sewerage systems, including the Sewage Farm, came under the centralised control of the Board of Water Supply and Sewerage, generally called the Water Board.

The main works of the Southern Sewage System were constructed between 1880-1889. Sewage discharged into a recessed chamber inside the Inlet House on the northern bank of Cook's River (Fig.2), and was passed through three sets of circular mesh screens. It was then transferred via an under-bed inverted syphon to a well inside the Outlet House on the southern side of the River from where it gravitated through the eastern portion of the farm in an open, concrete main carrier. The sewage was used to

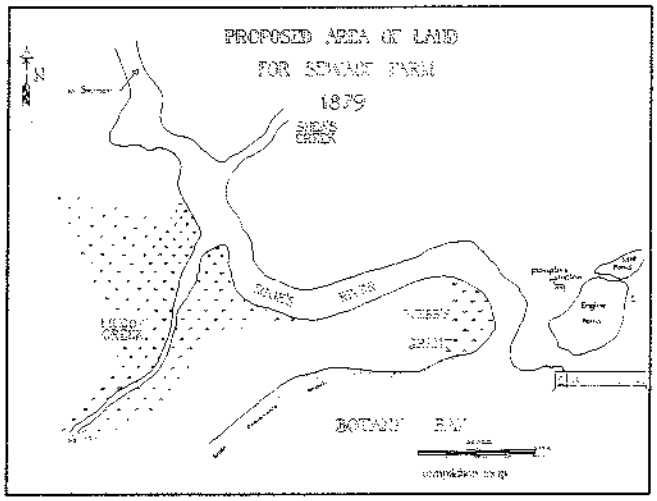


Fig. 1: Map of Botany-Rockdale Sewage Farm.

irrigate the beds on either side of the carrier, and the filtered effluent discharged into Cook's River and Botany Bay. A manually controlled Priestman grab mounted on a travelling gantry dredged the remaining sludge in the screening chambers for transfer into waiting skips, via chutes set into the side of the Inlet House. It was trucked by locomotive across a wooden bridge spanning Cook's River to the irrigation beds, where the farm's labourers manually dug it into the beds as manure (Fig.3). Crops were grown on the sheltered, northern side of the main carrier in a series of terraced, ridged and furrowed irrigation beds, which were separated by earth banks. On the exposed southern side, about 4 ha (10 acres) of partially underdrained ground was laid out in filtration beds. These received surplus sewage during heavy rainfall.

The farm commenced operating in 1887, and seven labourers were employed under the control of a manager. After three years of continual applications of sludge, about 8 ha (4 acres) of land were converted to a good loam from which successful crops of cabbages, turnips, lucerne and sorghum and other produce were grown. The Water Board's annual reports noted that the quality of the crops evidenced the value of liquid sewage when properly applied to raw sand, and lengthy inclusions from the Government Analytical Chemist declared that the high quality of the effluent demonstrated the suitability of the site and soil for purifying sewage by land filtration. However the Farm never produced enough income to cover operating expenses. To generate additional income some land was let for agistment, and around 1892 some land near Muddy Creek was leased for market gardens to Chinese and Europeans.

The Farm was in an exposed position. Sand blown by prevailing south-east winds destroyed early attempts at crop growing on the southern side of the main carrier. This limited the amount of land capable of producing crops, and reduced anticipated income. Documentary sources do not indicate if the SCSSH Board was aware of this factor when choosing the land, but site inspections testify to the fact that strong breezes sweep across the area, even on the calmest day. Although never clearly specified in official accounts, irrigation with crude sewage was not completely successful, and prolific growth could only be expected during a good rainy season. It was excellent for established crops, but was generally too strong for irrigating newly seeded land, as it burnt the plants.[15]

Webb's Grant was limited in size, and in choosing the English method of intermittent downward filtration the decisive factor had been the increased filtering capacity provided by underbed drains which were laid on the herringbone principle about a metre deep. To prevent soil clogging and maintain maximum filtering capacity, sewage applications were rotated. These aplications could also be varied i.e. broad irrigation, ridge-and-furrow irrigation or flood irrigation.[16] However, the imported system did not adapt successfully to local conditions as the sand was so fine it filtered through the gaskets choking the underground drains, and preventing the flow of sub-soil effluent. This impeded the filtration rate and the beds became sewage-logged. In one unsuccessful attempt to remedy this fault, the effluent drains were dug up, 'and after some trouble a cement joint, made of Nepean sand and cement mixed in proportions sufficient to make it porous, and at the same time, cohesive', was adopted.[17]

Around 1894, it was discovered that 'a coir mat wrapped around each joint and sewn on',[18] would successfully serve the purpose. Some of the material, 'made in the form of a mat', was found 'to be as sound as the day it was put in', after being buried in one of the filtration beds for over twelve months.[19] In line with the models proposed by Birmingham and Jeans, and later by Schreuder, this is a classic example of the modifications required before an imported technology could be adapted, mutated and eventually 'indiginised'.[20] Unfortunately the available information is tantalisingly insufficient. The Water Board's reports add little more, and it is doubtful if any other sources would elaborate on such a detailed point. The form of the coir used is unknown, and although the situation was critical, to wrap and hand-sew coir mats around every joint in all the underground effluent drains seems an extraordinarily laborious procedure. Furthermore, it seems too cumbersome a method to repel fine sand. As it is likely that many of the drains are still *in situ*, archaeological excavation is the only method which would explain exactly how this ingenious solution was accomplished.

Contemporary Attitudes to the Sewage Farm

Official histories relegate the role of the Sewage Farm to that of an experimental, temporary expedient. However, contemporary accounts belie this pejorative depiction, as does the quality of the buildings which were erected on the site. The deliberate matching of the Inlet and Outlet Houses, and the elaborate architectural detailing of their facades, represent a formal expression of civic pride in the establishment, and an external indication of the importance placed on the modern technological equipment which they housed. Pride in the establishment is also evidenced in the May 1892 edition of the *Illustrated Sydney News*, which describes, and illustrates, the Southern Sewerage System in considerable detail. A visit to the Sewage Farm is recommended; the best time being after a heavy storm to see how the 'inky tide within the carrier swells and threatens to become a banker'. Indirectly the article also indicates a lack of embarassment regarding the evacuation processes of the body that is alien in today's society, but which made the concept of the Sewage Farm acceptable to nineteenth century society.

Each year specific monies were allocated to improve the appearance of the Sewage Farm. Although never a stated policy, documentary and archaeological evidence indicate that the Water Board's longterm intention was to transform the Sewage Farm into an environmentally attractive, self-sufficient working environment. A substantial tree-planting program was instigated, which was still in progress in 1908. Fifteen hundred ornamental trees and shrubs were purchased from the Director of

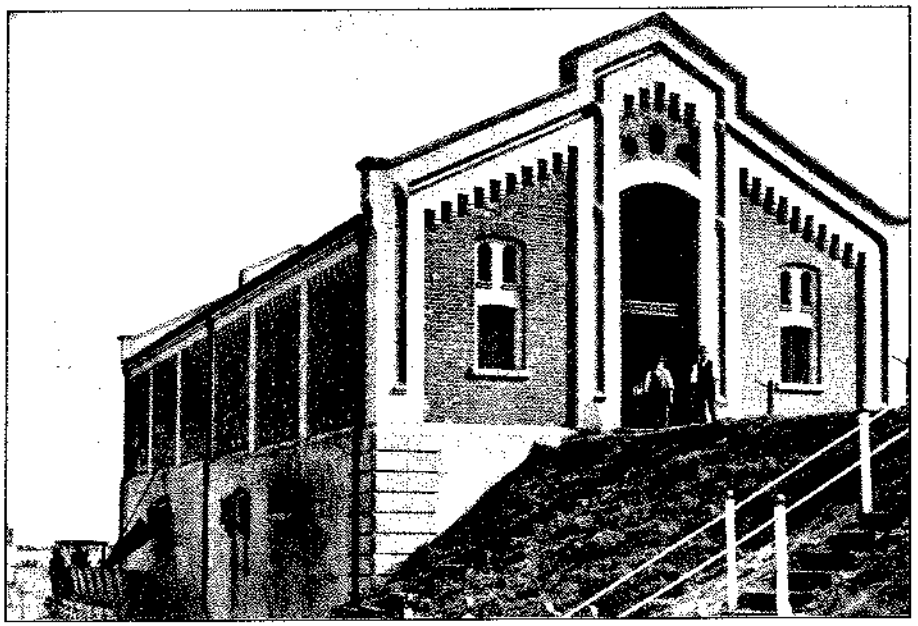


Fig. 2: The Inlet House at Botany Sewage Farm. (Archives of Sydney Water Board).

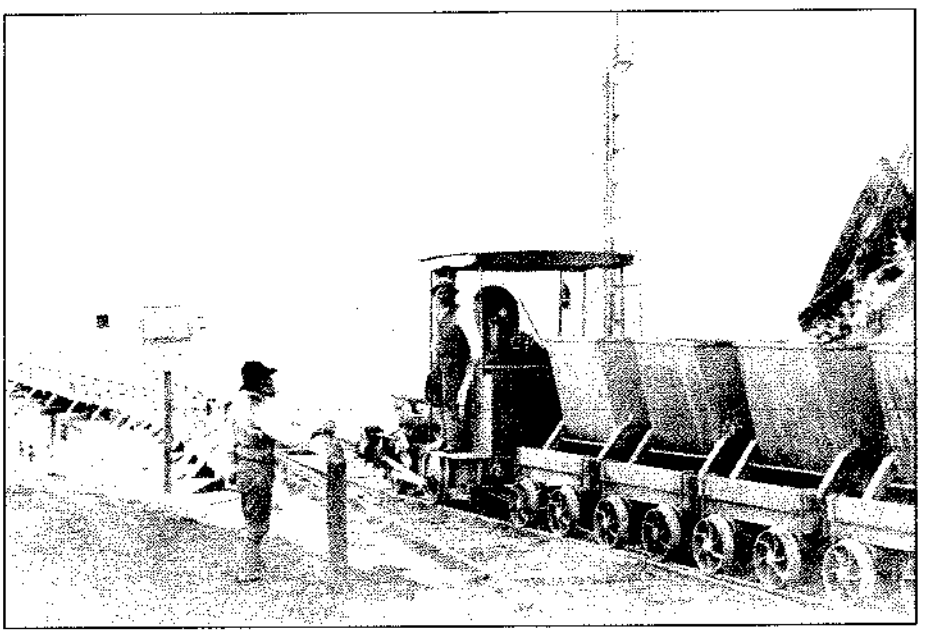


Fig. 3: Sludge being deposited into a waiting skip from the side of the Inlet House. (Archives of Sydney Water Board).

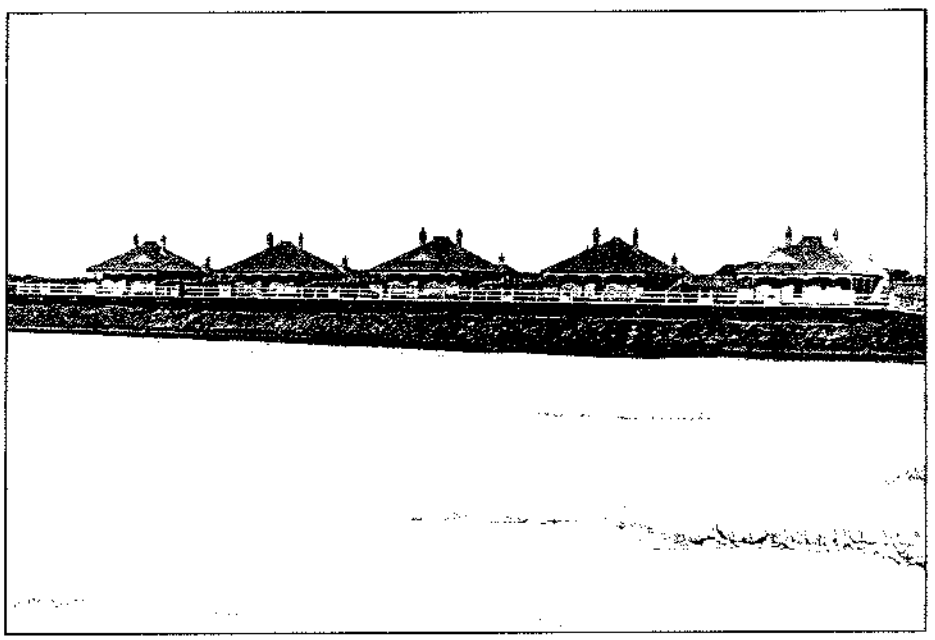


Fig. 4: Cottages built for the labourers at the sewage farm in 1898.

Botanical Gardens in the first year, and after trial and error it was found that Norfolk Island pines and Moreton Bay figs did especially well. Over 6 000 willows were also purchased. Apart from their attractive appearance, these were mainly planted in water-logged areas where their moisture- absorbing capacaties would do most good. The trees were intended to enhance the Farm's appearance, provide useful and ornamental windbreaks, and afford shade for the cattle.

The manager was provided with a residence at the Botany end of the Farm, and in 1898, five workmen's cottages in 'brick with tiled roofs to neat design', were erected on resumed land at Lady Robinson's Beach.[21] (Fig.4). The cottages were rented to the Farm's labourers, and were intended to conduce the appearance of the place. The foreshore bank of Botany Bay was trimmed and grassed, and the land enclosed by a substantial fence with entrance gates to keep out trespasses. The railway was also extended across Muddy Creek to the new western perimeter of the Farm at Eve Street, Rockdale, principally to convey farm employees' children to school.

Western Suburbs Sewerage Scheme

During the 1890s work commenced on the nucleus of the immense Western Suburbs Sewerage Scheme, which proposed draining portions of nineteen municipal districts, and was designed to meet the future requirements of the entire area. The Scheme was based on the superiority of a technologically-emphasised system which would eventually underpin the total suburban landscape with a network of self-regulating and self-cleansing sewers unobtrusively transporting all sewage to ocean outfalls for final disposal. The decision was taken to dispose of the sewage from this large system on resumed land adjacent to the Sewage Farm. An additional 124 ha (309 acres) of land were resumed to the west of Webb's Grant to form the Botany-Rockdale Sewage Farm, which placed the western perimeter on the edge of the populated Illawarra suburbs. Much of the resumed land was totally unsuitable for filtration or crop growing purposes as it was swampy, and subject to tidal influence. Saltwater could be found about 20–22 cm (8 or 9 inches) under the surface of the sand,[22] and when maximum filtering capacity was required it was necessary to flood the land with sewage to a depth of 30 cm. To make way for the larger and more cost-efficient urban sewage scheme, the Sewage Farm became a disposal area for immense quantities of urban sewage. In 1896 the Board had been able to report that 'the high standard of purity hitherto reached is still maintained',[23] but by 1902 analyses of the effluent showed that it was 'merely clarified sewage', which putrified when it was incubated.[24] The resource-management and anti-pollution ideology which had motivated the establishment of the Sewage Farm was now superseded by a different ideology of sewage.

The scattered nature of the Illawarra suburbs had begun to change with the construction of a railway from Sydney to Wollongong in the 1880s, and by the turn of the century the locality was undergoing its own process of urbanisation. The changed nature of the newer method of sewage management had began to alter private perceptions of human waste products, and while not yet a universal desire, many people considered that until their suburb was supplied with an efficient sewerage scheme it lacked total gentrification. It was deeply resented that the sewage from the western suburbs was dumped on the local doorstep. It was generally demanded that the Sewage Farm be totally abolished, and all sewage be disposed at sea where it could not be seen or smelt. Despite the fact that miasmatic-based medical beliefs were no longer current, it was considered to be a malodorous blot on the local landscape which depressed property prices in the locality; deterred a 'better class' of people from settling in the area; and prevented any 'decent residences' from being built for many years.[25] One resident described it as a foul nightmare which looked like a 'big sheet of water' in wet weather.[26]

Partition and Disappearance

Following a Parliamentary Inquiry held between 1905-1908, it was recommended that the Sewage Farm be abolished, and the sewage disposed into the ocean at Long Bay. The Botany-Rockdale Sewage Farm ceased operating in September 1916, when the Southern and Western Suburbs Ocean Outfall Sewer (SWOOS) No.1 was completed. The Farm cottages were let, and the plant and railway were sold in 1919. SWOOS No.2 was constructed in 1941. Both systems traversed the Sewage Farm and the existence of archaeological remains along their paths is unlikely, as their construction created considerable ground disturbance. The main carrier is not visible in aerial photographs taken in 1947, and was probably demolished when SWOOS No.2 was built. Sections of the concrete foundations could still exist in archaeological form.

Excepting about 18 ha (45 acres) retained by the Water Board along the path of the ocean outfall line, the lands were disposed during the 1930s. Rockdale Council reclaimed an area in the south-western corner to create a large recreational park.[27] The main areas of activity (irrigation and filtration beds) were occuped by a public area abutting Botany Bay, designated Cook Park, and two golf links on the northern side of the peninsula. Crop marks from ridge-and-furrow cultivation methods in the irrigation beds were visible in a 1950s aerial photograph, indicating minimal ground disturbance when these new land uses were developed. Consequently some below-ground archaeological evidence may have survived, particularly the filtration drains with their coir wrappings, as it would have been an unnecessary expense to remove them.

Between 1947-1956, Cook's River was diverted south of its original mouth to a new outlet into Botany Bay, to allow for extensions to Kingsford Smith Airport. A large area of land was resumed, including much of the site of the Sewage Farm, and during the ensuing civil engineering works, the Inlet and Outlets Houses were demolished. The foundations were probably left *in situ*, as the ground level was raised to create a new east-west runway, and the demolition rubble used as fill in the old river bed. The under-river syphons were probably left *in situ*, along with other archaeological deposits, some of which could predate the original installation in the 1880s. The workmen's cottages were demolished following the 1963 extension of the north-south runway into Botany Bay.

The Site Today

The site of the original Botany Sewage Farm now forms part of the airport complex, and orientation is extremely difficult as all distinguishing landmarks were obliterated by the airport extension (Fig.5). Nevertheless, site inspections are invaluable as they animate a comprehension of the environmental context, which allows an appreciation of the Sewage Farm as a working entity in a specific physical location. Despite busy airport traffic, the area still has a feeling of isolation which makes it easier to understand why the site was chosen in the first place. Yet the exposure of the land to the winds from the Bay, the fine sandy soil, and the scrubby nature of existing vegetation, clearly demonstrates the unsuitability of the

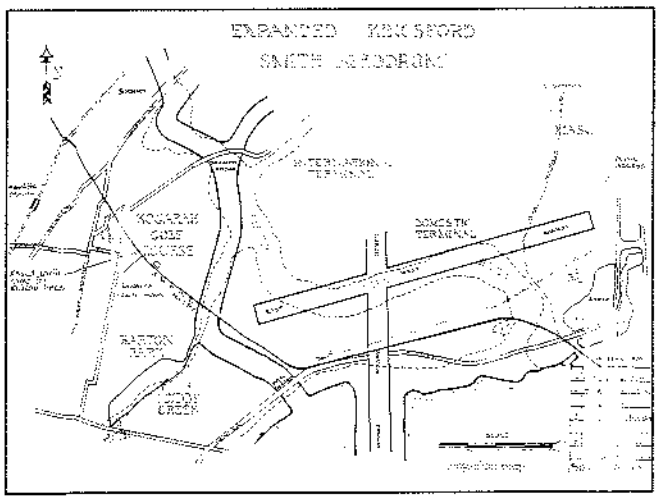


Fig. 5: The site today.

location for crop growing activities on a commercial scale.

The diversion of Cook's River had a radical effect on the physical site of the Sewage Farm. The new course of the river bisected Webb's Grant, alienating the Botany end of the Sewage Farm from the Rockdale extension. Also, the archaeological remains associated with the Botany water works and Mill Pond, which were originally on the opposite side of the River, became adjacent to the site of the Botany Sewage Farm when the disused river bed was filled in. Consequently the physical site of the Sewage Farm has become more obscured by the proximity and prominence of these archaeological remains, which are associated with some of Sydney's earliest history.[28] One direct link to the past is provided by a group of small Chinese market gardens which still operate alongside Muddy Creek, on low-lying land that was formerly part of the Sewage Farm.

A rear corner from one of the workers' cottages, eight brick-courses high, is the only remaining above-ground bricks and mortar structure from the Sewage Farm. Located outside the perimeter of the airport alongside General Holmes Drive, the site is discernable by demolition rubble, possibly from the former cottages, which is scattered between fairly dense native shrubbery resulting from natural revegetation. Despite the passing traffic, the site of the workmen's cottages is isolated. This isolation would have been even more pronounced when the cottages were first built, as they were situated on the extreme south-east perimeter of the Sewage Farm, quite remote from any other habitation. This remoteness must have increased the construction costs of the dwellings, reinforcing the fact that, at the time, the Sewage Farm was sufficiently important to have its workers housed on site, despite the expense. The context in which these cottages were built also highlights the more fundamental attitude to human waste products which then prevailed. The Sewage Farm would have been the focal point for those who lived in this isolated enclave, as external contact could only be gained by traversing the Farm to Arncliffe in the west, or by crossing Cook's River to Botany in the north.

On the western perimeter of the site is a small area of land now known as the Eve Street Wetlands. These are a relic of a larger water system originally paralleling the western margins of Botany Bay, and may be a surviving remnant of a pre-European landscape. The Wetlands are a valuable archaeological indicator, as a portion of this system was incorporated into Rockdale Sewage Farm. The land was left largely untouched because it was unsuitable either as a filtering medium or for crop-growing purposes. This very unsuitability illustrates the change in ideologies pertaining to sewage technology. With the commencement of the Western Suburbs Sewerage Scheme, it was ideologically more important to have a disposal area for large quantities of urban sewage, than to have a sewage farm which could purify and husband the resources of relatively small quantities of sewage. The swampy, low-lying nature of the area also demonstrates the physical difficulties in draining and desalinating the land to make it suitable as a filtering medium, and the magnitude of filling carried out during, and since, the closure of the Farm, which increases the survival rate of archaeological remains.

It is possible that a brick building used by Rockdale Council, which is adjacent to the the Wetlands, could contain some archaeological evidence. It is situated almost directly over the site of the screening chamber, which was in use at this end of the Farm.[29] However the only above-ground archaeological evidence at the Rockdale end of the Farm is a stretch of earthern embankment, which carried the railway past the swamplands to its termination point at Marsh Street, Rockdale, and a stand of pine trees, which are remnants of the Farm's tree-planting programme.

The two disparate sets of archaeological evidence – the remains of the worker's cottages on the south-eastern perimeter and the railway embankment and pine trees on the western perimeter – are virtually located on opposing extremities of the Sewage Farm, and are out of sight of each other. In conjunction with each other, they serve as archaeological indicators delineating the spatial distribution, as well as the size of the Sewage Farm, which appears far too large to have been attended successfully by a manager and seven labourers. Significantly, both sets are associated with the attempts to improve the appearance of the Sewage Farm and to make it a self-sufficient working environment. All traces of the working establishment have been totally abolished.

DISCUSSION

Despite miasmatic-based medical opinions, nineteenth century pragmatism saw nothing amiss with utilising human excreta to improve the soil and encourage crop growth; such practices were an indication of good husbandry. A government-funded sewage farm which proposed purifying sewage by land treatment, as well as utilising the manurial value of the sewage to produce and sell vegetables commercially, was therefore neither unusual not unacceptable; indeed there was considerable civic pride in the establishment, as witnessed by the elaborate public buildings which were erected at the Farm. Contemporary literature also indicates that, for most of the 1890s, the Sewage Farm managed to fulfil its goals, and was well regarded. However during this decade the ideologies which had motivated the establishment of the Botany Sewage Farm in the mid 1870s were superseded by an ideology of sewage management which was based on large-scale and cost-efficient technologies. The Sewage Farm became officially expendable in the late 1890s when it was extended to provide a sewage disposal area for the immense Western Suburbs Sewerage Scheme.

The twenty years prior to the turn of the century had been characterised by intense urbanisation. One of the effects of this process on the residents in the adjacent Illawarra suburbs had been to develop an awareness of their own collective identity. Miasmatic-based medical opinions had altered, but so had earlier fundamental attitudes to human waste products. While many residents considered the prestige of the area would be enhanced by

an efficient scheme of sewerage similar to that of the Western Suburbs, the majority strongly resented the sewage from the Western Suburbs Scheme being deposited so close to their suburbs. The Sewage Farm became privately expendable, when its malodorous proximity was considered to be a threat to the welfare and prosperity of the local community.

When the lands were partitioned during the 1930s, almost all of the site of the Sewage Farm was alienated for sport or recreational facilities. Rockdale Council created a large park, by raising the level of the land and obliterating the swamp lands in the south-west corner. An action which could be regarded as vindicative, as by totally changing the landscape, unpleasant memories associated with former landmarks were effectively eradicated. In 1939 the Sewage Farm became historically expendable when it was virtually written out of the Water Board's first official history. An historical process that was to continue when the second history was published in 1969.

Although it was never a stated policy of the Water Board, archaeological expendability was simply the final step in the process of reducing the Sewage Farm to a non-event in terms of sewage disposal techniques. No official, or private, objections were raised when the extensions to Kingsford Smith Airport proposed restructuring most of the site and demolishing the remaining buildings associated with the Sewage Farm. Significantly the archaeological evidence associated with the earlier Botany water works and Mill Pond survived the massive extensions to the Airport; the Inlet and Outlet Houses did not. Failing any hard evidence to the contrary, it would appear that the severe modification to the archaeological site of the Sewage Farm, as well as the absence of any prominent physical evidence, came about not through neglect or disuse, but by a change in the official ideology of sewage management. This ideological change caused the Sewage Farm to become defunct. It also caused the Sewage Farm to become such an anathema to the people in the local neighbourhood, that any action by any authority which aimed to replace or obfuscate the Sewage Farm with a 'respectable' alternative would not have been discouraged.

In the late twentieth century the disposal of sewage by ocean outfall has become a culturally acceptable fact of urbanised living, and the method of disposal is seldom called into question, despite pollution of the city's beaches. So far has the cultural pendulum swung from the more fundamental approach of the nineteenth century, it is probably fair to say that most people are unaware that Sydney once had a sewage farm which employed resource-management and anti-pollution techniques to dispose of urban sewage. To paraphrase Mark Leone, we only know the past by what we can see, and ignorance of the Sewage Farm has been fostered by the absence of any conspicuous archaeological evidence and the severe modifications to the site. This absence has had the effect of allowing its memory to fade from the collective consciousness, while simultaneously it has reinforced the ideological validity of current sewage technology. The past has been reinterpreted to buttress modern identity, and there is no place in this modern identity for the Sewage Farm.

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3. Leone, M. 1981. 'Archaeology's Relationship to the Present and the Past' in R.A. Gould & M.B. Schiffer (eds), *Modern Material Culture: The Archaeology of Us*, Academic Press, pp. 5-13.

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5. For discussion on the ramifications of self-perpetuating technological systems such as the sewerage system of Sydney see Beder, S., 1990. 'Early Environmentalists and the Battle against Sewers in Sydney'. *Journal of the RAHS*, 76:24-41.

6. F.J.J. Henry *op.cit.* p.1.

7. Twelfth and Final Report, SCSSH Board, 11 May 1877, p.4.

8. Debate on Sewage Disposal, Minutes of Evidence SCSSH Board, 1875, p.142.

9. Minutes of Evidence SCSSH Board p.134.

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23. Eleventh Annual Report, MBWS&S, 1899, p.83.

24. Fifteenth Annual Report, MBWS&S, 1902, p.37.

25 Minutes of Evidence, PSC on PW, 1907, p.72.

26. Arthur Goddard, Land and Estate Agent, Ancliffe, 1905. Scheme of Sewerage for the Illawarra Suburbs. Parliamentary Standing Committee on Public Works p.70.

27. Geeves P. & Jervis, J., 1986. *Rockdale Its Beginning & Development*, Council of the Municipality of Rockdale, p.113.

28. These remains are currently under review as part of the Botany Wetlands Heritage Study Report prepared for the Federal Airports Corp. & the Sydney Water Board, May, 1991, W. Thorp, B. McDonald, C. Burton, T. Brassil.

29. Oral information supplied by N.J. Thorpe.

ANNEXURE 2:
Allotments and land ownership map, Barton Park

Folio Identifier	Veris Plan Identifier	Lot No	DP No	Owner as Noted on Title	Current Alternate Name	Acquisition Notation or Road	Comments
1/107987	A	1	DP107987	Commonwealth of Australia			Subject of Lease to Sydney Airports
1/108492	B	1	DP108492	The Council of the Municipality of Rockdale	Bayside Council	DP1224219	Subject of Lease for Roads Act
1/219126	C	1	DP219126	The Council of the Municipality of Rockdale	Bayside Council		
1/329283	D	1	DP329283	The Commissioner for Main Roads	RMS	DP1224223	
1/514811	E	1	DP514811	Minister Administering the Environmental Planning and Assessment Act			
1/576148	F	1	DP576148	The Council of the Municipality of Rockdale	Bayside Council		
1/665481	G	1	DP665481	Rockdale Council	Bayside Council		
5/1050923	H	5	DP1050923	Commonwealth of Australia			
7/1050923	J	7	DP1050923	The State of New South Wales			Cooks River Diversion Canal
9/1050923	K	9	DP1050923	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
10/1050923	L	10	DP1050923	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
11/1050923	M	11	DP1050923	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
11/1069479	N	11	DP1069479	The Council of the Municipality of Rockdale	Bayside Council	DP1226091	
12/1050923	P	12	DP1050923	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
13/570900	Q	13	DP570900	The Commissioner for Main Roads	RMS	DP1224202	
14/213314	R	14	DP213314	Rockdale Council	Bayside Council	DP1224202	Old Systems Land
18/1069479	S	18	DP1069479	Sydney Water Corporation			Partly Limited in Stratum
25/1069479	T	20	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	and further Acquisition DP1226091
26/1069479	U	26	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	and further Acquisition DP1226091
27/1069479	V	27	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	and further Acquisition DP1226091
28/1069479	W	28	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	and further Acquisition DP1226091
29/1069479	X	29	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway (Limited in Stratum)
30/1069479	Y	30	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway (Limited in Stratum)
31/1069479	Z	31	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
32/1069479	AA	32	DP1069479	Roads and Traffic Authority of New South Wales	RMS	Dedicated as Road 7-3-2014	M5 Motorway
35/1069479	AB	35	DP1069479	Rockdale Council	Bayside Council	DP1226091	Public Road (Limited in Stratum)
36/1069479	AC	36	DP1069479	Rockdale Council	Bayside Council	DP1226091	Public Road
100/1133869	AD	100	DP1133869	Rockdale Council	Bayside Council		
A/400546	AE	A	DP400546	The Commissioner for Main Roads	RMS		
100/1231954	BA	100	DP1231954	Kogarah Golf Club Limited		DP1224202	
101/1231954	BB	101	DP1231954	Kogarah Golf Club Limited		DP1224202	
102/1231954	BC	102	DP1231954	Roads and Maritime Authority	RMS		Land is required for Road Purposes
103/1231954	BD	103	DP1231954	Roads and Maritime Authority	RMS	DP1231486	Land is required for Road Purposes
100/1228008	BE	100	DP1228008	The State of New South Wales			
101/1228008	BF	101	DP1228008	Her Most Gracious Majesty Queen Elizabeth the Second			
102/1228008	BG	102	DP1228008	Roads and Maritime Authority	RMS		Land is required for Road Purposes
103/1228008	BH	103	DP1228008	Roads and Maritime Authority	RMS		Land is required for Road Purposes
20/1224233	BJ	20	DP1224233	Sydney Water Corporation			Partly Limited in Stratum

M.G.A. NORTH

ISSUE	DATE	AMENDMENT	BY

TYPICAL NOTES:

1. ORIGIN OF LEVELS SSM 0000, RL00.000 (A.H.D.)
2. BEARINGS ARE ON XXXX NORTH
3. NO BOUNDARY SURVEY HAS BEEN UNDERTAKEN.
4. BEARINGS & DISTANCES HAVE BEEN COMPILED FROM TITLE AND/OR DEED INFORMATION SUPPLIED BY DEPARTMENT OF LANDS NSW
5. RELATIONSHIP OF IMPROVEMENTS AND DETAIL TO BOUNDARIES IS DIAGRAMMATIC ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
6. SERVICES SHOWN ARE BASED ON VISIBLE SURFACE INDICATORS EVIDENT AT THE DATE OF SURVEY AND THE RELEVANT SERVICE DIAGRAMS OF THE VARIOUS AUTHORITIES. ALL SERVICE MUST BE VERIFIED ON SITE PRIOR TO ANY WORK BEING UNDERTAKEN. LINKER SURVEYING PTY LTD BEAR NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE SERVICES SHOWN HEREON.
7. RIDGE, EAVE & GUTTER HEIGHTS HAVE BEEN OBTAINED BY AN INDIRECT METHOD AND ARE ACCURATE FOR PLANNING PURPOSES ONLY.
8. ADJOINING BUILDINGS AND DWELLINGS HAVE BEEN PLOTTED FOR DIAGRAMMATIC PURPOSES ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
9. THE DIAMETER (Ø), SPREAD (S) & HEIGHT (H) OF EACH TREE IS INDICATIVE ONLY AND SPECIFIC DETAILS, IF CRITICAL, WILL REQUIRE FURTHER SURVEY.
10. CONTOURS ARE AN INDICATION OF THE TOPOGRAPHY ONLY. SPOT LEVELS SHOULD BE USED IF DETAILED DESIGN IS TO BE UNDERTAKEN.
11. CONTOUR INTERVAL X.X METRE.

LEGEND OF TYPICAL CODES

AE - ARCHITECTURAL EMBELLISHMENT
AP - ALIGNMENT PIN
AWN - AWNING
BALC - BALCONY
BAWN - BOTTOM OF AWNING
BB - BOTTOM OF BANK
BCH - BOTTOM OF CHIMNEY
BD - BOTTOM OF DOOR
BDY - BOUNDARY
BF - BOTTOM OF FENCE
BHR - BOTTOM OF HANDRAIL
BT - BITUMEN
BK - BOTTOM OF KERB
BLD - BUILDING
BM - BENCH MARK
BOL - BOLLARD
BR - BOTTOM OF ROCK
BRK - BRICK
BRW - BOTTOM OF RETAINING WALL
BS - BOTTOM OF STEPS
BW - BOTTOM OF WALL
BWIN - BOTTOM OF WINDOW
CHIM - CHIMNEY
CL - CENTRELINE
CLID - CONCRETE LID
COL - COLUMN
COM - COMMUNICATIONS PIT
CONC - CONCRETE
CPT - CARPORT
D - DOOR
DD - DISH DRAIN
DH - DRILL HOLE
DHW - DRILL HOLE & WINGS
DWY - DRIVEWAY
EB - EDGE OF BITUMEN
EBOX - ELECTRICITY BOX
EC - EDGE OF CONCRETE
ED - EDGE OF DOOR
EG - EDGE OF GARDEN
ELEC - ELECTRICITY PIT
ELP - LIGHT POLE
EP - EDGE OF PATH
ER - EDGE OF ROAD
FCE - FENCE
FL - FLOOR LEVEL
FFL - FINISHED FLOOR LEVEL
FP - FENCE POST
GD - GLASS DOOR
GL - GROUND LEVEL
GM - GAS METER
HPG - HIGH POWERED GAS
HR - HANDRAIL
HYD - HYDRANT
IL - INVERT LEVEL
K - KERB
LIN - LINTEL
LP - LAMP POST
MH - MANHOLE
MLID - METAL LID
NS - NATURAL SURFACE
OCC - STRUCTURE
OPT - OPTUS PIT
PC - PRAM CROSSING
PCD - PEDESTRIAN CROSSING
PERG - PERGOLA
PM - PERMANENT MARK
PP - POWER POLE
RCK - ROCK
RLWY - RAILWAY
RM - REFERENCE MARK
RR - ROOF RIDGE
RSW - CONCRETE WALL
SEW - SEWER
SHR - SHRUB
SIP - SEWER INSPECTION PIT
SLH - SEWER LAMP HOLE
SMH - SEWER MANHOLE
SP - SIGN POST
SSM - STATE SURVEY MARK
SV - STOP VALVE
SW - STORM WATER
TARCH - TOP OF ARCH
TAWN - TOP OF AWNING
TB - TOP OF BANK
TBX - TELSTRA BOX
TCH - TOP OF CHIMNEY
TD - TOP OF DOOR
TEL - TELSTRA PIT
TELP - TELSTRA PILLAR
TF - TOP OF FENCE
TG - TOP OF GUTTER
THR - TOP OF HANDRAIL
TI - TRAFFIC ISLAND
TK - TOP OF KERB
TL - TRAFFIC LIGHT
TP - TOP OF PARAPET
TR - TREE
TRF - TOP OF ROOF
TRK - TOP OF ROCK
TRW - TOP OF RETAINING WALL
TS - TOP OF STEPS
TW - TOP OF WALL
TWIN - TOP OF WINDOW
US - UNDERSIDE
UAWN - UNDERSIDE OF AWNING
UKS - UNKNOWN SERVICE
USB - UNDERSIDE OF BEAM
USC - UNDERSIDE OF CEILING
USE - UNDERSIDE OF EAVE
USG - UNDERSIDE OF GUTTER
V - VENT
VER - VERANDAH
VC - VEHICLE CROSSING
W - WINDOW
WM - WATER METER

LEGEND OF TYPICAL SERVICES

C - COMMUNICATIONS CABLE
CSWP - CERAMIC STORMWATER PIPE
E - UNDERGROUND ELECTRICITY CABLES
AE—AO - UNDERGROUND ELECTRICITY & OPTUS CABLES
FS - FIRE SERVICE
G - GAS LINE
GE - GAS LINE & ELECTRICITY CABLES
NBN - NATIONAL BROAD BAND CABLES
NG - NATURAL GAS LINE
OH - OVERHEAD CABLES
OPT - OPTUS CABLE
PE - PRIVATE ELECTRICITY
PS - PRIVATE SEWER
PW - PRIVATE WATER
RW - RECYCLED WATER
RM - RISING MAIN
RMS - ROADS & MARITIME SERVICES
S - SEWER
SO - SEWER OUTFALL
ST - SHARED TRENCH
SW - STORM WATER
SW—CK - STORMWATER CREEK
T - TELSTRA CABLES
TG - TELSTRA & GAS CABLES
U - UNKNOWN SERVICE
VO - VOCUS CABLES
VR - VERIZON CABLES
W - WATER SUPPLY
WM - WATER MAIN

1. ALL UNDERGROUND SERVICE INFORMATION INCLUSIVE OF GENERAL POSITION AND SURFACE COVER DEPTHS NOTED ON THE PLAN ARE APPROXIMATELY ONLY.
2. ALL UNDERGROUND SERVICE INFORMATION HAS BEEN COMPILED FROM SERVICE AUTHORITY PLANS PROVIDED BY THE AUTHORITIES.
3. THE LOCATION OF SERVICES BETWEEN SURVEYED POINTS (AS INDICATED) HAVE BEEN SHOWN DIAGRAMMATICALLY ONLY USING THE SERVICE DIAGRAMS AS PROVIDED. THE EXACT LOCATION OF THESE SERVICES BETWEEN THE SURVEYED POINTS MUST BE VERIFIED PRIOR TO ANY EXCAVATION OR PILING. NO WARRANTY IS GIVEN AGAINST THE POSSIBILITY OF THE EXISTENCE OF FURTHER UNCHARTED SERVICES.
4. ALL CONTRACTORS, TRADESMEN, BUILDING & PROJECT CONSULTANTS MUST CONTACT THE VARIOUS AUTHORITIES, IN ACCORDANCE WITH STANDARD "DIAL BEFORE YOU DIG" PROCEDURES PRIOR TO UNDERTAKING ANY WORKS WITHIN THE VICINITY OF THE SERVICE LINES TO VERIFY THE POSITION OF THE SERVICE LINES.

Liability limited by a scheme approved under Professional Standards Legislation

REDUCTION RATIO 1 : 4000

0 50 100 150 200 250 300 350 400

LENGTHS ARE IN METRES

CLIENT

TITLE No	REF 171208
DATUM A.H.D.	ISSUE 1
DATE OF SURVEY	ISSUE DATE 11.12.17
SURVEYOR TM	SHEET SIZE A1
DRAFTER JJ	SHEET 1 OF 1 SHEETS

PLAN SHOWING TITLE & OWNERSHIP STRUCTURE OF COOKS COVE WITHIN THE BAYSIDE COUNCIL

LINKER
veris
Suite 301, Level 3, 55 Holt Street
Surry Hills NSW 2012
PO Box 1807
Strawberry Hills NSW 2012
t (02) 9212 4655
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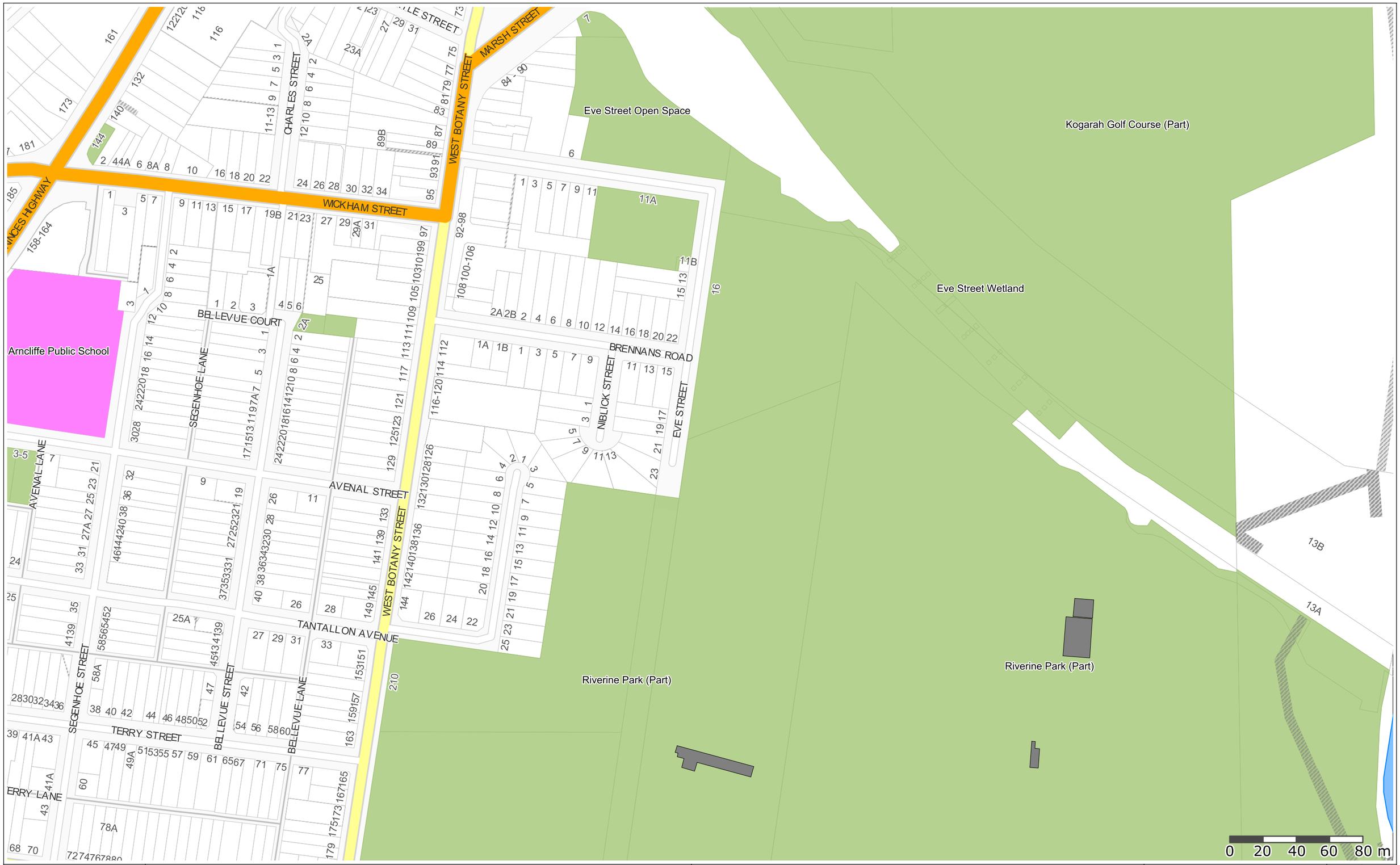
email reception@linkersurveying.com.au
web site www.linkersurveying.com.au

X:\17JOBS\171204 COOKS COVE\171204 TITLE REVIEW PLAN\171204 TITLE REVIEW PLAN.DWG

TITLE REVIEW PLAN



Bayside Council
Serving Our Community

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Prepared By: Kathy Pasalich

30/10/2018

1:2949

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Property Image	Street Address	Suburb	State	Postcode	Bed	Bath	Car	Land Size	Primary plan/Lot Plan	Owner 1 Name	Owner 1 Address	Owner 2 Name
	1 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	535	4/DP232592 ARNCLIFFE NSW	H MARTEENE	1 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	N MARTEENE
	2 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	534	3/DP232592 ARNCLIFFE NSW	R WHITEFORD	2 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	S WHITEFORD
	3 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	518	5/DP232592 ARNCLIFFE NSW	B LOWNE	3 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	4 Firmstone Gardens	Arncliffe	NSW	2205	3	1	1	561	2/DP232592 ARNCLIFFE NSW	E HYLAND	4 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	E HYLAND
	5 Firmstone Gardens	Arncliffe	NSW	2205	3	1	1	525	9/DP232592 ARNCLIFFE NSW	KENNEDY	5 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	6 Firmstone Gardens	Arncliffe	NSW	2205	5	2	0	474	14/DP232592 ARNCLIFFE NSW	F BEYDOUN	6 FIRMSTONE GDN ARNCLIFFE NSW 2205	S BEYDOUN
	7 Firmstone Gardens	Arncliffe	NSW	2205	4	1	2	487	10/DP232592 ARNCLIFFE NSW	J WILLIAMS	7 FIRMSTONE GDN ARNCLIFFE NSW 2205	M WILLIAMS
	8 Firmstone Gardens	Arncliffe	NSW	2205	2	1	0	500	13/DP232592 ARNCLIFFE NSW	BEYDOUN		
	9 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	496	11/DP232592 ARNCLIFFE NSW	A PETROU	9 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	J PETROU
	10 Firmstone Gardens	Arncliffe	NSW	2205	3	1	0	495	12/DP232592 ARNCLIFFE NSW	B KAREVSKI	10 FIRMSTONE GDN ARNCLIFFE NSW 2205	V KAREVSKI
	11 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	500	18/DP231717 ARNCLIFFE NSW	PAPANDREW		
	12 Firmstone Gardens	Arncliffe	NSW	2205	3	1	1	500	17/DP231717 ARNCLIFFE NSW	BLUNDELL	12 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	13 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	500	19/DP231717 ARNCLIFFE NSW	M JEET	13 FIRMSTONE GDN ARNCLIFFE NSW 2205	R JEET

	14 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	501	16/DP231717 ARNCLIFFE NSW	H KOUTROS	14 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	J KOUTROS
	15 Firmstone Gardens	Arncliffe	NSW	2205	3	1	1	500	20/DP231717 ARNCLIFFE NSW	LOMBARDI	15 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	16 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	497	15/DP231717 ARNCLIFFE NSW	J STAVROW	16 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	L STAVROW
	17 Firmstone Gardens	Arncliffe	NSW	2205	6	2	2	494	21/DP231717 ARNCLIFFE NSW	M MUNOZ	17 FIRMSTONE GDN ARNCLIFFE NSW 2205	M LOBOS
	18 Firmstone Gardens	Arncliffe	NSW	2205	6	0	0	500	14/DP231717 ARNCLIFFE NSW	S HUNGAR	18 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	19 Firmstone Gardens	Arncliffe	NSW	2205	3	1	2	500	22/DP231717 ARNCLIFFE NSW	KAREVSKI	19 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	20 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	508	13/DP231717 ARNCLIFFE NSW	B AVRAMOVSKI	20 FIRMSTONE GARDENS ARNCLIFFE NSW 2205	L AVRAMOVSKI
	21 Firmstone Gardens	Arncliffe	NSW	2205	4	1	4	498	23/DP231717 ARNCLIFFE NSW	M STOJANOVSKI	21 FIRMSTONE GDN ARNCLIFFE NSW 2205	P STOJANOVSKI
	22 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	487	12/DP231717 ARNCLIFFE NSW	IMPELLIZZERI	22 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	23 Firmstone Gardens	Arncliffe	NSW	2205	4	1	1	498	24/DP231717 ARNCLIFFE NSW	A STOJANOVSKI	23 FIRMSTONE GDN ARNCLIFFE NSW 2205	T STOJANOVSKA
	24 Firmstone Gardens	Arncliffe	NSW	2205	0	0	0	500	11/DP231717 ARNCLIFFE NSW	SLAVESKI	24 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	25 Firmstone Gardens	Arncliffe	NSW	2205	4	3	2	500	25/DP231717 ARNCLIFFE NSW	ABBAS	25 FIRMSTONE GDN ARNCLIFFE NSW 2205	
	26 Firmstone Gardens	Arncliffe	NSW	2205	3	1	1	500	10/DP231717 ARNCLIFFE NSW	BAKER	26 FIRMSTONE GDN ARNCLIFFE NSW 2205	CHEUNG-BAKER

Property Image	Street Address	Suburb	State	Postcode	Land Use 1	Zoning	Primary plan/Lot Plan	Owner 1 Name	Owner 1 Address	Owner 2 Name
	1 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Residential	17/DP10357 ARNCLIFFE NSW	N TRPESKI	1 NIBLICK ST ARNCLIFFE NSW 2205	S TRPESKI
	3 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Residential	16/DP10357 ARNCLIFFE NSW	TOOZE		
	5 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Residential	6/DP232592 ARNCLIFFE NSW	SMALL	5 NIBLICK ST ARNCLIFFE NSW 2205	
	7 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Undetermined Or Villa	7/DP232592 ARNCLIFFE NSW	L YOUNG	7 NIBLICK ST ARNCLIFFE NSW 2205	
	9 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Residential	8/DP232592 ARNCLIFFE NSW	M MILETIC	9 NIBLICK ST ARNCLIFFE NSW 2205	V MILETIC
	11 Niblick Street	Arncliffe	NSW	2205	Single Res Dwelling	Undetermined Or Villa	12/DP10357 ARNCLIFFE NSW	C KIEFFER	11 NIBLICK ST ARNCLIFFE NSW 2205	E KIEFFER
	13 Niblick Street	Arncliffe	NSW	2205			CP/SP62686 ARNCLIFFE NSW			
	1/13 Niblick Street	Arncliffe	NSW	2205	Residential Strata Unit	Residential	1/SP62686 ARNCLIFFE NSW	S DEBSIEH	1/13 NIBLICK ST ARNCLIFFE NSW 2205	
	13A Niblick Street	Arncliffe	NSW	2205	Residential Strata Unit	Residential	2/SP62686 ARNCLIFFE NSW	BUDD	13A NIBLICK ST ARNCLIFFE NSW 2205	JIANG
	13B Niblick Street	Arncliffe	NSW	2205		Residential		JOHN STUART REID & I	13 NIBLICK ST ARNCLIFFE NSW 2205	
	21 Niblick Street	Arncliffe	NSW	2205						

ANNEXURE 3:
Blank borehole log and Edison Sample Register

Edison Project ID .....
Project: .....
Client: .....
Hole ID: .....

Easting: .....
Northing: .....
Altitude: .....

EDISON
ENVIRONMENTAL + ENGINEERING

DRILLING INFO			LITHOLOGY		SAMPLE INFORMATION								WELL DETAILS				
							FID/PID (ppm)										
Depth	Method	Water	Symbol	Description	Sample ID	Type	0	250	500	750	1000		Flush Gatic				Depth
1																	1
2																	2
3																	3
4																	4
5																	5
6																	6

Drill Company: .....
Drill Model: .....
Hole Diameter:

Date commenced:
Date completed: .....
Logged by:

EEE SAMPLE COLLECTION REGISTER FORM

Sample numbering (ID) convention: *yymmdd.##.initials*

NOTE: Sample ID to be used on COCs and Field data sheets.

Weather conditions and general comments (If using multiple sheets, complete this section on first page only:

			Sample ID	Location	Site	Date	Time	Matrix	Description	Sampler	Client	EEE Project ID	Proj. Man.	Lab.
			200806- 01-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 02-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 03-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 04-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 05-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 06-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 07-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 08-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 09-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 10-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 11-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 12-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 13-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 14 -MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 15-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 16-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 17-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 18-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 19-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 20-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 21-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 22-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 23-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	

			Sample ID	Location	Site	Date	Time	Matrix	Description	Sampler	Client	EEE Project ID	Proj. Man.	Lab.
			200806- 24-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 25-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 26-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 27-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 28-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 29-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 30-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 31-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 32-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 33-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 34-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 35-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 36-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 37-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 38-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 39-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	
			200806- 40-MP		St George Site, Barton Park					PETROZZI	Bayside Council	E17011-CU	Petrozzi	