Volume 3: Appendices Bobbin Head + Apple Tree Bay Masterplan 2006

Ku-ring-gai Chase National Park

NSW National Parks and Wildlife Service

Department of Environment and Conservation NSW

Volume 3: Appendices
Bobbin Head + Apple Tree Bay Masterplan 2006
Ku-ring-gai Chase National Park

February 2007

Prepared for:
Department of Environment + Conservation

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Revision	Date	Description	By	Chk	App
01	10/05/06	Draft Masterplan Report - Rev 01	CP/LG/MY/BD/AB	MY	CP
02	24/05/06	Draft Masterplan Report - Rev 02	CP/LG/MY/BD/AB	MY	CP
03	26/05/06	Draft Masterplan Report - Rev 03	CP/LG/MY/BD/AB	MY	CP
04	04/08/06	Penultimate Masterplan Report - Rev 04	CP/LG/MY/BD/AB	MY	CP
05	16/08/06	Final Masterplan Report - Rev 05	CP/LG/MY/BD/AB	MY	CP
06	28/08/06	Final Masterplan Report - Rev 06	CP/LG/MY/BD/AB	MY	CP
07	02/02/07	Final Masterplan Report - Rev 07	CP/LG/MY/BD/AB		

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NSW National Parks and Wildlife Service

Department of Environment and Conservation NSW

Project Consultants

Head Consultants:

Conybeare Morrison
Masterplanning
Conservation Management Plan

Context Landscape Design
Landscape Management Plan

Sub-Consultants:

AMBS
Flora Report and Fauna Information

AMBS
Aboriginal Research and Analysis

Arup
Traffic and Transport Planning

Bay Partnership
Quantity Surveying

Douglas Partners
Geotechnical Engineering

PPM Consultants
Community Consultation

Stratcorp
Recreational Planning

Sydney Soils and Laboratory Services (SELS)
Soil Conditions

Taylor Lauder Bersten
Marine and Structural Engineering

Acknowledgements and thanks

The Project Control Group (PCG) for Bobbin Head and Apple Tree Bay Masterplans were:

Chris McIntosh	Regional Manager (Sydney North Region)	NPWS
Graeme Mitchell	Assistant Regional Manager, LHA	NPWS
Chris Grudnoff	Assistant Regional Manager	NPWS
Melanie Tyas	Assistant Area Manager	NPWS
Yma ten Hoedt	Planning Coordinator	DEC
Oriana Senese	Senior Projects Planning Officer, Central Branch	DEC
Mark Withford	Regional Works Coordinator, Sydney North Region	NPWS
Robin Aitken	Project Officer - Heritage, Central Branch	NPWS
Glen Crombie	Ranger, Ku-ring-gai Chase National Park	NPWS
Joanna Edney	Assistant Area Manager	NPWS
Michele Cooper	Senior Ranger, Neighbour + Community Relations Officer,	NPWS
Vince Moult	Assistant Area Manager	NPWS
Peter Milgate	Senior Field Supervisor (KCNP)	NPWS

CM+ and the Consulting Team wish to extend their special thanks to Chris McIntosh, Graeme Mitchell, Oriana Senese, Glen Crombie, Robyn Aitkin and Mark Withford for their great assistance with this project. Michele Cooper assisted with all liaison with the general public in relation to the Masterplanning process.

The Consultant Team Personnel were:

Bill Morrison	Company Director	Conybeare Morrison (CM+)
Colin Polwarth	Associate in Charge of Design	CM+
Lynette Gurr	Senior Heritage Specialist	CM+
Kate Denny	Heritage Specialist	CM+
Michelle Yik	Urban Designer	CM+
Rohini Mehta	Project Administrator	CM+
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Ben Dungey	Landscape Architect	Context
Astrid Brokamp	Landscape Architect	Context
Alan Duncan	Company Director	Bay Partnership (Quantity Surveying)
Leesi Lo	Quantity Surveyor	Bay Partnership
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Brett Maynard	Traffic and Transport Engineer	ARUP
Carolyn Stone	Company Director	PPM Consultants (Facilitator)
Richard Simon	Company Director	Stratcorp Recreational Planners
Brendon Ryan	Senior Project Manager	AMBS (Flora and Fauna)
David Thomas	Sub-Contractor (botanist)	AMBS (Flora)
Dr Melissa Carter	Project Manger	AMBS (Aboriginal heritage)
Alison Nightingale	Senior Project Manager	AMBS
Simon Leake	Company Director	SESL (Soils consultant)
Peter Oitmaa	Associate	Douglas Partners (Geotechnical engineering)

The project was directed by Bill Morrison and Oi Choong; the Masterplans were authored by Colin Polwarth with the assistance of Michelle Yik. The Conservation Management Plans were authored by Lynette Gurr with assistance from Kate Denny, and the Landscape Management Plans were authored by Ben Dungey with assistance from Astrid Brokamp. CM+ wishes to extend their thanks to the entire consulting team for their efforts and good will.

Special thanks go to the members of the community who assisted at various workshops and community consultation days, and for reading, reviewing and commenting on the Masterplan and for being involved in the process.

External Stakeholders

The External Stakeholders gave freely of their time, their enthusiasm and intimate knowledge of the parklands, which was of enormous benefit to the Masterplanning team. The External Stakeholders included:

NAME (no order)	Organisation
Pam Goldie	Chase Alive
Margarita Clayton	Coast Alive
Kurt Henkel	Landscape Coordinator, Hornsby Shire Council
Veronica Cook	'Bobbin Inn' Lessee
Miranda Heath	SNR Bobbin Head Information Centre
Stephen Smith	'Empire Marina' Bobbin Head
Stephen Black	Regional Manager, NSW Waterways
Alan Catford	National Parks Association.
John Roberts	Hornsby Shire Historical Society
Gordon Limburg	Hornsby Conservation Society
David Martin	Hornsby Conservation Society
Cindy Budai	'Kayak and Canoe Inc.'
John Stefas	'Kayak and Canoe Inc.'
Rodney Brown	Whittley Motor Boat Club of NSW
John Blundell	Apple Tree Bay Boat Owners Association.
Coral Blundell	Apple Tree Bay Boat Owners Association.
Geoff Gauslar	Apple Tree Bay Boat Owners Association.
Terrie Jenner	Boat Owners Association
Peter Stanford	Bobbin Head Cruising Lions Club Inc
Lavinia Schivella	Boating Industry Association
Bruce Foot	Gibberagong Field Studies Centre
Steven Head	Director, Open Space Ku-ring-gai Council
Jennifer Davis	District Officer, NSW Fisheries
Patricia Giles	SNR Advisory Committee
Lynn Parker	River Canoe Club

Preface

Volume 3, Appendices contains information in the form of reports, letters and reference material produced during the Masterplanning process for Bobbin Head and Apple Tree Bay.

This information should be read in conjunction with the Masterplan, Conservation Management Plan and Landscape Management Plans for Bobbin Head and Apple Tree Bay.

This Volume also contains a Bibliography of principal reference material.

Extensive historic drawings and supporting information regarding Bobbin Head, Apple Tree Bay and the Ku-ring-gai Chase National Park are available through DEC. The Appendices contain facsimile copies of historic information relevant to this Masterplan.

Abbreviations

AMBS
Australian Museum Business Services

AHIMS
Aboriginal Heritage Information and Management Systems

CMP
Conservation Management Plan

COAG
Council of Australian Governments

DDA
Disability Discrimination Act

DEC
Department of Environment and Conservation

DMR
Department of Main Roads

EMP
Environmental Management Plan

EP&A
Environmental Planning and Assessment

EPBC
Environment Protection and Biodiversity Conservation Act

EPRD
Environmental Protection and Regulation

ICOMOS
Australian Charter for the Conservation of Places of Cultural Significance

IDA
Integrated Development Approvals

KCNP
Ku-ring-gai Chase National Park

KCT
Ku-ring-gai Chase Trust

KCLC
Ku-ring-gai Chase Local Committee

LEP
Local Environmental Plan

LMP
Landscape Management Plan

MLALC
Metropolitan Local Aboriginal Land Council

NPWS
National Parks and Wildlife Service

NSW
New South Wales

REF
Review of Environmental Factors

SESL
Sydney Environmental and Soils Laboratory

TSC
Threatened Species Conservation Act

WWII
World War II

Contents

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Appendix 1: External Consultant Reports

Appendix 1 contains all consultants reports for Bobbin Head and Apple Tree Bay produced during the 2006 Masterplanning.The following consultant reports assisted in the development of the Masterplan:

1.1 Flora Report and Fauna Report (letters) - AMBS
1.2 Aboriginal Research and Analysis Report - AMBS
1.3 Traffic and Transport Planning Report (+ Supplementary Information) - Arup
1.4 Geotechnical Report - Douglas Partners
1.5 Recreational Planning Report - Stratcorp
1.6 Improving Soil Conditions for Trees and Turf Report - Sydney Environment Soil Laboratory and Simon Leake
1.7 Marine and Structural Engineering Report (letters) - Taylor Lauder Bersten
1.8 Quantity Surveying Report - Bay Partnership

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1.1 Flora Report and Fauna Report (letters) - AMBS

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AMBS CONSULTING

AMBS Reference:

14 March 2006

Lynette Gurr
Conybeare Morrison International Pty. Ltd.
Level 1, 52-58 William St
East Sydney NSW 1235

Dear Lynette

Bobbin Head and Apple Tree Bay - Natural Heritage

The following information on the natural environment and species of significance recorded surrounding Bobbin Head and Apple Tree Bay is provided for the purpose of the Project Control Group meeting to be held on Wednesday 15 March 2006. While a visit to Bobbin Head and Apple Tree Bay was conducted by myself at the inception meeting in January 06, however our botanist is yet to inspect the site to more closely inspect the areas within the project area that may require alterations as a consequence of the master planning process. The site inspection is scheduled for the week beginning 20th March 2006.

The information provided here has been obtained from searches of both the Department of Environment and Conservation's Atlas of Wildlife and the Department of Environment and Heritage's Protected Matters database. Searches were obtained for a radius of 10km around the project area and then at 5km and 1km for more detail on the likelihood of these species occurring with in the project area.

- A total of 52 threatened vertebrate species have been recorded within 10km of the project area, 21 additional listed migratory species have also been recorded. Of the fauna recorded 6 threatened frogs, 3 marine turtle, 2 reptiles, 45 Birds (16 migratory), 9 mammals, 4 sharks, 2 fish, 4 whales and dolphin (Table 1 and Figure 1)
- A total of 30 threatened flora species were recorded within ten kilometres of the project area, 20 with 5km and 3 within one kilometre (Table 2 and Figure 2)

It is unlikely that any threatened plant or animal species of state or national conservation significance listed under the TSC Act or EPBC Act would occur with any regularity in the reclaimed lands of the project area. It is more likely that these species previously recorded in the locality occur within naturally vegetated stands on the lower slopes and further into the National Park which also provide habitat for a wide range of fauna species, including those reliant on woodland/forest and riparian/wetland habitats.

Moreover, the bays and waterways of the project area would provide only transient habitat for any of the listed marine species and is unlikely to be utilised by most of the pelagic species recorded within ten kilometres.

Management Plans produced, including the CMP's, LMP's, would benefit from incorporating a strong focus on the conservation of the natural environment surrounding the project area and possibly including rehabilitation works (where appropriate) of currently modified natural features or created terrain by utilising locally indigenous plant species.

Further, any plans produced specifically for the management of native wildlife and their habitats as well as introduced species should include:

- management strategies for the creeklines and banks beyond the sea walled areas, vegetation and native fauna and their habitats, including specific considerations for threatened fauna species;
- feral fauna management;
- weed management; and
- bushfire hazard/control management.

Other EMPs of relevance to the protection of the natural environment include:

- Erosion and Sedimentation Control Plan;
- Wastewater Management Plan;
- Solid Waste Management Plan; and
- Hydrological Management Plan.

The implementation of the EMPs will reduce the potential for adverse impacts as a result of proposed development activities on site and on the adjoining National Park and marine areas and aim to improve habitat quality through addressing existing environmental issues on site, including habitat loss and modification, weeds, feral animals, erosion, and bushfire.

The EMPs prepared will also need to consider:

- NSW Fisheries (1999) Policy and Guidelines – Aquatic Habitat Management and Fish Conservation
- NSW Fisheries - Fish Passage Requirements for Waterway Crossings (Fairfull & Witheridge, 2003)
- Plans of Management for the Gardens of Stone National Park and the Greater Blue Mountains World Heritage Area
- DIPNR guidelines regarding:
  - Watercourse and Riparian Area Planning, Assessment and Design (V4 Draft)
  - Watercourse & Riparian Zone Rehabilitation Requirements
  - How to prepare a Vegetation Management Plan
  - Design and Construction of Paths and Cycleways along Watercourses and Riparian Areas (V2)
  - How to Collect Native Plant Seed Responsibly (V1)
- management actions contained in Final and Draft Recovery Plans for threatened fauna species prepared under the TSC Act (eg Yellow-bellied Glider; Large Forest Owls); and
- any relevant management guidelines for native wildlife prepared by DEC.

Given that the project area is within DEC estate and control it is considered that the likely limited adverse impacts of any proposed future development in relation to sea wall and road/access improvement will be minor and adequately offset through the retention and management of the surrounding area for conservation purposes. Potential exists to substantially contribute to flora and fauna conservation and habitat creation and enhancement though the development of this Master Planning Documentation.

If you require any additional information, or if I can be of assistance in any way please contact me on (02) 9320 6311 or email @austmus.gov.au.

Yours sincerely

Brendan Ryan
Senior Project Manager / Ecologist

Table 1: Threatened fauna species within a 10km radius of Bobbin Head and Apple Tree Bay

Scientific Name	Common Name	NSW Status (TSC Act)	Commonwealth Status (EPBC Act)	5km	Within 1km
Heleioporus australiacus	Giant Burrowing Frog	V	V	✔	✔
Pseudophryne australis	Red-crowned Toadlet	V	-	✔	✔
Litoria aurea	Green and Golden Bell Frog	E1	V	✔	
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	-	V	-	-
Mixophyes balbus	Stuttering Frog, Southern Barred Frog	-	V	-	-
Mixophyes iteratus	Giant Barred Frog	-	E	-	-
Dermochelys coriacea	Leathery Turtle	V	V,M	✔	-
Chelonia mydas	Green Turtle	-	V	-	-
Chelonia mydas	Green Turtle	-	M	-	-
Varanus rosenbergi	Rosenberg's Goanna	V	-	✔	✔
Hoplocephalus bungaroides	Broad-headed Snake	-	V	-	-
Ixobrychus flavicollis	Black Bittern	V	-	-	-
Pandion haliaetus	Osprey	V	-	-	-
Limicola falcinellus	Broad-billed Sandpiper	V	-	✔	-
Haematopus fuliginosus	Sooty Oystercatcher	V	-	✔	-
Haematopus longirostris	Pied Oystercatcher	V	-	✔	-
Diomedea antipodensis	Antipodean Albatross	-	V	-	-
Diomedea gibsoni	Gibson's Albatross	-	V	-	-
Lathamus discolor	Swift Parrot	-	E	-	-
Macronectes giganteus	Southern Giant-Petrel	-	E	-	-
Macronectes halli	Northern Giant-Petrel	-	V	-	-
Pterodroma neglecta neglecta	Kermadec Petrel (western)	-	V	-	-
Rostratula australis	Australian Painted Snipe	-	V	-	-
Thalassarche bulleri	Buller's Albatross	-	V	-	-
Thalassarche cauta	Shy Albatross	-	V	-	-
Thalassarche impavida	Campbell Albatross	-	V	-	-
Thalassarche salvini	Salvin's Albatross	-	V	-	-
Thalassarche steadi	White-capped Albatross	-	V	-	-
Ptilinopus superbus	Superb Fruit-Dove	V	-	-	-
Callocephalon fimbriatum	Gang-gang Cockatoo	V, E2	-	✔	-
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	✔	✔
Neophema pulchella	Turquoise Parrot	V	-	-	-
Polytelis swainsonii	Superb Parrot	V	-	-	-
Ninox connivens	Barking Owl	V	-	✔	-
Ninox strenua	Powerful Owl	V	-	✔	✔
Tyto novaehollandiae	Masked Owl	V	-	✔	-
Tyto tenebricosa	Sooty Owl	V	-	-	-
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subsp.)	V	-	✔	-
Xanthomyza phrygia	Regent Honeyeater	E1	E,M	-	-
Pomatostomus temporalis temporal	Grey-crowned Babbler (eastern subsp.)	V		✔	
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	M	-	-
Hirundapus caudacutus	White-throated Needletail	-	M	-	-
Monarcha melanopsis	Black-faced Monarch	-	M	-	-
Myiagra cyanoleuca	Satin Flycatcher	-	M	-	-
Rhipidura rufifrons	Rufous Fantail	-	M	-	-
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	-	M	-	-
Rostratula benghalensis s. lat.	Painted Snipe	-	M	-	-
Diomedea antipodensis	Antipodean Albatross	-	M	-	-
Diomedea gibsoni	Gibson's Albatross	-	M	-	-
Macronectes giganteus	Southern Giant-Petrel	-	M	-	-
Macronectes halli	Northern Giant-Petrel	-	M	-	-
Thalassarche bulleri	Buller's Albatross	-	M	-	-
Thalassarche cauta	Shy Albatross	-	M	-	-

Scientific Name	Common Name	NSW Status (TSC Act)	Commonwealth Status (EPBC Act)	5km	Within 1km
Thalassarche impavida	Campbell Albatross	-	M	-	-
Thalassarche salvini	Salvin's Albatross	-	M	-	-
Thalassarche steadi	White-capped Albatross	-	M	-	-
Dasyurus maculatus	Spotted-tailed Quoll	V	E	✔	✔
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern)	E1	E	✔	✔
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	-	V	-	-
Phascolarctos cinereus	Koala	V, E2		✔	✔
Cercartetus nanus	Eastern Pygmy-possum	V		✔	✔
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	✔	-
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		-	-
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	-	-
Miniopterus schreibersii oceanen	Eastern Bentwing-bat	V		✔	-
Rhincodon typus	Whale Shark	-	M	-	-
Carcharias taurus (east coast population)	Grey Nurse Shark (east coast population)	-	CE	-	-
Carcharodon carcharias	Great White Shark	-	V, M	-	-
Rhincodon typus	Whale Shark	-	V, M	-	-
Macquaria australasica	Macquarie Perch	-	E	-	-
Prototroctes maraena	Australian Grayling	-	V	-	-
Lagenorhynchus obscurus	Dusky Dolphin	-	M	-	-
Megaptera novaeangliae	Humpback Whale	-	V, M	-	-
Balaenoptera edeni	Bryde's Whale	-	M	-	-
Caperea marginata	Pygmy Right Whale	-	M	-	-
Eubalaena australis	Southern Right Whale	V	E,M	-	-

V = Vulnerable species
E, E1= Endangered species
E2 = Endangered population
CE = Critically Endangered species
M = Migratory species

Table 2: Threatened flora species within a 10km radius of Bobbin Head and Apple Tree Bay

Scientific Name	Common Name	NSW Status (TSC)	Commonwealth Status (EPBC)	5km	Within 1km
Epacris purpurascens var. purpurasce	-	V	-	✔	-
Cryptostylis hunteriana	Leafless Tongue-orchid	-	V	-	-
Acacia bynoeana	Bynoe's Wattle	E1	V	✔	-
Acacia gordonii	-	E1	-		-
Grammitis stenophylla	-	E1	-	✔	-
Haloragodendron lucasii	-	E1	E	✔	-
Callistemon linearifolius	-	V	-	✔	-
Darwinia biflora	-	V	V	✔	✔
Darwinia peduncularis	-	V		✔	-
Eucalyptus camfieldii	Heart-leaved Stringybark	V	V	✔	-
Eucalyptus scoparia	-	E1	-		-
Kunzea rupestris	-	V	V		-
Leptospermum deanei	-	V	V	✔	-
Melaleuca deanei	-	V	V	✔	-
Micromyrtus blakelyi	-	V	V	-	-
Deyeuxia appressa	-	-	E	-	-
Caladenia tessellata	Thick Lip Spider Orchid	E1	-	✔	-
Diuris bracteata	-	E1	-	✔	-
Genoplesium baueri	-	V	-	✔	-
Microtis angusii	-	E1	E	✔	-
Ancistrachne maidenii	-	V	-	✔	-
Grevillea caleyi	-	E1	E	-	-
Grevillea parviflora	-	V	-	-	-
Grevillea parviflora subsp. supplica	-	E1	-	-	-
Persoonia hirsuta	-	E1	E	✔	-
Persoonia mollis subsp. maxima	-	E1	E	✔	-
Asterolasia elegans	-	E1	-	-	
Lasiopetalum joyceae	-	V	V	✔	✔
Pimelea curviflora var. curviflora	-	V	V	✔	-
Tetratheca glandulosa	-	V	V	✔	✔

V = Vulnerable species
E, E1= Endangered species

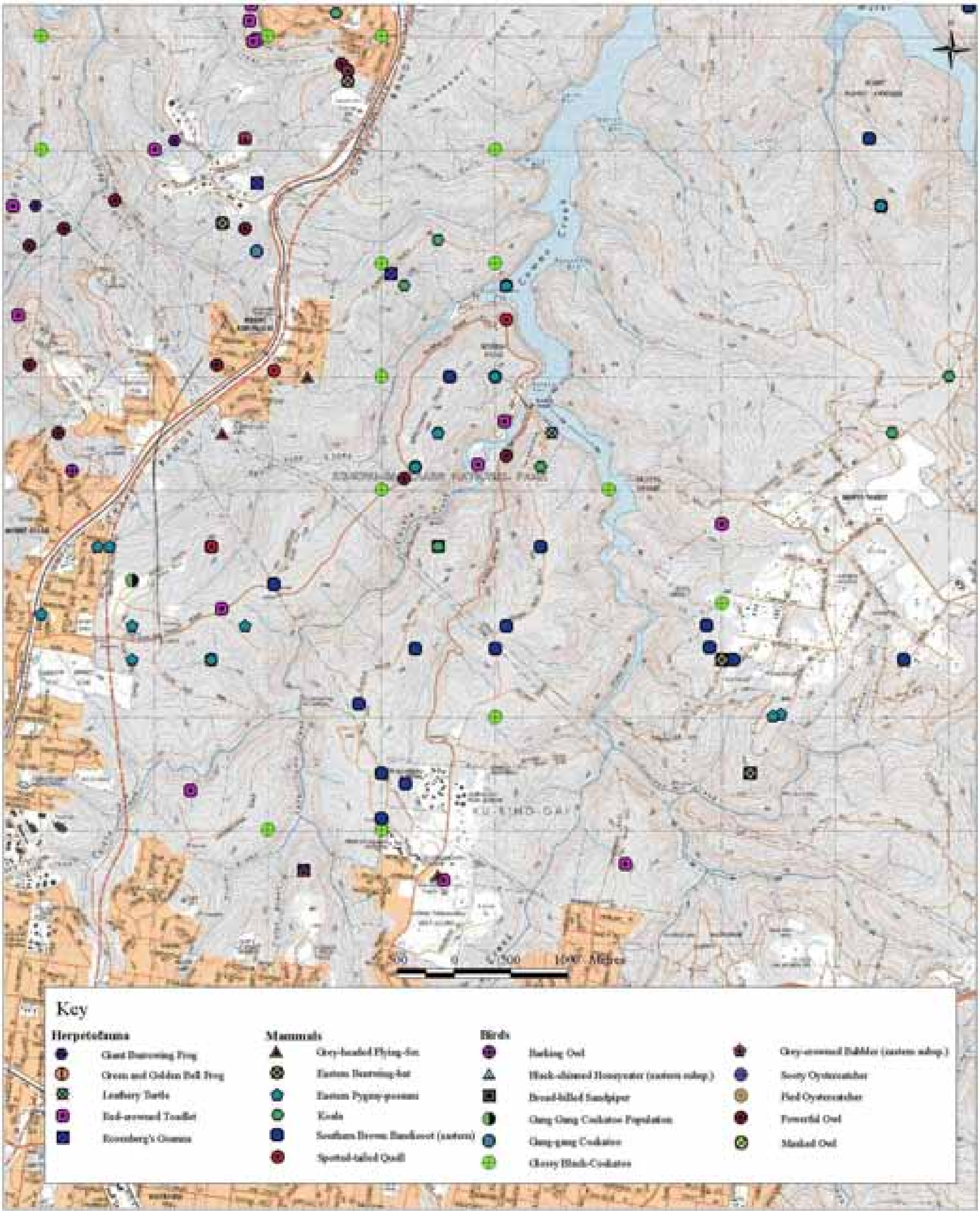

Figure 1: **DEC records of threatened fauna in the locality**

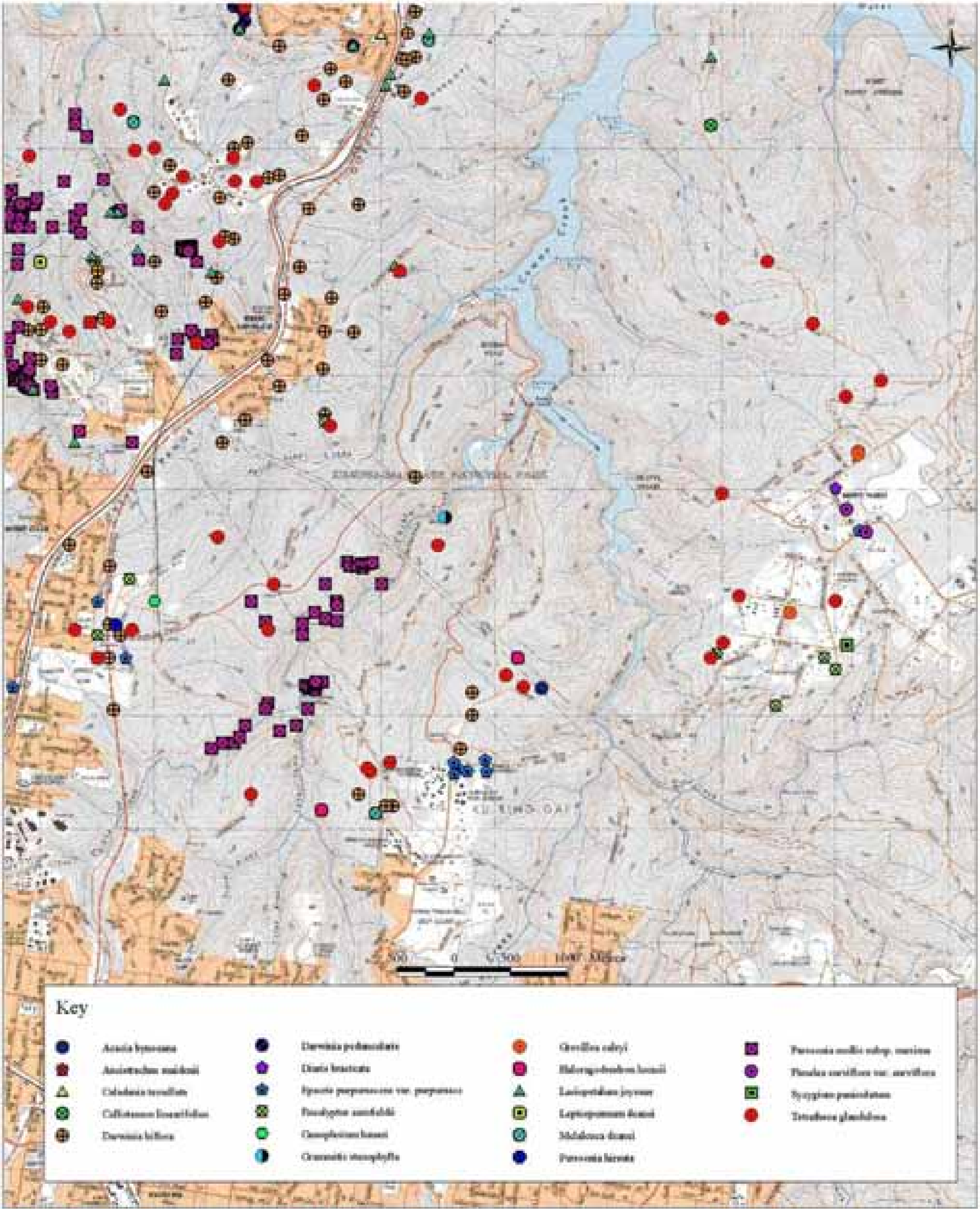

Figure 2: DEC records of threatened flora in the locality

AMBS Reference:

27 March 2006

Michelle Yik
Conybeare Morrison International Pty. Ltd.
Level 1, 52-58 William St
East Sydney NSW 1235

Dear Michelle

Bobbin Head and Apple Tree Bay - Natural Heritage

The following information on the natural environment and species of significance recorded surrounding Bobbin Head and Apple Tree Bay is provided for the purpose of the Project Control Group meeting to be held on Wednesday 29 March 2006. While a visit to Bobbin Head and Apple Tree Bay was conducted by myself at the inception meeting in January 06, our botanist is yet to inspect the site to more closely inspect the areas within the project area that may require alterations as a consequence of the master planning process. The site inspection is scheduled for the 28th March 2006.

Despite this, please find attached (Addendum A) some relevant information about the threatened species more likely to occur in the Master Plan area. All species may occur across the site and would need careful consideration for all works outside the immediate reclaimed lands of Bobbin Head, the Marina and Apple Tree Bay.

In relation to the e-mail request from Colin Polwarth on the 15th March 2006, it must be re-iterated that should any areas of native vegetation be proposed for any additional development such as the proposed car park at the entrance gate area to the Ku-ring-gai Chase National Park – (approx 18.2x50m), any track along the shore edge between Apple Tree Bay and Bobbin Head or any other new walking trail will need more detailed impact assessment conducted and are beyond the scope of the current contracted works.

We are however, endeavouring to compile a broad vegetation community map, as requested, for the areas immediately surrounding the project area and hope to have a good understanding about the likelihood of any threatened species presence in those areas described above. Each will need careful assessment in relation to Aboriginal heritage also.

Moreover, the bays and waterways of the project area which may only provide transient habitat for any of the listed marine species will also require attention under the relevant acts to assess any potential impacts in relation to the sea wall re-construction. Please refer to my previous letter for a list of relevant legislation.

If you require any additional information, or if I can be of assistance in any way please contact me on (02) 9320 6311 or email @austmus.gov.au.

Yours sincerely

Brendan Ryan
Senior Project Manager / Ecologist

Australian Museum Business Services
6 College Street Sydney NSW 2010
Ph (02) 9320 6311 Fax (02) 9320 6428

Species	Conservation Status	Species Information	Threats and Management Options
FLORA			
Epacris purpurascens var. purpurasce	Vulnerable, TSC Act	This erect shrub (50 - 180 cm high) has been recorded from Gosford in the north, to Narrabeen in the east, Silverdale in the west and Avon Dam vicinity in the South. It is found in a range of habitat types, most of which have a strong shale soil influence. Its lifespan is recorded to be 5-20 years, requiring 2-4 years before seed is produced in the wild. This plant is killed by fire and re-establishes from soil-stored seed (DEC Species Profile).	Threats to this species mainly arise from increasing clearance or habitat modification resulting from urban or rural development, urban run-off leading to flooding, erosion, nitrification of soil substrate, altered pH, weed invasion, and introduction of plant pathogens. Other threats include altered fire regimes, uncontrolled vehicular access, soil compaction, slashing eg. powerline easements, fill and rubbish dumping, and trampling through inappropriate pedestrian access. Management options for this species include fire intervals of 10-15 yrs (where there are no needs for asset protection zones) and prevention of further loss and fragmentation of habitat (DEC Species Profiles).
Acacia bynoeana	Endangered, TSC Act, Vulnerable, EPBC Act	Bynoe's Wattle is a semi-prostrate shrub to a metre high. It is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. It has recently been found in the Colymea and Parma Creek areas west of Nowra, occurring in heath or dry sclerophyll forest on sandy soils. It seems to prefer open, sometimes slightly disturbed sites such as trail margins, edges of roadside spoil mounds and in recently burnt patches (DEC Species Profiles).	Threats to the survival of this species includes catastrophic events and localised extinction (due to the fragmented nature of the populations and their small size the species), disturbance to habitat during road, trail and powerline maintenance, damage by recreational vehicles, horse riding and pedestrian use and invasion by weeds. Management options for this species includes the implementation of fire regimes which maintain floristic and structural diversity, education of road and track maintenance staff of the presence of a threatened species, limitation of movement of people through Bynoe Wattle populations, usage of signs to alert visitors to the presence of this species and weed control (DEC Species Profile).
Grammitis stenophylla	Endangered, TSC Act	The Narrow-leaf Finger Fern is a little fern, growing in small colonies, with hanging or erect fronds that occurs in eastern Queensland and eastern NSW. In NSW it has been found on the south, central and north coasts and as far west as Mount Kaputar National Park near Narrabrai. Its preferred habitat appears to be moist places, usually near streams, on rocks or in trees, in rainforest and moist eucalypt forest (DEC Species Profile).	Threats to this species include loss of habitat through clearing, especially along streamsides, damage to habitat by human visitation and illegal collection by fern enthusiasts. Management options for this species includes keeping visitors to established paths when in national parks to avoid trampling small plants and encouraging fern enthusiasts to view and photograph native plants but leave them in the wild. Other management activities include protection of areas of habitat from clearing and development and assisting to re-establish potential moist forest habitat, especially along streams (DEC Species Profiles).

Haloragodendron lucasii	Endangered, TSC Act, Endangered, EPBC Act	This species is an erect hairless shrub to 1.5 m tall, with four-winged branches arising in pairs. The known locations of this species are confined to a very narrow distribution on the north shore of Sydney. It is generally associated with dry sclerophyll forest, reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. It is associated with high soil moisture and relatively high soil-phosphorus levels and is highly clonal, which implies the true population size may be considerably smaller than expected (DEC Species Profile).	This species suffers the risk of local extinction due to low numbers. Threats include urban runoff, resulting in increased soil pH and soil moisture levels, invasion of habitat by weeds, physical damage and disturbance to plants from unrestrained access and vandalism and too-frequent or too-intense fires depleting the rootstocks of existing populations. Management options include restricting access to the sites, establishing long term protection of known populations, undertaking research into population dynamics, and surveying suitable habitat and locations for further populations (DEC Species Profile).
Callistemon linearifolius	Vulnerable, TSC Act	This shrub is up to 3-4 m tall, with linear (long and narrow) to linear-lanceolate (lance shaped) leaves. It has been recorded from the Georges River to Hawkesbury River in the Sydney area, and north to the Nelson Bay area of NSW. For the Sydney area, recent records are limited to the Hornsby Plateau area near the Hawkesbury River. This species was more widespread across its distribution in the past and now there are currently only 5-6 populations in the Sydney area, of the 22 populations recorded in the past. It grows in dry sclerophyll forest on the coast and adjacent ranges (DEC Species Profiles).	The main threat to this species is the continuing loss of habitat due primarily to urban development. There is a high risk of local extinction due to low population numbers. Management options include searching for the species in suitable habitat in areas that are proposed for development or management actions and protecting any such site found, protecting known habitat from clearing or disturbance and determining response of species to fire and developing and promoting a recommended fire regime (DEC Species Profiles).
Darwinia biflora	Vulnerable, TSC Act, Vulnerable, EPBC Act	*Darwinia biflora* is an erect to spreading shrub to 80cm high. It occurs at 129 sites in the northern and north-western suburbs of Sydney, in the Ryde, Baulkham Hills, Hornsby and Ku-Ring-Gai local government areas on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. It is associated overstorey species include Eucalyptus haemastoma, Corymbia gummifera and/or E. squamosa. The vegetation structure of its preferred habitat is usually woodland, open forest or scrub-heath.Fire is an important factor in the life cycle of this species. Fire kills all plants, but also produces a flush of germination from seed stored in the soil. The number of individuals at a site then declines with time since fire, as the surrounding vegetation develops (DEC Species Profile).	The main threats to this species include habitat loss, particularly as a result of clearing for urban and industrial development and habitat degradation (from inappropriate fire regimes, slashing for easement maintenance, illegal track creation and weed invasion). Management options includes the implementation of appropriate fire regimes, prevention of mechanical damage and trampling by livestock, weed control and increasing protection of sites, especially in those parts of the species' range where few sites are in conservation reserves (DEC Species Profile).
Darwinia peduncularis	Vulnerable, TSC Act	A more or less horizontal shrub to 1.5 m high, this species occurs as local disjunct populations in coastal NSW with a couple of isolated populations in the Blue Mountains. It has been recorded from Brooklyn, Berowra, Galston Gorge, Hornsby, Bargo River, Glen Davis, Mount Boonbourwa and Kings Tableland. It usually grows on or near rocky outcrops on sandy, well drained, low nutrient soil over sandstone. It is Ikely to be killed by fire, based on the response of other Darwinias (DEC Species Profile).	Given populations are small, it is threatened by isolation, fragmentation and local extinction. This can be caused by inappropriate fire regimes, recreational use eg trail bikes, walking tracks and weed invasion. Management options include the implementation of appropriate fire regimes, management of visitor use of known and potential habitat, weed control and the protection of areas of habitat from clearing and further fragmentation (DEC Species Profile).

Eucalyptus camfieldii	Vulnerable, TSC Act, Vulnerable, EPBC Act	Mostly mallee to 4 m tall though can grow to a straggly tree to 9 m high. This species has a restricted distribution in a narrow band with the most northerly records in the the Raymond Terrace Area south to Waterfall. Localised and scattered distribution includes sites at Norah Head (Tuggerah Lakes), Peats Ridge, Mt Colah, Elvina Bay Trail (West Head), Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites in Royal National Park. It is found on poor coastal country in shallow sandy soils overlying Hawkesbury sandstone and coastal heath mostly on exposed sandy ridges. It occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodland of the slightly more fertile inland areas (DEC Species Profile).	Threats to this species include loss of habitat through clearing for development and weed invasion. Inappropriate fire regimes also pose a serious threat. Management options for this species include reducing the impact of arson eg. buffer zones around arson-prone areas to prevent spread of fire, as well as buffers around populations, using mechanical means rather than burning to reduce fuel loads, protecting areas of known and potential habitat from clearing and disturbance and prevention of further loss and fragmentation of habitat (DEC Species Profile).
Leptospermum deanei	Vulnerable, TSC Act, Vulnerable, EPBC Act	This shrub grows up to 5 m, with bark peeling in long strips. It is distributed in Hornsby, Warringah, Ku-ring-gai and Ryde LGAs. It occurs in woodland on lower hill slopes or near creeks on sandy alluvial soil or sand over sandstone, in Riparian Scrub (e.g. Tristaniopsis laurina, Baechea myrtifolia; Woodland - e.g. Eucalyptus haemstoma; and Open Forest - e.g. Angophora costata, Leptospermum trinervium, Banksia ericifolia).It is probably killed by fire (DEC Species Profile).	The limited distribution of this species makes it vulnerable to stochastic events. It is particularly vulnerable to invasion by exotic weeds (DEC Species Profile).
Melaleuca deanei	Vulnerable, TSC Act, Vulnerable, EPBC Act	Deane's Paperbark is a shrub to 3 m high with fibrous, flaky bark. It occurs in two distinct areas, in the Ku-ring-gai/Berowra and Holsworthy/Wedderburn areas respectively. There are also more isolated occurrences at Springwood (in the Blue Mountains), Wollemi National Park, Yalwal (west of Nowra) and Central Coast (Hawkesbury River) areas. The species grows in heath on sandstone and flowers appear in summer but seed production appears to be small and consequently the species exhibits a limited capacity to regenerate (DEC Species Profile).	Threats to the survival of this species arise from the small size of populations, regimes of frequent fire and urban development. Many locations occur on the edge of fire trails and may be impacted by trail maintenance and widening and by associated changes in runoff and weed encroachment. Risk of extinction is high due to low population numbers and this species shows evidence of a limited capacity to regenerate, with many sites having little or no seeds set. There are very few field observations of seedlings. Risk of extinction is high due to low population numbers. Management options for this species include ensuring that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat, ensuring that personnel planning and undertaking road maintenance are able to identify the species and are aware of its habitat, developing a fire management plan for the population and applying a mosaic pattern hazard reduction techniques to ensure the same areas are not burned repeatedly. Further research on the ecology and distribution of this species is necessary (DEC Species Profile).

Caladenia tessellata	Endangered, TSC Act	The Tessellated Spider Orchid is from a group of orchids characterised by five long spreading petals and sepals around a broad down-curled labellum ('lip'). It is known from the Sydney area (old records), Wyong, Ulladulla and Braidwood in NSW. The populations in Kiama and Queanbeyan are presumed extinct. The species occurs on the coast in Victoria from east of Melbourne to almost the NSW border and is generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil (DEC Species Profile).	At least two known sites have been lost due to clearing associated with urban development. This has probably also caused the destruction of many of the historical populations in the Sydney area. This species is at risk from catastrophic events because of small number of extant populations and low number of plants. The remaining populations could be under threat from intensive use of coastal locations for recreation and other purposes and possibly threatened by long-term absence of fire. Management options include surveying for this species for any developments in suitable habitat within the known range of the species in NSW but extending in coastal areas to the Victorian border and monitoring all populations each year to determine trends in mortality and recruitment (DEC Species Profile).
Diuris bracteata	Endangered, TSC Act	*Diuris bracteata* is a terrestrial 'donkey' orchid with yellow flowers with blackish markings. It was known only from the original collection near Gladesville, made before 1889. The absence of recent records meant *Diuris bracteata* was listed as Species presumed extinct on Part 4 of Schedule 1 of the Threatened Species Conservation Act. Since 1998 specimens from the Sydney Basin Bioregion have been confirmed as *Diuris bracteata. Diuris bracteata* is now known from a few sites in dry sclerophyll woodland, and the total number of individuals is about 50. The known populations do not occur in conservation reserves (DEC Species Profile).	The small population sizes and limited area of extent means that survival is threatened by environmental and demographic stochasticity. Several occurrences are on roadsides and are at risk from earthworks, herbicide spraying, slashing/mowing and illegal collection (DEC Species Profile).
Genoplesium baueri	Vulnerable, TSC Act	This species is a terrestrial orchid 6-15 cm high, fleshy, brittle, yellowish-green or reddish. The species has been recorded from locations between Nowra and Pittwater and may occur as far north as Port Stephens. About half the records were made before 1960 with most of the older records being from Sydney suburbs including Asquith, Cowan, Gladesville, Longueville and Wahroonga. No collections have been made from those sites in recent years. The species has been recorded at locations now likely to be within the following conservation reserves: Berowra Valley Regional Park, Royal National Park and Lane Cove National Park. May occur in the Woronora, O'Hares, Metropolitan and Warragamba Catchments. It grows in sparse sclerophyll forest and moss gardens over sandstone and flowers between December and March (DEC Species Profile).	Threats to the survival of this species includes urban and infrastructure development and probably inappropriate fire regimes. Management options include protecting remaining habitat from clearing and development, determining appropriate fire regimes and undertaking further surveys to locate any additional populations (DEC Species Profile).

Microtis angusii	Endangered, TSC Act, Endangered, EPBC Act	A terrestrial orchid, *Microtis angusii* are commonly called “onion orchids”. This refers to the leaves which are cylindrical like those of plants of the onion family. Currently it is only known from one site at Ingleside in the north of Sydney. A collection previously thought to be this species was made from Sunny Corner 100 km west of Sydney, but this has since been confirmed as being genetically distinct and may possibly be a sub-species. It is not easy to define the preferred natural habitat of this orchid as the Ingleside location is highly disturbed. The dominant species occurring on the site are introduced weeds *Hyparrhenia hirta* (Coolatai grass) and *Acacia saligna*. The Ingleside population occurs on soils that have been modified but were originally those of the restricted ridgetop lateritic soils in the Duffys Forest - Terrey Hills - Ingleside and Belrose areas. These soils support a specific and distinct vegetation type, the Duffys Forest Vegetation Community which is listed as an endangered ecological community under the TSC Act and ranges from open forest to low open forest and rarely woodland (DEC Species Profile).	As the known site occurs along a major road, there is great potential for the population to be adversely affected by an inappropriate fire regime. The most likely scenario is too frequent fire caused by arson, hazard reduction activities and accidental sparking from cigarettes etc. Uncontrolled site access has lead to the degradation of the site in the past. Rubbish dumping, soil compaction and soil dumping have lead to habitat degradation as well as construction of a sewerage pipe, use of the site as a fill dump, as a portaloo parking area and by the construction of a cement dam. The weed species of concern at the known site are *Acacia saligna* and Coolatai grass (*Hyparrhenia hirta*). Plants at the site have been grazed almost to the ground by rabbits and goats in the past. The goats have since been trapped and returned and Council has undertaken control of the rabbits. It is thought that if this grazing continued then the population may fail to flower and set seed for the season. The long term effect of grazing may be detrimental to the population. As a rare orchid it is unfortunately a possible target for unscrupulous amateur orchid enthusiasts and professional orchid propagators. No level of unauthorised collection could be sustained by the population at this stage (DEC Species Profile). The main management priority for this species is further research.
Ancistrachne maidenii	Vulnerable, TSC Act	A scrambling perennial with slender, rigid horizontal stems and ascending branches, *Ancistrachne maidenii* is restricted to northern Sydney, around St Albans - Mt White - Maroota - Berowra areas and to the Shannon Creek area south-west of Grafton. Its habitat requirements appear to be specific, with populations occurring in distinct bands in areas associated with a transitional geology between Hawkesbury and Watagan soil landscapes. It grows in dry sclerophyll forest on sandstone-derived soils and flowers in summer (DEC Species Profile).	Threats to this species includes habitat loss and degradation due to roadside maintenance and weed spraying, inappropriate fire regimes, habitat degradation due to track maintenance, track widening or trampling and habitat loss due to urban development. The risk of extinction is high due to low population numbers at sites. These plants are possibly sensitive to pollution and weed invasion as it is not found along urban creeklines. Management options include implementation of appropriate fire regimes, undertaking sensitive track and roadside maintenance activities and protection of known habitat from clearing and fragmentation (DEC Species Profile).

Persoonia hirsuta	Endangered, TSC Act, Endangered, EPBC Act	The Hairy Geebung is best distinguished by its hairiness - long coarse hairs on flowers and branchlets and short stiff ones on the leaves. The Hairy Geebung has been recorded in the Sydney coastal area (subsp. hirsuta - Gosford to Berowra to Manly to Royal National Park), the Blue Mountains area (subsp. evoluta - Springwood, Lithgow, Putty) and the Southern Highlands (subsp. evoluta - Balmoral, Buxton, Yanderra and Hill Top areas). It is found in sandy soils in dry sclerophyll open forest, woodland and heath on sandstone, usually as an isolated individuals or very small populations. It is probably killed by fire (as other Persoonia species are) but will regenerate from seed (DEC Species Profile).	Burning for hazard reduction and other unnatural ignitions have increased fire frequency and may threaten the species' survival. Other threats arise from the loss of habitat through clearing for urban and small-rural-lot development and the European honey bee Apis mellifera (which may be a factor in the rarity of Hairy Geebung and several other Geebungs). This is because although A. mellifera is able to collect pollen its method of pollen transport makes it a poor pollinator of Geebungs, among many other native plant species. Management options for this species includes ensuring that personnel planning and undertaking hazard reduction burns are able to identify the species and are aware of its habitat, that following burning, populations are protected (where possible) from further fires until plants have reached reproductive maturity and the development of a fire management plan for the populations (DEC Species Profile). A management priority for this species is further research.
Persoonia mollis subsp. maxima	Endangered, TSC Act, Endangered, EPBC Act	This species is a tall, branching, spreading shrub which grows 2 – 6 m high. Its distribution is highly restricted, known from the Hornsby Heights–Mt Colah area north of Sydney in the Sydney Basin Bioregion. It occurs in three populations (described on a catchment basis) located over an approximate north-south range of 5.75 km and east-west distance of 7.5 km. Additional locations may exist outside the current distribution. This species is found in sheltered aspects of deep gullies or on the steep upper hillsides of narrow gullies on Hawkesbury Sandstone. These habitats support relatively moist, tall forest vegetation communities, often with warm temperate rainforest influences. This species is fire sensitive and usually killed by fire. Regeneration is from soil stored seed (DEC Species Profile).	Threats to this species arise from wildfire and inappropriate hazard reduction/fire management activities (such as trail maintenance and turbo-mowing), habitat degradation through weed invasion, reduced water quality and rubbish dumping, habitat loss and fragmentation through clearing for development and loss genetic diversity and inbreeding depression. Management options includes maintaining an ex-situ living collection of this species at Mt Annan Botanic Gardens, implementing an appropriate fire management actions and including fire free interval of 12-15 years and targetting rubbish removal, weed control and bush regeneration. DEC should be consulted when planning development to avoid and minimise impacts on populations (DEC Species Profile). A management priority for this species is further research.
Lasiopetalum joyceae	Vulnerable, TSC Act, Vulnerable, EPBC Act	Lasiopetalum joyceae is an erect shrub to 2 m tall. Leaves are linear, 3 - 9 cm long, mostly 3 - 6 mm wide, with revolute margins. It has a restricted range occurring on lateritic to shaley ridgetops on the Hornsby Plateau south of the Hawkesbury River. It is currently known from 34 sites between Berrilee and Duffys Forest. It grows in heath on sandstone (DEC Species Profiles).	Several unreserved sites where this species occur are threatened by proposed development. Many sites are subject to ongoing threats because of their proximity to residential areas, park boundaries, tracks and fire trails. Frequent hazard reduction burns could deplete the seedbank and a number of sites with small numbers of individuals could be prone to catastrophic events. Management options include seeking a low fire frequency by informing local government, RFS and NPWS staff about populations and ensuring that this species is considered in all planning matters on land that contains or may contain populations (DEC Species Profile).

Pimelea curviflora var. curviflora	Vulnerable, TSC Act, Vulnerable, EPBC Act	This species are confined to the coastal area of Sydney between northern Sydney in the south and Maroota in the north-west. Former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. It occurs on shaley/lateritic soils over sandstone and shale/sandstone transition soils on ridgetops and upper slopes amongst woodlands. This species has an inconspicuous cryptic habit as it is fine and scraggly and often grows amongst dense grasses and sedges. It may not always be visible at a site as it appears to survive for some time without any foliage after fire or grazing, relying on energy reserves in its tuberous roots. It is likely to be fire tolerant species capable of resprouting following fire due to the presence of a tap root. Seedlings have been observed following fire (DEC Species Profile).	Threats to this species includes habitat loss due to clearing for urban development, habitat degradation due to for example, weed invasion, recreational activities, road and trail maintenance, and bush rock removal. Management options include introducing measures to prevent habitat degradation related to unrestricted access and/or trail maintenance, managing weed infestation and protecting areas of known and potential habitat from clearing and further fragmentation (DEC Species Profile).
Tetratheca glandulosa	Vulnerable, TSC Act, Vulnerable, EPBC Act	Tetratheca glandulosa is a small, spreading shrub which grows 20 - 50cm in height. It is restricted to the following Local Government Areas: Baulkham Hills, Gosford, Hawkesbury, Hornsby, Ku-ring-gai, Pittwater, Ryde, Warringah, and Wyong. There are approximately 150 populations of this plant ranging from Sampons Pass (Yengo NP) in the north to West Pymble (Lane Cove NP) in the south. The eastern limit is at Ingleside (Pittwater LGA) and the western limit is at East Kurrajong (Wollemi NP). There are historical collections of this species south to Manly, Willoughby and Mosman, however these populations are now extinct. This species is associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gymea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Field observations following fire indicate that the plant is likely to be clonal. Tetrathecas are reported to be readily propagated by cuttings, however the long term survival of these plants is poorly known (DEC Species Profile).	Threats to this species arise from habitat loss through vegetation clearing and habitat degradation, fire control activities and habitat fragmentation of small, isolated populations. Management options includes ensuring that sufficient vegetative buffers exist to prevent habitat degradation and maintain habitat connectivity where development is in or adjacent to populations, minimising habitat loss (in particular vegetation clearance within large populations and those at the edge of the species range), maintaining and improving habitat connectivity within and among populations, restoration of degraded habitat using bush regeneration techniques and minimising and/or prevent factors which promote habitat degradation (eg. large edge-area ratios, urban/agricultural runoff and stormwater, unrestricted access etc) (DEC Species Profile).

Species	Conservation Status	Species Information	Threats and Management Options
FAUNA: Mammals			
Eastern Bentwing-bat, *Miniopterus schreibersii oceanensis*	Vulnerable, TSC Act	The Eastern Bent-wing rely on caves or similar artificial structures (such as mines and culverts) for roosting. This bat occupies a range of forested environments (including wet and dry sclerophyll forests), along the coastal portion of eastern Australia, and through the Northern Territory and Kimberley area (Churchill, 1998). This highly mobile species forages for insects above the tree canopy, and is capable of large regional movements in relation to seasonal differences in reproductive behaviour and winter hibernation (Gilmore & Parnaby, 1994).	Threats to this species mainly arise from the damage to or disturbance of roosting caves, particularly during winter or breeding, loss of foraging habitat, application of pesticides in or adjacent to foraging areas and predation by feral cats and foxes. Management options for this species includes foxes and feral cat control around roosting sites, retention of native vegetation around roost sites, minimising the use of pesticides in foraging areas and protecting roosting sites from damage or disturbance.
Spotted-tailed Quoll, *Dasyurus maculatus*	Vulnerable, TSC Act; Endangered EPBC Act	The Spotted-tailed Quoll occupies a range of environments within a disjunct distribution along the east coast of Australia. Its distribution extends from south eastern Queensland through NSW and Victoria to Tasmania. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites and feed on gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects; also eats carrion and takes domestic fowl.	The species range has declined in area, where its range previously extended into South Australia and to both sides of the Great Dividing Range, it is now restricted to "isolated areas that may be too small to support long-term viable populations". Threats to the species such as competition with introduced predators and habitat loss continue (Edgar & Belcher, 1995). The only part of its range where the species population seems to be increasing rather than decreasing is in Tasmania, where competition with foxes has until recently not been an issue (Edgar & Belcher, 1995).
Grey-headed Flying Fox, *Pteropus poliocephalus*	Vulberable, TSC Act, Vulnerable EPBC Act	Grey-headed Flying Foxes roost in large camps which are commonly located in vegetation with a dense canopy in gullies in close proximity to water. The Grey-headed Flying-fox is endemic to Australia and primarily occurs along the east-coast of Australia from Bundaberg to Victoria. They are a highly mobile species whose migration patterns are determined by the availability of flowering food resources (Eby, 1991). The Grey-headed Flying-fox occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. During times when native food resources are limited, Grey-Headed Flying-foxes disperse from traditional roost sites and forage on fruit crops and cultivated gardens.	The distribution of this species has recently suffered a southward contraction and a 30% population decline over the last ten years (Tidemann et al., 1999). The most serious threatening process to Grey-headed Flying-foxes is the destruction of habitat by clearing for urban development and agriculture, particularly critical winter foraging habitat in the coastal forests of north-east NSW. Shortages in food supply lead to the starvation of animals, self-abortion by pregnant females (Dukelow et al., 1990) and high infant mortality in Summer. Unregulated shooting, electrocution on powerlines and disturbance to roosting sites have all contributed to the reported 30% overall population decline (Tidemann et al., 1999).

Southern Brown Bandicoot (eastern), *Isodon obesulus obesulus*	Endangered, TSC Act, Endangered EPBC Act	The Southern Brown Bandicoot (Isoodon obesulus) (Shaw and Nodder 1797) is a medium-sized (400-1600g) ground-dwelling marsupial. It has a patchy distribution being found in south-eastern NSW, east of the Great Dividing Range south from the Hawkesbury River, southern coastal Victoria and the Grampian Ranges, south-eastern South Australia, south-west Western Australia and the northern tip of Queensland. They feed on a variety of ground-dwelling invertebrates and the fruit-bodies of hypogeous (underground-fruiting) fungi. Their searches for food often create distinctive conical holes in the soil.	Threats to this species mainly arise from loss and fragmentation of habitat through land-clearing for agriculture and urban development and changes in forest structure, burning regimes, predation by introduced predators such as cats, dogs and foxes. Management options include fox, feral dog and feral cat control programs, fire regime control and prevention of domestic cats and dogs from roaming into habitat areas. Large scale management attempts should protect all known and potential habitat and include linkages across the broader landscape.
Koala, *Phascolarctos cinereus*	Vulnerable, TSC Act	Koalas are solitary animals which occupy distinct home ranges that vary in size according to population density and the abundance of mature food resources in the area (Phillips 1997, Martin & Handasyde 1995). Koalas feed almost exclusively on *Eucalypt* foliage, but display marked selectivity as to which species and particular individual trees they will feed on. The best habitat for a breeding koala is likely to be one with a variety of resources including food tree abundance, food tree diversity, forest structure, soil type, topographic position and disturbance history (Smith & Andrews 1997).	Although still widespread, many populations have management issues especially with regard to remnant populations living at high densities in isolated habitat (Martin and Handasyde, 1995). Threatening processes include loss, fragmentation and degradation of habitat through land clearing (EPBC ACT, 1999) and they often suffer from predation by dogs and being hit by vehicles. Current threats to the status and distribution of the Koala include loss, fragmentation and degradation of habitat through land clearing (EPBC ACT, 1999) for development and agriculture. Although Koalas suffer from predation by dogs, only predation by foxes and domestic cats are listed by the NSW Scientific Committee.
Birds			
Glossy Black-Cockatoo, *Calyptorhynchus lathami*	Vulnerable, TSC Act	The Glossy Black Cockatoo prefers woodland dominated by *Allocasuarina* or open sclerophyll forest or woodlands with a middle stratum of *Allocasuarina*, but also occurs in bushland remnants in agricultural and urban areas (Higgins, 1999). Glossy Black Cockatoos feed almost exclusively on the seeds of Forest Oak *Allocasuarina torulosa* and Black She-oak *Allocasuarina littoralis* although they also occasionally eat the seeds of Swamp Oak *Casuarina glauca* and Shrub She-oak *Allocasuarina distyla*. Roosting is communal usually in the canopy of live leafy trees (Higgins, 1999). Large hollows in living, old eucalypt trees (hollows of sufficient size for nesting generally do not form in eucalypt trees less than 200 years old – Mackowski, 1984) are required for nesting	Threats to the survival of this species arise from habitat fragmentation and loss, especially logging of nest trees within the proximity of feeding resources. Management options include protection and maintenance of known or potential habitat, replanting areas with casuarina trees and promotion of their growth and development in areas from which they have been eliminated (DEC Species Profile).

Powerful Owl, *Ninox strenua*	Vulnerable, TSC Act	The Powerful Owl inhabits a large home range (>1000ha) in vegetation types ranging from woodland and open forest to moist forest and rainforest. Eucalypt forests of northeastern NSW provide a stronghold for the species. Nests are in large tree-hollows (at least 50cm deep) in mature eucalypts. Adult birds have strong nesting site fidelity and remain in one large home range throughout their life. Primary prey includes medium-sized arboreal mammals (*eg*. Greater Gliders, Ringtail Possums, Sugar Gliders and flying-foxes).	The level of understanding of the breeding biology and habitat use by Powerful Owls has not been defined in terms of a "viable local population" of the species. However, studies to date have shown that Powerful Owls can breed within urban areas, but the "degree of urbanization that the Powerful Owl can tolerate is still unknown" (Cooke, *et al*., 2002). Results suggest that breeding is reduced in response to an increased level of urban activity, such as birds not returning to a nest site once a timber boardwalk was constructed under a tree (Cooke *et al*., 2002). Similarly, habitat fragments less than 200ha were generally not large enough to provide significant habitat for Powerful Owls in southeastern NSW (Cann *et al*., 2002).
Gang-gang Cockatoo, *Callocephalon fimbriatum*	Vulnerable, TSC Act	The Gang Gang utilises large hollows in the trunk or limbs of living or dead eucalypt trees for nesting (Garnett *et al*. 1999). Hollows of sufficient size for nesting generally do not form in eucalypt trees less than 150 - 200 years old (Mackowski 1984). Gang Gang Cockatoos feed mainly on the fruits of eucalypts and acacias but will feed on other seeds and fruit such as Callitris (as observed nearby the study area), garden fruits, hawthorn and Callistemon as well as some insects and their larvae.	Threats to this species result from clearing of vegetation and degradation of habitat may reduce the abundance of optimal foraging and roosting habitat (clearing and frequent fire posing a threat to continued successful breeding), climate change which may alter the extent and nature of its preferred habitat (cool termperate vegetation) and disease (birds are susceptible to Psittacine cirovirus disease (PCD) which is spread through contaminated nest chambers).
Barking Owl, *Ninox connivens*	Vulnerable, TSC Act	The Barking Owl is a typical hawk-owl, with staring, yellow eyes and no facial-disc. It has declined across much of its distribution across NSW and now occurs only sparsely. It is most frequently recorded on the western slopes and plains. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as Acacia and Casuarina species, or the dense clumps of canopy leaves in large eucalypts. They feed on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding (DEC Species Profile).	Threats to this species are caused by clearing and degradation of habitat (mostly through cultivation, intense grazing and the establishment of exotic pastures), inappropriate forest harvesting practices that have changed forest structure and removed old growth hollow-bearing trees, firewood harvesting and too-frequent fire. Management options for this species includes mosaic pattern hazard reduction techniques to ensure the same areas are not burned too frequently and retention of standing dead trees, retention of woodland and open forest remnants (especially containing hollowed trees) (DEC Species Profile).

Masked Owl, *Tyto novaehollandiae*	Vulnerable, TSC Act	The southern subspecies of Masked Owls occupies a home range of 5-10km2 within a diverse range of wooded habitats that provide large hollow-bearing trees for roosting and nesting and nearby open areas for foraging (Garnett and Crowley 2000; Higgins 1999). Masked Owls also sometimes roost in caves and their typical diet consists of tree-dwelling and ground mammals, especially rats (NSW NPWS 2000).	The decline of this species has been attributed to the decline of its food resources since European settlement, to habitat clearance and fragmentation, and to destruction of potential nest trees. The imbalance in tree age classes in agricultural lands and commercial forests is a potential threat to this species' future survival. The main concerns in relation to timber harvesting are the continued availability of standing hollow trees for the owls' roost and nest sites, the maintenance of suitable foraging habitat, and resources utilised by the owls' prey; e.g. logs or ground cover. Loss of hollow trees during the breeding cycle is one cause of breeding failure. It occurs in harvested and thinned stands, although it avoids dense post-logging regrowth and is associated with high densities of old hollow trees (DEC Species Profile).
Black-chinned Honeyeater (eastern subsp), *Melithreptus gularis gularis*	Vulnerable, TSC Act	The Black-chinned Honeyeater occurs predominantly along the inland slopes of the Great Dividing Range (Longmore 1991) and is rarely recorded east of the divide in NSW (Higgins *et al* 2001). In the New England Region, the species has a patchy distribution, which is to the west of the range (Ford & McFarland 1991; H. Ford pers. comm.). The species mostly occurs in open forests and woodlands dominated by box and ironbark eucalypt associations (Longmore 1991) but is also recorded in other mixed open forests (Higgins *et al* 2001). It appears to be sedentary, with populations centred around a permanent locality from which they are occasionally absent, and is a noisy and active species (Longmore 1991).	Threats to the survival of this species includes clearing of remnant open forest and woodland habitat, poor regeneration of open forest and woodland habitats because of intense grazing and exclusion from smaller remnants by aggressive species such as the Noisy Miner (*Manorina melanocephala*).Management options include retention of suitable woodland habitats, particularly those with unimproved pasture and an intact native ground plant layer, increasing the size and connectivity of existing remnants, planting trees and establishing buffer zones of unimproved uncultivated pasture around woodland remnants (DEC Species Profile).
Grey-crowned Babbler (eastern subsp), *Pomatostomus temporalis temporalis*	Vulnerable, TSC Act	The Grey-crowned Babbler was formerly common throughout northern and eastern Australia (Boles 1988), with the eastern form occurring from South Australia, through Victoria, NSW and Queensland to southern New Guinea (NPWS 2001). In NSW, the species was less common on the higher altitude tablelands with its main distribution occurring on the western slopes and plains (NPWS 2001).	In recent years the species has suffered a considerable decline throughout much of its south-eastern range; it appears to be extinct in South Australia and the ACT and is declining in NSW, south-east Queensland and Victoria (Garnett & Crowley 2000). Threats to this species includes clearing of woodland remnants, heavy grazing and removal of coarse, woody debris within woodland remnants and nest predation by species such as ravens and butcherbirds (DEC Species Profile).

Pied Oystercatcher, *Haematopus longirostris*	Vulnerable, TSC Act	The Pied Oystercatcher is an unmistakable, large, black and white wader, reaching 50 cm in length. The species is distributed around the entire Australian coastline, although it is most common in coastal Tasmania and parts of Victoria, such as Corner Inlet. In NSW the species is thinly scattered along the entire coast. This species favours intertidal flats of inlets and bays, open beaches and sandbanks and forages on exposed sand, mud and rock at low tide, for molluscs, worms, crabs and small fish. The chisel-like bill is used to pry open or break into shells of oysters and other shellfish. It nest mostly on coastal or estuarine beaches although occasionally they use saltmarsh or grassy areas. Nests are shallow scrapes in sand above the high tide mark, often amongst seaweed, shells and small stones (DEC Species Profile).	Threats to this species include disturbance to coastal feeding, nesting and roosting areas, predation of eggs and chicks by foxes, dogs, cats, Australian Ravens and raptors, habitat destruction as a result of residential, agricultural and tourism developments and hydrological changes to estuaries and similar water bodies causing modification or removal of important areas of suitable habitat. Management options include fox, feral cat and Australian Raven control programs, assessment of the appropriateness of dog and cat ownership in new subdivisions, installation of interpretive signs at major nesting sites, management of estuaries and the surrounding landscape to ensure the natural hydrological regimes are maintained and protection and maintenance known or potential habitat, including the implementation of protection zones around known habitat sites and sites of recent records (DEC Species Profile).
Sooty Oystercatcher, *Haematopus fuliginosus*	Vulberable, TSC Act	The Sooty Oystercatcher is an unmistakable, large wader, reaching 50 cm in length. Like the Pied Oystercatcher, the Sooty Oystercatcher has a bright orange-red bill, eye-ring and iris, and coral pink legs and feet. However, the Sooty Oystercatcher has entirely black plumage. Sooty Oystercatchers are found around the entire Australian coast, including offshore islands, being most common in Bass Strait. Small numbers of the species are evenly distributed along the NSW coast. The availability of suitable nesting sites may limit populations. This species favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries and forages on exposed rock or coral at low tide for foods such as limpets and mussels. The Sooty Oystercatcher breeds in spring and summer, almost exclusively on offshore islands, and occasionally on isolated promontories (DEC Species Profile).	Threats to this species are caused by hydrological changes to estuaries and similar water bodies causing modification or removal of important areas of suitable habitat, disturbance to coastal feeding, nesting and roosting areas, predation of eggs and chicks by foxes, dogs, cats, rats and raptor and habitat destruction as a result of residential, agricultural and tourism developments. Management options for this species includes fox, feral cat and rat control programs, assessment of the appropriateness of dog and cat ownership in new subdivisions, management of estuaries and the surrounding landscape to ensure the natural hydrological regimes are maintained, installation of interpretive signs at major nesting sites and protection and maintenance of known or potential habitat, including the implementation of protection zones around known habitat and breeding sites and sites of recent records (DEC Species Profile).
Broad-billed Sandpiper, *Limicola falcinellus*	Vulnerable, TSC Act	The Broad-billed Sandpiper is a small, short-necked, stint-like wader with short legs. The Broad-billed Sandpiper is distributed over the northern coasts, particularly the north-west, with occasional birds seen on the southern coasts, and very few inland (Smith 1991).Sandpipers are known to favour estuarine mudflats, saltmarshes and reefs as feeding and roosting habitat (DEC Species Profile).	Threats to this species include hydrological changes to inland lakes that may modify or remove important areas of suitable habitat for those individuals that remain in Australia overwinter. The other main threat is the development of preferred habitat, specifically coastal estuaries, mudflats and saltmarshes. The main management option for this species is the protection and maintenance of known or potential habitat (DEC Species Profile).
Reptiles			

Rosenberg's Goanna, *Varanus rosenbergi*	Vulnerable, TSC Act	Rosenberg's Goanna reaches up to 1.5 metres in length. It is dark grey above, finely spotted with yellow or white, and with paired, blackish cross-bands from the neck to the end of the tail. Rosenberg's Goanna occurs on the Sydney Sandstone in Wollemi National Park to the north-west of Sydney, in the Goulburn and ACT regions and near Cooma in the south. There are records from the South West Slopes near Khancoban and Tooma River. Rosenberg's Goanna are found in heath, open forest and woodland, associated with termites. Individuals require large areas of habitat and feed on carrion, birds, eggs, reptiles and small mammals. They shelters in hollow logs, rock crevices and in burrows, which they may dig for themselves, or they may use other species' burrows, such as rabbit warrens (DEC Species Profiles).	Threats to this species include habitat loss and fragmentation as land is cleared for residential, agricultural and industrial developments, removal of habitat elements, such as termite mounds and fallen timber, road kill and predation by cats and dogs. Management options for this species includes keeping cats indoors and restraining dogs in and adjacent to areas where this species occurs, assessment of the appropriateness of cat and dog ownership in new subdivisions, avoiding fragmenting known habitat, retention of all termite mounds and fallen timber in areas that support this species, retention and protection of heath, woodland and forest remnants within the known distribution of the species, ensuring remnant populations remain connected or linked to each other; and new roads or road upgrades in areas supporting habitat should have elevated sections constructed (to facilitate goannas passing underneath) to reduce roadkill (DEC Species Profiles).
Amphibians			
Giant Burrowing Frog, *Heleioporus australiacus*	Vulnerable, TSC Act, Vulnerable EPBC Act	The Giant Burrowing Frog is a large, squat, slow-moving frog that grows to about 10 cm long. It has prominent, large eyes and has dark chocolate-brown upperparts with white or yellow spots on the side. The Giant Burrowing Frog occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney sandstone. It has been found from the coast to the Great Dividing Range. This frog is found in heath, woodland and open forest with sandy soils and generally lives in the heath or forest and will travel several hundred metres to creeks to breed. It burrows into deep litter or loose soil, emerging to feed or breed after rain feeding on ground-dwelling invertebrates such as ants, beetles and spiders (DEC Species Profiles).	Processes affecting the survival of this species includes habitat loss through clearing for residential, agricultural and urban infrastructure development, high intensity fires, disease (chytrid fungus), reduction of water quality generally in the vicinity of urban development and forestry activities (especially post-harvest burns). Management options include applying mosaic, low frequency, low intensity burns where fire hazard reduction is necessary, applying post-harvest burns only when habitat assessment have been carried out, retention of native vegetation and minimisation of ground disturbance where the species occurs and protection of breeding sites from disturbance, sedimentation and pollution (DEC Species Profiles).

Red-crowned Toadlet, *Pseudophryne australis*	Vulnerable, TSC Act	The Red-crowned Toadlet has a restricted distribution, known from a relatively small area of mid-eastern New South Wales.Known only from Triassic sandstones of the Sydney Basin Red-crowned Toadlets are found in steep escarpment areas and plateaus, as well as low undulating ranges with benched outcroppings. Known prey for Red-crowned Toadlets are ants, termites, mites, pseudo-scorpions, collembolans and small cockroaches (Rose 1974; Webb 1983), although they are likely to eat most small invertebrates encountered (DEC Species Profile).	Threats to this species includes high frequency fire, bush rock removal, expanding urbanisation (particularly along ridge tops), disease – particularly Chytrid fungus, water pollution and changed hydrological regimes. Management options for this species includes prevention of habitat loss, development and implementation of fire management plans with an appropriate fire regime for known areas of habitat, active prevention of bushrock removal, strategies to reduce stormwater runoff from ridgetop development and existing urban areas which alter the natural hydrology and development of erosion and sediment control measures (DEC Species Profiles).
Green and Golden Bell Frog, *Litoria aurea*	Endangered, TSC Act, Vulnerable EPBC Act	The Green and Golden Bell Frog is a relatively large frog which inhabits a variety of freshwater habitats including marshes, swamps, lagoons, farm dams and ornamental ponds (Cogger 2000). Optimum habitat usually contains macrophyte cover (e.g bull rushes *Typha spp.* or spikerushes *Eleocharis spp.*) for diurnal sheltering with nearby grassed areas and an unshaded waterbody free of predatory fish *Gambusia holbrooki* (Pyke and White 1996). The species is largely aquatic and known to breed from September to early April (*personal observations*) but most commonly during the summer months (Pyke and White 2001).	The historical distribution of the Green and Golden Bell Frog extended along the eastern coast of Australia from the far north coast of NSW, near Brunswick Head to East Gippsland in Victoria and included populations on the western slopes and tablelands of NSW (Pyke and White 1996; Gillespie 1996). This distribution has declined markedly, especially in NSW with the species having disappeared from over 80% of previous known locations since the late 1960s. Today the species distribution consists of isolated populations scattered throughout its former range (reviewed in Pyke and White 2001). Threats to this species arise from destruction of wetlands, alteration of drainage patterns and stormwater runoff, death from a fungal pathogen known as Frog Chytrid Fungus, predation by feral animals such as foxes, herbicides and other weed-control measures, road mortality, predation by exotic fish such as Plague Minnow and loss of suitable breeding habitat through alteration by infilling and destruction of wetlands (DEC Species Profile).

Flora Constraints Report – Bobbin Head/Apple Tree Bay Master Plan, Ku-ring-gai Chase National Park

Conybeare Morrison International Pty Ltd

Final Report

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Contents

1 Methodology

Five areas were inspected for the survey:

- Bobbin Head including Orchard Park (north and south) and Gibberagong Park (north and south);
- The Wharf Area;
- Apple-tree Bay;
- The satellite car park, North Turramurra; and
- The proposed walking track between Bobbin Head to Apple Tree Bay

Inspections were made of the vegetation in the Bobbin Head, the wharf area, Apple Tree Bay and a potential site for the satellite car park at North Turramurra. Plant species were recorded in areas such as in the grassy picnic zones and along the bushland margins up to a height of approximately two metres above the generally flat ground level. This included an estimated horizontal distance of 1 to 15 metres, depending on the slope. Other records included the presence of any threatened flora (listed under the Threatened Species Conservation Act 1995 or Environmental Protection & Biodiversity Conservation Act 1999), the condition of bushland areas, the likely impact of raising the soil level on conservation, and the aesthetic values of the reclaimed areas.

The field assessment across the Bobbin Head/Apple-tree Bay location entailed a brief inspection in order to record the main species and condition of any native plant community present, and the occurrence of any threatened flora.

The route of the proposed walking track was inspected at its beginning and ending areas, and from the nearby road from Bobbin Head to Apple Tree Bay. The difficult nature of the terrain, and the lack of time, precluded the walking of the likely track route. Notes were taken of the plant communities present, the general condition of bushland, the nature of the terrain, and its suitability for construction of a walking trail.

Plant communities were described based on the dominant canopy species and community structure, according to Specht (1970). Plant species nomenclature conforms to Harden (1990-93), except for the change of *Eucalyptus maculata* to *Corymbia maculata*.

The potential conservation significance of communities and species was based on the Threatened Species Conservation Act 1995 (TSC Act) Schedules, Environmental Protection & Biodiversity Conservation Act 1999 (EPBC Act), Briggs & Leigh (1995) and Benson & Howell (1994).

2 Limitations of Survey

The survey was conducted during one site visit in March 2006. At the time of the survey the weather conditions had been favourable for plant growth and production of features required for identification of most species.

Owing to the survey relying on a single inspection of any one location within this study area, it is unlikely that all species present have been recorded. Despite this, it is probable that the vast majority of species have been recorded and that issues including conservation significance of the flora, condition and viability of bushland and likely impact on native vegetation have been able to be satisfactorily assessed.

3 Results

3.1 Bobbin Head (Orchard Park and Gibberagong Park)

These parks mostly comprised of flat picnic areas and car parks. The picnic areas had been planted with a mixture of Australian and exotic trees. Some of the planted Australian species were native to the local area (Appendix A).

The majority lower strata were restricted to *Cynodon dactylon* (Couch Grass) lawn with smaller amounts of *Pennisetum clandestinum* (Kikuyu). Weeds, especially *Richardia brasiliensis* were common.

The surrounding remaining native vegetation particularly in the upper reaches of Cockle Creek conformed to the plant communities *Angophora costata-Eucalyptus piperita* open forest and woodland (Smooth-barked Apple-Sydney Peppermint). The base of the steep southern aspect slope of Orchard Park North contained a high proportion of mesic species, mainly *Glochidion ferdinandi* var. *ferdinandi* (Cheese Tree) and *Pittosporum undulatum* (Sweet Pittosporum) in the understorey.

The bushland in all locations was in relatively weed-free condition owing to their elevation above the surface of the reclaimed (picnic) area and the lack of development further upslope.

3.2 Apple Tree Bay

Apple-tree Bay comprised a flat picnic area and car park. The picnic areas had been planted with a mixture of Australian and exotic trees. Some of the planted Australian species were native to the local area (Appendix A).

The majority lower strata were restricted to *Cynodon dactylon* (Couch Grass) lawn with smaller amounts of *Pennisetum clandestinum* (Kikuyu). Weeds, especially *Richardia brasiliensis* were common.

The surrounding remaining native vegetation particularly in the upper reaches of Apple-tree Creek conformed to the plant communities *Angophora costata-Eucalyptus piperita* open forest and woodland (Smooth-barked Apple-Sydney Peppermint).

The bushland in all locations was in relatively weed-free condition owing to their elevation above the surface of the reclaimed (picnic) area and the lack of development further upslope.

3.3 The Wharf Area

This area was similar to Orchard Park except that it comprised a developed area with Cowan Creek on one side and bushland on the other. The developed zone differed in having boating facilities in lieu of the picnic areas, and some of the bushland above the car park had been developed for residential purposes.

Some of the car park zone had been landscaped using native species. Exotic species were common in the planted areas and along the roadsides. The bushland community above the car park was *Angophora costata-Eucalyptus piperita* open forest and woodland.

The bushland zone was generally in weed-free condition except at the side of the main entry road and in the vicinity of the toilet block. The latter location was below an abandoned residential site and was dominated by exotics that are widely considered to be environmental weeds. Of special concern were *Macfadyena unguis-cati* (Cats Claw Creeper) and *Bryophyllum delagoense* (Mother-of-millions), *Tradescantia fluminensis* (Wandering Tradescantia), *Asparagus densiflora* (Fern Asparagus) and *Hyparrhenia* sp. (a grass). These species have been observed to be highly invasive of disturbed sites north of Sydney, although they have been previously uncommon in bush regeneration work in the Sydney district.

3.4 Proposed Satellite Car Park, North Turramurra

An inspection was made of the ridgetop near and north of the entry to the National Park, in an area that has been identified as a potential site for a new car park. This area was a disturbed zone between the main entry road and the head of the Bobbin Head and Sphinx walking trails. As no defined details had been provided for the location of the proposed car park a detailed survey was not done.

The site has previously been cleared of natural vegetation but subsequently planted with native species, including numerous species that would not have occurred in the location naturally. The vegetation mainly comprised trees with a mixed exotic and native ground cover.

Corymbia maculata (Spotted Gum) was the main canopy species, with lesser amounts of *Lophostemon confertus* (Brush Box) and *Syncarpia glomulifera* (Turpentine). *Acacia parramattensis* (Parramatta Wattle) and *Callistemon salignus* (Willow Bottlebrush) were the main understorey trees. Each of the above are not locally-occurring species, and are also unlikely to occur in *Eucalyptus haemastoma-Corymbia gummifera* woodland that appeared to be the original plant community in this location.

The ground cover varied from dense *Stenotaphrum secondatum* (Buffalo Grass) to the native *Imperata cylindrica* var. *major* (Blady Grass) and Microlaena stipoides (Weeping Meadow-grass). Other exotics included *Nephrolepis cordifolia* (Fishbone Fern), *Sporobolus indica* var. *capensis* (Parramatta Grass) and *Acacia binervia* (Coast Myall).

3.5 Bobbin Head to Apple Tree Bay Proposed Walking Track

No details were provided of the alignment of the proposed walking trail, except that it was to be between the existing sealed road between Bobbin Head and Apple Tree Bay, and Cowan Creek, a width of roughly 20 to 80 metres.

The southern section of the trail would pass through *Angophora costata-Eucalyptus piperita* open forest and woodland. This changed to *Angophora floribunda-Eucalyptus punctata* open forest and woodland in the northern section, comprising an estimated 70% of the corridor. *Eucalyptus punctata* (Grey Gum) occurred sporadically through both communities.

Most of this corridor is on very steep slopes with numerous localised vertical rocky outcrops and minor benches. Some of the vertical outcrops overhang Cowan Creek.

Part of the toe of the slope occurs at the water's edge, however much of it is within the tidal zone, with steep slopes immediately above.

3.6 Conservation Significance

3.6.1 Plant Communities

No plant community observed in the study area is listed under the TSC Act or EPBC Act as being threatened.

Angophora costata-Eucalyptus piperita open forest and woodland is a variant of Sydney Sandstone Gully Forest (Benson & Howell, 1994). It is a widespread and common community in the Sydney Basin Bioregion.

Angophora floribunda-Eucalyptus punctata open forest and woodland is not specifically mentioned by Benson & Howell (1994) but is included in their mapping with Sydney Sandstone Gully Forest. *Angophora floribunda*, *Eucalyptus punctata*, *Allocasuarina torulosa* open forest is mentioned in their description of plant communities in Ku-ring-gai Chase National Park, and is stated as occurring on "footslopes above saltwater estuaries and foreshores of Cowan Creek … mostly Narrabeen Group" bedrock.

Angophora floribunda-Eucalyptus punctata open forest and woodland is widespread but of limited extent in sandstone areas in the Sydney district.

3.6.2 Plant Species

No plant species recorded in the study area is listed under the TSC Act or EPBC Act as being threatened, and no recorded species was considered significant according to Briggs & Leigh (1995) or Benson & Howell (1994).

4 Likely Impacts On Native Flora

4.1 Bobbin Head (Orchard and Gibberagong Parks)

The potential raising of soil level by more than 750 millimetres would not have a significant effect on the conservation value of native plant communities on the slopes surrounding the parklands. However, in some bushland margins individual trees could be affected, ranging from saplings to mature specimens.

It is understood that all trees in the parklands have been assessed by an arborist and plans are being prepared to preserve the majority of trees across the area, where possible. Most of these landscape trees are widespread and common in cultivation. Moreover, it is expected that two large Redwoods (*Sequoia sempervirens)* will be retained as part of this plan. Owing to their age, size and uncommon use in landscaping these trees are seen to have some landscape value. At the time of this survey both were producing vigorous coppice growth, which could be a sign of tree stress. Soil improvements around the root zones of these trees may improve health.

Any loss of other landscape trees would not be significant on an individual basis. It is suggested that future replacement of lost trees and other landscape planting should incorporate locally occurring indigenous species.

4.2 The Wharf Area

The potential raising of soil level by more than 750 millimetres would not have a significant effect on the conservation value of native plant communities. It would be unlikely that any noticeable effect would occur to bushland in this area as the proposed soil levels will not change in these areas. Proposed fill levels grade up toward the sea wall.

The loss of trees in the landscaped zone is considered to be of low significance and temporary, considering that numerous locally endemic tree and shrub species are proposed for planting across this area.

The raising of the road surface level could be of benefit if the area is flood prone. This could be done without any impact on the landscaped section or the bushland in this zone.

4.3 Apple Tree Bay

The impact of raising the soil level in limited areas nearer to the sea wall in the Apple-tree Bay area would have a limited impact on the trees in the picnic and car areas. Only the few, planted trees in the areas proposed for filling would be impacted and much of the area would remain unchanged.

Considering that numerous trees and shrubs are proposed for planting in the Apple-tree Bay area it is considered that the loss of a limited number of introduced trees would be acceptable. Further, considering that the proposed planting will include only locally endemic the landscape integrity of the site will be enhanced.

There is unlikely to be any impact on natural bushland on the slopes surrounding the site.

4.4 North Turramurra proposed car park

There should be no significant impact on native plant communities in this general area as most of the vegetation has been planted with non-local species. However, a more thorough inspection and assessment will be undertaken as a Review of Environmental Factors, to adequately document any potential impacts in relation to the *Threatened Species Conservation Act* and *Environment Protection and Conservation Act*.

4.5 Bobbin Head to Apple Tree Bay proposed walking track

The construction of a walking trail between the two precincts will be investigated more thoroughly in a Review of Environmental Factors once a design has been formalised. It is anticipated that a raised boardwalk would be proposed and this would then minimise many of the potential impacts on local flora and fauna.

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Appendix A: Plant Species Recorded in Bobbin Head Study Area

Plant Communities

Smooth-barked Apple-Sydney Peppermint Woodland - 1, 3, 5
Couch or other exotic Grassland - 2, 4, 6
Spotted Gum-Parramatta Wattle Woodland – 7

Trees			1	2	3	4	5	6	7
Araucariaceae	*Araucaria cunninghamii	Hoop Pine						x	
	*A. heterophylla	Norfolk Island Pine		x		x			
Cupressaceae	*Callitris rhomboidea	Port Jackson Pine		x					
	*Cupressus sp.	Cypress sp.		x					
	*?Dacrydium sp.			x					
	*Sequioa sempervirens	Redwood		x					
Podocarpaceae	*Podocarpus falcatus	Common Yellowwood		x					
Aceraceae	*Acer negundo	Hard Alder		x					
Anacardiaceae	*Schinus molle	Peppercorn Tree		x					
Bignoniaceae	*Jacaranda mimosifolia	Jacaranda		x					
Casuarinaceae	Allocasuarina littoralis	Black She-oak	x		x		x		
	A. torulosa	Forest Oak					x		
	Casuarina glauca	Swamp Oak		x	x	x		x	
Cunoniaceae	Ceratopetalum apelatum	Coachwood	x						
	C. gummiferum	Christmas Bush	x						
Elaeocarpaceae	Elaeocarpus reticulatus	Blueberry Ash	x		x		x		
Euphorbiaceae	Glochidion ferdinandi var. ferdinandi	Cheese Tree	x	x	x	x	x		
Fabaceae	*Acacia binervia	Coast Myall							x
	A. parramattensis	Parramatta Wattle							x
	*Robinia pseudoacacia	Honey Locust		x					
	*Castanospermum australe	Black Bean		x					
Meliaceae	Synoum glandulosum	Scentless Rosewood	x						
	*Toona ciliata	Red Cedar	x						
Moraceae	*Ficus coronata	Creek Sandpaper Fig		x					
	*F. microcarpa var. hillii	Hills Weeping Fig		x					
	F. rubiginosa	Rusty Fig	x		x		x		
Myrsinaceae	Aegiceras corniculatum	River Mangrove	x				x	x	
	Rapanea variabilis	Variable Muttonwood	x						
Myrtaceae	Acmena smithii	Lilly Pilly	x	*x					
	*Acmena smithii rheophytic race	Small-leaved Lilly Pilly		x					
	Angophora costata	Smooth-barked Apple	x	x	x	x	x	x	
	A. floribunda	Rough-barked Apple			x			x	
	*Backhousia anisata	Aniseed Tree		x					
	B. myrtifolia	Grey Myrtle		x					
	Callistemon salignus	Willow Bottlebrush						x	x
	*Corymbia citriodora	Lemon-scented Gum						x	
	C. gummifera	Red Bloodwood		*x				x	
	*C. maculata	Spotted Gum						x	x
	*Eucalyptus botryoides	Bangalay	x	x		x			
	E. ?globoidea	White Stringybark						x	
	E. haemastoma	Scribbly Gum						x	
	E. paniculata	Grey Ironbark						x	

	E. pilularis	Blackbutt	x	x					
	E. piperita	Sydney Peppermint	x				x	x	
	E. punctata	Grey Gum		*x	x		x	x	
	*E. robusta	Swamp Mahogany		x					
	*E. saligna	Blue Gum		x					
	*E. sieberi	Silvertop Ash						x	
	*E. sp.			x					
	*Lophostemon confertus	Brush Box						x	x
	*Melaleuca armillaris	Bracelet Honey-myrtle						x	
	*M. linariifolia	Snow-in-summer		x	x				
	*M. quinquenervia	Broad-leaved Paperbark		x				x	
	*M. styphelioides	Prickly Paperbark							
	*Syncarpia glomulifera	Turpentine							x
	*Syzygium paniculatum	Magenta Cherry		x					
Oleaceae	*Fraxinus oxycarpa cv	Claret Ash		x					
Pittosporaceae	Pittosporum undulatum	Sweet Pittosporum	x		x	x	x		
Platanaceae	*Platanus sp	Plane Tree		x		x			
Proteaceae	*Grevillea robusta	Silky Oak		x					
	Banksia integrifolia	Coast Banksia	x	*x					
	B. serrata	Old Man Banksia		*x					
	*Stenocarpus sinuatus	Wheel-of-fire Tree						x	
Salicaceae	*Populus sp.	Poplar		x					
Sapindaceae	*Cupaniopsis anacardioides	Tuckeroo	*x	x	x				
Sterculiaceae	*Brachychiton acerifolius	Flame Tree		x					
	*B. populnea	Kurrajong						x	
Verbenaceae	Avicennia marina	Grey Mangrove	x				x	x	
Arecaceae	*Syagrus romanzoffiana	Cocos Palm		x					
	*Livistona australis	Cabbage Palm		x					x
Shrubs									
Cyatheaceae	*Cyathea australis	Rough Tree Fern	x						
	*C. cooperi	Straw Tree Fern	x						
Amygdalaceae	*Prunus sp.			x					
	*Photinia sp.			x					
	*Rhaphiolepis indica			x					
Apiaceae	Platysace linearifolia						x		
Apocynaceae	*Gardenia sp			x					
Araliaceae	Astrotricha latifolia	Broad-leaved Sneeze Bush	x				x		
Asteraceae	Cassinia aculeata		x		x				
	Ozothamnus diosmifolius	White Dogwood	x			x			
Dilleniaceae	Hibbertia bracteata						x		
Epacridaceae	Dracophyllum secundum		x						
Ericaceae	*Rhododendron sp cv	Azalea hybrid		x					
Euphorbiaceae	Breynia oblongifolia	Dwarfs Apples	x		x				
Fabaceae	Dillwynia retorta	Eggs & Bacon	x						
	Phyllota philicoides						x		
	Pultenaea flexilis	Graceful Bush Pea	x						
	*Acacia floribunda	Sally Wattle	x						
	A. longifolia	Sydney Golden Wattle		*x	*x	x			
	A. myrtifolia	Myrtle-leaved Wattle		x					
	*A. sophorae	Coast Wattle				x			
	A. suaveolens	Sweet-scented Wattle					x		
	A. ulicifolia	Prickly Moses			x		x		

Lamiaceae	*Lavendula sp cv	Lavender		x					
	*Westringia fruticosa	Coast Rosemary		x					
Myrtaceae	*Angophora hispida	Dwarf Apple		x					
	*Callistemon citrinus	Lemon Bottlebrush		*x					
	*C. linearis			x			x		
	Kunzea ambigua	Tick Bush	x						
	*Leptospermum petersonii								x
	*Leptospermum squarrosum	Pink Tea Tree				x			
	L. trinervium	Paperbark Tea Tree			x		x		
Oleaceae	*Ligustrum sinense	Small-leaved Privet		x					
	Notelaea longifolia	Large Mock Olive	x						
Pittosporaceae	Bursaria spinosa	Blackthorn	x				x		
	Pittosporum revolutum	Yellow Pittosporum		*x					
Proteaceae	*Banksia ericifolia	Heath Banksia	x						
	Grevillea buxifolia	Grey Spider Flower			x				
	G. linearifolia					x			
	G. sericea	Pink Spider Flower				x			
	*Hakea salicifolia	Willow Hakea					x		
	*H. sericea	Silky Hakea		*x		x			
	Persoonia levis	Broad-leaved Geebung	x		x				
	P. linearis	Narrow-leaved Geebung			x		x		
	P. pinifolia					x			
Rhamnaceae	Pomaderris ferruginea						x		
Rutaceae	*Crowea sp				x				
Sapindaceae	Dodonaea boroniifolia						x		
	D. triquetra	Common Hop Bush			x		x		
Solanaceae	*Solanum mauritianum	Tobacco Weed		x					
Theaceae	*Camellia sassanqua	Camellia		x					
Verbenaceae	*Lantana camara	Lantana		x	x				
Xanthorrhoeaceae	Xanthorrhoea arborea	a Grass Tree	x				x		
Herbs - Ferns									
Adiantaceae	Adiantum hispidulum	Rough Maidenhair Fern			x				
Blechnaceae	Doodia caudata var caudata		x						
Davalliaceae	*Nephrolepis cordifolia	Fishbone Fern		x					x
Dennstaedtiaceae	Histiopteris incisa	Bats Wing Fern	x						
	Hypolepis muelleri	Harsh Ground Fern	x						
	Pteridium esculentum	Bracken Fern	x	x	x				
Dicksoniaceae	Calochlaena dubia	False Bracken Fern	x		x		x		
Gleicheniaceae	Gleichenia dicarpa	Pouched Coral Fern	x		x		x		
Pteridaceae	Pteris tremula	Tender Brake	x						
Sinopteridaceae	Cheilanthes sieberi	Rock Fern	x						
Thelypteridaceae	Christella dentata	Binung		x					
Herbs - Dicots									
Amaranthaceae	Alternanthera nodiflora					x			
Apiaceae	Centella asiatica	Pennywort					x		
Asteraceae	*Conyza sp	a Fleabane	x		x	x			
	*Gnaphalium americanum	American Cudweed	x					x	
	Sigesbeckia orientalis				x				
	*Sonchus oleraceus	Sow Thistle						x	
Chenopodiaceae	Chenopodium sp.					x			
Convolvulaceae	Dichondra repens	Kidney Weed	x						
Crassulaceae	*Bryophyllum delagoense	Mother-of-millions			x				
Euphorbiaceae	*Euphorbia peplus	Petty Spurge		x					

Geraniaceae	Geranium homeanum		x						
	*Pelargonium sp.			x					
Goodeniaceae	Dampiera purpurea						x		
	Goodenia heterophylla						x		
Malvaceae	*Modiola caroliniana		x						
	*Sida rhombifolia	Paddys Lucerne	x			x	x		
Lamiaceae	Plectranthus parviflorus	Cockspur Flower	x						
Oxalidaceae	Oxalis sp.		x						
Plantaginaceae	*Plantago lanceolata	Lambs Tongue		x			x		
Polygonaceae	*Persicaria capitata	Japanese Knotweed	x						
	*Polygonum aviculare	Wireweed	x						
	Rumex brownii					x			
Rubiaceae	*Richardia brasiliensis	White Eye			x	x	x		
Solanaceae	*Solanum chenopodioides		x		x				
	*S. nigrum	Blackberry Nightshade		x	x				
Violaceae	*Viola hederacea	Native Violet		x					
Herbs-Monocots									
Agavaceae	*Aloe vera	Aloe Vera			x				
Amaryllidaceae	*Crinum pedunculata	Swamp Lily		x					
Asparagaceae	Protasparagus aethiopicus				x				
Commelinaceae	Commelina cyanea	Blue Wandering Jew	x		x				
	*Tradescantia fluminensis	Wandering Jew	x	x	x				
Cyperaceae	*Carex brevifolius		x						
	*Cyperus congestus							x	
	*C. eragrostis		x				x		
	C. gracilis			x					
	C. laevis		x						
	C. sp.						x		
	Gahnia sp.						x		
	Lepidosperma laterale	Broad Sword-sedge							
Juncaceae	Juncus prismatocarpus						x		
	J. usitatus	Forest Rush		x	x				
	J. sp.						x		
Lomandraceae	Lomandra longifolia	Spiny-headed Mat-rush	x	*x	x				
	L. confertifolia ssp rubiginosa						x		
Phormiaceae	Dianella caerulea var producta	Flax Lily	x		x	x	x		
Poaceae	*Andropogon virginicus	Whisky Grass	x				x		x
	Anisopogon avenaceus				x				
	Aristida vagans	Three-awned Grass			x	x			
	*Axonopus affinis	Carpet Grass	x	x	x		x	x	
	Bothriochloa macra	Red Leg Grass					x		
	*Briza minor	Shivery Grass		x					
	*Cynodon dactylon	Couch Grass	x	x	x	x	x		x
	*Digitaria sanguinalis	Summer Grass	x						
	*Ehrharta erecta	Veldt Grass	x		x		x		
	Entolasia stricta	Wiry Panic	x		x		x		
	*Eragrostis curvula	African Love-grass				x			
	E. sp						x		
	*Hyparrhenia hirta	Coolatai Grass			x		x		
	Imperata cylindrica var major								x
	Paspalidium distans						x		
	Microlaena stipoides	Weeping Meadow-grass	x						x
	Oplismenus aemulus	Basket Grass		x					

	Panicum simile				x				
	*Paspalum dilatatum	Paspalum		x		x	x		
	*P. urvillei	Vasey Grass		x	x		x		
	*Pennisetum clandestinum	Kikuyu		x		x			
	*Setaria sp.	Slender Pigeon Grass		x	x	x	x		
	*Sporobolus indica var capensis	Parramatta Grass	x		x	x	x	x	x
	*Sporobolus indica var major						x		
	*Stenotaphrum secundatum	Buffalo Grass	x	x		x	x		x
	Themeda australis	Kangaroo Grass	x		x		x		
Vines									
Bignoniaceae	*Macfadyena unguis-cati	Cats Claw Creeper			x	x			
	Pandorea pandorana	Wonga Wonga Vine			x				
Caprifoliaceae	*Lonicera japonica	Japanese Honeysuckle			x				
Dilleniaceae	*Hibbertia scandens	Climbing Guinea Flower		x					
Menispermaceae	Sarcopetalum harveyanum	Pearl Vine							
	Stephania japonica var discolor	Tape Vine	x						x
Nyctaginaceae	*Bougainvillea sp cv	Bouganvillea			x				
Ranunculaceae	Clematis glycinoides	Travellors Joy	x				x		
Rubiaceae	Morinda jasminoides	Morinda Jasmine	x		x				
Vitaceae	Cayratia clematidea	Slender Grape	x		x				
	Cissus hypoglauca	Five-leaved Water Vine	x	*x	x				
Geitonoplesiaceae	Eustrephus latifolius	Wombat Berry	x						
Smilaceae	Smilax australis	Prickly Supplejack							
	S. glyciphylla	Sarsaparilla	x						
Lithophytes									
Aspleniaceae	Asplenium flabellifolium	Necklace Fern	x						
Polypodiaceae	Pyrrosia rupestris	Rock Felt Fern	x						
Orchidaceae	Dendrobium speciosum	Rock Orchid							
	Liparis reflexa	Yellow Rock Orchid							

KEY
Site 1 - Bobbin Head Precinct bushland zone
Site 2 - Bobbin Head Precinct developed zone
Site 3 - Halvorsen Precinct bushland zone
Site 4 - Halvorsen Precinct developed zone
Site 5 - Apple Tree Bay Precinct bushland zone
Site 6 - Apple Tree Bay Precinct developed zone
Site 7 - North Turramurra Precinct proposed car park

x indicates occurrence in zone indicated
* indicates exotic species (Some indigenous species shown as exotics where planted)

NB Site 7 species list not comprehensive

1.2 Aboriginal Research and Analysis Report - AMBS

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ABORIGINAL HISTORY

The presence of a large and diverse number of archaeological sites throughout Ku-ring-gai Chase National Park (NP), including numerous shell middens, rock shelters, engravings and grinding grooves located near the Bobbin Head and Apple Tree Bay recreation areas, attest to the long term Aboriginal occupation of the region. This archaeological record provides evidence of Aboriginal life - including movements and occupation patterns, hunting and collecting of resources, ceremonial practices and material culture - before the arrival of Europeans. This evidence combined with the documentary records produced from the time of European contact in the Sydney region provides important information on the Aboriginal history of the area known as Ku-ring-gai Chase NP.

Although there is some confusion concerning the pre-European tribal organisation around Sydney, the Guringai tribe is believed to have inhabited the coastal area from Lake Macquarie to Botany Bay (Bradney et al. 1984:16). The Guringai tribe consisted of a number clans, with early historical records indicating considerable group movement and interaction along the coast. This occurred through daily and seasonal activities of food gathering and hunting, religious events such as initiation ceremonies, as well as more hostile associations through fighting and conflict.

Prior to European contact the Guringai groups subsisted largely on coastal resources, including fish and shell fish. Historical records indicate that the diet was also supplemented by various vegetable foods, macropods, birds, possums and grubs. (Ross 1976:24). However, the many shell middens located along the foreshore and creeks throughout Ku-ring-gai Chase NP are testimony to the important role that marine foods played in the traditional Aboriginal subsistence economy.

Historical observations of traditional Guringai food gathering strategies demonstrate that there was a basic division of labour between men fishing with spears, and women using hooks and lines and collecting shell fish (Ross 1976:48). Spears were also used for hunting and fighting, and were made from the shafts of grass trees (*Xanthorrhoea* sp.). According to the task they were used for, spears were fitted with various barbs made from stone, shell or hardwood, which were secured by resin obtained from the base of grass trees. The *Xanthorrhoea* species is still very prevalent throughout Ku-ring-gai Chase NP, and is culturally significant to the local Aboriginal community. Fish hooks were fashioned by women from Turban shells (*Turbo torquata*), and were fastened to a line made out of fibrous bark (Turbet 2001:49). Fishing from canoes was also a common daily activity by men and women. Canoes were made from the bark of several different tree species, and were large enough (up to 6 meters in length) to transport as many as six people (Turbet 2001:52).

The arrival of the First Fleet in 1788 signalled the beginning of major changes to the traditional life of the original occupants of the Sydney region. Although earliest impacts were felt by Aboriginal communities living around Port Jackson and Botany Bay, by the early 19th century the Guringai territory was being gazetted and occupied by European settlers. Early road construction and logging also contributed to the reduction of traditional Aboriginal territories and resources. Due to the affects of smallpox and other introduced diseases, only a small number of Aboriginals were observed in the Bobbin Head and Apple Tree Bay areas in the 1850's (Bradney

1984:19). This suggests a considerable reduction in the size of the Aboriginal population of the Hawkesbury River and its southern tributaries, which prior to 1788 is estimated at around two hundred (Turbet 2001:26).

References

Bradney, R, Kremer, M, Lautrec, D, Rhodes, D, Stirling, W. and C. Webb 1984 *An Archaeological Survey of Cotton Tree Bay*. Unpublished report to the NSW NPWS.

Ross, A. 1976 *Inter-tribal Contacts – What the First Fleet saw.* Unpublished BA(Hons) thesis, Department of Anthropology, University of Sydney.

Turbet, P. 2001 *The Aborigines of the Sydney District before 1788*. Kangaroo Press, East Roseville NSW.

AMBS CONSULTING

AMBS Reference: 2005038

28 April 2006

Colin Polwarth
Associate
Conybeare Morrison Pty Ltd
Level 1, 52-58 William Street
East Sydney NSW 2011

Dear Colin

Aboriginal Heritage Input - Bobbin Head and Apple Tree Bay
Draft Conservation Management Plan

This letter provides the final documentation on Aboriginal Heritage at Bobbin Head and Apple Tree Bay for inclusion in the Draft Conservation Management Plan (CMP) for these precincts currently being prepared on behalf of the Department of Environment and Conservation (DEC). As a component of the Draft CMP, Australian Museum Business Services (AMBS) was commissioned by Conybeare Morrison to provide information on Aboriginal heritage issues within the Bobbin Head and Apple Tree Bay precincts. AMBS understands that this process will ensure that Aboriginal heritage is considered within the Master Plan, which will guide the future use and development of these recreational areas.

To provide the input on Aboriginal heritage issues at Bobbin Head and Apple Tree bay, AMBS has undertaken the following key tasks:

- Review of existing background material, including search of the Aboriginal Heritage Information Management System (AHIMS) maintained by the DEC;
- Consultation with the Metropolitan Local Aboriginal Land Council (MLALC) and National Parks and Wildlife Service (NPWS) Aboriginal Sites Officer about their knowledge of the study area;
- Brief site visit (combined with above task) to verify what is known about the archaeological potential of the study area;
- Synthesis/integration of information;
- Statement of significance of Aboriginal heritage, based on established criteria (includes both archaeological significance and cultural value identified by the local Aboriginal community;
- Identification of constraints and opportunities in relation to Aboriginal heritage; and
- Provision of appropriate information for inclusion in the CMP prepared for Bobbin Head and Apple Tree Bay (i.e. not a stand-alone report).

Previous correspondence to Conybeare Morrison has provided preliminary information on the Aboriginal heritage input for the Draft CMP. This letter provides the finalised documentation relating to the location of Aboriginal archaeological sites, significance assessment, and constraints and opportunities identified for the Bobbin Head and Apple Tree Bay recreation precincts (as designated in the Master Plan). This information is provided below under several subject headings for inclusion in the Draft CMP. As requested, the information for Bobbin Head is provided in accordance with the sub-precinct names devised during the Project Control Group (PCG) meeting on 29 March 2006.

Australian Museum Business Services
6 College Street Sydney NSW 2010
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Archaeological Background and Landscape History

Aboriginal archaeological sites are recorded throughout Ku-Ring-Gai Chase National Park (NP). A search of the AHIMS for recorded sites within a three kilometre radius search area of the Bobbin Head and Apple Tree Bay precincts found 103 sites (Table 1). This demonstrates the diversity of the archaeological resource of the area, with the majority of sites comprising more than one archaeological feature. The presence of shell middens and natural rock platforms and shelters displaying evidence of occupation (art and middens), broadly reflects the local geology and landforms of the Ku-Ring-Chase NP. The high incidence of shell middens in the area is indicative of the nature of available resource zones, including bays and creeks that provided shellfish and other marine resources.

Table 1: Aboriginal sites recorded within 3km radius of Apple Tree Bay and Bobbin Head.

Site Type	Number of sites	Percentage of Total
Rock engraving	23	22.4
Rock engraving, Water hole/well	1	0.9
Axe grinding groove/rock engraving	7	6.8
Axe grinding groove	10	9.8
Midden	13	12.6
Rock shelter with midden	20	19.5
Rock shelter with art	12	11.6
Rockshelter with art and midden	10	9.8
Unknown rock shelter site type	2	1.9
Fish trap/rock engraving/rock shelter with art and midden	1	0.9
Stone arrangement	2	1.9
Open camp site	2	1.9
TOTAL	**103**	**100.0**

A review of the information recorded on the AHIMS site cards, including the AMG Easting and Northing coordinates and directions for site relocation, revealed that no archaeological sites have previously been recorded within the Apple Tree Bay and Bobbin Head recreation precincts. However, this excludes the registered site 45-5-2777, which is recorded as a rockshelter with art under the site name of 'Apple Tree Bay'. As the site card is currently missing from the AHIMS register, the map coordinates and location information for this site cannot be checked and confirmed. The unconfirmed location of site 45-5-2777 is illustrated on Figure 1.

Two further limitations of the AHIMS data should be also recognised. Firstly, AHIMS only includes information on Aboriginal sites and objects that have been provided to the DEC, and secondly, the records may be variable in their accuracy. As an additional consideration in identifying the presence of archaeological sites in Bobbin Head and Apple Tree Bay recreation precincts, a brief review of the land use and development of these precincts offers useful information.

A review of available background information on the Bobbin Head and Apple Tree Bay recreation precincts has revealed that both areas were created through reclamation of mud flats. At Bobbin Head the first phase of fill and development dates to the late nineteenth century, with the full extent of reclamation completed in the late 1960s. The Apple Tree Bay precinct has as similar history of reclamation and development. Topographic overlays of the development phases at both precincts, however, illustrate that the areas furthest from the foreshore and abutting the sandstone scarp represent original landscape http://www.nationalparks.nsw.gov.au/npws.nsf/Content/kuringgai_bobbinhead_appletree_masterplan_draft, accessed on 10 March 2006). This highlights the archaeological potential of the zone at the base of the steep slopes and rocky outcrops at both precincts. To confirm the absence/presence of archaeological sites in the areas, and to address the limitation of the AHIMS data outlined above, a brief site inspection of both the Apple Tree Bay and Bobbin Head recreation areas was undertaken.

Figure 1: Blue arrow indicates unconfirmed location of site 45-6-2777 within Apple Tree Bay recreation precinct.

Site Visit – Aims and Outcomes

The site visit was undertaken on 17th March 2006 by AMBS archaeologists Alison Nightingale and Melissa Carter in association with MLALC representatives Rowena Welsh-Jarrett and Joshua Lyons, and NPWS Aboriginal Sites Officer Bradley Welsh. The aims of the site visit were to:

- discuss the background of the Bobbin Head and Apple Tree Bay CMP and Master Plan,
- consult with members of the local Aboriginal community about their knowledge of the areas,
- locate and identify archaeological sites within the two recreation precincts (paying attention to the areas detailed above), and
- discuss any issues or concerns relating to the management of archaeological sites to be considered as part of the planning process.

The site visit confirmed that no archaeological sites are located in the Apple Tree Bay recreation precinct. The possible location of site 45-6-2777 was inspected, and no site was identified. During the review of the available documentation for sites previously recorded within the vicinity of the Bobbin Head and Apple Tree Bay precincts, AMBS recognised a high level of inaccuracy in the map coordinates. It is concluded that like the other sites recorded in the vicinity of the precinct, the map coordinates for site 45-6-2777 are incorrect and the site is located elsewhere.

During the inspection of the Bobbin Head recreation precinct, three archaeological sites were recorded. Each of these sites is located along the base of the rocky scarp in the large picnic area on the western side of Cockle Creek. Although it is recognised that a more thorough review of the site cards may demonstrate that records for these sites already exist, for the purpose of this documentation they are described as previously unrecorded. Therefore site cards will be completed and forwarded to the DEC. Details of the sites are provided below and there locations are illustrated in Figure 2.

BH 1: This site is located in the Gibberagong South sub-precinct at the base of the sandstone scarp behind the grassed picnic area and car park. The site comprises a small rockshelter with a significant quantity of stratified shell midden deposit (Photo 1). The shelter has been vandalised; there is visible graffiti (written in charcoal) on the face of the shelter (Photo 2). The extent of dispersal of the shell midden also suggests regular visitation by picnickers, resulting in significant treadage of the cultural deposit (during the site visit we observed a tourist entering the rockshelter to get a photo of a goanna that had ran into the rockshelter minutes earlier).

BH 2: This site is located in the Orchard Park North sub-precinct at the base of the sandstone scarp parallel to Apple Tree Bay Road. This site consists of shell midden deposit which appears to have been excavated from the base of the sandstone scarp during the construction of a drainage channel (running parallel to the base of the scarp, Photo 3), then redeposited into a low rock overhang adjacent to the channel (Photo 4). The presence of broken ceramics, recent bone (fauna) and pieces of asbestos in addition to cultural shell remains, confirm the disturbed nature of this deposit.

BH 3: This site comprises two hand stencils located on two adjacent rock faces at the commencement of the Gibberagong Track and Boardwalk zone (Photo 5). As indicated by Brad Welsh, however, there is some question over the antiquity of these hand stencils. Although not confirmed at this stage, it is likely that one or both of the hand stencils have been recently (last 20 years) painted onto the rock faces. Until the age of these hand stencils is confirmed by a rock art specialist, the archaeological and cultural significance of this site remains undetermined.

Significance Assessment

One of the primary steps in the process of cultural heritage management is the assessment of significance. Not all sites are equally significant and not all are worthy of equal consideration and management (Sullivan and Bowdler 1984; Pearson and Sullivan 1995:7). The determination of significance can be a difficult process as the social and scientific context within these decisions are made is subject to change (Sullivan and Bowdler 1984). This does not lessen the value of the heritage approach, but enriches both the process and the long-term outcomes for future generations are the nature of what is conserved and why, also changes over time.

Significance assessment can generally be described under three broad headings (Pearson and Sullivan 1995:7):

- Value to groups such as Aboriginal communities.
- Value to scientists and other information gatherers.
- Value to the general public in the context of regional, state and national heritage.

Professional guidelines for the assessment of significance (NPWS Aboriginal Heritage Guidelines 1997) discuss two types of significance: social significance and archaeological significance.

Social Significance

This area of assessment concerns the value(s) of a site or feature to a particular community group – in this case the local Aboriginal community. Aspects of social significance are relevant to sites, items and landscapes that are important or have become important to the local Aboriginal community. This importance involves both traditional links with specific areas as well as an overall concern by Aboriginal people for sites generally and their continued protection. Aboriginal cultural significance may include social, spiritual, historic and archaeological values.

Scientific Significance

Scientific significance is assessed using criteria to evaluate the contents of a site, state of preservation, integrity of deposits, representativeness of the site type, rarity/uniqueness and potential to answer research questions on past human behaviour (NPWS, 1997). NPWS guidelines recommended criteria for assessing archaeological significance include:

- *Archaeological Research Potential*- significance may be based on the potential of a site or landscape to explain past human behaviour and can incorporate the intactness, stratigraphic integrity or state of preservation of a site, the association of the site to other sites in the region or a datable chronology;

- *Representativeness* - all sites are representative of those in their class (site type/subtype), however, the issue here relates to whether particular sites should be conserved to ensure a representative sample of the archaeological record is retained. Representativeness is based on an understanding of the regional archaeological context in terms of site variability in and around the study area, the resources already conserved and the relationship of sites across the landscape; and

- *Rarity*- defines how distinctive a site may be, based on an understanding of what is unique in the archaeological record and consideration of key archaeological research questions (ie. some sites are considered more important due to their ability to provide certain information). It may be assessed at local, regional, state and national levels.

Statement of Significance

Ku-Ring-Gai Chase NP is important archaeologically because it exhibits a large number and a diverse range of Aboriginal sites that represent a range of past activities. These activities include resource gathering and tool production, indicated by shell middens and grinding grooves, as well ceremonial processes demonstrated by rock art and engravings. The marine resources provided by the creeks and tributaries located around Bobbin Head (Cockle Creek) and Apple Tree Bay (Apple Tree Creek) would have attracted Aboriginal occupation of these areas. The mud flat and mangrove habitats that existed in these areas prior to European occupation and eventual reclamation for development would have also provided a plentiful resource zone. The prevalence of rockshelters in the area would have also offered suitable sites for regular visitation and use.

The presence of two sites (BH1 and BH2) within the transition zone from grassed area to sandstone scarp at the back of the Bobbin Head precinct is interpreted as confirming the subsurface archaeological potential of this area. Although both sites show a high level of disturbance, the history of development at Bobbin Head demonstrates that this area is not reclaimed land. As the unreclaimed zone at the base of the sandstone scarp at Bobbin Head potentially represents the only natural landscape in this area, this zone is of high archaeological potential (this excludes the Orchard Park South sub-precinct where there has been a high level of past disturbance demonstrated by several buildings that currently stand on the site). Although the history of reclamation at the Apple Tree Bay recreation precincts also shows the area at the base of the sandstone scarp to be natural landscape, cutting of the sandstone cliff in the eastern portion of the precinct (evidenced by drilling scars) suggests that past disturbance in this area may have been considerable. The archaeological potential for the unreclaimed zone at the base of the sandstone scarp at Apple Tree Bay is therefore considered to be low. In summary, the area at the rear of the Bobbin Head recreation precinct which comprises unreclaimed land is considered to be archaeologically significant.

The Bobbin Head and Apple Tree Bay recreation precincts have a high level of cultural significance (regardless of the site-specific archaeology). The improvement of facilities in these precincts is likely to result in increased visitation to area, providing a good opportunity to educate/increase awareness of Aboriginal values and significance of the area among the public. In this context there is also concern that increased visitation may have implications for the conservation of Aboriginal archaeological sites in the area. During on-site discussions, MLALC representatives Rowena Welsh-Jarrett and Joshua Lyons and NPWS Aboriginal Sites Officer Bradley Welsh recommended that appropriate management strategies for Aboriginal heritage be considered as part the Master Planning process. In regards to both the interpretation and management of Aboriginal heritage within the vicinity of the Bobbin Head and Apple Tree Bay recreation precincts, it may be beneficial for DEC to work closely with the MLALC.

Aboriginal Heritage Management

All Aboriginal archaeological sites are protected by commonwealth and state statutory controls, as detailed below.

Commonwealth Legislation

The *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* is the principal Commonwealth legislation protecting Aboriginal heritage. This Act complements State legislation and is intended to be used only as a 'last resort' where state laws and processes prove to be ineffective. Under this Act the responsible Minister can make temporary or long-term declarations to protect areas and objects of significance under threat of injury or desecration. The Act also encourages heritage protection through mediated negotiation and agreement between land users, developers and Aboriginal people. On 17 December 1998 responsibility for administration of the *Heritage Protection Act* was transferred by Administrative Arrangement Orders from ATSIC to the Environment and Heritage portfolio and the Act is now administered by the department of Environment and Heritage.

The Burra Charter (ICOMOS Australia 1999) also provides guidance for the conservation and management of places of cultural significance (cultural heritage places). The Charter was adopted by Australia ICOMOS (the Australian National Committee of ICOMOS) in 1979 with recent revisions adopted in 1999. The Charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians.

State Legislation

The National Parks and Wildlife Act (1974) and the Environmental Planning and Assessment Act (1979) are the primary statutory controls protecting Aboriginal heritage within New South Wales.

National Parks and Wildlife Act (1974)

Under the provisions of the National Parks and Wildlife Act 1974, all Aboriginal Objects are protected regardless of their significance or land tenure. Aboriginal Objects are defined as "*any deposit, object or material evidence (not being a handicraft made for sale) relating to Aboriginal habitation of the area that comprises NSW, being habitation before or concurrent with the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains*".

Aboriginal objects are therefore limited to physical evidence and may also be referred to as 'Aboriginal sites', 'relics' or 'cultural material'. Aboriginal objects can include pre-contact features such as scarred trees, middens and artefact scatters, as well as physical evidence of post-contact use of the area such as Aboriginal built fencing or stockyards, fringe camps.

The NPW Act also protects Aboriginal Places, which are defined as "a place that is or was of special significance to Aboriginal culture. It may or may not contain Aboriginal objects". Aboriginal Places can only be declared by the Minister administering the NPW Act.

Under Section 91 of the Act, the DEC must be informed upon the identification of all Aboriginal Objects. Failure to do this within reasonable time is an offence under the Act.

Under Section 90 of the Act, it is an offence for a person to destroy, deface, damage or desecrate an Aboriginal Object or Aboriginal Place without the prior issue of a Section 90 consent (formerly referred to as a "Consent to Destroy"). The Act requires a person to take reasonable precautions and due diligence to avoid impacts on Aboriginal Objects. Section 90 consents may only be obtained from the Environmental Protection and Regulation Division (EPRD) of DEC. In considering whether to issue Section 90 consents, DEC take into account the:

- cultural and archaeological significance of the Aboriginal object(s) or Aboriginal place(s) subject to the proposed impacts;
- effect of the proposed impacts and the mitigation measures proposed;
- alternatives to the proposed impacts;
- conservation outcomes that will be achieved if impact is permitted; and
- outcomes of Aboriginal community consultation regarding the proposed impact and conservation outcomes.

The Act also provides for stop-work orders under Section 91AA if an action is likely to significantly affect an Aboriginal Object or Aboriginal Place. The order may require that an action is to cease or that no action is carried out in the vicinity of the Aboriginal Object or Aboriginal Place for a period of up to 40 days.

It is also an offence under Section 86 of the NPW Act to disturb or excavate land for the purpose of discovering an Aboriginal object, or to disturb or move an Aboriginal object on any land, without first obtaining a permit under Section 87 of the NPW Act. In issuing a permit under Section 87, DEC will take into account the:
- views of the Aboriginal community about the proposed activity;
- objectives and justification for the proposed activity;
- appropriateness of the methodology to achieve the objectives of the proposed activity; and
- knowledge, skills and experience of the nominated person(s) to adequately undertake the proposed activity.

Environmental Planning and Assessment Act (1979)

The Environmental Planning and Assessment Act (EP&A Act) requires that consideration be given to environmental impacts as part of the land use planning process. In NSW, environmental impacts include cultural heritage impacts. Part 3 of the Act relates to planning instruments including those at local and regional levels, Part 4 of the Act controls development assessment processes and Part 5 of the Act refers to approvals by determining authorities.

Under Part 4 of the Act, approvals by State government agencies can be linked to the development consent process. Development applications that require specified approvals from State agencies are referred to as Integrated Development Approvals (IDA). The Department of Environment and Conservation is an approval body in the IDA process when a development will impact on an Aboriginal object or Aboriginal place, thereby requiring a Heritage Impact Permit pursuant to Section 90 of the NPW Act. Under the IDA process, applicants are required to provide the Department of Environment and Conservation with sufficient information to allow them to provide general terms of approval, prior to the granting of any development consent.

Part 4 also requires that in reaching a decision to grant development consent, a consent authority is to take into consideration the likely impacts of that development, including environmental impacts on both the natural and built environments, and social and economic impacts in the locality. This requires the consent authority to consider the impact on all Aboriginal heritage values, including natural resource uses or landscape features of spiritual importance, as well as the impact on Aboriginal objects and Aboriginal places.

Conservation Aims in Heritage Management

Conservation strategies for Aboriginal objects, places and areas of archaeological or cultural sensitivity are necessary to retain this finite and valuable resource. Management of Aboriginal cultural heritage in the development process is also required to ensure identification and management of Aboriginal heritage issues, and incorporation of conservation outcomes into land use planning and development.

All Aboriginal archaeological sites are protected under Section 90 of the National Parks and Wildlife Act 1974, regardless of their significance or land tenure. Conservation for all known sites is the preferred management strategy by DEC. Even in instances when development approvals are granted, DEC stress the incorporation of conservation outcomes as part of the larger project.

Conservation strategies are important for retaining archaeological deposits in situ. Conservation areas can have two primary aims: to retain archaeological sites of high archaeological and cultural significance, and to retain a representative sample of the archaeological resource of an area. Conservation strategies for the WDRA can reflect both outcomes, in aiming to preserve known sites of significance, but also to conserve landscape areas likely to contain sites of high significance and/or a range of archaeological resources.

Aboriginal Heritage Recommendations

A number of recommendations for the management of Aboriginal heritage at the Bobbin Head and Apple Tree Bay precincts have arisen from the concerns documented during the site visit and ongoing consultation with Bradley Welsh (NPWS Aboriginal Sites Officer) and the MLALC (please also refer to attached letter from the MLALC). These are identified for each precinct and are detailed below.

Bobbin Head

- **Recommended** that site BH3 be inspected by a qualified rock art specialist so that if required, appropriate management of the site can be implemented as part of the Master Plan process,
- **Recommended** that development as part of the improvement to recreation facilities avoid impact to sites BH1, BH2 (and BH3), and that appropriate impact mitigation measures are put in place to avoid indirect impact to these sites,
- **Recommended** that if the unreclaimed land at the base of the sandstone scarp is to be impacted by development, that test excavations be undertaken to identify any cultural material, and as a strategy to formulate impact mitigation measures as part of the development process,
- It has been suggested by the MLALC and NPWS Aboriginal Sites Officer Bradley Welsh that a test excavation of the rock shelter at site BH 1 be conducted as an opportunity to gain a better understanding of the archaeological resource of the area, and to use this knowledge as an educational tool. This site is currently unmanaged and is subjected to regular treadage and vandalism by visitors to the picnic area. It is concluded that, before this site is damaged further, important information may be gained from conducting a controlled archaeological excavation of the shell midden deposit. The knowledge produced from this investigation could be incorporated into interpretive signage at Bobbin Head to promote Aboriginal heritage.

Bobbin Head and Apple Tree Bay:

- As a result of improvement/expansion to recreation facilities, there is concern that increased visitation to the precincts may have implications for the conservation and management of Aboriginal archaeological sites. It is **recommended** that this possibility be considered as part of the Master Plan process.
- Due to the ambiguity and inaccuracies in the information recorded for known sites within the immediate vicinity of the recreation precinct, there is concern that works may inadvertently have direct/indirect impact on archaeological sites. This directly relates to the proposal for the construction of several new walking tracks throughout the area, including the looping track between Bobbin Head and Apple Tree Bay. Shell middens and rockshelters with art have previously been recorded along several of the walking tracks in the area, including the Berowra Track leading north from Apple Tree Bay. It is therefore **recommended** that a more comprehensive archaeological survey/assessment of all areas to be affected by the construction/upgrading of tracks be undertaken before works commence.

- As part of the Master Plan, it is **recommended** that there is recognition of the excellent opportunity provided by the Aboriginal heritage of the precincts for incorporation into the design and facility upgrades. The production of interpretive signage, cultural displays and pamphlet distribution are among the numerous possible formats for increasing and enhancing visitor education and awareness of the archaeological and cultural significance of Aboriginal heritage at Bobbin Head and Apple Tree Bay.

If you require any additional information, or if I can be of assistance in any way regarding the above information on the Aboriginal heritage input for the Draft CMP for the Bobbin Head and Apple Tree Bay recreation precincts, please contact me on (02) 9320 6467 or email melissac@austmus.gov.au.

Yours sincerely

Dr Melissa Carter
Project Officer / Archaeologist

References

Pearson, M. and Sullivan, S. 1995 *Looking after Heritage Places: The Basics of Heritage Planning for Managers, Landowners and Administrators*. Melbourne: University Press.

Sullivan, M. and Bowdler, S. 1984 *Site Survey and Significance Assessment in Australian Archaeology*. Research School of Pacific and Asian Studies, Australian National University, Canberra.

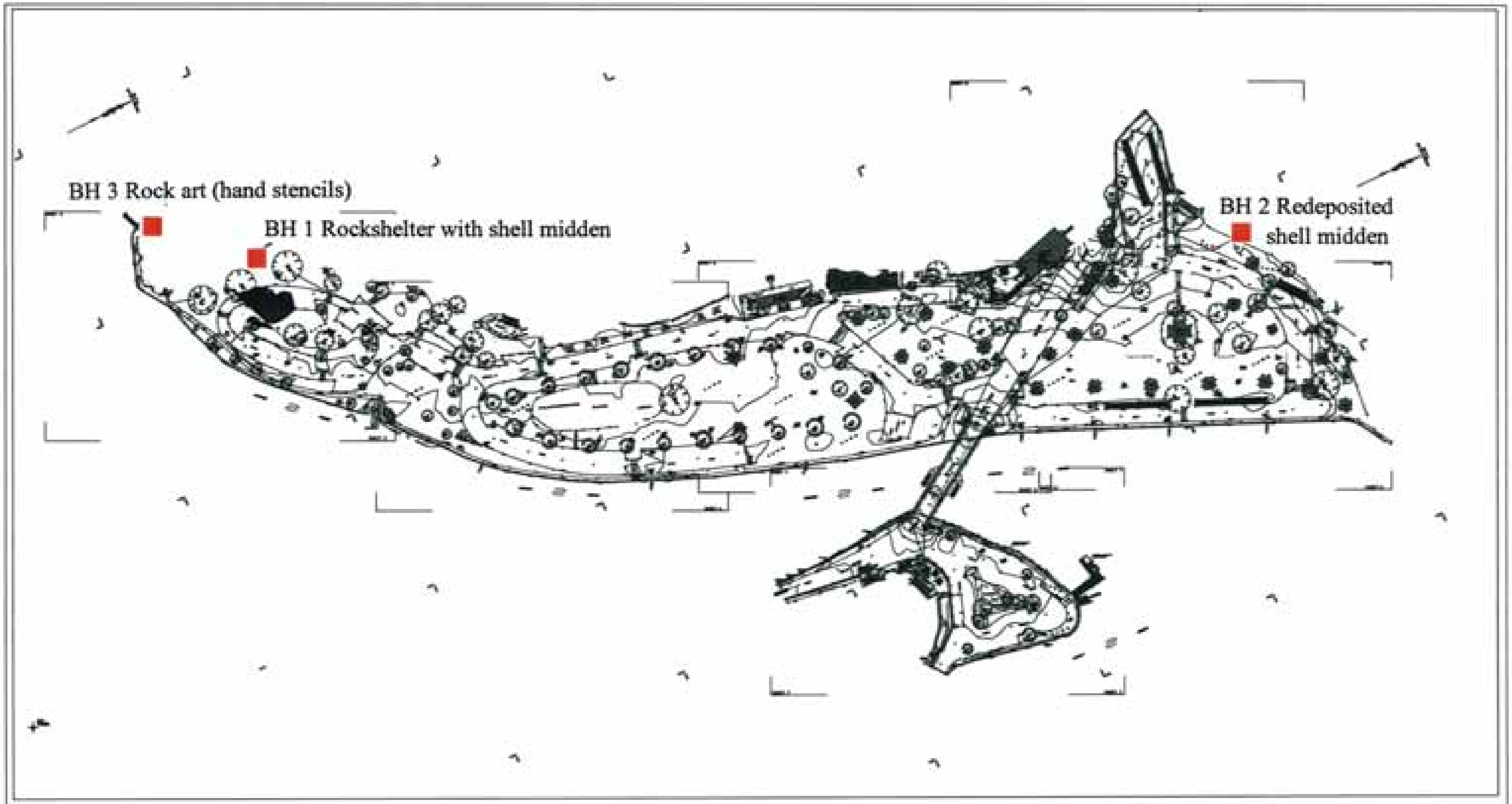

Figure 2: Revised archaeological site locations at Bobbin Head precinct

BOBBIN HEAD PLAN
Scale 1:1000@A1

CM+

Bobbin Head & Apple Tree Bay

February 2006, Dwg No 05.167-01-49

Master Plan
Existing Carpark Layout

Photo 1. Shell midden deposit at BH 1. Although deposit is dispersed investigation of site revealed intact stratified deposits.

Photo 2. Graffiti written in charcoal on rockshelter wall at BH 1.

Photo 3. View showing excavated channel running parallel to sandstone scarp in Orchard Park North sub precinct. Melissa Carter is standing in front of location of redeposited shell midden (BH 2).

Photo 4. Redeposited shell midden material (BH 2). Deposit includes cultural shell remains and fragments of ceramic and asbestos.

Photo 5. Arrows point to hand stencils at BH 3. Site is located at the Gibberagong footbridge.

METROPOLITAN LOCAL ABORIGINAL LAND COUNCIL
36-38 George Street, Redfern NSW 2016
P.O. Box 1103 Strawberry Hills, NSW 2012
Telephone (02) 8394 9666 Fax: (02) 8394 9733
Email: metrolalc@metrolalc.org.au

Colin Polwarth
Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street, East Sydney NSW 2011

26 April 2006

Dear Colin

In association with the Australian Museum Business Services (AMBS), the Metropolitan Local Aboriginal Land Council (MLALC) has recently been involved in providing heritage input to the Bobbin Head and Apple Tree Bay Conservation Management Plan (CMP).

On 17th March 2006 MLALC representatives (Rowena Welsh-Jarrett and Nathan Lyons) attended a site inspection with Brad Welsh (NPWS Aboriginal Sites Officer) and archaeologists Melissa Carter and Alison Nightingale (AMBS). Ongoing consultation with Melissa Carter regarding the cultural significance, the constraints and opportunities and management of Aboriginal heritage at Bobbin Head and Apple Tree Bay has also been undertaken.

MLALC supports the statement of significance, the recommendations for conservation and management and the interpretation of Aboriginal heritage outlined by AMBS. We support the inclusion of this information in the Draft CMP for Bobbin Head and Apple Tree Bay. We look forward to continuing working the Department of Environment and Conservation in the future.

Yours sincerely

Allen John Madden

Allen Madden
Cultural and Education Officer
Metropolitan Local Aboriginal Land Council

Adam Madden
Metropolitan Local Aboriginal Land Council

cc. Melissa Carter (AMBS)

1.3 Traffic and Transport Planning Report (+ Supplementary Information) - Arup

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PUBLIC TRANSPORT ACCESS

Train and Public Buses

Without your own transport, apart from the ferry, the best way to get to Bobbin Head is by train to Turramurra Station then the Shorelink Bus #577 (tel 9457 8888) to the Bobbin Head Road entrance. Currently this bus service does not continue down to Bobbin Head itself although it has in the past as indicated by the destination board on the Shorelink Bus pictured. It is recommended that extending this service down to Bobbin Head or through to Mt Colah Station be investigated.

Private Buses

The Gibberagong Environmental Education Centre located at Bobbin Head attracts many school groups that arrive by private charter bus. Corporate and other large groups using the parks facilities also charter buses and require parking areas within the park.

Ferry / Boat Cruise

Palm Beach and Hawkesbury River Cruises runs a daily scenic cruise from Palm Beach Wharf in Sydney's Northern Beaches. The cruise crosses Pittwater for a brief stop at Patonga then cruises up the lower Hawkesbury into Cowan Waters stopping at Bobbin Head for lunch. You may board at either Palm Beach at 11:00am or Patonga at 11:30am.

The scenic cruise includes a commentary pointing out items of interest along the way such as the Penguin colony of Lion Island, sandstone lined shore of the Ku-ring-gai Chase National Park and the lighthouse at Palm Beach. The cruise arrives at Bobbin Head at 12:50 for lunch and departs Bobbin head at 1:45 returning to Patonga at 3:00pm and Palm Beach at 3:30pm.

CAR PARKING

Bobbin Head

The parking areas in the Bobbin Head area have been rationalised following a number of key principles as follows:

- Concentrate car parking along circulation roadways to maximise efficiency of land take
- Move parking away from prime water front locations
- Allow for coach access to parking area and trailer access to canoe launching area
- Car parking and aisle width dimensions in accordance with the Australian Standard for off-street car parking User Class 2 for medium term car parking duration.
- Provide 2% of car parking spaces designated for disabled parkers. These are spread across the parking areas in four locations – 2 in Orchard Park, 3 at Bobbin Head Inn, 2 in Gibberagong Park and 1 in Orchard Park east adjacent to Ferry Wharf and Bus Stop.

Three coach parking spaces have been located in Gibberagong Park south along the western edge of the park so that parked coaches do not impact on view corridors. The turning loop has been designed to allow for the turning of these large coaches.

The canoe launching area is located at the southern end of Gibberagong Park south and incorporates three trailer and tow vehicle parking spaces. Trailers may be reversed onto the launch ramp for unloading or canoes may be unloaded directly from the adjacent trailer parking spaces.

A bus stop has been incorporated into the parking area at Orchard Park east adjacent to the Ferry Wharf. This is easily accessible due to the loop road configuration of this car park.

Apple Tree Bay

A simplified trailer and vehicle parking area has been developed for Apple Tree Bay which comprises of a loop arrangement with reverse parking for tow vehicles with trailers predominantly on the inside of the loop and other park users vehicles parked nose in to the outside kerb. Parking around the outside of the loop provides good access to the park area without the need to cross the boat trailer manoeuvring area. The layout provides more car parking spaces than currently available which should serve the improved public facilities in this park well. The trailer parking bays have been designed to allow for the majority of tow vehicle and trailer combinations to park wholly within the bay. For longer combinations, such as the design combination used, the trailer may overhang into the central lansdscaped space as shown on Figure 1.

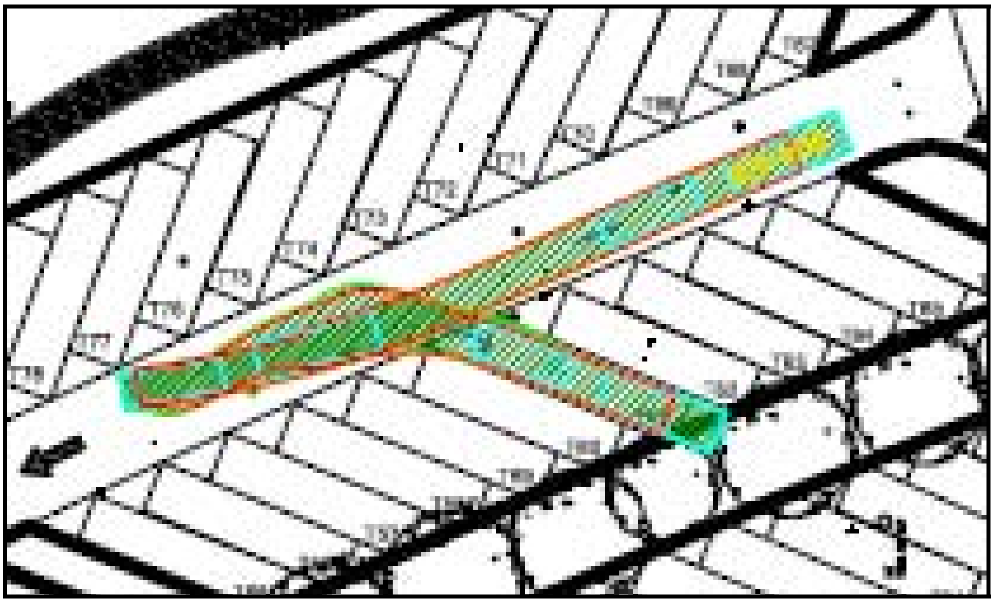


Figure 1. Trailer and car parking combination at Apple Tree Bay

The same principles adopted for Bobin Head have been used for the car park design at Apple Tree Bay. Two disabled car parking spaces are located adjacent to the facilities building.

Three coach parking spaces are provided located at the southern end of the park. Coaches proceed around the loop road to park in one of the available spaces. Passengers may be dropped-off at a suitable location prior to parking or at the coach parking area.

Satellite parking at Ku-ring-gai Chase Road and Bobbin Head Road Gates

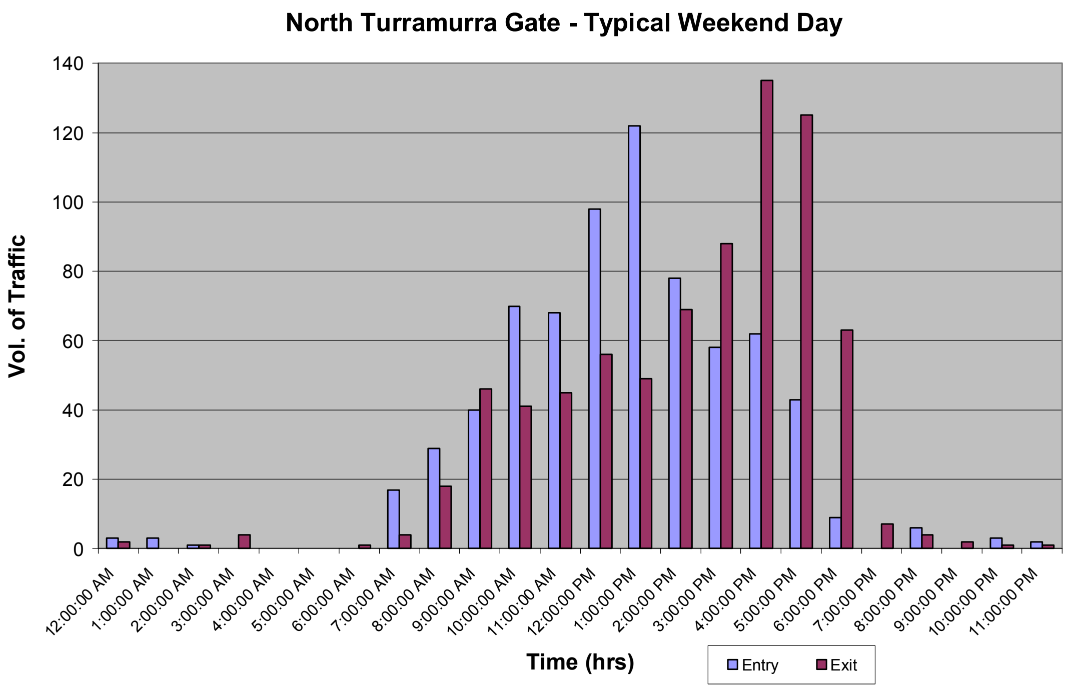
On peak days the car parking areas at Bobbin Head and Apple Tree Bay reach capacity and vehicles need to be turned away at the gates. The Master Plan has been developed on the principle of retaining at least the same number of car parking spaces in both areas. To allow for ongoing growth in visitation to the park, it is proposed that a satellite car park could be installed at either or both of the gates. Park users would be shuttled from the satellite parking area to the relevant area and back again on these days.

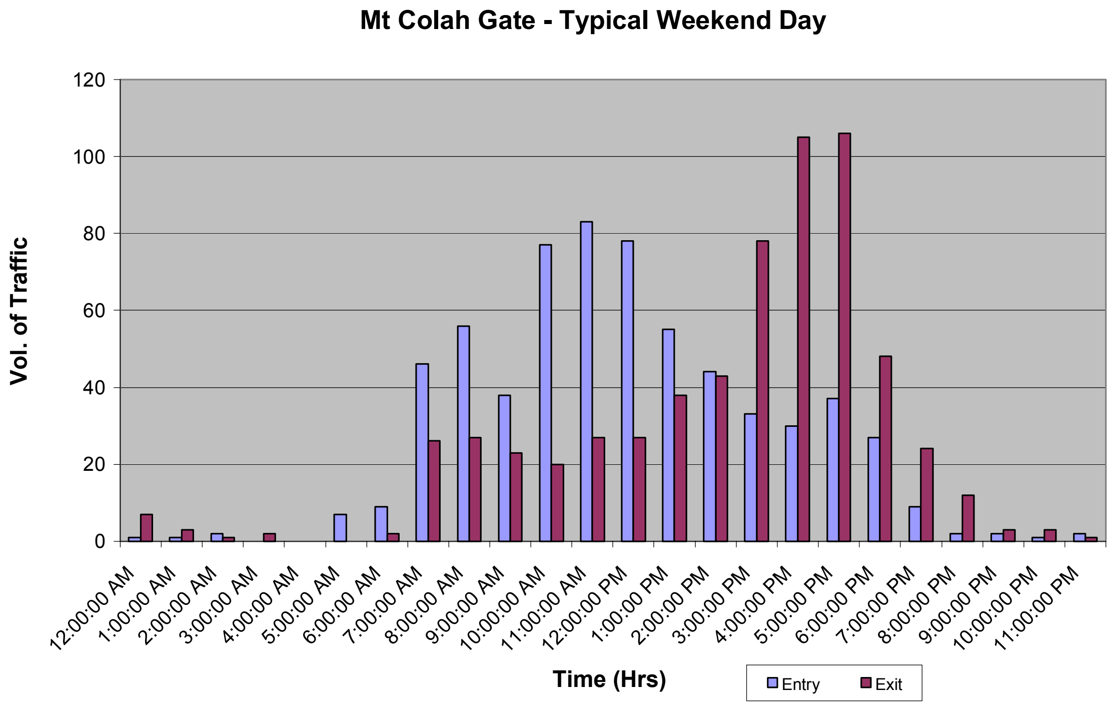
The car park would be configured as a series of parking spaces along a new fire trail roadway. In this way it will minimise the impact on the parkland. Consideration should be given to using a natural surface treatment given the infrequent use of this parking facility.

KU-RING-GAI CHASE ROAD AND BOBBIN HEAD ROAD

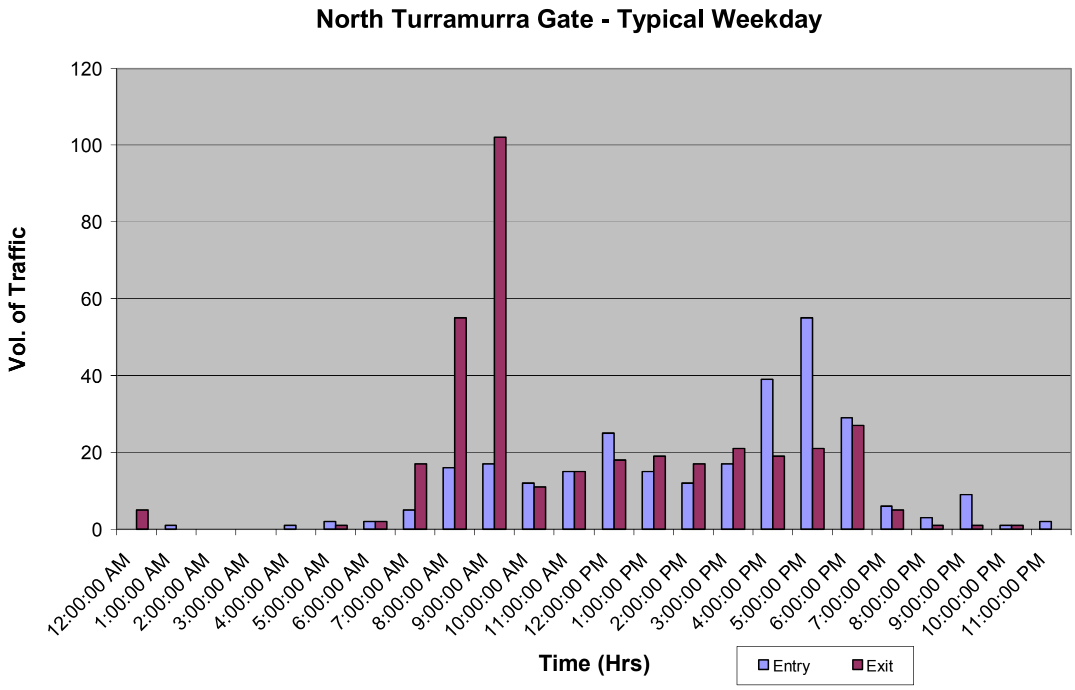
Vehicle access to the park is monitored through loop counters located at each of the entry and exit gates. This data has been reviewed for the period April 2004 through to November 2005 to look at daily, weekly and annual trends.

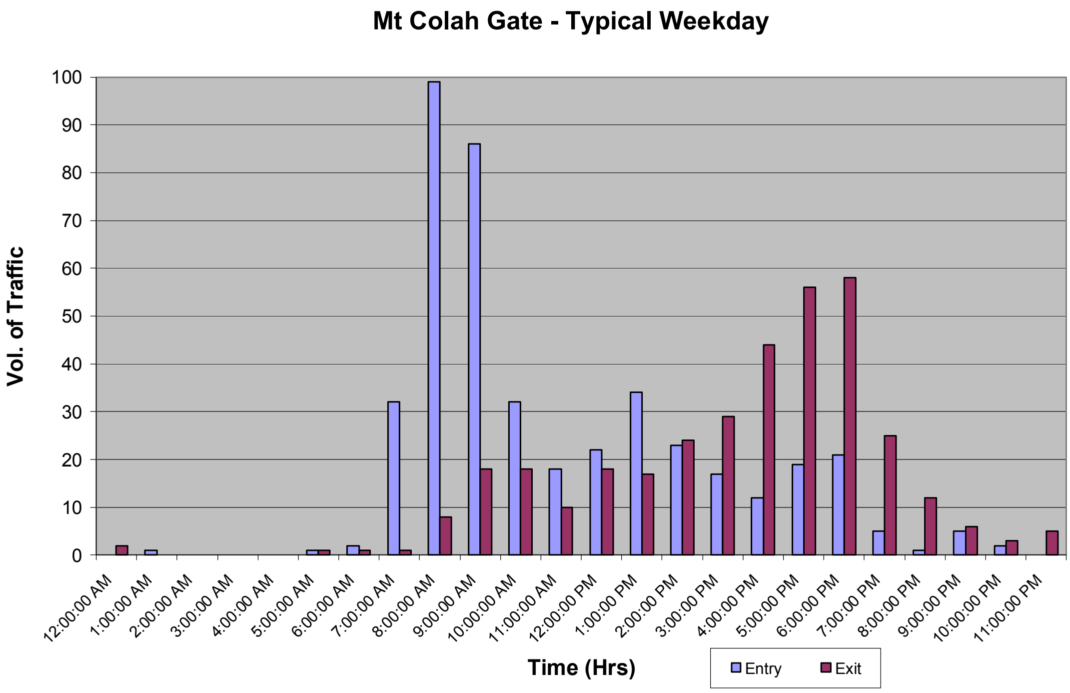
On a typical busy day, which occurs on a Sunday, traffic entering the park at either North Turramurra or Mt Colah climbs steadily from 7.00am through to 1.00pm and then declines through the afternoon to 6.00pm. departures peak from 4.00pm to 6.00pm.



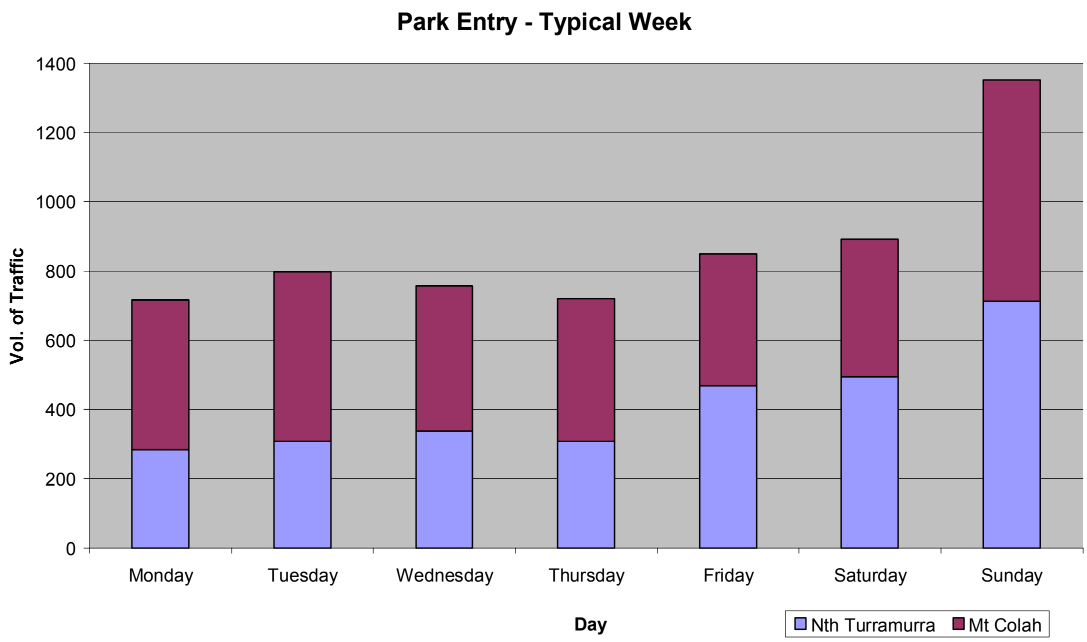


On a weekday the profile is flatter throughout the day with the exception of the morning and afternoon peak commuter periods when there is a noticeable peak. This peak activity is a morning peak flow from Mt Colah through to North Turramurra and an afternoon reverse peak flow from North Turramurra to Mt Colah. There are approximately 100 vehicles using Bobbin Head Road as a through route. A possible explanation is that residents living along the Pacific Highway in suburbs such as Mt Colah, Mt Ku-ring-gai and Berowra use this route to avoid the end of the F3 and use this route as a way of connecting to the Pacific Highway at Pymble. At these times on a weekday the gates are not usually staffed and hence no entry fee is required.

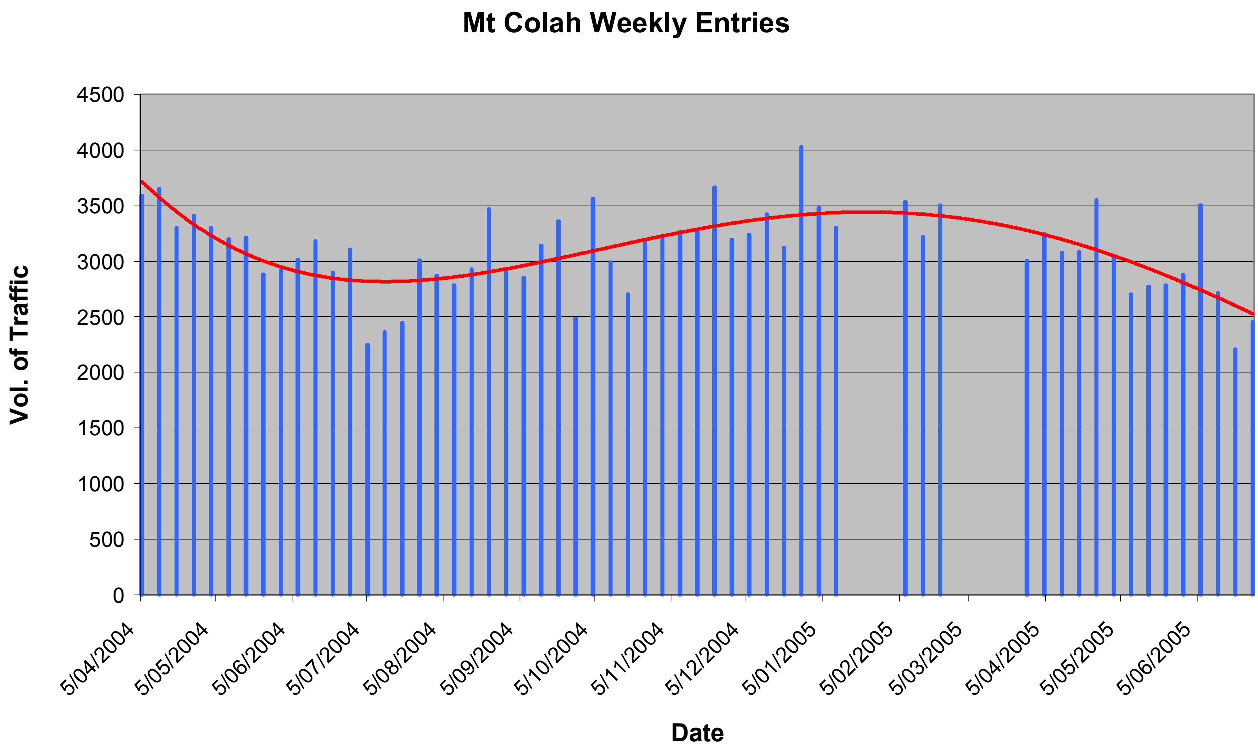




The profile over a typical week of activity indicates the strong weekend peak on Sunday. The graph below shows the combined entry flow for both gates on each day of the week. The Monday to Friday entry volumes include approximately 200 vehicles that travel through the park during the peak periods.



The profile from April 2004 through to July 2005 at the Mt Colah entry gate provides an indication of the trend over the year. The fluctuation is less than might be expected with continued activity through the winter months.



Traffic Management
As Bobbin Head Road / Ku-ring-gai Chase Road passes through the Bobbin Head area, there is a need to manage

the movement of traffic and the crossing of pedestrians to recognise the parks activities. The majority of vehicle movements have a destination at Bobbin Head either for boating or picnicking in one of the areas. The only through traffic movements appear to occur in the morning and afternoon weekday peak periods when approximately 100 vehicles traverse the park in each direction.

It is considered appropriate to reduce the speed of vehicles by installation of traffic management measures that include appropriate pedestrian crossing facilities. It is proposed that entry treatments be installed to identify entry into the Bobbin Head precinct. These devices should include a different pavement treatment, possible slightly raised, with edge kerbing to define the traffic lanes. These devices will create a visual and physical friction to slow the entry speed of vehicles. In the Orchard Park area, it is proposed to install two raised pedestrian crossing to further reinforce a slow speed environment and create safe pedestrian crossing locations.

The entrance to the Giberagong Park area will be retained in its current location just to the west of the bridge. The kerb radii will be designed to ensure appropriate vehicle turning. Ku-ring-gai Chase Road has been relocated to the north away from Bobbin Head Inn to provide an improved pedestrian environment and forecourt to the building. This will have no impact on the functionality of the road.

Ku-ring-gai Chase Road adjacent to the bridge at Bobbin Head Inn is prone to flooding at king tide events. The master plan considers raising of the park including the roadway. The design of the intersections along this section of the road and the connection to the bridge will need to allow for this. This issue should be raised with the Roads and Traffic Authority after the draft master plan has been endorsed to ensure that there are no major constraints to the raising of the road system.

Pedestrian access between the bridge and the Orchard Park east area will be facilitated by a pedestrian crossing across the entrance to this area from Bobbin Head Road. The crossings in the precinct associated with the traffic calming devices proposed will work together and assist in creating a slower speed environment.

Cyclists
Recreational and training cyclists use the Bobbin Head Road and Ku-ring-gai Chase Road for access to Bobbin Head. It is appropriate that vehicle speeds are set at appropriate levels on these roads with occasional enforcement. Signage should indicate that the road is shared with cyclist and appropriate repetition of signage is required, particularly where sightline conditions are poor.

Bicycle parking rails will be located at key locations throughout the park areas at locations where passive surveillance is available. These locations will include Bobbin Head Inn and the ferry wharf.

BOAT LAUNCHING FACILITIES AT APPLE TREE BAY

The boat launching facilities at Apple Tree Bay cater for up to 4 boat trailers to launch at the same time. A large open area currently facilitates the arrival, preparation, launching and retrieval of boats. This area is not well defined and hence not efficient. A revised layout for the boat launching are has been developed which clearly defines areas for the various activities associated with launching as retrieving boats. A tow vehicle and trailer combination made up of a 5.8m long tow vehicle and a 9.1m long trailer with boat has been used to design the turning and manoeuvring areas as shown on Figure 2.

- On arrival, boats on trailers arrive and queue in "ready bays" where they are prepared for launching. A bypass aisle allows other boats ready for launching to proceed to the ramp or empty trailers to proceed to the ramp for boat retrieval.
- Four boat launching lanes are marked at 5.0m width each allowing parallel operation. The length of these lanes has been determined to allow the car and trailer combination to be on a straight alignment so that the reverse launch or retrieval movement can be undertaken.
- After retrieval, boats can proceed into one of three wash bays where they can be washed down (during non water restriction periods) and tied down for travel.
- A canoe launching ramp which is adjacent to the boat ramp can be easily accessed by trailer from the boat launching area.

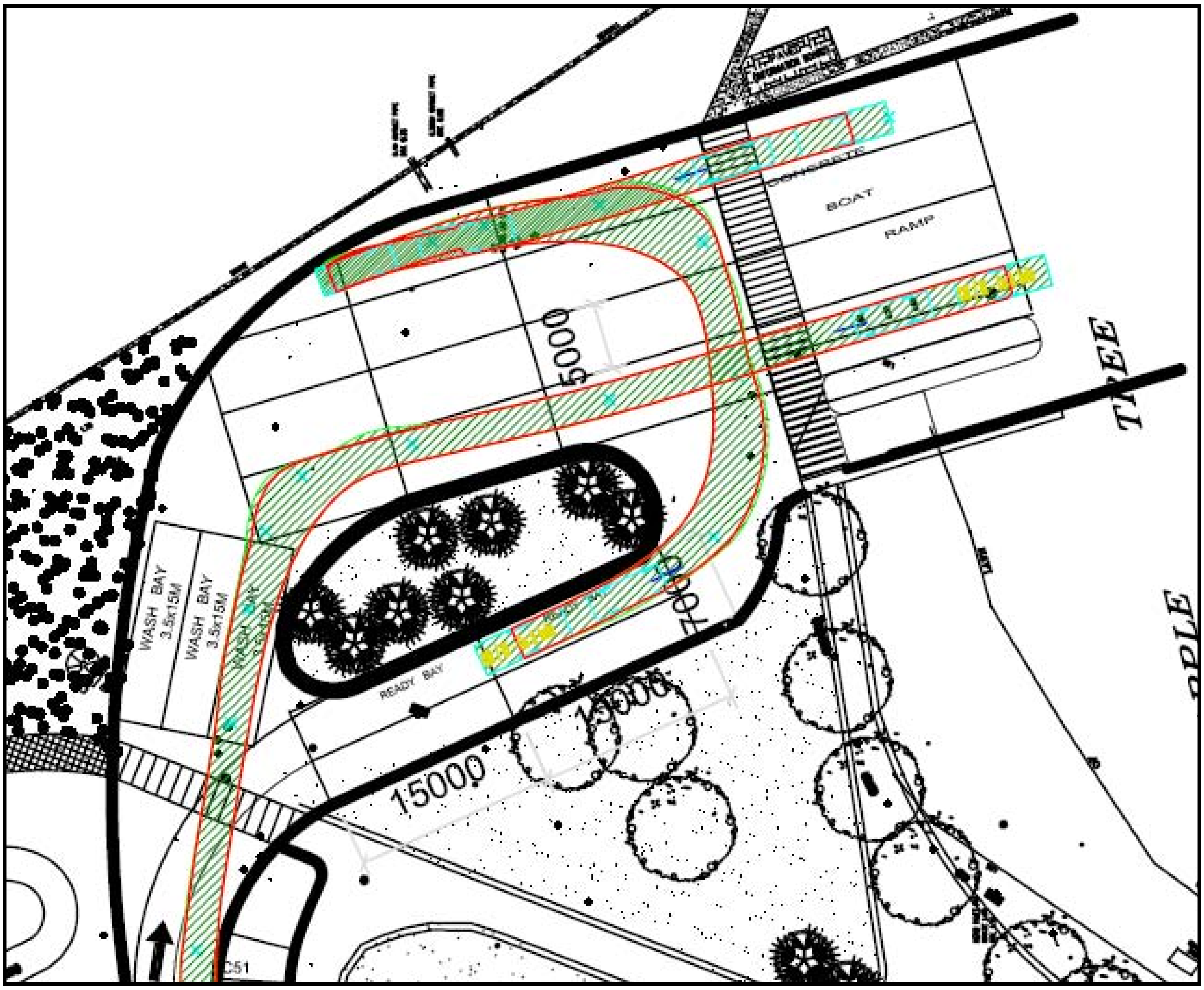


Figure 2. Tow vehicle and trailer turning paths at boat ramp

There are a number of arrangements that could be employed to introduce boat launching charges.

Option 1: Manual collection at boat ramp
This would require a person to be located at the boat ramp entrance area to collect a fee manually from drivers as they arrive. With this method it would only be economic to collect during peak activity boat launching times.

Option 2: Automatic collection at boat ramp
Access control gates could be installed on entry to and exit from the boat ramp area. Entry would be through payment at the entry gate or insertion of an annual or periodic access card purchased elsewhere. This arrangement would enable a fee to be collected at all times. This type of equipment located at an isolated location such as this is highly susceptible to vandalism. It would also be difficult to stop drivers from going around the control gates unless secure fencing surrounded the whole area.

Option 3: Charge collected and combined with park entry fee
Given that an entry fee is payable for access to the parklands, an additional type of ticket could be sold that included the boat launching fee. This ticket could be displayed on the windscreen of the vehicle. This method of collection may require a parking ranger to circulate around the parking area to verify payment. Given that all vehicles with trailers would be identified by the gate staff, further verification at the parking location may however not be warranted.

1.4 Geotechnical Report - Douglas Partners

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Douglas Partners
Geotechnics · Environment · Groundwater

Douglas Partners Pty Ltd
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sydney@douglaspartners.com.au

PMO:aj
Project 43730
8 May 2006

Conybeare Morrison International Pty Ltd
PO Box A866
SYDNEY SOUTH NSW 1235

Attention: Mr Colin Polwarth

Dear Sir

SUMMARY OF GEOTECHNICAL ISSUES
BOBBIN HEAD PRECINCT MASTER PLAN
KU-RING-GAI CHASE NATIONAL PARK

1. INTRODUCTION

This report discusses various geotechnical issues associated with future development in the Bobbin Head precinct of Ku-ring-gai Chase National Park. Conybeare Morrison International Pty Ltd has been commissioned by the Department of Environment and Conservation NSW to prepare a Master plan for the site.

Comment is required on various geotechnical issues associated with the area for inclusion in the planning document. This report outlines a description of the site as well as comments on certain issues highlighted by Conybeare Morrison as being relevant to the Master Plan.

2. SITE DESCRIPTION AND GEOLOGY

Bobbin Head is located in the Ku-ring-gai Chase National Park near the junction of Cockle Creek and Cowan Creek. There are recreational areas on the western and eastern side of Cockle Creek with amenities buildings, picnic facilities and vehicle parking areas. There is a Marina on the southern side of Cowan Creek to the west of Cockle Creek. Bobbin Inn, the Gibberagong Environmental Education Centre, The Station and a toilet block are located on the western side of the site. A two lane vehicular bridge provides access across Cockle Creek.

The parkland areas are generally low lying and between about RL 2 and RL 5. The topography then rises steeply away from the waterways to form ridges some 180 m above.

Reference to the Sydney 1:100 000 Geological Series sheet indicates that the low lying areas of the site are underlain by man-placed filling, which is likely to be underlain by soft Quaternary aged, potentially acid sulphate affected alluvium. The filling is supported by sandstone block retaining walls (seawalls) around the lower edges of the parkland. The steep slopes and ridges consist of Hawkesbury Sandstone which typically comprises medium to coarse grained sandstone with minor shale and laminite lenses.

3. DISCUSSION OF GEOTECHNICAL ISSUES

3.1 Settlement of Filling and Alluvium

There is evidence that the filling and alluvium on the site has undergone settlement since placement. The Orchard Park toilet block on the western side of the site is understood to have been damaged by movement of the footings. The perimeter retaining walls of the parklands also appear to have experienced some footing movement which may be partly attributable to settlement of the underlying soils.

Settlement of the site is likely to be due to consolidation of the alluvium, increased stress in the alluvium caused by the placement of filling, and settlement of the filling material itself. The rate and expected extent of settlement is a function of the soil and filling properties, the depth to rock and the magnitude of stress increase caused by filling placement.

There is insufficient information available to provide quantitative information on the settlement potential of the site. Detailed investigation and analysis is required to predict the future behaviour of the soils. Settlement of the site is expected to continue over time, although the rate and magnitude of such settlement will probably decrease if no additional stress is applied.

It is understood that Orchard Park and the wharf may be raised by up to 1 m (approximately RL 2.1) to reduce the impact of flooding on the recreational areas. The addition if 1 m of filling will increase the stress on the underlaying soils and cause additional settlement. This will probably affect the existing services (depending on their composition), although the existing structures on the raised areas will need to be lifted and can probably be placed in footings designed to limit the effects of settlement (e.g. stiff rafts or piles). Services that cannot tolerate differential settlement (e.g. concrete pipes) may need to be replaced with materials that are more settlement tolerant (e.g. PVC pipes).

3.2 Condition of Existing Retaining Walls

Visual inspection of the seawalls indicates outward movement has occurred over time. It is possible that this movement has been caused by settlement of the footings, inadequate bearing capacity of the soils, and inadequate wall design. There is also evidence that wave action in front of the walls has eroded soil and caused subsidence of the ground behind.

Further rotation of the walls is expected over time, particularly if additional filling is placed on the site. A report by Paterson Britton & Partners Pty Ltd (1997) included a limited geotechnical investigation of problem areas of the seawalls. This investigation was not exhaustive and further detailed investigation is required to determine the foundation conditions below the entire length of wall and determine whether underpinning or reconstruction would be the best alternative. No detailed information on foundation conditions of wall has been sighted to date.

There is no preference for hard or soft landscaping behind the walls from a geotechnical perspective. The critical factors for seawall design are foundation conditions, mass of the wall itself, and protection of the soil behind the wall from erosion. Tree roots may have structural impacts on the wall facing (e.g. loosening of blocks) but are not likely to have any negative geotechnical impacts.

It should be possible to reuse soils excavated from other areas of the site as filling behind retaining walls from a geotechnical perspective, though salt-rich soil should be kept away from the walls to reduce the potential for salt weathering of the sandstone blocks within the walls. Such soils could be used behind walls that are constructed using salt tolerant materials, or else used in areas of the site that will not be required to support vegetation (e.g. below buildings).

3.3 Impact on Bridge and Road

Design information prepared for the bridge in 1952 suggests that the bridge is supported on piles founded in suitable bearing material. Settlement of the bridge is therefore unlikely to occur. The proposed areas of filling are well away from the bridge and hence should not affect the bridge footings.

Settlement of the road would be expected to be of similar magnitude to the surrounding parkland area.

3.4 Constraints to the Development of Walking Tracks

It is understood that a new walking track is proposed and will link the Mangrove Walk with the wharf area at Bobbin Head. It is possible that unstable blocks of rock may be present above any tracks (new and existing) on the site. Such blocks would be a potential risk to the public and would need to be assessed on a case by case basis to determine whether any stabilisation would be required. Such stabilisation may include removal of rock blocks/wedges, installation of rock bolts/anchors, or installation of catch fencing.

3.5 Further Investigation

Detailed geotechnical investigation would be required to provide advice on settlement potential of the site, retaining wall design and construction, and the impact of settlement on existing structures. Such investigation may include boreholes, Dutch cone penetration tests, test pits, laboratory analysis and engineering interpretation. The extent of investigation will depend on the amount of information required and the stages of proposed development.

It should be noted that the issues discussed in this report will not necessarily hinder development of the area but will need to be considered during the detailed design stage of the project.

We trust the above information meets your present requirements.

Yours faithfully
DOUGLAS PARTNERS PTY LTD

Reviewed by

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Associate

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Principal

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PMO:aj
Project 43730
8 May 2006

Conybeare Morrison International Pty Ltd
PO Box A866
SYDNEY SOUTH NSW 1235

Attention: Mr Colin Polwarth

Dear Sir

SUMMARY OF GEOTECHNICAL ISSUES
APPLE TREE BAY PRECINCT MASTER PLAN
KU-RING-GAI CHASE NATIONAL PARK

1. INTRODUCTION

This report discusses various geotechnical issues associated with future development in the Apple Tree Bay precinct of Ku-ring-gai Chase National Park. Conybeare Morrison International Pty Ltd has been commissioned by the Department of Environment and Conservation NSW to prepare a Master plan for the site.

Comment is required on various geotechnical issues associated with the area for inclusion in the planning document. This report outlines a description of the site as well as comments on certain issues highlighted by Conybeare Morrison as being relevant to the Master Plan.

2. SITE DESCRIPTION AND GEOLOGY

Apple Tree Bay is located in the Ku-ring-gai Chase National Park near the junction of Apple Tree Creek and Cowan Creek. There in a recreational area on the south-western side of the bay with amenities buildings, picnic facilities, a boat ramp, two floating pontoons and vehicle parking areas. There is also a pedestrian bridge crossing Apple Tree Creek which provides access to the north-western side of the bay.

The parkland areas are generally low lying and between about RL 2 and RL 4. The topography then rises steeply away from the waterways to form ridges some 180 – 200 m above.

Reference to the Sydney 1:100 000 Geological Series sheet indicates that the low lying areas of the site are underlain by man-placed filling, which is likely to be underlain by soft Quaternary aged, potentially acid sulphate affected alluvium. The bank along the western and southern sides of the bay is supported by sandstone rip rap. The filling near the pedestrian bridge is supported by a sandstone block retaining wall (seawall). The steep slopes and ridges consist of Hawkesbury Sandstone which typically comprises medium to coarse grained sandstone with minor shale and laminite lenses.

3. DISCUSSION OF GEOTECHNICAL ISSUES

3.1 Settlement of Filling and Alluvium

It is likely that the reclaimed area has experienced settlement since placement. This would be due to consolidation of the alluvium, increased stress in the alluvium caused by the placement of filling, and settlement of the filling material itself. The rate and expected extent of settlement is a function of the soil and filling properties, the depth to rock and the magnitude of stress increase caused by filling placement.

There is insufficient information available to provide quantitative information on the settlement potential of the site. Detailed investigation and analysis is required to predict the future behaviour of the soils. Settlement of the site is expected to continue over time, although the rate and magnitude of such settlement will probably decrease if no additional stress is applied.

Construction of new buildings and the installation of new services should be undertaken with consideration to the possible movement of foundation materials over time. Footings and buried conduits may need to be designed to be settlement tolerant (e.g. the use of piles to support the infrastructure).

3.2 Landscaping Adjacent to Existing Retaining Walls

There is no preference for hard or soft landscaping behind the walls from a geotechnical perspective. The critical factors for seawall design are foundation conditions, mass of the wall itself, and protection of the soil behind the wall from erosion. Tree roots may have structural impacts on the wall facing (e.g. loosening of blocks) but are not likely to have any negative geotechnical impacts.

It should be possible to reuse soils excavated from other areas of the site as filling behind retaining walls from a geotechnical perspective, though salt-rich soil should be kept away from the walls to reduce the potential for salt weathering of the sandstone blocks within the walls. Such soils could be used behind walls that are constructed using salt tolerant materials, or else used in areas of the site that will not be required to support vegetation (e.g. below buildings).

3.3 Constraints to the Development of Walking Tracks

It is understood that a new walking track is proposed and will link Apple Tree Bay with Bobbin Head. It is possible that unstable blocks of rock may be present above any tracks (new and existing) on the site. Such blocks would be a potential risk to the public and would need to be assessed on a case by case basis to determine if any stabilisation measures would be required. Such stabilisation may include removal of rock blocks/wedges, installation of rock bolts/anchors, or installation of catch fencing.

3.4 Further Investigation

Detailed geotechnical investigation would be required to provide advice on settlement potential of the site, retaining wall design and construction, and the impact of settlement on existing structures and slope stability issues. Such investigation may include site inspections, boreholes, Dutch cone penetration tests, test pits, laboratory analysis and engineering interpretation. The extent of investigation will depend on the amount of information required and the stages of proposed development.

It should be noted that the issues discussed in this report will not necessarily hinder development of the area but will need to be considered during the detailed design stage of the project.

We trust the above information meets your present requirements.

Yours faithfully
DOUGLAS PARTNERS PTY LTD

Reviewed by

Peter Oitmaa
Associate

John Braybrooke
Principal

1.5 Recreational Planning Report - Stratcorp

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EXECUTIVE SUMMARY

AN ASSESSMENT OF RECREATIONAL USES OF BOBBIN HEAD PRECINCT

Ku-ring-gai Chase National Park, NSW

Research for the preparation of a
master plan for the Bobbin Head Precinct

April 2006

Prepared for Conybeare Morrison International Pty Ltd

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1. INTRODUCTION

The Department of Environment and Conservation (NSW National Parks & Wildlife Service) engaged Conybeare Morrison International (CMI) in December 2005 to prepare a Master Plan (incorporating Conservation Management Plans and Landscape Management Plans) to guide the future conservation, development and management of the Bobbin Head and Apple Tree Bay Precincts. Both Precincts are key existing recreation nodes within the Ku-ring-gai Chase National Park, situated approximately 20km north of the Sydney Central Business District.

Stratcorp Consulting, a sport and recreation planning firm, was sub-contracted by CMI to assist with the assessment and analysis of the recreational uses of both Precincts, and where appropriate, provide direction and input into the design process for the Landscape Management Plans. The result of this work has been documented in the *Recreational Planning Report* which consolidates into one report the information gathered from the research and community/stakeholder consultation undertaken, and the proposed directions and recommendations to improve recreation provision.

This Executive Summary deals with the analysis and recommendations for improved recreation provision at Bobbin Head only. The key objectives for the recreational planning project are outlined in the *Recreational Planning Report* (see Appendix X).

1.1. Study Process

The specific research tasks carried out by Stratcorp Consulting during the assessment and analysis of recreational uses at Bobbin Head Precinct included:

1. Review of previous relevant reports and studies concerning the Bobbin Head Precinct, or features, facilities and services therein.

2. Site review of the Bobbin Head Precinct, with particular consideration of the recreational places, spaces and facilities.

3. Stakeholder and visitor consultation, including:
   - Community/visitor consultation (survey, submissions and onsite community information sessions).
   - External stakeholders, including commercial lessees, boat owners, neighbouring Councils, and user groups/clubs (meetings).
   - Agencies, including DEC, RTA, Fisheries, and Waterways (meetings).
   - Project Control Group, including DEC, NPWS Rangers and staff (meetings).

4. Review and analysis of research data relating to the recreational use of the Bobbin Head Precinct gathered both during this study and previous studies.

5. Formulation of key strategic directions for the use of Bobbin Head Precinct for recreation pursuits.

6. Involvement in the planning and development of the Bobbin Head Master Plan and associated written supporting material prepared by the Project Team.

2. CONTEXT

2.1. Ku-ring-gai Chase National Park Plan of Management

Ku-ring-gai Chase National Park is located within the northern reaches of the Sydney metropolitan area and is bound by residential areas on the eastern and southern sides, by the Sydney-Newcastle Freeway on its western side, and the Hawkesbury River and associated tributaries to the north. The National Park and other adjoining parks and reserves protect the natural scenic values of the lower Hawkesbury River as well as being important for the conservation and natural and cultural values.

A *Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves* was adopted by the NSW Minister for the Environment in May 2002 and sets out a strategic direction for the management and operation of the total area under the Plan, including Ku-ring-gai Chase National Park in which Bobbin Head is located.

Relevant policies and actions established for the future management of recreation in Ku-ring-gai Chase National Park, and which have been considered as part of this project to develop the Bobbin Head Precinct Landscape Management Plan, include:

- Recreational use will be focused on sites which can sustain such use. Existing visitor use areas will be promoted in preference to constructing new areas for recreation.
- Preference will be given to recreation activities which do not degrade the natural or cultural values of the park and which maintain the quiet and restful atmosphere desired by most visitors to the park.
- The Bobbin Head picnic areas will be maintained as developed picnic areas.
- Sections of the dead-end roads along the foreshores of Bobbin Head will be replaced with grass to increase safety and improve views from the picnic area.
- The play equipment at Bobbin Head will be progressively replaced with play equipment that is educational and more compatible with its national park setting.
- A network of walking tracks will continue to be maintained in the park to cater for a range of abilities and desired experiences, including tracks suitable for wheelchairs.
- Existing walking tracks will be investigated for possible upgrade.
- Swimming, camping, horse riding, rock climbing and abseiling activities will be permitted only at designated areas within Ku-ring-gai Chase National Park, all of which do not fall within the study area (so have not been considered as possible new activities for the Bobbin Head Precinct).
- Cycling will only be permitted on the public road system and on management trails within the Park. Cycling will not be permitted on walking tracks.
- The shoreline of the Park will be maintained in as natural a state as possible.

- Prohibition of power boats on Cowan Creek upstream of the Bobbin Head marina and on Cockle Creek upstream of the road bridge at Bobbin Head so as to provide quiet natural waterways within the Park.
- The goal over the life of the Plan of Management will be to reduce the total number of moorings within the Park. While the total combined number of moorings and marina berths will not be increased beyond current levels, the ratio between the two may change. There shall be no additional commercial moorings in or near Bobbin Head beyond those permitted by the current leases.
- Fishing will be permitted in accordance with the regulations of NSW Fisheries.
- Orienteering and rogaining events involving 10 or more persons will not be permitted in the park without prior written approval.

2.2. Bobbin Head Precinct

Bobbin Head today is a very popular and well known destination for family and social groups wishing to enjoy a range of passive recreation activities and pursuits in a peaceful and natural setting. Whilst a majority of visitors to Bobbin Head are from Metropolitan Sydney, the attractiveness and notoriety of the Precinct ensures that a good proportion of visitors come from areas beyond the Sydney area.

Popular activities undertaken by visitors to Bobbin Head include picnicking and barbecuing, bushwalking, boating and fishing. There is a good range of facilities and spaces to support these activities, including picnic grounds, tables, shelters and BBQs, walking trails, marinas, a jetty, a playground and the Bobbin Inn. In addition, Bobbin Head contains several opportunities for visitors to enjoy, appreciate and learn about the unique natural, cultural and heritage values of not only the Bobbin Head Precinct but also the Ku-ring-gai Chase National Park. These opportunities include interpretive signage, information centres, NPWS staff, Coast Alive staff, and the Gibberagong Environmental Education Centre.

With the passing of time many recreational facilities and spaces at Bobbin Head now no longer wholly meet the needs and changing expectations of visitors, or simply do not conform to accepted standards of provision. In addition, the increased popularity of the Precinct has placed pressure on the capacity of essential infrastructure, such as roads, car parking, public toilets and pathways, to adequately cope with the high visitor numbers.

3. KEY DIRECTIONS FOR IMPROVED RECREATION PROVISION

Based on the outcomes of the site analysis, research data and the consultative processes, a range of recreational issues were identified and assessed, and new opportunities proposed.

The key directions and recommendations for improved recreation facilities and services for Bobbin Head are summarised below. (Refer the *Recreational Planning Report* in Appendix X for a comprehensive analysis and review of issues).

<u>Sense of Place</u>

- The key attributes or values of Bobbin Head identified by users were its "scenery and views", "outdoors/natural environment", "quietness/tranquillity" and "recreation opportunities".

<u>Pedestrian Circulation</u>

- Investigate options to improve (off-road) pedestrian thoroughfare throughout Bobbin Head Precinct which better links sub-precincts and improves pedestrian safety.
- Promote and encourage visitors to walk around Bobbin Head through strategic use of views, natural features, signage and seating.
- Increase the width of the walking path along the water edge at Bobbin Head.
- Relocate car parking away from the water edge to both improve pedestrian safety and to maximize the opportunity to enhance views and retain sightlines across the water, with no net reduction in the number of car parking spaces.

<u>Walking Tracks</u>

- Investigate the feasibility of developing a new shared trail (walking and cycling) between Bobbin Head and Apple Tree Bay.
- Establish new opportunities for short distance "loop" walking trips around Bobbin Head and Apple Tree Bay.
- Connect the start/finish points of existing and proposed walking tracks within the Bobbin Head and Apple Tree Bay Precincts with the proposed improved pedestrian path network.
- Provide improved directional signage and additional seating along walking tracks throughout the Precinct.

<u>Playgrounds</u>

- Replace the existing playground at Bobbin Head with a new playground offering an expanded range of experiences designed and built in keeping with a natural setting.
- Retain the location of the main playground in Gibberagong Park and incorporate educational, informative and discovery-based experiences for users. Include shade, limited fencing, seating and 1-2 drinking fountains.

- Develop a new, smaller play area within Orchard Park South adjacent to the Bobbin Inn café area which integrates with existing trees in the area.
- Plan for the design of the smaller playground to focus on the cultural history and values of Bobbin Head.

Visitor Facilities

- Install additional BBQs at Bobbin Head.
- Consider installing additional picnic shelters/areas in Orchard Park North and Gibberagong Park which are more suitable for larger groups.
- Remove the flat picnic benches at Bobbin Head and replace some of them with more functional park furniture.

Bobbin Inn

- Undertake an investigation into options to optimise the future use of Bobbin Inn as a public facility, with opportunities to be explored to include information/discovery centre, conference/function facility, café/restaurant and/or entertainment centre.
- Ensure that the quality of service by the contractor engaged to operate the kiosk/cafe at Bobbin Inn is of a high quality, commensurate with the general expectations of visitors.

Sporting Facilities

- No formal sporting areas to be provided at Bobbin Head.
- Retain an area of open space within Gibberagong Park for informal ball games associated with family group picnics.
- Not recommended that this area be formally sign posted as an activities area.

Boating Facilities

- Continue to support the provision of boating facilities (moorings, jetty, support services) to current levels at Bobbin Head, in accordance with existing agreements.
- Upgrade the existing canoe ramp at Bobbin Head to incorporate a loading zone, a wash-down facility and an information sign (liaise with the Kayak & Canoe group during concept and detailed planning).
- Investigate the feasibility of introducing a commercial boat hire service at Bobbin Head, including wooden rowing boats.

Other Considerations

- The existing provision for car parking at Bobbin Head The current width and condition of Bobbin Head Road creates an unsafe environment for the shared use of the road pavement between cars, cyclists and pedestrians. A combination of options should be considered to improve safety, including widening the road in selected sections, reducing speed limits and/or installing other traffic calming scenarios, extending the road shoulders, use of coloured paving to delineate designated zones on the roadway for exclusive use by riders/pedestrians, and driver, rider and pedestrian education.

- Any upgrades and improvements to pathways, buildings and other structures (such picnic shelters) need to be compliant with the DDA to enhance the accessibility of Bobbin Head for people with a disability, or people with poor mobility (such as older adults).
- Continue to facilitate the provision of programs and mediums at Bobbin Head designed to educate the public about the natural environment , conservation, flora and fauna and cultural heritage/history (such as the Park discovery/information centres, Coast Alive, Ranger liaison with users and the Gibberagong Environment Education Centre).
- There were no new community requirements that were inconsistent with the 2002 *Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves*.

4. PRELIMINARY MASTER PLAN DEVELOPMENT

Throughout the project period, the Project Team has prepared a series of preliminary master plans which were "work in progress" and have proved valuable resources during stakeholder, community and client meetings. The current draft Bobbin Head Master Plan features some key directions which reflect many of the previously listed improvements and recommendations for recreation provision, and are likely to significantly enhance the visitor experience.

Some of the significant proposals identified in the draft Master Plan which are set to impact recreation provision include:

1. The proposal to reinstate plantings and pathways to reinterpret the original 1930s park layout of Orchard Park (North and South) will enhance the cultural value of Bobbin Head Precinct, whilst improving user safety through more formalised traffic and pedestrian treatments.

2. The proposal to lift the level of Orchard Park to a new level above inundation will significantly improve the visual amenity of the Park as well as the quality of the turf for uses such as picnicking, resting (sitting/lying) and the participation in informal games. This proposal whilst expensive and which is likely to significantly disrupt visitor usage and capacity is a long-term solution to sustainable management of the park surface, plants and infrastructure.

3. The proposal to remove car parking from the water edge in both Orchard Park and Gibberagong Park will enhance vistas across the parkland areas to the water as well as providing improved opportunities to utilise the water edge as a key destination for visitors (promenade with seating, interpretative signage and plantings). Removal of the cars will result a in a less cluttered and less busy ambience around the water edge.

4. The proposal to provide a more appropriate design and layout for the main playground in Gibberagong Park (more natural setting, improved shade and seating provision, etc) will not only improve the play experience for children but will also provide an educative outcome for users.

5. The proposed walking/cycle path to be constructed between Bobbin Head and Apple Tree Bay will provide users of both Precincts with a short (approximately 1.3km), relatively easy (flat) and scenic exercise option.

6. The retention and enhancement of the picnic shelters and installation of additional BBQs will further consolidate the reputation of the Precinct as a favoured and valued destination for family and social outings.

5. SUMMARY

A range of recreational pursuits are currently enjoyed by visitors to Bobbin Head Precinct. These include family recreation in the form of picnics and BBQs, boating (powered and non-powered), hiking, walking, informal games and playground use, a variety of nature-based activities, and fishing. The underlying appeal of each activity in the Precinct setting, is the sense of attachment to and association with nature. This quality should be maintained and enhanced through the current Master Planning process for Bobbin Head currently being coordinated by Conybeare Morrison International for the Department of Environment and Conservation (NSW National Parks & Wildlife Service).

Several initiatives and recommendations for improving the recreational experience for visitors have been identified and/or validated by Stratcorp Consulting as part of our involvement with the Project Team. These include:

- Increase and upgrade the provision of facilities in the picnic areas, including shelters, BBQs, park furniture and public toilets.

- Improved provision of playgrounds and other informal play facilities, with particular emphasis on their use as mediums to improve visitors' appreciation of the natural, cultural and environmental values of the Park.

- Improved provision and safety for walking / hiking, including relocation of car parking areas from the water edge, and the development of a new link between Bobbin Head and Apple Tree Bay.

- Development of additional facilities to promote canoeing within the Precinct.

- Advocate for the introduction of a commercial boat hiring service for non-powered craft.

These and the other improvements to Bobbin Head being investigated by other sub-consultants will deliver a more relevant and sustainable public open space area for the enjoyment of all people for many years to come.

EXECUTIVE SUMMARY

AN ASSESSMENT OF RECREATIONAL USES OF APPLE TREE BAY PRECINCT

Ku-ring-gai Chase National Park, NSW

Research for the preparation of a
master plan for the Apple Tree Bay Precinct

April 2006

Prepared for Conybeare Morrison International Pty Ltd

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1. INTRODUCTION

The Department of Environment and Conservation (NSW National Parks & Wildlife Service) engaged Conybeare Morrison International (CMI) in December 2005 to prepare a Master Plan (incorporating Conservation Management Plans and Landscape Management Plans) to guide the future conservation, development and management of the Bobbin Head and Apple Tree Bay Precincts. Both Precincts are key existing recreation nodes within the Ku-ring-gai Chase National Park, situated approximately 20km north of the Sydney Central Business District.

Stratcorp Consulting, a sport and recreation planning firm, was sub-contracted by CMI to assist with the assessment and analysis of the recreational uses of both Precincts, and where appropriate, provide direction and input into the design process for the Landscape Management Plans. The result of this work has been documented in the *Recreational Planning Report* which consolidates into one report the information gathered from the research and community/stakeholder consultation undertaken, and the proposed directions and recommendations to improve recreation provision.

This Executive Summary deals with the analysis and recommendations for improved recreation provision at Bobbin Head only. The key objectives for the recreational planning project are outlined in the *Recreational Planning Report* (see Appendix X).

1.1. Study Process

The specific research tasks carried out by Stratcorp Consulting during the assessment and analysis of recreational uses at Apple Tree Bay Precinct included:

1. Review of previous relevant reports and studies concerning the Bobbin Head and Apple Tree Bay Precincts, or features, facilities and services therein.

2. Site review of the Apple Tree Bay Precinct, with particular consideration of the recreational places, spaces and facilities.

3. Stakeholder and visitor consultation, including:
   - Community/visitor consultation (survey, submissions and onsite community information sessions).
   - External stakeholders, including commercial lessees, boat owners, neighbouring Councils, and user groups/clubs (meetings).
   - Agencies, including DEC, RTA, Fisheries, and Waterways (meetings).
   - Project Control Group, including DEC, NPWS Rangers and staff (meetings).

4. Review and analysis of research data relating to the recreational use of the Apple Tree Bay Precinct gathered both during this study and previous studies.

5. Formulation of key strategic directions for the use of Apple Tree Bay Precinct for recreation pursuits.

6. Involvement in the planning and development of the Apple Tree Bay Master Plan and associated written supporting material prepared by the Project Team.

2. CONTEXT

2.1. Ku-ring-gai Chase National Park Plan of Management

Ku-ring-gai Chase National Park is located within the northern reaches of the Sydney metropolitan area and is bound by residential areas on the eastern and southern sides, by the Sydney-Newcastle Freeway on its western side, and the Hawkesbury River and associated tributaries to the north. The National Park and other adjoining parks and reserves protect the natural scenic values of the lower Hawkesbury River as well as being important for the conservation and natural and cultural values.

A *Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves* was adopted by the NSW Minister for the Environment in May 2002 and sets out a strategic direction for the management and operation of the total area under the Plan, including Ku-ring-gai Chase National Park in which Apple Tree Bay is located.

Relevant policies and actions established for the future management of recreation in Ku-ring-gai Chase National Park, and which have been considered as part of this project to develop the Apple Tree Bay Precinct Landscape Management Plan, include:

- Recreational use will be focused on sites which can sustain such use. Existing visitor use areas will be promoted in preference to constructing new areas for recreation.
- Preference will be given to recreation activities which do not degrade the natural or cultural values of the park and which maintain the quiet and restful atmosphere desired by most visitors to the park.
- The Apple Tree Bay picnic areas will be maintained as developed picnic areas. The provision of additional picnic shelters at Apple Tree Bay will be investigated.
- A network of walking tracks will continue to be maintained in the park to cater for a range of abilities and desired experiences, including tracks suitable for wheelchairs.
- Existing walking tracks will be investigated for possible upgrade.
- Swimming, camping, horse riding, rock climbing and abseiling activities will be permitted only at designated areas within Ku-ring-gai Chase National Park, all of which do not fall within the study area (so have not been considered as possible new activities for the Apple Tree Bay Precinct).
- Cycling will only be permitted on the public road system and on management trails within the Park. Cycling will not be permitted on walking tracks.
- The shoreline of the Park will be maintained in as natural a state as possible.
- Prohibition of power boats on Apple Tree Creek upstream of the footbridge so as to provide quiet natural waterways within the Park.
- The goal over the life of the Plan of Management will be to reduce the total number of moorings within the Park. While the total combined number of moorings and

marina berths will not be increased beyond current levels, the ratio between the two may change.

- Fishing will be permitted in accordance with the regulations of NSW Fisheries.
- Orienteering and rogaining events involving 10 or more persons will not be permitted in the park without prior written approval.

2.2. Apple Tree Bay Precinct

Apple Tree Bay is mainly used as boat launching area, with limited facilities available for picnicking/barbecuing, fishing and walking. The Precinct was originally developed as an overflow area to better cater for the large numbers of people being attracted to Bobbin Head. Where Bobbin Head has been historically a parkland with cultural and recreation values, Apple Tree Bay has been a more natural, and relatively less developed Precinct.

Apple Tree Bay is a very busy boating area with peak periods of use being experienced on most weekends during the early morning and late afternoon periods, coinciding with the launching and collection of boats by day-trippers. The peak periods of use and the high numbers of cars and boat trailers parking at Apple Tree Bay are now creating conflicts not only between boat enthusiasts but also with other people/groups wishing to use Apple Tree Bay as a picnic, fishing or bush walking area.

There is a limited range of recreational facilities and spaces at Apple Tree Bay compared to Bobbin Head. Existing facilities include a four-lane boat ramp, expansive car and boat trailer parking spaces, boat moorings, a fish cleaning facility, informal picnic areas (tables, a BBQ and one shelter), a public toilet and kiosk combination (kiosk not currently operating) and walking trails (Apple Tree Bay to Waratah Bay and links to Birrawanna Track).

A key issue with the Precinct is the dominance of car and boat trailer parking and the lack of visitor facilities, the latter particularly in the context of the increased usage of Bobbin Head and the need to provide a legitimate alternate option for people wishing to utilise both Precincts for large family and social gatherings.

3. KEY DIRECTIONS FOR IMPROVED RECREATION PROVISION

Based on the outcomes of the site analysis, research data and the consultative processes, a range of recreational issues were identified and assessed, and new opportunities proposed.

The key directions and recommendations for improved recreation facilities and services for Apple Tree Bay are summarised below. (Refer the *Recreational Planning Report* in Appendix X for a comprehensive analysis and review of issues).

Sense of Place

- Like Bobbin Head, the users of Apple Tree Bay identify the key attributes or values of the Precinct to be its "scenery and views", "outdoors/natural environment", "quietness/tranquillity" and "recreation opportunities".

Pedestrian Circulation

- Develop a walking path along the water edge at Apple Tree Bay.
- Better integrate the water edge, the public toilet/café building and the footbridge across Apple Tree Creek as a recreation sub-precinct.
- Relocate car parking away from the water edge to both improve pedestrian safety and to maximize the opportunity to enhance views and retain sightlines across the water, with no net reduction in the number of car and boat trailer parking spaces.

Walking Tracks

- Investigate the feasibility of developing a new shared trail (walking and cycling) between Apple Tree Bay and Bobbin Head.
- Connect the start/finish points of existing and proposed walking tracks within the Bobbin Head and Apple Tree Bay Precincts with the proposed improved pedestrian path network.
- Provide improved directional signage and additional seating along walking tracks throughout the Precinct.

Playgrounds

- Develop a new play space (not a playground) for children at Apple Tree Bay within the northern sub-precinct adjacent to the toilet/café building (café to be re-opened).
- Develop a second play space (not a playground) within the southern sub-precinct at the proposed upgraded picnic area.
- Design these play spaces to be in keeping with the natural setting of Apple Tree Bay through use of materials such as logs, rocks, and shaped earth, and install without fencing. Maximise opportunities for children's interpretation and education of the natural values of the national park through the design and selection of materials for these playgrounds.

Visitor Facilities

- Redesign the layout of Apple Tree Bay to expand the grassed areas within the northern and south west sub-precincts ensuring no net reduction in the number of car and boat trailer parking spaces.
- Remove the flat picnic benches at Apple Tree Bay and replace some of them with more functional park furniture.
- Install additional BBQs and a picnic shelter at Apple Tree Bay.
- Upgrade the existing refreshment facility at Apple Tree Bay, however, it is recommended that the facility be modified into a quality café with outdoor eating area looking out over Apple Tree Bay.
- Undertake a comprehensive audit of the public toilet facilities across the Bobbin Head and Apple Tree Bay Precincts and upgrade their condition to meet DDA requirements, as a minimum.

Sporting Facilities

- No formal sporting areas or open space areas for informal ball games to be provided at Apple Tree Bay.

Boating Facilities

- Continue to support the provision of boating facilities (launching ramp, moorings, jetties) to current levels at Apple Tree Bay, in accordance with existing agreements.
- Consider options for developing a new (but separate) canoe launching ramp at Apple Tree Bay.
- Upgrade the traffic circulation and parking arrangements at Apple Tree Bay to ensure a more efficient system of traffic management is in place, which also supports and integrates with expanded and improved passive recreation areas.

Other Considerations

- Retain and build onto the existing natural setting and theme of Apple Tree Bay with any proposals for new/improved facilities and infrastructure.
- Any upgrades and improvements to pathways, buildings and other structures need to be compliant with the DDA to enhance the accessibility of Apple Tree Bay for people with a disability, or people with poor mobility (such as older adults).
- There were no new community requirements that were inconsistent with the 2002 *Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves.*

4. PRELIMINARY MASTER PLAN DEVELOPMENT

Throughout the project period, the Project Team has prepared a series of preliminary master plans which were "work in progress" and have proved valuable resources during stakeholder, community and client meetings. The current draft Apple Tree Bay Master Plan features some key directions which reflect many of the previously listed improvements and recommendations for recreation provision, and are likely to significantly enhance the visitor experience.

Some of the significant proposals identified in the draft Master Plan which are set to impact recreation provision include:

1. The proposal to divert all vehicular traffic east of the existing public toilet/café building and away from the water edge to create an expanded passive recreation and visitor area adjacent to the Bay will significantly improve the visual amenity of the Precinct and the provision of quality recreation space.

2. The proposal to consolidate all car and boat trailer parking in the central area of Apple Tree Bay will create a safer Precinct and will also enhance vistas across the parkland areas to the Creek and Bay as well as providing improved opportunities to utilise the water edge for improved pedestrian use and tree plantings.

3. The upgraded and expanded picnic area in the south west will ensure a more secluded and remote family recreation area is available at Apple Tree Bay, whilst retaining the strong focus of use of the Precinct as a key destination for boating enthusiasts (and the inherent traffic and car and trailer parking requirements).

4. The proposed walking/cycle path to be constructed between Apple Tree Bay and Bobbin Head will provide users of both Precincts with a short (approximately 1.3km), relatively easy (flat) and scenic exercise option.

5. SUMMARY

A restricted range of recreational pursuits are currently available to visitors at Apple Tree Bay. These include boating facilities (powered and non-powered), limited family recreation in the form of picnics and BBQs, hiking, walking, and fishing. The underlying theme and amenity of the Precinct is a recreation place in a natural setting, albeit the importance of boat launching and the associated periods of high traffic concentration. This quality should be maintained with the impact of car and boat trailer parking mitigated through new design and placement of parking and new traffic management.

Several initiatives and recommendations for improving the recreational experience for visitors have been identified and/or validated by Stratcorp Consulting as part of our involvement with the Project Team. These include:

- Expanded open space area and revetment treatment of the Bay foreshore to provide a better quality recreation space for visitors and to enhance the vista across the Bay.
- Increased and upgraded provision of visitor facilities including picnic areas, shelters, BBQs, park furniture, public toilets and café.
- Parking corralled to the central area of the Precinct to "open-up" the Bay and Creek foreshores.
- Introduction of natural play spaces with particular emphasis on their use as mediums to improve visitors' appreciation of the natural and environmental values of the Precinct.
- Development of separate facilities for canoe launching within the Precinct.

These and the other improvements to Apple Tree Bay being investigated by other sub-consultants will deliver a more relevant and sustainable public open space area for the enjoyment of all people for many years to come.

AN ASSESSMENT OF RECREATIONAL USES OF BOBBIN HEAD & APPLE TREE BAY PRECINCTS

Ku-ring-gai Chase National Park, NSW

Research for the preparation of master plans
for the Bobbin Head & Apple Tree Bay Precincts

April 2006

Prepared for Conybeare Morrison International Pty Ltd

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1. INTRODUCTION

The Department of Environment and Conservation (NSW National Parks & Wildlife Service) engaged Conybeare Morrison International in December 2005 to prepare a Master Plan (incorporating Conservation Management Plans and Landscape Management Plans) to guide the future conservation, development and management of the Bobbin Head and Apple Tree Bay Precincts. Bobbin Head and Apple Tree Bay are key existing recreation nodes within the Ku-ring-gai Chase National Park, the second oldest national park in Australia and situated approximately 20km north of the Sydney Central Business District.

Stratcorp Consulting, a sport and recreation planning firm, was sub-contracted by Conybeare Morrison International to assist with the assessment and analysis of the recreational uses of Bobbin Head and Apple Tree Bay, and where appropriate, provide direction and input into the design process for the Landscape Management Plans for both Precincts.

The key objectives outlined in the project brief relating to recreation provision and opportunity at Bobbin Head and Apple Tree Bay Precincts include:

1. Raise perceptions of Bobbin Head as a special place for visitors and the general community.

2. Plan to better meet recreational/user expectations through improved facilities and access in a national park context.

3. Reflect community view in the development of the plan.

4. Review visitor facilities and develop concepts for improved design solutions.

5. Analyse and present current recreational use with specific consideration of conflicts of use and potential use.

6. Provide guidelines for the improvement of facilities to meet user needs and expectations, including potential re-adaptive uses/improvements to existing buildings within the Precincts.

7. Deliver improved site planning and design of increased amenity in the Precincts.

8. Review the siting and design of the existing playground.

The specific research tasks carried out by Stratcorp Consulting during the assessment and analysis of recreational uses within both Precincts, and to prepare the Recreational Plan included:

1. Review of previous relevant reports and studies concerning the Bobbin Head and Apple Tree Bay Precincts, or features, facilities and services therein.

2. Site review of the Bobbin Head and Apple Tree Bay Precincts, with particular consideration of the recreational places, spaces and facilities.

3. Stakeholder and visitor consultation, including:
   - Community/visitor consultation (survey, submissions and onsite community information sessions).
   - External stakeholders, including commercial lessees, boat owners, neighbouring Councils, user groups/clubs (meetings).
   - Agencies, including DEC, RTA, Fisheries, Waterways (meetings).
   - Project Control Group, including DEC, NPWS Rangers and staff (meetings).
4. Review and analysis of research data relating to the recreational use of the Bobbin Head and Apple Tree Bay Precincts gathered both during this study and previous studies.
5. Formulation of key strategic directions for the use of Bobbin Head and Apple Tree Bay Precincts for recreation pursuits.
6. Involvement in the planning and development of the Master Plan for Bobbin Head and Apple Tree Bay Precincts and associated written supporting material prepared by the Project Team.

This Report describes and documents the key outcomes from the processes undertaken during our research, and outlines a series of proposed directions and recommendations to assist Conybeare Morrison International to develop the Landscape Management Plans for both Precincts.

Two Executive Summary Reports have been prepared – one for the Bobbin Head Landscape Management Plan and one for the Apple Tree Bay Landscape Management Plan – each of which has drawn on the research data and analysis contained in this report which has consolidated all relevant information for both Precincts.

2. CONTEXT

2.1. Broad Strategic Direction for Parks Management

The *Living Parks* strategy (2006) outlines the broad strategic direction and management framework adopted by the Department of Environment and Conservation to manage people's use and visitation to those protected areas managed by NSW National Parks and Wildlife Service. It articulates the Government's commitment to conserving and protecting the unique natural and cultural values of NSW parks, whilst also ensuring sustainable and culturally appropriate visitations.

Several Guiding Principles underpin the various Strategies and Actions contained in the document, some of which directly inform the recreational use of NSW parks. These Principles have been considered during the assessment of recreation opportunities when developing the Landscape Management Plans for Bobbin Head and Apple Tree Bay Precincts:

1. Facilities and services associated with visitors are managed to ensure that they are environmentally sustainable and culturally appropriate.

2. Visitor use promotes awareness of conservation.

3. Information and interpretation are integral to visitor understanding and appreciation of the natural and cultural values of parks and in making informed choices about recreation opportunities.

4. Equitable opportunities are provided for all to enjoy NSW parks, including people with disabilities or from non-English speaking backgrounds.

5. Visitor facilities and services are managed to a standard of excellence that takes into account national and international benchmarks.

6. Consultation is the key to identifying the environmental, social and economic expectations of communities and visitors.

2.2. Ku-ring-gai Chase National Park Plan of Management

Ku-ring-gai Chase National Park is part of an open space system of protected areas on the lower reaches of the Hawkesbury River. The National Park and other adjoining parks and reserves protect the natural scenic values of the lower Hawkesbury River as well as being important for the conservation and natural and cultural values.

Ku-ring-gai Chase National Park is located within the northern reaches of the Sydney metropolitan area and is bound by residential areas on the eastern and southern sides, by the Sydney-Newcastle Freeway on its western side, and the Hawkesbury River and associated tributaries to the north. The National Park provides a range of recreation opportunities, including walking and hiking tracks, camping[1] and picnic areas, and waterways for various water-based activities. Importantly, the extensive bushland areas

[1] Please note camping is excluded from the Bobbin Head and Apple Tree bay Precinct.

and waterways within the National Park provide visitors with extensive opportunities for seclusion and a sense of isolation from the City without leaving the Sydney metropolitan area.

A Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves was adopted by the NSW Minister for the Environment in May 2002. It sets out a strategic direction for the management and operation of the total area under the Plan, including Ku-ring-gai Chase National Park. Within the Plan of Management there are general objectives outlined for the management of national parks in NSW and specific objectives which apply to the management of Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves. Further, the Plan of Management articulates the following overall strategy for the management of the parks:

1. Protect the national park and nature reserves from detrimental impacts of fire, weeds, feral animals, pollution, erosion and visitor use impacts through direct control and remediation works and through the education of park visitors, stakeholders and neighbours.

2. Protect the outstanding scenic values of the national park when viewed from both within and outside the park.

3. Maintain and promote selected sites and facilities within the national park which can cope with high levels of visitor use.

4. Limit facilities to existing developed areas of the national park or park boundaries where possible, rather than further dissecting the park with new developments.

5. Continue to limit access to the nature reserves to protect the nature conservation values for which they were dedicated.

2.3. Future Directions for Recreation Activities Within Ku-ring-gai Chase National Park

Ku-ring-gai Chase National Park contains a broad range of recreation facilities and opportunities, including picnic areas, boat launching ramps, boat moorings, marinas, restaurants, kiosks, scenic roads, camp sites, visitor/information centres, lookouts and walking tracks. The existing provision of these assets and their capacity for improvement and expansion have been assessed as part of the 2002 Plan of Management process. Relevant policies and actions established for the future management of recreation in Ku-ring-gai Chase National Park, and which have been considered as part of this project to develop Landscape Management Plans for Bobbin Head and Apple Tree Bay Precincts, include:

- Recreational use will be focused on sites which can sustain such use. Existing visitor use areas will be promoted in preference to constructing new areas for recreation.
- Preference will be given to recreation activities which do not degrade the natural or cultural values of the park and which maintain the quiet and restful atmosphere desired by most visitors to the park.

- The Bobbin Head and Apple Tree Bay picnic areas will be maintained as developed picnic areas. The provision of additional picnic shelters at Apple Tree Bay will be investigated.
- Sections of the dead-end roads along the foreshores of Bobbin Head will be replaced with grass to increase safety and improve views from the picnic area.
- The play equipment at Bobbin Head will be progressively replaced with play equipment that is educational and more compatible with its national park setting.
- A network of walking tracks will continue to be maintained in the park to cater for a range of abilities and desired experiences, including tracks suitable for wheelchairs.
- Existing walking tracks will be investigated for possible upgrade.
- Camping will be permitted only at The Basin and at Brooklyn Dam (so has not been considered as a possible new activity for the Bobbin Head and Apple Tree Bay Precincts).
- Horse riding will continue to be permitted only on trails permitted for this purpose (none of which traverse the study area so horse riding has not been considered as a possible new activity for the Bobbin Head and Apple Tree Bay Precincts).
- Cycling will only be permitted on the public road system and on management trails within the Park. Cycling will not be permitted on walking tracks.
- The shoreline of the Park will be maintained in as natural a state as possible.
- Prohibition of power boats on Cowan Creek upstream of the Bobbin Head marina, on Apple Tree Creek upstream of the footbridge and on Cockle Creek upstream of the road bridge at Bobbin Head so as to provide quiet natural waterways within the Park.
- The goal over the life of this Plan will be to reduce the total number of moorings within the Park. While the total combined number of moorings and marina berths will not be increased beyond current levels, the ratio between the two may change. There shall be no additional commercial moorings in or near Bobbin Head beyond those permitted by the current leases.
- Fishing will be permitted in accordance with the regulations of NSW Fisheries.
- Rock climbing and abseiling activities involving ropes and mountaineering equipment will not generally be permitted in the Park, other than at Baronjoey Head (so has not been considered as a possible new activity for the Bobbin Head and Apple Tree Bay Precincts).
- Orienteering and rogaining events involving 10 or more persons will not be permitted in the park without prior written approval.
- Swimming is only permitted within the enclosure at The Basin[2] (so has not been considered as a possible new activity for the Bobbin Head and Apple Tree Bay Precincts).

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[2] Swimming was previously available within a number of enclosures sited within the Park, including Bobbin Head, but these have been progressively phased out due to continued damage caused by boats and flooding.

3. USER RESEARCH AND CONSULTATION

This section provides a summary of research into the patterns of recreation use of visitors to the Bobbin Head and Apple Tree Bay Precincts, and their aspirations for new/improved facilities and services.

Key results from previous research have also been referenced, as well as an overview of the outcomes of the user survey carried out during this project, and other input received from meetings and submissions. The implications from this data have been used in the analysis of recreation issues and opportunities in Section 4.

3.1. Previous User Research

The two most recent visitor surveys commissioned by the NSW Department of Environment & Conservation (DEC) were:

1. 1997 Easter Visitor Survey (Ku-ring-gai National Park), Alison Ramsay, 1997.
2. Parks Visitor Survey (Central Branch Parks), Taverner Research, 2004/05.

Key outcomes informing the recreation assessment of issues and opportunities for the master Plan have been summarised below.

3.1.1. 1997 Easter Visitor Survey

(132 survey respondents who visited Bobbin Head area on Easter Saturday and Sunday,1997)

- A majority (44%) of respondents reside within 10km of Bobbin Head, with a further 42% from within a catchment of 10 – 20km.
- The main reasons for visiting Bobbin Head were picnic (27%), followed by BBQ (19%), sightseeing (11%), boating (10%), fishing (8%) and bushwalking (8%).
- Bobbin Head (60%) was a more popular destination than Apple Tree Bay (28%).
- 40% of respondents used a walking track during their visit, with the Boardwalk Track (46%) and the Waratah Track (19%) the most popular.
- The main qualities which attracted visitors to Bobbin Head were (in order) the "quiet and restful atmosphere", the "scenery", the "recreation opportunities", and the "park facilities". Visitors were also ask to rate the level of importance of each attraction, and the order of importance was the same as above.
- When ask to suggest improvements to Bobbin Head area, 55% of all survey respondents offered suggestions, with the most popular being:
  - Improve quality of toilets.
  - Maintain walking tracks.
  - Provide gas/electric BBQs.

3.1.2. 2004/05 Parks Visitor Survey (Central Branch Parks)

(166 survey respondents who visited Bobbin Head in January and February, 2005)

- 87% of respondents had visited Bobbin Head previously.
- In relation to the frequency of visits in the 12 months prior to the day of survey, 29% of respondents had visited the park more than 10 times, with a further 29% 2-4 times, followed by 20% 5-10 times. 22% were visiting for the first time since the preceding 12 month period.
- Most respondents (62%) travelled no more than 30 minutes to get to Bobbin Head *(estimated less than 15km)*.
- Most respondents visited Bobbin Head for a half-day (35%) or full-day (32%), whilst 31% stayed for less than 2 hours.
- When asked what the main reasons were for visiting Bobbin Head, the most popular responses were *(multiple responses were accepted)*:
  - Rest and relax (64%).
  - Spend time with family/friends (53%).
  - Outdoors/natural environment (45%).
  - Participate in recreational activities (28%).
- In relation to activities undertaken, or planned to be undertaken, the most popular responses were *(multiple responses were accepted)*:
  - Rest and relax (64%).
  - Picnic/BBQ (55%).
  - Socialise with family/friends (53%).
  - Short walk (< 1 hour) (44%).
  - Fishing / boating (30%).
  - Sightseeing (25%).
  - View animals/plants (20%).
- Other findings:
  - Visitors rated the number of people in picnic areas as important, and were satisfied with the management of this issue.
  - Visitors rated the condition of public toilets as important, and were only somewhat satisfied with the present conditions.
  - Visitors rated the condition of picnic areas and BBQs as important, and were moderately satisfied with the present conditions.
  - Visitors rated the condition and availability of "easy" walking tracks as important, and were satisfied with the present conditions.
  - Conversely, visitors rated the condition and availability of "challenging" walking tracks as less important, and were somewhat satisfied with the present conditions.
  - There was high overall satisfaction with their visit to Bobbin Head expressed by respondents ("satisfied": 33%; "very satisfied": 67%).

3.2. Current User Research

Staff from the Department of Environment and Conservation (NSW National Parks & Wildlife Service) coordinated a survey seeking feedback from users of Bobbin Head and Apple Tree Bay during the period 17th – 28th February 2006. The survey was administered in the following ways:

- Available for downloading from the website of NSW Department of Environment and Conservation (DEC).
- Available for collection from the Visitor Centre, Bobbin Inn, Bobbin Heads.
- Available for collection from the Kalkari Information Centre, Ku-ring-gai Chase Road.
- Handed to park visitors at entry from both the Mt Colah and Turramurra Gates.

The survey questionnaire was jointly designed by Stratcorp Consulting and Connybeare Morrison International and primarily sought information from people on their current recreational usage and perception of Bobbin Head and Apple Tree Bay. The questionnaire also invited ideas from people on how the two Precincts could be improved to better meet their recreational needs. There were 173 survey questionnaires returned, with the section pertaining to Bobbin Heads being completed by all respondents, whilst the section dealing with Apple Tree Bay being completed by 122 respondents.

Whilst the overall sample size is small when compared to the total number of visitors who used the park during the survey period (estimated 2,000 people per week[3]), the findings do provide an opportunity for the consultant team to assess the patterns of use of visitors to Bobbin Head and Apple Tree Bay, and to gauge their aspirations and ideas for improving the Precinct.

A copy of the survey has been attached in Appendix 1. The following sections summarise the key results from the survey, and where possible a comparison has been made with the following recent previous visitor surveys commissioned by DEC:

1. Parks Visitor Survey (Central Branch Parks), Taverner Research, 2004/05.
2. 1997 Easter Visitor Survey (Ku-ring-gai National Park), Alison Ramsay, 1997.

[3] *Estimate calculated from 2005 visitor data provided by DEC.*

3.2.1. Respondent Profile

The Age Profile of respondents was:

Age Category	Percentage
Under 17 years	0%
18 – 24 years	2%
25 – 34 years	12%
35 – 44 years	18%
45 – 54 years	14%
55 – 64 years	21%
65+ years	19%
Not provided	14%

This profile is similar to the age profile of the sample used in the 2004/05 Visitor Survey, but older than the survey sample used in the 1997 Easter Visitor Survey.

The Postcode of Residence of respondents was:

Suburb	Percentage
Turramurra	15%
Hornsby/Asquith	8%
Berowra/Cowan	8%
Berowra Heights	6%
Wahroonga	6%
Mt Colah	5%
St Ives	4%
Other (< 3%)	36%
Not provided	12%

More than half of all respondents were from the suburbs immediately west and south of Ku-ring-gai Chase National Park. This profile is similar to the place of residence of the sample used in the 2004/05 Visitor Survey and the 1997 Easter Visitor Survey when a majority of the sample came from within 10 – 20km of Bobbin Head.

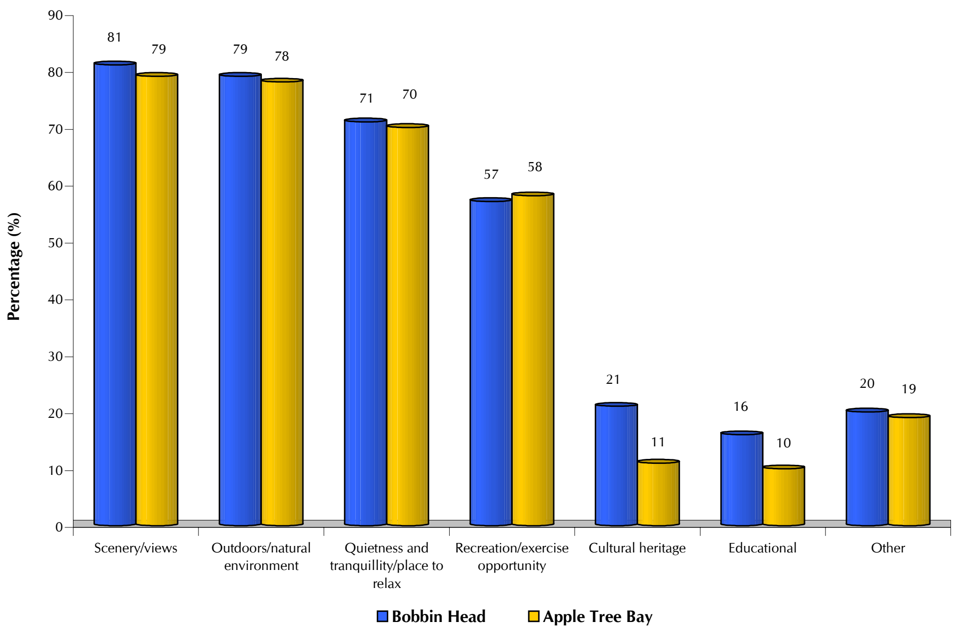
The following table shows the Frequency of Visits by respondents to Bobbin Head and Apple Tree Bay in the past 12 months.

Frequency	Percentage
First time visitor when surveyed	3%
2 – 4 occasions	10%
5 – 10 occasions	22%
More than 10 occasions	46%
Don't Know/No Response	19%

When compared to the 2004/05 Visitor Survey and the 1997 Easter Visitor Survey, respondents visited Bobbin Head and Apple Tree Bay Precinct more frequently in the past 12 months. (This difference can be partially explained by the lower number of "first time visitors" completing the study questionnaire compared with the other two surveys).

3.2.2. Likes and Values

Respondents were asked, *"What do you like and most value about Bobbin Head and Apple Tree Bay?"*



Multiple responses were accepted

Likes and Values about Visiting Bobbin Head and Apple Tree Bay

The graph shows that what people most like or value about Bobbin Head and Apple Tree Bay were very similar. The key attributes of both sites were "scenery and views", followed by "outdoors/natural environment" and "quietness/tranquillity". These results are consistent with the findings of the 2004/05 Visitor Survey and the 1997 Easter Visitor Survey.

Interestingly, Bobbin Head was rated by respondents as a destination with greater "cultural" and "educational" value than Apple Tree Bay and this should be an important consideration for the master planning process.

3.2.3. Improvements

Respondents were asked if *"there is anything about Bobbin Head and Apple Tree Bay that they don't like of think needs improving"*. The question was open-ended and a collation of responses for each park area identified the following trends.

<u>Bobbin Head</u>

The most frequently requested improvements for Bobbin Head were:

- Improve condition of toilets.
- Install shade over the playground.
- Upgrade the condition of the surface of the picnic areas, and improve the picnic shelters and BBQs.
- Improve the safety of the access road, particularly the conflict between cars and cyclists.
- Improve directional signage on the walking trails.
- Provide a safe swimming area.

There were several respondents who also suggested the overall provision and condition of Bobbin Head was satisfactory – *"we love it the way it is"*.

<u>Apple Tree Bay</u>

There were three main issues / improvements identified for Apple Tree Bay:

- Re-open the existing kiosk / upgrade to café standard.
- Reduce the number of cars and boat trailers.
- Conversely, retain as a boat launching area, and improve the car and boat trailer parking and extend the boat ramp facility to accommodate an increased number of boats.
- Other improvements were to provide more BBQs and picnic areas, increase provision of shade and introduce a playground area.

3.2.4. New Recreational Facilities, Activities or Services

Respondents were asked if *"there are any recreational facilities, services or activities that are currently not provided at Bobbin Head or Apple Tree Bay that you would like introduced in the future"*. The question was open-ended and a collation of responses for each park area identified the following trends.

Bobbin Head

The most frequently requested recreational additions for Bobbin Head were:

- Shade cloth over the playground.
- Improved management and use of Bobbin Inn (includes upgrading of the quality of food and refreshments available).
- Public boat launching ramp.
- Drinking fountains.
- Walking track between Bobbin Head and Apple Tree Bay.

Apple Tree Bay

The most frequently requested recreational additions for Apple Tree Bay were new BBQ and picnic areas, however, there was reinforcement by many respondents of the need to increase and/or improve boat launching facilities.

3.2.5. Level of Importance of Specific Facilities and Services

Respondents were asked to rate the level of importance to them of a range existing or new/improved facilities and services at Bobbin Head and Apple Tree Bay using a rating scale of *"very important", "important" or "not important"*. Ratings have been collated and converted to a percentage of all responses in the following tables.

Bobbin Head

Feature	Very Imp	Imp	Not imp	No Resp
Improving the condition of the landcape	21%	38%	29%	12%
The restoration of the 1930's landscape at Orchard Park	14%	34%	25%	27%
Planting additional trees at the water edge for shade areas and amenity	34%	40%	19%	8%
Upgrading and widening the paths along the water edge	18%	36%	35%	10%
Relocating the parking areas so that cars do not dominate the park	23%	29%	40%	8%
Improving the seating and tables in the historic shelters	18%	47%	26%	9%
Providing additional BBQ facilities	17%	35%	37%	11%
Improving the existing playground area	16%	29%	39%	16%
Upgrading the public toilets	39%	38%	16%	7%
Providing a variety of connected loop walking tracks (from 30mins to 4 hours)	39%	43%	10%	8%
Constructing a new walking/cycle track to Apple Tree Bay (distance 1.3km)	32%	30%	21%	17%
More interpretative signage about the history of Bobbin Head	19%	44%	27%	10%
More information about the plants and animals in the National Park?	21%	51%	20%	9%
New canoe launching facilities	16%	27%	39%	18%

Rating of Importance of Selected Facilities at Bobbin Head

The facilities or services that were rated as most important to respondents at Bobbin Head included “planting additional trees at the water edge for shade areas and amenity”, “upgrading the public toilets” and “providing a variety of connected loop walking tracks (from 30mins to 4 hours)”.

The facilities or services that were not rated as important as the above mentioned three included “providing additional BBQ facilities”, upgrading and widening the paths along the water edge” “relocating the parking areas so that cars do not dominate the park”, “improving the existing playground area” and “new canoe launching facilities”.

The remaining facilities or services were considered important, but were not rated highly or lowly in their relative level of importance. It should be noted that there was a high non-response rate to the importance or otherwise of “the restoration of the 1930's landscape at Orchard Park”, presumably due to minimal on-site interpretation of this significant historical cultural landscape and respondents ultimately not being aware of the scale and scope of the 1930s layout.

Apple Tree Bay

There is a high non-response rate to most of the facilities and services options predominantly due to the lower number of respondents who completed the survey questions for Apple Tree Bay (122 only, compared to 173 respondents in total).

Feature	Very Imp	Imp	Not imp	No Resp
Improving the condition of the landcape	34	46	41	52
Planting additional trees at the water edge for shade areas and amenity	45	57	27	44
Constructing a new track along the water edge	26	56	37	54
Relocating the parking areas away from the bay end so that roads and cars do not dominate this area	34	37	52	50
Improving the seating and tables for picnicking	45	52	30	46
Providing additional BBQ's and shelters	46	38	42	47
Providing a playground	20	29	71	53
Upgrading the public toilets	45	56	24	48
Providing a variety of connected loop walking tracks (from 30mins to 4 hours)	43	58	23	49
Constructing a new walking/cycle track to Bobbin Head (distance 1.3km)	45	50	27	51
Providing a café/kiosk service	48	38	38	49
More interpretative signage about the history of Apple Tree Bay	22	59	41	51
More information about the plants and animals in the National Park?	23	63	39	48
New canoe launching facilities	22	41	47	63

Rating of Importance of Selected Facilities at Apple Tree Bay

Not one facility or service at Apple Tree Bay was a stand-out in relation to being rated as most important to respondents. Those rated as being more important than others included "planting additional trees at the water edge for shade areas and amenity", "providing a variety of connected loop walking tracks (from 30mins to 4 hours)", "constructing a new walking/cycle track to Bobbin Head (distance 1.3km)", "improving the seating and tables for picnicking", and "upgrading the public toilets".

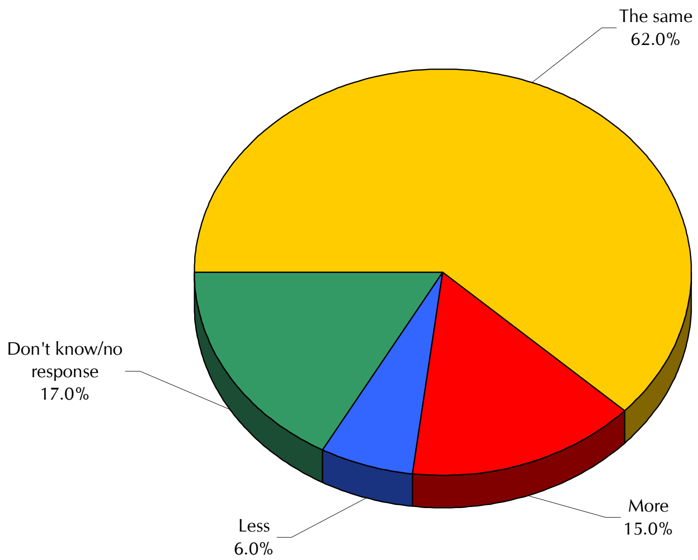
Conversely, the facilities or services that were not rated as important as those identified above included "relocating the parking areas away from the bay end so that roads and cars do not dominate this area", "providing a playground" and "new canoe launching facilities".

The following facilities or services received an even rating by respondents, meaning that they were very important to some but not important to others. These included "providing additional BBQs" and "providing a café/kiosk service".

3.2.6. Car Parking

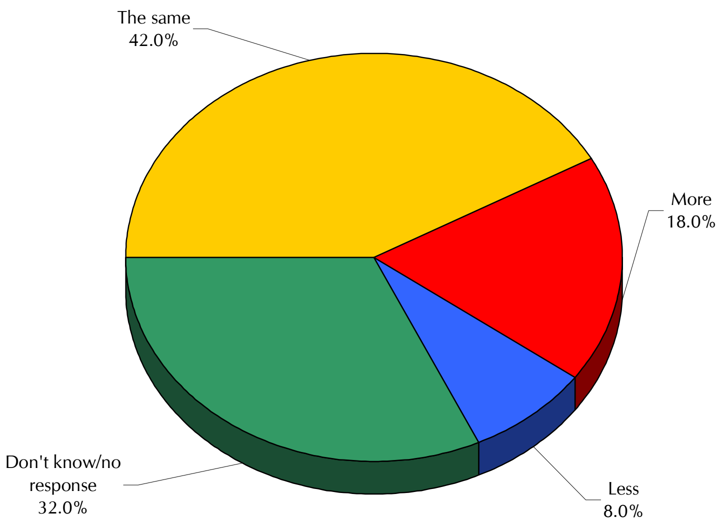
Respondents were asked whether the number of car parking and (for Apple Tree Bay only) boat trailer parks should remain the same, be decreased or increased.

Bobbin Head



Preferences for Parking at Bobbin Head

Apple Tree Bay

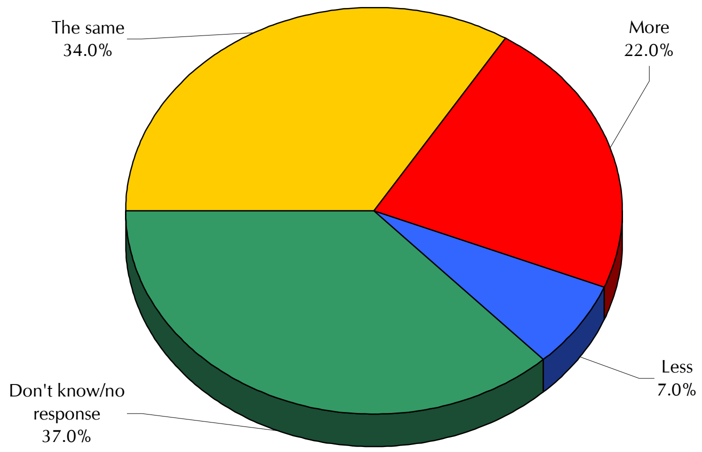


Preferences for Parking at Apple Tree Bay

Whilst there was a relatively high "don't know / no response" for both areas, the key trends from each are:

- There was a common theme that the number of parking facilities in both areas should not be reduced.
- A higher proportion of respondents believe that parking in Bobbin Head should remain the same, rather than be increased, which is the opposite view for Apple Tree Bay, in which a relatively higher proportion of respondents believe there should be more parking.

Respondents were also asked whether **boating facilities** at Apple Tree Bay should remain the same, be decreased or increased.



Preferences for Boating Facilities at Bobbin Head

Again, there was a high "don't know / no response" for the question, however, for those who did respond a high proportion (34%) indicated that the number of moorings should remain the same, followed by "more moorings" (22%) and "less moorings" (7%).

3.3. Other Research

Other information about people's use of Bobbin Head and Apple Tree Bay Precincts was identified through community submissions and a Community Information Session. The following summarises the key outcomes from these two consultative processes.

3.3.1. Community Submissions

Three written and one verbal submission were received by Stratcorp Consulting:

1. Kayak & Canoe Inc. (written and verbal submission).
2. Volunteer, Coast Alive.
3. Resident (St Ives).

Kayak & Canoe Incorporated

- Kayak & Canoe Inc (K & C) is a not-for-profit organisation providing a range of canoe activities for members and friends. The group and its members are regular users of the facilities and waterways in and around the Bobbin Head and Apple Tree Bay Precincts.
- K & C has a partnership with the Gibberagong Environmental Education Centre whereby canoes and other equipment owned by the K & C are stored at the Centre, and in return, the canoes can be used by the Centre during on weekdays to supplement their activities.
- The canoe launch at Bobbin Head (Cockle Creek) is the main location from which members launch canoes and also conduct training sessions. The safe waters of Cockle Creek provide the ideal area for these purposes. Suggested improvements include:
  – Establish a short-stay canoe loading zone for vehicles adjacent to the Bobbin Head ramp.
  – Establish a wash down area adjacent to the Bobbin Head ramp (would comprise two 3m wide wooden rails being set in the ground approximately 3m apart adjacent to the above loading zone).
  – Install a water access point and short-length hose adjacent to the wash down area.
  – Installation of an information and directional sign adjacent to the Bobbin Head ramp (specific to canoeing activities and use of the waterways).
- Launching canoes from Apple Tree Bay was identified as being suitable for experienced canoeists only, due to the inherent risks associated with co-location with powered craft, the area around the boat launching ramp being a high traffic area, the short distance from shore to open water on Cowan Creek, and the constraints on adequate supervision being achieved from the shore.

- K & C consider the existing canoe launching arrangements from the boat ramp to be adequate, but would support the establishment of a separate but dedicated canoe ramp, albeit considering such an installation of low priority when compared to the suggested improvements at Bobbin Head.

Volunteer, Coast Alive

- Coast Alive conduct free nature-based educational activities for visitors to Bobbin Head from the Coast Alive Centre every second Sunday of each the month.
- Suggested improvements include:
  - Refurbishing and upgrading the internal condition of the Coast Alive Centre.
  - Provision of a safe pedestrian crossing between the Centre and the Bridge.
  - Installation of additional interpretive signage around Bobbin Head explaining the different eco-systems which exist.

Resident (St Ives)

- Bobbin Head is highly valued for its quiet surroundings, bush walking options, natural values and picnic facilities.
- Suggested improvements:
  - Provision of accessible paths.
  - Theming the design of the playground at Bobbin Head around nature.
  - Installation of shade covers over the playground.

3.3.2. Community Information Session

(Conducted in Gibberagong Park over the lunchtime period on 26 February 2006, approximately 20 people participated)

As the Information Session was conducted at Bobbin Head, a large proportion of the feedback from visitors related to Bobbin Head Precinct. The information, issues and opportunities identified by participants included:

- Overcrowding evident at Bobbin Head.
- Suggested that generally the facilities at Bobbin Head needed to be upgraded.
- Introduce canoe hire facilities at Bobbin Head.
- Provide more group picnic areas in the shade - existing picnic shelters appear underutilised due to their design constraints.
- Support expressed for the retention of some parkland under the cliffs at Bobbin Head for picnicking, i.e. rain forest experience.
- Retain space for ball games at Bobbin Head.

- Improve the quality of the playground facilities, perhaps introduce a "discovery" element to its design and experiential value (more naturalistic type of facility).
- Develop a safe cycle track throughout the parkland at Bobbin Head.
- Perceived lack of opportunities and relevancy of the parks to young people (14 – 17 years).
- Some concerns expressed about the poor choice of food currently available from Bobbin Inn, and the general poor amenity of the building contrasting with the natural surrounds.
- Safety concerns expressed about the conflict between cyclists and vehicles using Bobbin Head Road.
- Support for an increase in the provision of passive parkland at Apple Tree Bay.
- Support for the development of a track between Bobbin Head and Apple Tree Bay.
- Improve and expand on the provision of interpretive signage "telling the story" of the bushlands, topography, and the history of the area.

4. RECREATIONAL USES / FACILITIES

This section provides a summary of:

1. Existing provision of recreational facilities within the Bobbin Head (BH) and Apple Tree Bay (ATB) Precincts and associated assessment of their appropriateness, or otherwise.

2. Ideas and suggestions to enhance the visitor experience to the area from a recreational use perspective.

Recreation Experience	Issues / Opportunities
1. Pedestrian Circulation	• Pedestrian access is not clearly defined across Orchard Park and Gibberagong Park at BH, other than along the water edge. Likewise, at ATB, there is little provision for pedestrian paths other than in and around the boat ramp/foot bridge area. • Three key issues with this informal approach to circulation are: – The inherent personal risk to the safety of pedestrians as they share roadways and car parking areas with vehicles. – There is little connectivity between the various sub-precincts within both the BH and the ATB Precincts. (In Bobbin Head, these sub-precincts include the water edge, Bobbin Inn, the bridge, the major group picnic shelters, and the commencement of the walking tracks and trails). (In ATB, these sub-precincts include the water edge – both along Apple Tree Bay and Apple Tree Creek – the public toilet/"café" building, the foot bridge, and the grassed areas in the south west section of the park). – There is little encouragement for people to move between Orchard Park and Gibberagong Park at BH, and around ATB, as people do not readily identify a designated pedestrian circulation network. • The provision of dedicated and clearly defined pedestrian paths throughout both BH and ATB is likely to further encourage visitors to "explore" different areas within each Precinct and to move beyond the zone into which they have arrived or parked. This has the potential to not only improve the visitor experience as people walk to areas beyond the water edge (particularly if there is additional provision of interpretive signage), but will

Recreation Experience	Issues / Opportunities
	also assist in ensuring that existing and proposed future commercial areas (e.g. boat hire, kiosk at ATB) are included in pedestrian circuits and are readily accessible by all visitors to maximise the "commercial viability" of the respective leases.
	• The focus of both Precincts is currently the water edge and the ability to stroll along them. This activity will no doubt continue to be popular due to the importance of those expressed values of visitors (such as "scenery" and ""tranquillity") and the continued increasing trend of the popularity of "walking" as a preferred physical activity by the broad community[4]. An opportunity exists to better provide for walking at BH by increasing the width of the path along the water edge to not only help reduce conflict, but also to enable the installation of additional seats and interpretative signage. For ATB, a defined walking path along the water edges does not presently exist, so the development of one will provide new opportunities for visitors.

Recommendations:

1. *Investigate options to improve (off-road) pedestrian thoroughfare throughout both Bobbin Head and Apple Tree Bay which better links sub-precincts within each Precinct.*
2. *Promote and encourage visitors to walk around both Bobbin Head and Apple Tree Bay through strategic use of views, natural features, signage and seating.*
3. *Increase the width of the walking path along the water edge at Bobbin Head.*
4. *Develop a walking path along the water edge at Apple Tree Bay.*

2. Walking Tracks	• The study area has good provision for walking tracks, and visitor research endorses the continued provision of these as a feature of the Ku-ring-gai Chase National Park. Further, "bush walking" is currently ranked 8th as a preferred physical activity by NSW residents as a whole[5].
	• The existing walking tracks connecting to both Precincts are generally medium to long distance walks across challenging terrain. Whilst the exception to this is the Mangrove Boardwalk section of the Gibberagong Track, this section currently has to be walked as an out-and-back course by most people wanting to enjoy a short walk.
	• There are opportunities to establish some "loop" courses of comparatively shorter distances than the established tracks, to further encourage people into

[4] *Source: Exercise Recreation and Sport Survey (ERASS), Australian Sport Commission, 2001-04. The rate of participation in "walking" in NSW increased from 26.8% in 2001 to 37.2% in 2004.*
[5] *Ibid. The rate of participation in "bush walking" in NSW is stable, being 6.6% in 2001 and 6.3% in 2004.*

Recreation Experience	Issues / Opportunities
	bush walking as an activity undertaken whilst visiting. • A significant opportunity exists to develop a new 1.3 – 1.5km track between BH and ATB (strongly advocated for by community and stakeholders, and also supported by the Plan of Management for Ku-ring-gai Chase National Park). This track should be a shared path, ideally be separated from the road and, where possible, should incorporate sections along the water edge. • Consideration needs to be given to providing some "rest stops" (as simple as a bench seat) to further encourage those people who might otherwise be challenged by having to complete a full circuit with no obvious opportunity for some respite. • The "sign posting" of the commencement point of existing walking tracks is well defined with information signs. • An opportunity exists to integrate the commencement point of existing walking tracks with the proposed improved pedestrian network around the Precincts.

Recommendations:

1. *Investigate the feasibility of developing a new shared trail (walking and cycling) between Bobbin Head and Apple Tree Bay.*
2. *Establish new opportunities for short distance "loop" walking trips around Bobbin Head and Apple Tree Bay.*
3. *Connect the start/finish points of existing and proposed walking tracks within the Bobbin Head and Apple Tree Bay Precincts with the proposed improved pedestrian path network.*

3. Playground	• A large well used playground area suitable for pre-primary and primary-aged children exists at BH. The playground has a sand base and is fenced, but currently has no shade relief for users or adjacent seating for parents/guardians supervising children. • An opportunity exists to better integrate the main playground structure and space at BH into a more natural setting. This could be achieved through the choice of natural materials in its construction (such as logs, formed earth, stone and planted landscaping) and a design theme more sympathetic with the setting of Gibberagong Park. Its location in the central space of Gibberagong Park is still considered the optimal location for this main play space.

Recreation Experience	Issues / Opportunities
	• Explore opportunities for the outcome of the play experience at this main playground to be educational, informative and discovery-based. • The existing fencing treatment of the main playground (powder coated, tubular, aluminium pipe material) is not appropriate for the future playground. However, some restraining treatments are still required along those sides of the playground which interface with the roadways and the water edge (for safety reasons). • The importance of Bobbin Inn as a place of congregation for refreshments and information supports the need for consideration of a second, but smaller playground in this location. The playground would have the function of providing young children with a short play opportunity whilst parents/guardians are seeking out park information and/or refreshments. • An area adjacent to the Bobbin Inn's outdoor café/kiosk area in Orchard Park South would be the optimal location for this playground. Its location in the more formal area of BH (Orchard Park) suggests a design direction focussing on the cultural history and importance of the area would be appropriate, and would also give this playground a point-of-difference to the main playground. Again, its location next to busy Bobbin Head Road will require the playground to be fenced (perhaps low rock wall, or wooden fencing treatment) to ensure integration with the natural landscape, Bobbin Inn and the rock wall treatment at the commencement of the adjacent walking trail. • There is no children's playground currently available at ATB. Whilst the recent historic function and emphasis of ATB has been as a place from which to launch boats and park cars and boat trailers, the general direction to modify the function and use of this Precinct to be more "passive-recreation" friendly creates a need to consider the strategic installation of play spaces for children. • The "visitor-friendly" areas in this Precinct will be the northern section along the water edge (near the café which is proposed to be re-opened) and the south western section beyond the car parking bays near to the proposed new shelter. The naturalistic setting of ATB suggests that the design direction for the play spaces should have the outcome of children connecting with and appreciating nature. To achieve this, logs, rocks, and shaped earth should be

Recreation Experience	Issues / Opportunities
	integrated into the landscape at these two locations to provide play areas for children to sit on, jump from, and climb and hang from.
	• Any new play areas at ATB should be of a scale and size significantly less than what currently exists at BH due not only to constraints of land availability but also the smaller number of visitors using this Precinct as a half-day or full-day destination for land-based recreational use (as opposed to on-water use).

Recommendation:

1. *Replace the existing playground at Bobbin Head with a new playground offering an expanded range of experiences and which is designed and built in keeping with a natural setting and which provides users with educational, informative and discovery-based experiences. Include shade, limited fencing, seating and 1-2 drinking fountains.*
2. *Develop a new, smaller play area within Orchard Park South adjacent to the Bobbin Inn café area and which integrates with existing trees in the area. The design for this playground to focus on the cultural history and values of Bobbin Head.*
3. *Develop two new play spaces (not playgrounds) for children at Apple Tree Bay within the northern and southern sub-precincts. The design of these unfenced play spaces to be in keeping with the natural setting of ATB and be designated for children's interpretation and education. The choice of materials could include logs, rocks, and shaped earth.*

4. Sporting Facility(s)	• No formal sporting areas are currently available at BH or ATB, and it is not appropriate, or necessary, to provide formal sporting areas. • An informal recreation and ball games area is currently available at BH in Gibberagong Park, between Bobbin Head Road and the playground. It is a popular location for informal ball games and unstructured activity. Whilst the participation in such activities should not be encouraged due to the likelihood of potential conflict with other visitors, it must be recognised that family and/or social groups will from time to time wish to participate in informal ball games as part of their day out in the park. It is reasonable for people to expect to have access to such open spaces in large parklands such as BH. • Not recommended that the area be formally sign posted as an activities area, to enable the space to be utilised by picnickers on high visitation days, or other uses permitted by management. • Apple Tree Bay already has spatial constraints on the land available and with a proposed increased allocation of space for passive recreation areas it is considered not appropriate that a similar informal activities area be supported at this site.

Recreation Experience	Issues / Opportunities

Recommendations:

1. *Retain an area of open space within Gibberagong Park for informal ball games associated with family group picnics.*
2. *Not recommended that the area be formally sign posted as an activities area.*
3. *Recommended no space or zone be provided at Apple Tree Bay for informal ball games, due to existing and likely continued future high demand within the Precinct for car parking and associated circulation space, and the aim to create additional areas for passive recreation (picnics and BBQ areas, seating, shelters, etc).*

5. Boating

- The number of available commercial and public moorings across the Precincts is subject to continued review in accordance with the directions and recommendations of the *Plan of Management for Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves (2002)*.
- BH and ATB Precincts are popular areas for powered and non-powered boating. A charm of the Precincts is the backdrop created by the boats moored at each site and this will continue in the foreseeable future as existing agreements for boat moorings take their course.
- There is a stable number of canoeists which are utilising the Precincts. BH is currently the more popular of the two Precincts as a launching point and a location for organised groups (such as the Gibberagong Educational Centre and the Kayak & Canoe group) to conduct activities and services.
- It was suggested during the consultation that some minor additions to the canoe launching area at BH would improve the site not only for the convenience of regular users, but also make the site a more attractive destination for canoeists. The improvements include the installation of a wash down structure, provision for a short-stay loading zone adjacent to the BH canoe ramp, and some information signage. These improvements are supported.
- In relation to ATB, the provision of a new canoe launching ramp which is separate from the existing boat ramp is considered important due to the ongoing safety risks associated with canoeists utilising the existing ramp and the increasing number of car/boat trailers also utilising the ramp.
- There is support from the community for the provision of a commercial non-powered boat hire service to be available at BH. Boats for hire may

Recreation Experience	Issues / Opportunities
	include fishing boats, canoes, kayaks and row boats. Brightly coloured water bikes and versions thereof, would not be expected to significantly add to the natural setting of the Precinct and would be discouraged. (The type of row boat considered appropriate is similar to those available for hire in Studley Park, Kew, Victoria).

Recommendations:

1. *Upgrade the existing canoe ramp at Bobbin Head to incorporate a loading zone, a wash-down facility and an information sign (liaise with the Kayak & Canoe group).*
2. *Investigate the feasibility of introducing a commercial boat hire service at Bobbin Head, including wooden rowing boats.*
3. *Consider options for developing a new (but separate) canoe launching ramp at Apple Tree Bay.*

6. Visitor Facility(s)	• BH features a variety of recreational areas and facilities for visitors, including the numerous BBQ/picnic areas, the historic shelters and the picnic shelters for large groups (including the Station and the Pavilion), the jetty, the Coast Alive Centre, Bobbin Inn and public toilets. • The historic picnic shelters have an important cultural and historical value, however, their functional value and popularity as picnic facilities appear limited, based on observation and community feedback undertaking during this project. Any new picnic facilities need to better cater for larger groups. • The flat benches at both BH and ATB should be removed and some replaced with alternate park furniture. • An additional BBQ should be provided in both Orchard Park North and Gibberagong Park at BH, and an additional two BBQs at ATB. BBQs should be gas or electric and should be free, button operated units. • Bobbin Inn appears underutilised and the current food service is not meeting visitors' needs. A detailed investigation into the options to optimise the future use of Bobbin Inn as an information/discovery centre, conference, function and/or entertainment centre needs to be undertaken. Any future use will need to be considered in accordance with the overall aims of the National Park, and existing constraints in relation to access. • There is strong community support to re-establish a refreshment outlet at ATB. Notwithstanding the

Recreation Experience	Issues / Opportunities
	current high use of the Precinct, the economic feasibility of operating a concession service at ATB may be dependent upon the capacity of the DEC to ultimately increase the number of land-use visitors to ATB. This increase will be partially dependent upon the progress of the implementation of this Master Plan. • The location of the public toilets at both BH and ATB are considered appropriate as they are generally well spaced throughout the Precincts. It is the poor accessibility to most of them and the general poor condition of them that make their upgrade an important outcome of this Master Plan for visitors. • The desirability of ATB as a destination for land-based family recreation is low due to the proliferation of car and boat trailer parking, and the general lack of appropriate spaces and places to congregate. This is despite the high quality of the natural environment and the relatively easy access to the site. A re-design of ATB to better utilise the existing site should realise a more attractive and useable space for family recreation. Research indicates that the northern end of the site needs to allow for an extended open grassed area for picnicking and walking, with the car and trailer parking corralled into a more appropriate area of the park. Also, the south western end of the site has potential to be better utilised as a picnicking and passive recreation area due to the sense of remoteness, solitude and peacefulness able to be experienced.

Recreation Experience	Issues / Opportunities

Recommendations:

1. *Install additional BBQs at Bobbin Head (x 2) and Apple Tree Bay (x 2).*
2. *Consider installing additional picnic shelters/areas in Orchard Park North and Gibberagong Park suitable for larger groups.*
3. *Remove the flat benches at both Bobbin Head and Apple Tree Bay and replace some of them with more functional park furniture.*
4. *Ensure that the quality of service by the contractor engaged to operate the kiosk/cafe at Bobbin Inn is of a high quality, commensurate with the general expectations of visitors.*
5. *Undertake an investigation into options to optimise the future use of Bobbin Inn as a public facility, with opportunities to be explored to include information/discovery centre, conference/function facility, and/or entertainment centre.*
6. *Upgrade the refreshment facility at Apple Tree Bay, however, it is recommended that the facility be modified into a quality café with outdoor eating area looking out over Apple Tree Bay.*
7. *Undertake a comprehensive audit of the public toilet facilities across the Bobbin Head and Apple Tree Bay Precincts and upgrade their condition to meet DDA requirements, as a minimum.*
8. *Redesign the layout of Apple Tree Bay to expand the grassed areas within the northern and south west sub-precincts within the site whilst providing no net loss of car and boat trailer parking.*

5. SUMMARY

A range of recreational pursuits are currently enjoyed by visitors to Bobbin Head and Apple Tree Bay Precincts. These include family recreation in the form of picnics and BBQs, boating (powered and non-powered), hiking, walking, informal games and playground use, a variety of nature-based activities, and fishing. The underlying appeal of each activity in the Precinct setting, is the sense of attachment to and association with nature. This quality should be maintained and enhanced through the current Master Planning process for Bobbin Head and Apple Tree Bay Precincts currently being coordinated by Conybeare Morrison International for the Department of Environment and Conservation (NSW National Parks & Wildlife Service).

Several initiatives and recommendations for improving the recreational experience for visitors have been identified and/or validated by Stratcorp Consulting as part of our involvement with the Project Team. These include:

- Increase and upgrade the provision of facilities in the picnic areas, including shelters, BBQs, park furniture and public toilets.
- Improved provision of playgrounds and other informal play facilities, with particular emphasis on their use as mediums to improve visitors' appreciation of the natural, cultural and environmental values of the Park.
- Improved provision and safety for walking / hiking, including relocation of car parking areas from the water edge at both Precincts, and the development of a new pedestrian link between Bobbin Head and Apple Tree Bay.
- Upgrade food and beverage provision throughout the Precincts through a combination of advocating for improved catering facilities and services at the Bobbin Inn and a new café at Apple Tree Bay.
- Develop additional facilities to promote canoeing within the Precincts.
- Advocate for the introduction of a commercial boat hiring service for non-powered craft.

APPENDIX 1

User Survey Questionnaire

BOBBIN HEAD AND APPLE TREE BAY MASTERPLANNING PROJECT
Initial User Feedback Survey - Stage 1 Consultation

The National Parks and Wildlife Service (NPWS) has commissioned Conybeare Morrison and Context Landscape Design to prepare a Masterplan for Bobbin Head and Apple Tree Bay in the Ku-ring-gai Chase NP. This plan will guide their protection, enhancement and conservation for the future. As part of the initial Masterplanning process, we invite your feedback and input about what you value about BOBBIN HEAD and APPLE TREE BAY, and what you would like to see happen in the future at both of these public areas.

Important Information

- One side of this survey form invites feedback about BOBBIN HEAD whilst the other side deals with APPLE TREE BAY. You may complete the survey for both areas or for one area only – **all survey respondents need to complete the Respondent Information on page 2. The form must be submitted by 28 February 2006.**
- If you wish to make additional comments, you can email these directly to kcnp.masterplanning@environment.nsw.gov.au.
- Bobbin Head and Apple Tree Bay research analysis can be viewed on www.nationalparks.nsw.gov.au or at the display in the Bobbin Inn Information Centre, Bobbin Head and the Kalkari Discovery Centre in the Ku-ring-gai National Park from 16-28 February 2006.
- The Draft Masterplan will be on public exhibition in May 2006.

BOBBIN HEAD MASTERPLAN

1. What do you like and value most about Bobbin Head? (Multiple responses accepted)

   O Scenery / views
   O Recreation / exercise opportunity
   O Educational
   O Outdoors / natural environment
   O Quietness and tranquillity / place to relax
   O Cultural heritage
   O Other (specify) ____________________

2. Is there anything about Bobbin Head that you don't like or think needs improving?

   ____

   ____

   ____

3. How important is the following in Bobbin Head to you ? **(Tick 1 box on each line)**:

Facility	Very Imp	Imp	Not Imp	Don't Know
Improving the condition of the landscape?				
The restoration of the 1930s landscape at Orchard Park?				
Planting additional trees at the water edge for shade areas and amenity?				
Upgrading and widening the paths along the water edge?				
Relocating the parking areas so that cars do not dominate the park?				
Improving the seating and tables in the historic shelters?				
Providing additional BBQ facilities?				
Improving the existing playground area?				
Upgrading the public toilets?				
Providing a variety of connected loop walking tracks (from 30mins to 4 hours)?				
Constructing a new walking/cycle track to Apple Tree Bay (distance 1.3km)?				
More interpretative signage about the history of Bobbin Head?				
More information about the plants and animals in the National Park?				
New canoe launching facilities?				

4. In relation to the number of car parks, there should be … ☐ the Same ☐ More ☐ Less ☐ Don't Know

5. Are there any recreational facilities, activities or services that are currently not provided at Bobbin Head that you would like introduced in the future? And any other comments or feedback about Bobbin Head?

   ____

   ____

   ____

   ____

CM+ Conybeare Morrison context

APPLE TREE BAY MASTERPLAN

6. What do you like and value most about Apple Tree Bay? (Multiple responses accepted)

O Scenery / views | O Recreation / exercise opportunity | O Educational
O Outdoors / natural environment | O Quietness and tranquillity / place to relax | O Cultural heritage
O Other (specify)________________________________

7. Is there anything about Apple Tree Bay that you don't like or think needs improving?

____

____

____

8. How important are the following in Apple Tree Bay to you? **(Tick 1 box on each line)**:

Facility	**Very Imp**	**Imp**	**Not Imp**	**Don't Know**
Improving to the condition of the landscape?				
Planting additional trees at the water edge for shade areas and amenity?				
Constructing a new track along the water edge?				
Relocating the parking areas away from the bay end so that roads and cars do not dominate this area?				
Improving the seating and tables for picnicking?				
Providing additional BBQs and shelters?				
Providing a playground?				
Upgrading the public toilets?				
Providing a variety of connected loop walking tracks (from 30mins to 4 hours)?				
Constructing a new walking/cycle track to Bobbin Head (distance 1.3km)?				
Providing a café/kiosk service?				
More interpretative signage about the history of Apple Tree Bay?				
More information about the plants and animals in the National Park?				
New canoe launching facilities?				

9. In relation to the number of car and trailer parks, there should be … ☐ the Same ☐ More ☐ Less ☐ Don't Know

10. In relation to boating facilities, there should be … ☐ the Same ☐ More ☐ Less ☐ Don't Know

11. Are there any recreational facilities, activities or services that are currently not provided at Apple Tree Bay that you would like introduced in the future? And any other comments or feedback about Apple Tree Bay?

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____

____

Respondent Information Age ________ Country of Residence ________________ Postcode of Residence ________

How often have you visited Bobbin Head or Apple Tree Bay in the past 12 months?

☐ First time today ☐ 2- 4 times ☐ 5 - 10 times ☐ More than 10 times ☐ Don't Know

If you wish to be advised when the draft masterplan is available to comment on please provide your name and contact details:

____

____

Thank you for you time. We consider all responses are important in the Masterplanning process.

Please post to: Masterplanning, NPWS, PO Box 3031, Asquith, NSW 2077
Drop off at: Bobbin Inn Information Centre, or Kalkari Discovery Centre, or Park Entrance.
Email for comments: kcnp.masterplanning@environment.nsw.gov.au

Your submission may contain information that is defined as 'personal information' under the NSW Privacy and Personal Information Protection Act 1998 and identifies you. All submissions will be stored in DEC's record system and may be publicly available, upon request to DEC. If you do not want your personal details to become public, please mark on your submission that you want your personal details to remain 'confidential'. It is not necessary that you supply personal information if you wish to remain anonymous.

CM+ Conybeare Morrison context

1.6 Improving Soil Conditions for Trees and Turf Report - Sydney Environmental Soil Laboratory and Simon Leake

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Improving Soil Conditions for Trees and Turf at Bobbin Head

January 2006

Scope

The following discussion is provided to Conybeare Morrison International Pty. Ltd., head contractor for the Bobbin Head and Apple Tree Bay Master Plan project for the National Parks and Wildlife Service (NPWS).

The discussion concerns the remediation of soil conditions for the Bobbin Head park areas based on a review of existing site observations, previous soil or geo-technical related studies and plans submitted to NPWS over several years. While none of the previous studies provides a complete picture of soil conditions for horticultural purposes the GHD report provides some. The direct first hand knowledge of the author in the Orchard Park area is used to provide some level of certainly to these preliminary opinions and advice.

Since the purposes of these previous studies was not necessarily focussed on the health of parks and gardens the conclusions and suggested remedial work herein should be considered tentative and subject to further site specific investigation prior to any precise specification of works programs.

Four documents are chiefly relied upon as well as first hand observations from TAFE student field days conducted with the aboriculture group run by Judy Fakes of Ryde TAFE in May 2005. These unpublished observations of student project write ups from Ryde TAFE conducted under the supervision of Sydney Environmental and Soil Laboratory are cited as TAFE 2005.
The documents chiefly relied upon are-

1. **1.** Bobbin Head and Apple Tree Bay Management Plan. Gutteridge Haskins and Davey Pty. Ltd. 1991.
2. **2.** Arborists Report: Bobbin Head and Apple Tree Bay Picnic Areas . The Tree Wise Men 2004.
3. **3.** Conservation Management Plan for Orchard Park. Bachman *et. al*. 2003.
4. **4.** Conservation Management Plan for Gibberagong Park. McGoverne 2003.
5. **5.** TAFE Arboriculture Certificate, Fakes, J. and Leake, S. (2005) Observations from field work component, Reasons for decline of *Metasequoia semperivens* Bobbin Head Orchard Park. Unpublished field notes and student submissions.
6. **6.** Douglas Partners 1998. Report on Preliminary Geotechnical Investigation, Damaged Toilet Block, Orchard Park. Bobbin Head.

In this report an attempt is made to identify the major soil related reasons for failure or poor condition turf and tree components of the park and to suggest remedial actions. The suggested actions are given in order of lowest to highest anticipated cost which is directly related to the likelihood of a permanent solution to the problems (ie lowest cost is least likely to provide permanent solution). Advice is offered on which is the most appropriate action for a given area but this must be subject to more detailed site specific investigation before any degree of certainly of improvement can be provided.

Background

Soil Physical Properties

The main areas of interest, Gibberagong and Orchard Park are formed on in-filled estuarine bays. While dredging of the adjacent waterways may have contributed to some of the infilling indications are that the surface metre or so is formed from imported material of, sometimes, foreign geology. Student work in Orchard Park (TAFE 2005) indicated layers and lenses of what appears to be clay soil of Wianamatta Shale origin at least in part. Douglas(1998) indicated highest penetration resistance in the first metre or so indicating highest density and compaction (and almost certainly lowest permeability). This observation fits with the findings of TAFE 2005. GHD indicated some areas where the surface fill is more sandy and silty but I would challenge their conclusion that this material is of suitable permeability. It could be that closer to the seawall or in locations where sandy fill was used the fill is more silty/sandy and of dredging origin but it is not a guarantee that the whole profile is composed of permeable material. I would also challenge a conclusion that this silty/sandy material is providing a suitable rootzone for trees. Chemically such sandy materials can be very nutrient deficient. Not having extensive survey work of the whole park the existence of dredged sandy materials close to the surface cannot be ruled out.

Generally the picture is one of uncontrolled fill with little or no thought put into creating suitable tree rootzones during construction. This is hardly a criticism since most of the knowledge regarding tree rootzones has only emerged in the last 15 years or so.

GHD indicate that “white” sand was present in all bore logs at Orchard Park at around 1m. The student TAFE 2005 work confirmed this. The same level of detail is not available for Gibberagong, only that the surface soil is said to be sandy. A sieve test analysis of sands found at depth in Orchard Park by TAFE students is attached. It is typical of water sorted sand in sandstone geology.

It is likely that alluvial silty loam, the most commonly available “topsoil” in Sydney, was used to cap the original fill, topdress, re-form and repair areas over time. This soil type shows an evenly graded particle size distribution (equal quantities of medium, fine and very fine sands, fine and coarse silts and some clay). Experience in other parks shows that it compacts to high densities with no structure and aeration and is particularly ill suited to resisting pedestrian traffic in busy parks.

In a significant portion of Orchard Park closest to the seawall occasional inundation by saline tidal water occurs by movement of very high tides up the stormwater drains. Today the areas affected by this can virtually be delineated by the absence of grass with bare soil areas showing salt efflorescence in dry weather. Trees in this area, particularly one of the original *Cupressus* (Tree 117 in Tree Wise Men Report) are showing dieback and decline. Many have been lost over time, most likely as a result of salinity. A number of other specimens, notably a Norfolk Pine have grown very poorly from inception, appear spare and unthrifty, with salinity being the most likely cause.

Work by GHD and TAFE (2005), in Orchard Park confirm that water tables at 1.0-1.5m are not saline until within about 10-15m of the seawall. In places both parties identified surface salinity as greater than salinity of the water table. This confirms a model of surface inundation of impermeable soils by saline water with subsequent evaporation of saline water leaving a “salt scald” surface. GHD correctly identify, in my view, that the salinity is not a result of rising saline water tables. Soil tests by TAFE (2005) showed hyper-saline (salinity higher than seawater) in surface soils where ponding of seawater occurs, confirming the evaporative model.

The hydrology of these areas is likely to be unusual with the surface water system arising from rainfall and tidal flooding essentially separate (although cross connections could occur) from the flux of ground water flowing from the base of the sandstone hills through the sandy subsurface layers, and at some point within 15 to 10 m of the seawall, meeting the saline tidal water. Surface soils, as a result of this system are likely to alternate between dry, saline and waterlogged, a very hostile environment for tree roots. In some cases tree roots may penetrate the impermeable layers through cracks and fissures to find a permanent fresh water table below but, given that soil oxygen levels are likely to be low in this saturated sand layer, the functioning of any such roots is likely to be limited.

Aside: The Functioning of Tree Roots

The roots of plants require oxygen to absorb water and nutrients, grow and indeed live. The atmosphere is 21% oxygen. Roots cannot absorb optimal water and nutrients below 15%, cannot grow below 12%, cannot function at all below 5% and cannot live below about 3% oxygen. This explains why, in the typical soils of forests the root system forms a “root plate” with 90% of the root within the surface 300mm. Notions of “root balls” and “tap roots” must be abandoned in soils with a heavy clay subsoil, there is insufficient oxygen for roots to live. Only special trees adapted to waterlogged soils, or trees growing in deep well aerated sand will produce root systems other than plates. In a normal soil with 200-300mm of loamy or sandy and well aerated A horizon the roots spread horizontally up to two or even three times the canopy height. Notions of roots extending to the “drip line” of the canopy must also be abandoned.

Where the fill layers are not so impermeable and are, as GHD indicate in places, sandier, roots may form a deeper system which is likely to be less prone to drought. It must be remembered, however, that if the roots of older plantings did develop to depth and then an inappropriate surface treatment, soil build up, or “blinding” of the surface sandy layers with silt and dust occurs, the subsoil oxygen levels will drop and these deep root systems can die. This is likely to occur in parks with a long history of ad-hoc surface changes.

Soil Chemical Properties

It is commonly assumed that trees do not need special attention with regard to soil nutrients and that being long lived and slow growing they find all the nutrients they need over time. In a natural forest environment where nutrients are recycled through the litter layer this might be true. In an anthropic soil, made from subsoil and fill, where nutrients are constantly removed through mowing and leaf litter removal this is certainly not true. It is perfectly obvious to any experienced person that trees are highly responsive to added soil nutrients and that poor or slow growth of trees in chemically poor soil can be greatly improved by the use of fertiliser.

Maintaining reasonable soil chemical properties will also help plants of all kinds growing in soils with poor physical properties. Thus plants with adequate nutrition produce better root systems in compacted dense soils than starving plants.

Aside: The Bioaccumulation of Limiting Nutrients

The chemical constituents in the geology are not necessarily optimal for plant growth, but universally we find that topsoils from differing geology are remarkably uniform chemically. The vegetation community seems to "bioaccumulate" nutrients that are limiting into a certain chemical "window of life". How does it do this? By recycling limiting nutrients through the intact litter layer. Thus even a sandstone derived topsoil will show phosphorus and potassium levels significantly higher than the underlying geology. This Bioaccumulation of Limiting Nutrients takes time, a stable litter layer and a closed nutrient system. Parks are open systems. Nutrients are lost through mowing, litter removal etc. The geology of this park is fill, not topsoil, the vegetation has had little time to bioaccumulate and the nutrient system is open. Thus nutrient ratios in the surface do not reflect optimal conditions. Intelligent use of fertiliser can make up for the open system losses and greatly shorten the bioaccumulation time, turning fill into topsoil.

Park trees are not "set and forget" installations. Park soils become depleted because of the constant removal of soil nutrients from mowing and removal of falling leaves and organic matter. Tree growth itself is net acidifying of soils as the alkaline or "basic" ions calcium and magnesium are taken up into the growing canopy. It is common to find soils in older parks acidic and severely nutrient depleted unless intelligent and informed soil nutrient replacement programs have been in place. Most often trees are the unintentional beneficiary of turf fertiliser programs but such programs are not necessarily balanced for making good the actual nutrient deficiencies occurring. For example turf fertilisers often emphasise nitrogen and phosphorus over potassium.

The attached test results from GHD and from TAFE 2005 addresses just two areas of the park but both show either significant soil acidity and/or deficiencies of potassium, phosphorus, nitrogen, sulphur and magnesium roughly in that order. In some places phosphorus is adequate in others deficient but potassium appears to be a common deficiency. Potassium deficiency is particularly common in older parks and results from constant removal of clippings and leaf litter. Potassium is also particularly prone to leaching losses.

Conclusions

Generally it must be concluded that the geological and maintenance history of the parks has resulted in several problems summarised as follows-

1. Subsidence resulting in levels prone to occasional tidal inundation,
2. An "inverted" soil profile with less permeable or impermeable material overlying coarse permeable sand. Natural soils <u>never</u> show this. Perched water tables will result following rain or tidal inundation.
3. A complete inability for saline water to leach or be otherwise removed (eg by "dams" formed by curbing and guttering) and hence evaporation is the only means of water being lost, leaving salt scalds behind.

4. Very low permeability and ponding meaning that rainfall and irrigation cannot function normally to desalinate the profile. In highly permeable soils a single 100mm rainfall event can completely desalinate 1 metre of saline soil.
5. In areas of the park not subject to salinity there is virtually no “A horizon”. Tree roots grow essentially in the surface layer of clayey fill.
6. Where alluvial topsoil was imported it has severely compacted into a massive unstructured mass preventing aeration and drainage.
7. Neglect over many years of soil chemical properties resulting in severe acidity, potassium and other nutrient deficiencies. Trees and turf suffering nutrient deficiency are less able to cope with adverse physical properties also. While adequate nutrition will not overcome physical problems it will certainly assist plants to cope better.

Solutions

This analysis leads to a number of possible interventions aimed at solving or at least alleviating the major problems facing turf and trees cover in the parks. These interventions include both chemical (soil amelioration and fertilising) and physical improvements. The two are not mutually exclusive and in some areas both inverventions may be needed.

Remedial actions or interventions, in order of increasing cost and likely degree or permanence of amelioration can be summarised as follows-

1. **Chemical Soil Amelioration**. There is every expectation that turf and tree conditions could improve significantly, <u>in the non saline areas</u>, using a combination of lime or dolomite and a good quality high analysis NPK fertiliser with an appropriate NPK ratio reflecting the soil nutrient deficiencies. The actual NPK formulation chosen should be subject to closer mapping of soil chemistry across all sites but generally a high analysis fertiliser with an NPK ratio around 8:4:12 should be considered with the aim of correcting potassium deficiency. There is not sufficient topsoil chemical analysis to be sure of the nutrient deficiencies prevailing in each section of the park and the general NPK mix suggested is notional only at this stage. <u>Subject to more extensive soil testing</u> additional amounts of potassium may be required around individual trees or particularly deficient areas. Special fertiliser blends can be made up if necessary. For costing purposes allow 200 grams per square metre of lime or dolomite (similar cost) and 100 g/sqm of NPK fertiliser (allow around $ 750 per tonne) spread preferably in 2 applications 12 months apart. Allow annual additions of 20 g/sqm of NPK fertiliser for future maintenance for at least 5 years and thereafter every two years.
2. **Sand Slitting, Coring and Topdressing.** The simplest approach to improving surface soil conditions for both trees and turf is to mechanically cut slits and cores and then topdress, filling the slits and cores as well as leaving 10-20mm of the topdressing material on the surface, with a medium sand. Contractors are

available to do this work that is commonly done on sports playing fields where similar physical problems occur. Mechanical aeration with spiked rollers provides temporary relief only and is usually performed twice yearly consuming significant labour resources for no permanent relief. Sand slitting is usually combined with a fertiliser application in spring before root growth commences. Soil removed in the slitting and coring operation must be removed. The sand used must be a medium size sand with little or no fines and may have around 5-10% composted organic matter by volume added. Specifications can be provided. The operation can occur up to the critical rootzone (CRZ) but not within it.

> Aside: **The Critical Rootzone of Trees**. Defined as the area close to the stem where any mechanical damage is unacceptable the CRZ varies but a general rule of thumb is a radius 7 times the trunk diameter. Shallow coring but not slitting can occur within the CRZ. Any root damage done outside the CRZ is quickly made up by the trees responding to the better physical environment.

This process will not relieve the saline areas and, naturally, will not be of much use where existing soil is permeable and sandy. It would certainly be appropriate, from existing knowledge, for all non saline areas in Orchard Park.

Existing trees can handle safely up to 50mm of sandy material being placed over their rootzones. Any deeper than this and the risk of suffocation and death of roots increases.

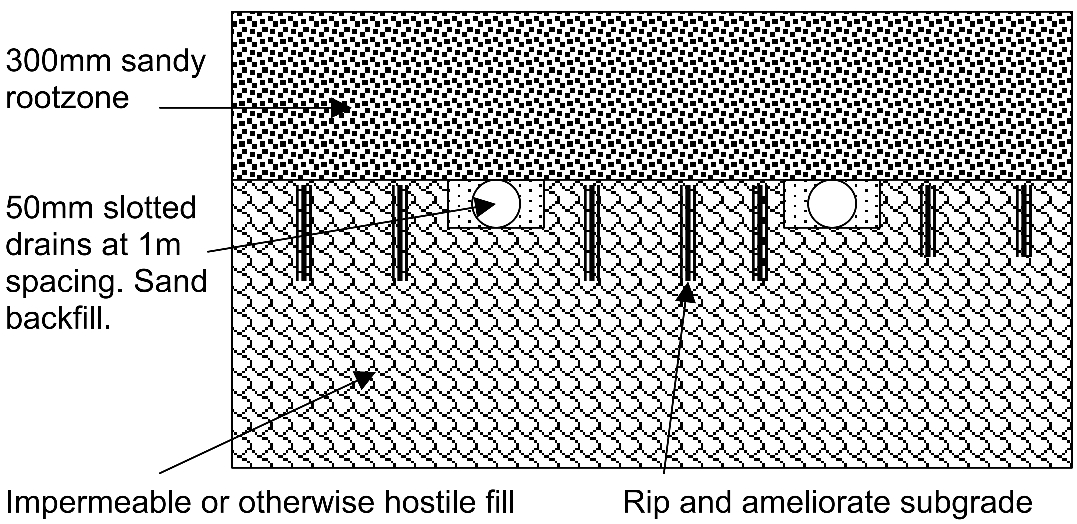
3. **Strategic Topsoil Replacement.** In strategic areas around severely stressed trees or grossly compacted high wear areas, complete replacement of the topsoil, or replacement in trenches radiating out from tree trunks (avoiding major root destruction ie manual soil removal within the CRZ) has been shown to produce sometimes dramatic improvements. Soil again should be a medium sand material with perhaps some allowance for fines (eg maximum 10% silt plus clay), some organic matter, and some fertiliser. Allow 200mm of soil replacement around trees and 250mm in the worst high wear areas.

> **Aside: Soil Around Pavilions:** Topsoil replacement will not solve the problem of wear around picnic pavilions and intense desire lines. Shade, damp, drought and intense constant use leads to the inevitable conclusion that <u>no soil profile or turf will ever cope</u> and the consumption of resources attempting it will be money wasted. A number of “hard” surface options occur ranging from artificial turf to extension of sandstone flagging. Combine such hard surfacing with the installation of drains to remove water that tends to pond around the main pavilion.

4. **Complete Reconstruction**. This approach is virtually mandatory in the salinised areas of Orchard Park. The program fits in with the current notions of increasing the soil elevation in Orchard Park above the high tide levels. Basically the approach is to provide at least 200 and preferably 300mm of sandy root zone soil over the clay or impermeable base and install a drainage system. At the interface of the two soil layers a systematic drainage system must be installed in a "herringbone", "grid" or other drainage pattern. Ideally, branch drains of 50mm slotted agricultural drain pipe must be no more then 1m apart for best effect. Trunk drains are usually 100mm slotted ag drains and these must beconnected to stormwater outlets.

   Ideally, the system levels should be designed such that the very highest tidal inflows do not backflush up the drains. In such a situations the pallet of trees available is very wide and would include species not normally tolerant of salinity. This would probably require raising existing levels in Orchard Park by over 400mm. As a compromise, if drains are at such a levels that saline tides do reflux up the drains then highest tide level should not be allowed to come within 200mm of the surface. In this situation some salt tolerance in the trees plantings is essential. The diagram below illustrates the fundamentals of the system.

   <u>Figure 1. Reconstructed Park Soil Profile</u>



   In salinised areas removal of the surface 100-200mm of salinised fill will be required before topsoils are installed. Where this occurs subgrade levels can be brought up to within -300mm of finished RLs using clean, preferably sandy, fill. There is little advantage in making topsoils deeper than 300mm and in fact deeper layers of sandy rootzone soil than this can be "droughty" and lose cohesion in the surface resulting in loose sand at the surface.

Specifications for particle size distribution, organic matter content, fertiliser use and work procedures for the new sandy rootzone soils can be provided.

It is very likely that existing trees in reconstruction zones will not be able to cope with the changed soil levels of up to 300mm. There is little that can be done about this and removal of such trees is probably the only solution. Replacement of similar or identical species into the new improved soil conditions will provide a far more satisfactory solution. Trees chosen for this area must be tolerant of some, at least intermittent, salinity. Trees likely to cope with this situation, both indigenous and "heritage" are-

Ficus rubiginosa – Port Jackson Fig.
Araucaria hetrophylla – Norfolk Island Pine
Melaleuca quinquinerva and Melaleuca spp – Paperbarks
Casuarina glauca – Swamp She-oak.
Eucalyptus botryoides and robusta – Swamp mahogany
Livistona palms
Phoenix canariensis – Canary Island Date
Syzygium spp Lilli pilli species
Glochidion ferdinandi – Cheese tree
Pinus Halepensis – Allepo pine
Ficus microcarpa – Small leaf fig
Washingtonia filifera Washingtonia Palm

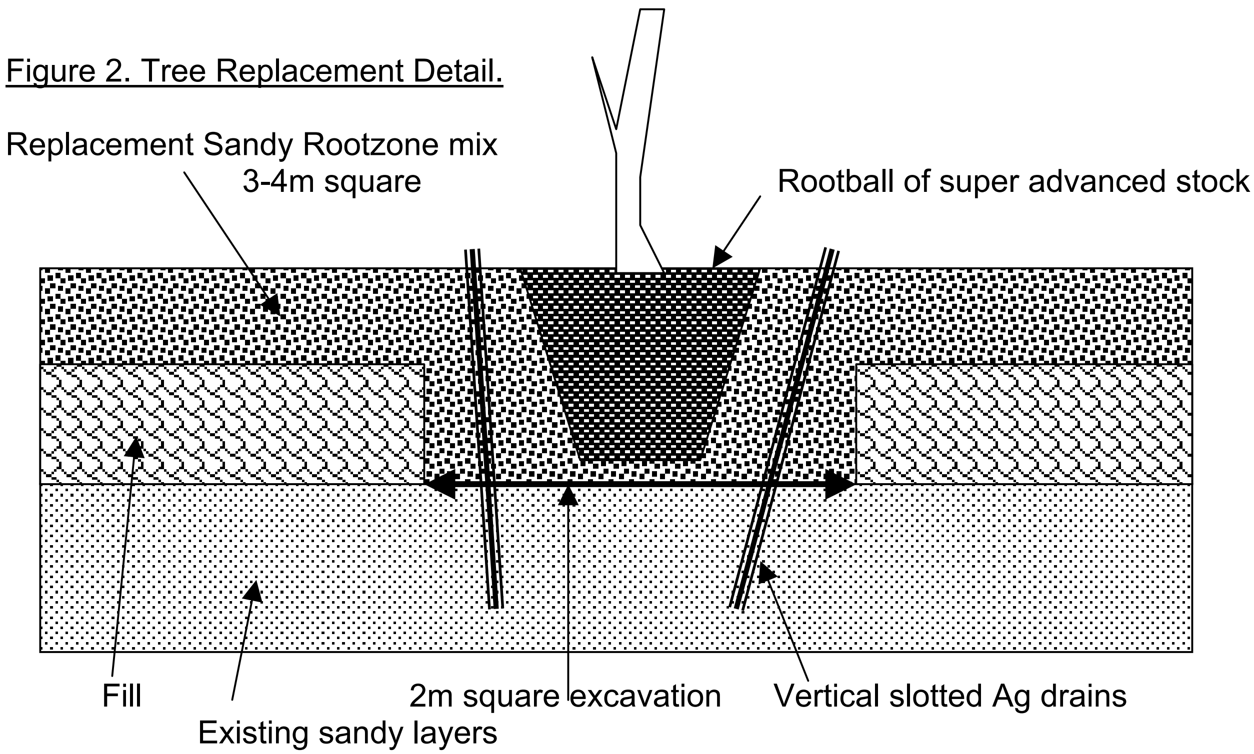
Note that in northern hemisphere texts *Populus spp* are generally considered tolerant of salts but *Cupressus* spp are considered intolerant except *C. arizonica* which is considered moderately tolerant. These lists are not definitive and local experience with the species should be used to draw up final lists of trees that will confidently cope with the intermittent salinity regime.

5. **Tree Replacement**. When replacing trees in areas not specifically reconstructed an opportunity to improve the soil profile exists. This should involve constructing a "planting vault" 2m by 2m by removal of all impermeable fill material down to the underlying sand and backfilling this excavation with sandy medium to connect the upper permeable layer with the lower dredged sand layer at depth. Remove and replace the surface 300mm within a 3m square with a sandy rootzone mix as specified for reconstruction areas. The new profile is illustrated in Figure 2.

   This technique of "connecting" surface sandy soil to sandy permeable subsurface layers has the advantage of allowing slow percolation of excess water, and better penetration of oxygen to depth allowing a deeper root system to develop, as well as connecting roots to a permanent water table of (mostly) fresh water. The technique may not be desireable in the areas of saline water table within 15m of the seawall unless species are know to be highly salt tolerant. The technique will prevent ponding but is not designed to cope with peak stormwater flows (ie is not a stormwater drain). It is always desireable to install 2 to 4 50mm slotted Ag drains leaving them open to the surface to further ensure good aeration at depth.

The technique could be modified to improve existing trees by auguring 300mm holes around ailing trees and backfilling with sand to allow slow salt removal and new effective rooting volume for sick trees. These well drained augur holes could then be connected with any surface trenches or slit drains to be installed.

Figure 2. Tree Replacement Detail.



In areas that are not salinised or prone to tidal inundation some compromise of this installation is possible, reducing topsoil sandy rootzone mix to say 200mm and reducing or even eliminating the 2m square “connection” replacing it with just two or three 300mm auger holes to allow some root penetration to depth.

Where no subsurface sandy layer exists that can practically be connected to, soil replacement and the reconstruction of A and B horizons will be required. Roughly this involves removal of surface 200-300mm, amelioration of the existing compacted subgrade by ripping and application of ameliorants (eg lime and gypsum but subject to testing), and replacement of the A horizon with permeable sandy loam materials. There is little point in simply replanting trees in the present hostile physical conditions.

Effort expended at the planting stage is rewarded with faster growth rates, better structured root systems and better resistance to future stress.

Summary

A range of easily identifiable soil related problems for both turf and trees can be found in Bobbin Head park areas related to the history of bay reclamation, subsequent occasional tidal inundation and general management of tree rootzone conditions both physical and chemical.

While the areas have not been subjected to a systematic soil survey focussed on the needs of trees and turf, broad conclusions and recommended solutions can fairly confidently be identified based on the piecemeal work available. Choice and final design of a solution for a given area may in many cases require some site specific analysis.

Adverse soil physical conditions, where impermeable variously clayey fill overlies original sandy bay deposits, are virtually uniform across the sites. The severity of the poor drainage and soil aeration resulting from this inversion of the normal soil profile varies across the site with some areas having produced good growth of trees over the last 70-80 years and other areas virtual stunting suspension of plant growth.

Where these poor physical conditions have coincided with tidal inundation, trees have actually been killed or are in serious decline.

Landscape technology or urban soil science has advanced greatly in the last 15 years so that reliable and tested solutions to these problems are available. A series of interventions can be identified ranging from simple improvement in soil chemical properties to full reconstruction of the entire soil profile. The particular choice of option for a given area depends on the interaction of several considerations not least of which is cost. Further detailed site investigation is required before the best option (ie the cheapest option with a good chance of success) can be chosen. Progressing options should also be considered, eg fertilise now but plan to slit and core and replace individual trees within the next 5 years. The following Table attempts to provide a guide on the type and applicability of these interventions-

Intervention Program	Most applicable to-
1. Chemical Soil Amelioration (lime/dolomite and NPK fertiliser) or special corrections	Non saline areas of reasonable tree growth and performance and acceptable soil physical properties with valued specimen trees and turf
2. Sand Slitting, Coring and Topdressing	Non saline areas of worn turf, compacted tree rootzones and general improvement of all park areas
3. Strategic Topsoil Replacement	Stressed valued specimen trees, areas of compaction and desire line wear
4. Complete Reconstruction	All salinised areas and any area to be reconstructed including Apple Tree Bay
5. Individual or Group Tree Replacement	Any saline or non saline location outside of reconstruction areas where new major tree specimens are to be planted

It is not proposed that the reconstruction of salinised areas will completely cure the problem as subgrades may remain saline. Additional confidence will be provided by choosing tree species with some salt tolerance. In reconstructed areas the limitations of salt tolerance mean that some of the original, now heritage species, notably *Cupressus* species, may not be worth replanting.

Given the combined stresses of shade, compaction and high traffic use it is viewed as consumptive of resources, and probably impossible, to maintain grass cover in certain areas. In particular, for the areas around the heritage pavilions and intensively used desire lines hard or semi hard surfacing should be considered as the only practical solution. Options are artificial turf, pavers, stone flagging but all should be accompanied by drainage work to remove saline water after flooding occurs.

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Principal Soil Scientist

Attachments: Test Results Chiefly Relied Upon

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

CLIENT: Treescan David Ford

SAMPLE: Bobbin Head pH and Salinities.

DATE: 8-2-91

Sample Name	pH in water	pH in CaCl	EC 1:2 mS/cm	
S1 Surface A 100mm	4.9	4.7	0.05	
S1 Horizon B 200mm	5.1	4.8	0.03	
S1 Horizon C 300mm	5.1	4.7	0.02	
S1 Horizon D 700mm	8.6	8.4	0.04	shell grit
S1 Horizon E 1	7.0	7.5	0.02	
S1 Horizon E 2	8.5	7.6	0.02	
S1 horizon E 3	7.7	6.8	0.02	
S1 Horizon E 4	6.6	6.8	0.02	
S2 300mm organic	4.8	3.6	0.03	peaty
S4 Surface	6.2	5.3	0.05	
S5 Horizon A 100mm	6.0	5.9	0.42	salts
S5 Horizon B 300-500mm	6.2	5.3	0.34	salts
S5 Horizon C 500-600mm	7.4	6.7	0.57	slightly saline
S5 Horizon D 1000-1300	8.5	7.7	0.10	no salts
S5 Horizon D 800-1100mm	8.5	7.8	0.11	
S6 Horizon A Surface	6.2	5.7	0.32	some salts
S6 Horizon D 400-500mm	6.0	4.9	0.28	OK
S6 Horizon E 750-800mm	7.9	7.2	0.34	some salts
S6 Horizon E 800-900mm	8.2	7.5	0.13	OK
S6 Horizon F 900-1070mm	7.3	6.4	0.10	no salts
S7 Horizon A Surface	5.9	5.5	0.12	
S7 100-400mm	5.6	5.2	0.17	
S7 450-650mm	5.7	4.8	0.12	
S7 750mm	6.0	5.4	0.03	
S7 850mm	5.6	4.5	0.02	
S7 850-1000 water	4.4	4.1	0.17	
S8 Surface 100mm	5.0	4.3	0.10	
S8 Horizon C 300-900mm	5.1	4.6	0.08	
S8 900-1000mm	6.3	6.2	1.62	high salts
S8 1000-1200mm	6.6	6.4	2.75	saline
S8 1200-1500mm water	6.0	5.9	3.56	saline water table
S9 Surface 100mm	5.6	4.6	0.11	
S9 100-500mm	4.8	4.1	0.06	
S10 Surface 100mm	5.0	4.6	0.27	
S10 100-450mm	5.6	4.9	0.06	

Note saline conditions in profile 8 below 900mm depth.

All other profiles are salt free essentially. pHs vary and recommendations are made on the complete tests. Since salinity is only below 900mm in profile 8 it is not worth taking any action.

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SYDNEY
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LABORATORY
· PTY · LTD ·

Client: Treescan

Sample: Bobbin Head sites 1 and 2 plus horizon E 51

Date: 1-2-91

TEST		Result		
Code		204		
pH in water		4.8		very acidic
pH in CaCl2		3.9		high exchangable acidity
Salinity mS/cm		0.05		very low nutrients
Chlorides ppm		1.4		
*Soluble Cations				
	meq/100g	ppm		
Sodium	0.05	11.0		some Na
Potassium	0.01	3.9		
Calcium	0.04	8.8		
Magnesium	0.01	1.0		
* Soluble plus Exchangeable Cations				
	meq/100g	ppm	% of CEC	
Sodium	0.08	18.4	1.4	OK
Potassium	0.07	25.4	2.4	very low
Calcium	2.05	410.0	86.8	high Ca
Magnesium	0.18	22.0	7.4	low Mg
* Sum of Exchangeable Cations			2.3	
* Cation Exchange Capacity (CEC)			2.3	
* Ca/Mg ratio			11.4	high
* Nutrient			ppm	
Phosphorus			3.0	very low
N as ammonium			1.6	
as nitrate			0.1	very low
Sulphate			3.0	very low
Iron			192.0	OK

An extremely acidic and nutrient poor material. Ca is excessive and Mg is very low.

Apply- dolomite 3t/ha
cultivate in if possible.
Then apply- ABOSKA No 27 Red 150g/sqm (1.5t/ha)

This fertiliser is a very high analysis and contains a good blend of NPK for both trees and grassings. Around P sensitive trees use the same rate of ABOSKA Native plant food.

Given the very suboptimal conditions here I expect a profound improvement in condition of grassings from these fertilisers alone regardless of any relieving of physical conditions.

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TELEPHONE

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

Client: Treescan

Sample: Bobbin Head Sites 4, 5, & 6 surface

Date: 1-2-91

TEST		Result		
Code		205		
pH in water		6.2		pH good
pH in CaCl2		5.8		good
Salinity mS/cm		0.20		OK
Chlorides ppm		32.2		
*Soluble Cations				
	meq/100g	ppm		
Sodium	0.21	48.8		some Na
Potassium	0.03	10.9		
Calcium	0.06	12.0		
Magnesium	0.04	5.4		
* Soluble plus Exchangeable Cations				
	meq/100g	ppm	% of CEC	
Sodium	0.54	124.2	6.8 bit high	
Potassium	0.17	66.3	3.0 low K	
Calcium	3.44	688.0	70.4 OK	
Magnesium	1.00	122.0	19.9 OK	
* Sum of Exchangeable Cations			4.8	
* Cation Exchange Capacity (CEC)			4.8	
* Ca/Mg ratio			3.4 OK	
* Nutrient			ppm	
Phosphorus			14.5 some P	
N as ammonium			2.4	
as nitrate			0.6 low N	
Sulphate			10.0 low	
Iron			129.0 OK	

pH and Ca/Mg ratio are good but a boost to nutrition is needed. Apply ABOSKA No 27 at 150g/sqm.

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SYDNEY
ENVIRONMENTAL
AND SOIL
LABORATORY
PTY LTD

Client: Treescan

Sample: Bobbin Head Sites 6, 9, 10 surface

Date: 1-2-91

TEST		Result	
Code		206	
pH in water		5.4	pH low
pH in CaCl2		4.8	acidic
Salinity mS/cm		0.10	no salts
Chlorides ppm		14.7	
*Soluble Cations			
	meq/100g	ppm	
Sodium	0.10	23.0	some Na
Potassium	0.04	16.4	
Calcium	0.03	5.6	
Magnesium	0.02	2.4	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC
Sodium	0.21	48.3	3.4 OK
Potassium	0.24	93.6	6.2 not bad
Calcium	2.27	454.0	70.1 OK
Magnesium	0.82	100.0	25.0 OK

* Sum of Exchangeable Cations 3.4

* Cation Exchange Capacity (CEC) 3.2

* Ca/Mg ratio 2.8 OK

* Nutrient	ppm
Phosphorus	9.5 bit low
N as ammonium	3.3
as nitrate	0.6 low
Sulphate	2.0 low
Iron	85.0 OK

Acidic and low nutrients. Apply lime at 2t/ha followed by ABOSKA No 27 Red at 150g/sqm.

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THORNLEIGH NSW 2120

TELEPHONE

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

Client: G.H.D.
Attn: Peter Coe

Date: 12.2.91

Sample	Test Result pH	EC mmhos/cm
Bobbin Head		
(SS1) 1 0-100	5.7	2.7 saline
1 100-200	5.0	3.1 saline
2 0-100	4.9	7.0 highly saline
(SS2) 2 100-175	5.7	9.1 highly saline

As suspected this area is saline from marine inundation.

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SYDNEY
ENVIRONMENTAL
AND SOIL
LABORATORY
PTY - LTD

Client: GHD
Attn: John Chetham

Date: 4.3.91

	Sample	Test Result pH in water	pH in CaCl2	EC mmhos/cm	
	Bobbin Head				
SS11	Sample 1 (500mm)	5.6	5.5	2.30	saline
SS12	2 (—"—)	6.1	6.1	2.63	saline
SS11	3 (1000mm)	7.0	6.7	1.01	saline
SS12	4 (—"—)	7.3	6.8	1.19	saline

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RESULTS OF DYNAMIC PENETROMETER TESTS

CLIENT	NSW NATIONAL PARKS AND WILDLIFE SERVICE	DATE	29/10/98
PROJECT	DAMAGED TOILET BLOCK	PROJECT NO	27775
LOCATION	ORCHARD PARK, BOBBIN HEAD	PAGE NO	1 of 1

TEST LOCATIONS	1	2	3							
RL OF TEST	0.4 m below pavers									
DEPTH m	PENETRATION RESISTANCE BLOWS/150mm									
0.00 - 0.15	-	2	2							
0.15 - 0.30	6	12	20							
0.30 - 0.45	8	11	12							
0.45 - 0.60	25/125 mm	25/125 mm	11							
0.60 - 0.75			7							
0.75 - 0.90			9							
0.90 - 1.05			3							
1.05 - 1.20			2							
1.20 - 1.35										
1.35 - 1.50										
1.50 - 1.65										
1.65 - 1.80										
1.80 - 1.95										
1.95 - 2.10										
2.10 - 2.25										
2.25 - 2.40										
2.40 - 2.55										
2.55 - 2.70										
2.70 - 2.85										
2.85 - 3.00										

TEST METHOD AS 1289 6.3.2, CONE PENETROMETER ✓
AS 1289 6.3.3, FLAT END PENETROMETER ✓

TESTED BY: JN
CHECKED BY: RMc

Douglas Partners
Geotechnics · Environment · Groundwater

Soil Chemistry Profile

Test Type: FS
Order No: Job No:
Reference: Bobbin Head Tree Study
Sample Name: Catena 1-1 0-150
Sample No: 08740
Date Received: 04/05/2005 Total No Pages: 1 of 1
CLIENT: House Account
Ryde School of Hort

Sydney Environmental and Soil Laboratory

Sydney Environmental & Soil Laboratory Pty Ltd
ABN 73 106 618 795
16 Chilvers Road
Thornleigh NSW 2120
Australia
Address mail to
PO Box 357
Pennant Hills NSW 1715
Tel 02 9980 6554
Fax 02 9484 2427
Em info@sesl.com.au
Web www.sesl.com.au

TEST	RESULT	COMMENTS
pH in water 1:2	6.4	pH normal
pH in $CaCl_2$ 1:2	5.6	slightly acidic, acceptable
EC mS/cm 1:2	.05	very low salinity (low nutrient levels)
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium			.07	1.80	non sodic
Potassium			.07	1.80	very low K, deficient
Calcium			3.26	85.30	slightly excessive
Magnesium			.42	11.00	slightly low
Aluminium					
		ECEC	3.82		low CEC
		Ca/Mg	7.80		high, excessive Ca

	mg/kg	
Phosphate as P	68.4	plenty of P
Ammonium as N	<0.54	
Nitrate as N	5.1	low N
Sulphate as S	<5	very low S
Iron	134.5	acceptable
Zinc	12.5	acceptable
Copper	3.6	acceptable
Manganese	8.7	acceptable
Boron		

Recommendations

This is the first profile we did in the grass behind the first tree. General soil chemistry is reasonable apart from a slightly high calcium level but importantly for tree health potassium is very deficient. This may be one result of excessive calcium displacing potassium from the exchange capacity. The very shallow rooting depths resulting from the impermeable clay layers will confine feeder root systems to the very surface and could also result in all the potassium being depleted form the surface soil. Without foliage tests it is difficult to be certain of a clinical potassium deficiency in the trees but sparse foliage, marginal "burns" or necrosis of leaves is one symptom of K deficiency. It would certainly be worth applying sulphate of potash to the entire rootzone area of the tree, say a circle 20m diameter to at least reduce potassium deficiency as one source of stress on the trees. The results may be quite significant. this is a very low potassium level not commonly seen in any soil and certainly never so low in a stable forested soil.

Explanation of the Methods:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983) Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961) Aluminium: Method 3500 APHA (1992) Phosphate: Method 9E1 Rayment & Higginson (1992) Ammonium, Sulphate, Iron,
Copper, Manganese + Zinc: Method 83-1 to 83-5 Black (1983) Boron: Method 12C2 Rayment & Higginson (1992)

Checked by ....

S. Leake

Date of Report 13/05/2005

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Soil Chemistry Profile

Test Type: FS

Order No: Job No

Reference Bobbin Head Tree Study

Sample Name: Catena 1-2 @100

Sample No 68741

Date Received 04/05/2005 Total No Pages: 1 of 1

CLIENT: House Account

Ryde School of Hort

Quality Endorsed Company

Sydney Environmental and Soil Laboratory

Sydney Environmental & Soil Laboratory Pty Ltd
ABN 70 106 810 708
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Thornleigh NSW 2120
Australia
Address mail to
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Pennant Hills NSW 1715
Tel 02 9980 6554
Fax 02 9484 2427
Em info@sesl.com.au
Web www.sesl.com.au

TEST	RESULT	COMMENTS
pH in water 1:2	6.0	pH fine
pH in $CaCl_2$ 1:2	5.4	slightly acidic, acceptable
EC mS/cm 1:2	.34	significantly higher EC
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium	.21		.32	1.60	non sodic
Potassium	.31		1.13	5.50	just adequate
Calcium	.25		14.75	72.30	perfect
Magnesium	.12		4.2	20.60	perfect
Aluminium					
		ECEC	20.40		high CEC
		Ca/Mg	3.50		good

	mg/kg	
Phosphate as P	30.4	acceptable
Ammonium as N	16.8	significant ammonium level
Nitrate as N	3.7	some N
Sulphate as S	<5	low S
Iron	298.9	acceptable
Zinc	24	acceptable, elevated from the "natural" soil
Copper	4.6	acceptable
Manganese	58.5	acceptable
Boron		

Recommendations

This the mulched soil under the trees themselves. Significantly the CEC, K levels, and nitrogen levels are all much higher than the surrounding park soil. From experience we know that green waste mulch provides good potassium levels, some nitrogen if it is leafy rather than woody, zinc, and of course organic matter to improve the CEC. We can probably conclude that the mulched area is the only area of soil providing adequate potassium levels. It could be that the main issue for these trees, apart from the physical limitations is potassium, sulphur and nitrogen deficieny in that order. I would recommend a one-off dose of sulphate of potash at 50g/sqm now and small doses of soluble N, probably as potassium nitrate starting in spring and continuing with two feeds through the warmers months too. Too often the nutrient needs of trees are forgotten. Where lawn or turf is fed regularly this is not an issue but looking at the very poor state of grass cover in this park I would say the turf is seldom if ever fed. The result is that the tree is not growing in a fertile forest soil but a depleted compacted soil. Adequate nutrient levels certainly helps plants battle poor physical conditions.

Explanation of the Methods
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983) Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961) Aluminium: Method 3500 APHA (1992) Phosphate: Method 9E1 Rayment & Higginson (1992) Ammonium, Sulphate, Iron, Copper, Manganese + Zinc: Method 83-1 to 83-5 Gage (1983) Boron: Method 12C2 Rayment & Higginson (1992)

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Date of Report 13/05/2005

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Soil Chemistry Profile

Test Type: pHEC,MC, dens(calc)
Order No. Job No:
Reference: Bobbin Head Tree Study
Sample Name: Calena 2 Hole #3
Sample No: 98746
Date Received: 04/05/2005 Total No Pages: 1 of 2
CLIENT: House Account
Ryde School of Hort

Tests are performed under a quality system certified as complying with ISO 9001
Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full.

TEST	RESULT	COMMENTS
pH in water 1:2	7.9	alkaline, maybe influenced by seawater which is alkaline
pH in $CaCl_2$ 1:2	7.1	
EC mS/cm 1:2	1.45	high salinity level, ECe about 10-12
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium					
Potassium					
Calcium					
Magnesium					
Aluminium					
ECEC					
Ca/Mg					

	mg/kg
Phosphate as P	
Ammonium as N	
Nitrate as N	
Sulphate as S	
Iron	
Zinc	
Copper	
Manganese	
Boron	

Recommendations

Densities are not actually that bad but given the sandy loam nature is almost certainly limiting. Any plant roots in this area will be battling salinity, density and low soil oxygen levels. Very few terrestrial plants could tolerate this salinity level

Explanation of the Methods:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983); Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chlorides: Vogel (1961); Aluminium: Method 3500 APHA (1992); Phosphate: Method 9E1 Rayment & Higginson (1992); [illegible]
Copper, Manganese + Zinc: Method [illegible] Black (1965); Boron: Method 12C2 Rayment & Higginson (1992)

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Soil Chemistry Profile

Test Type pH,EC,MC, dens(calc)

Order No: Job No:

Reference Bobbin Head Tree Study

Sample Name: Catena 2 Hole #4

Sample No: 88747

Date Received 04/05/2005 Total No Pages: 2 of 2

CLIENT: House Account

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Tests are performed under a quality system certified as complying with ISO 9001.
Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full

TEST	RESULT	COMMENTS
pH in water 1:2	6.3	acidic
pH in $CaCl_2$ 1:2	5.0	
EC mS/cm 1:2	6.59	very highly saline ECe about 53 to 79 - hypersaline
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium					
Potassium					
Calcium					
Magnesium					
Aluminium					
ECEC					
Ca/Mg					

	mg/kg
Phosphate as P	
Ammonium as N	
Nitrate as N	
Sulphate as S	
Iron	
Zinc	
Copper	
Manganese	
Boron	

Recommendations

Here is our beautiful salinity catena, plot surface salinity in a line from the tree and see it rise rapidly in the more frequently inundated areas closest to the seawall. Density, low nutrients, and hypersalinity are virtually precluding plant growth, from memory this area was bare. The salinity is compounded by low water holding capacity and, although not measured, low permeability will be on the cards.

Explanation of Methods
pH, EC, Soluble Cations, Nitrate - Bradley et al (1983) Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961); Aluminium: Method 3500 APHA (1992) Phosphate: Method 9E1 Rayment & Higginson (1992) Ammonia, Sulphate, Iron,
Copper, Manganese + Zinc: Method 65-1 to 65-5 Black (1965) Boron: Method 12C2 Rayment & Higginson (1992)

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Date of Report 13/05/2005

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Soil Chemistry Profile

Test Type: pHEC,MC, dens(calc)
Order No: Job No:
Reference Bobbin Head Tree Study
Sample Name: Catena 3 Hole #3
Sample No. 88750
Date Received 04/05/2005 Total No Pages: 1 of 2
CLIENT: House Account
Ryde School of Hort

Tests are performed under a quality system certified as complying with ISO 9002.
Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full

TEST	RESULT	COMMENTS
pH in water 1:2	5.6	pH fine
pH in $CaCl_2$ 1:2	5.1	
EC mS/cm 1:2	1.39	becoming saline, ECe 11 to 14 highly stressful
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium					
Potassium					
Calcium					
Magnesium					
Aluminium					
ECEC					
Ca/Mg					

mg/kg

Phosphate as P
Ammonium as N
Nitrate as N
Sulphate as S
Iron
Zinc
Copper
Manganese
Boron

Recommendations

If this area was not bare then it should be! Salinity, low moisture and high density are all stressful.

Explanation of the Methods.
pH, EC, Soluble Cations, Nitrate: [illegible] (1983) Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: [illegible] (1981) Aluminium: Method 3500 APHA (1992) Phosphate: Method 9C1 Rayment & Higginson (1992), Ammonium, Sulphate, Iron,
Copper, Manganese + Zinc: Method [illegible] (1983) Boron: Method 12C2 Rayment & Higginson (1992)

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Soil Chemistry Profile

Test Type: pHEC,MC, dens(calc)

Order No: Job No:

Reference: Bobbin Head Tree Study

Sample Name: Catena 4 Hole #1

Sample No: 88751

Date Received: 04/05/2005 Total No Pages: 1 of 2

CLIENT: House Account

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Tests are performed under a quality system certified as complying with ISO 9002.
Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full

TEST	RESULT	COMMENTS
pH in water 1:2	6.3	pH normal
pH in $CaCl_2$ 1:2	6.1	
EC mS/cm 1:2	9.99	extreme salinity ECe 80 to 100- hypersaline
Chlorides mg/kg		

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
Unit	meq%	Comment	meq%	% of ECEC	Comment
Sodium					
Potassium					
Calcium					
Magnesium					
Aluminium					
		ECEC			
		Ca/Mg			

	mg/kg
Phosphate as P	
Ammonium as N	
Nitrate as N	
Sulphate as S	
Iron	
Zinc	
Copper	
Manganese	
Boron	

Recommendations

believe this was the bare salty area near the seawall. It could be put together with Catena 3 to show a similar catenary relationship to the Catena 2 results where salinity rises rapidly as you approach the seawall. Density is not so high, possibly to to "heaving" by salt crystals (surprisingly, hypersaline soils can be lighty and fluffy as a result of such heaving). Even so obviously nothing was growing.

Explanation of the Methods:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Ammonium, Sulphate, Iron,
Copper, Manganese + Zinc: Method [illegible] (1983). Boron: Method 12C2 Rayment & Higginson (1992)

Checked by ....

S Leake

Date of Report 13/05/2005

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AS1289 - Sieve Profile

Test Type	MRC.Wet Siv-1289 * See ML for Prep
Order No:	Job No:
Reference	Bobbin Head Tree Study
Sample Name:	Bulked Various Sands
Sample No:	88752
Date Received	04/05/2005 Total No Pages: 1 of 2
CLIENT:	House Account
	Ryde School of Hort

Tests are performed under a quality system certified as complying with ISO 9002.
Results & Conclusions assume that sampling is representative. This document shall not be reproduced except in full

Sieve Size	Fraction	% Retained by mass	% Passing by mass	Specification	Comments
75.0mm	Cobbles	0.0	100		
63.0mm	Very Coarse Gravel	0.0	100		
37.5mm	Coarse Gravel	0.0	100		
26.5mm	Coarse Gravel	0.0	100		
19.0mm	Medium Gravel	0.0	100		
13.2mm	Medium Gravel	0.0	100		
9.5mm	Medium Gravel	0.0	100		
6.70mm	Fine Gravel	0.0	100		
4.75mm	Fine Gravel	0.1	100		
2.36mm	Fine Gravel	0.1	100		
1.18mm	Very Coarse Sand	0.9	99		
0.600mm	Medium Sand	12.9	86		
0.425mm	Medium Sand	30.6	55		
0.300mm	Medium Sand	32.2	23		
0.150mm	Fine Sand	19.8	3		
0.075mm	Fine Sand	1.3	2		
Pan	Very Fine Sand/Silt/Clay	2.1	0		

Recommendations

This is a blended sample of sands from beneath several profiles. It shows an ideal particle size distribution for a heavily used park being largely medium sand with a low silt plus clay content ie "gap graded" as discussed in lectures. The Water Retention Curve" shows a nice break in capillaries at 150-200mm just as would be predicted. Layed at a depth of 300mm the very surface would adopt a moisture content of 10% by volume following drainage after rainfall. This is a little low and some slight increase in silt and clay would be permissible. However, in this case I suggest not as we want to retain high permeability to promote salt leaching. Fines soon build up from organic matter, root decay, accretion of fines etc. See MAP for overall comment.

Explanation of the Methods:
AS1289.3.6.1-1995

Checked by ....
S. Leake Date of Report 13/05/2005

Consultant ....
S.Leake

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Improving Soil Conditions for Trees and Turf at Apple Tree Bay

January 2006

Scope

The following discussion is provided to Conybeare Morrison International Pty. Ltd., head contractor for the Bobbin Head and Apple Tree Bay Master Plan project for the National Parks and Wildlife Service (NPWS).

The discussion concerns the remediation of soil conditions for the Apple Tree Bay park areas based on a review of existing site observations, previous soil or geo-technical related studies and plans submitted to NPWS over several years. While none of the previous studies provides a complete picture of soil conditions for horticultural purposes the GHD and Tree Wise Men reports provide some limited information. Some direct observations are made by the author in order to provide some level of certainly to these preliminary opinions and advice.

However, since the purposes of these previous studies was not necessarily focussed on the health of soils for parks and gardens use the conclusions and suggested remedial work herein should be considered tentative and subject to further site specific investigation prior to any precise specification of works programs. It may, for example, be that full reconstruction work, recommended for the sea front areas, may not be needed in areas to be retained in current form.

Two documents are chiefly relied upon as well as limited first hand observations.
The documents chiefly relied upon are-

1. Bobbin Head and Apple Tree Bay Management Plan. Gutteridge Haskins and Davey Pty. Ltd. 1991.

2. Arborists Report: Bobbin Head and Apple Tree Bay Picnic Areas . The Tree Wise Men 2004.

In this report an attempt is made to identify the major soil related reasons for failure or poor condition turf and tree components of the park and to suggest remedial actions. The suggested actions are given in order of lowest to highest anticipated cost which is directly related to the likelihood of a permanent solution to the problems (ie lowest cost is least likely to provide permanent solution). Advice is offered on which is the most appropriate action for a given area but this must be subject to more detailed site specific investigation before any degree of certainly of improvement can be provided.

Background

Soil Physical Properties

The Apple Tree Bay park are formed on in-filled estuarine bays. While dredging of the adjacent waterways may have contributed to some of the infilling indications are that the surface metre or so is formed from imported material of largely sandstone geology. In Apple Tree Bay GHD indicate that the fill is of possible local Hawkesbury sandstone origin but is still very stony and compacted. In our experience sandstone materials can be very unsuitable as soil, compacting to very high densities even if small clay contents are present. No heavy plastice clays are indicated as being present.

It is likely that alluvial silty loam, the most commonly available “topsoil” in Sydney, was used to cap the original fill, topdress, re-form and repair areas over time. This layer now forms a thin darker layer on the surface in places lost through erosion. This soil type shows an evenly graded particle size distribution (equal quantities of medium, fine and very fine sands, fine and coarse silts and some clay). Experience in other parks shows that it compacts to high densities with no structure and aeration and is particularly ill suited to resisting pedestrian traffic in busy parks.

Generally the picture is one of uncontrolled fill over pre-existing sandy or muddy estuarine layers. Little or no thought put into creating suitable tree rootzones during construction. This is hardly a criticism since most of the knowledge regarding tree rootzones has only emerged in the last 15 years or so. Surface and subsurface soils are likely to be highly compacted and the poverty of the grass layer and slow growth of trees supports such a conclusion.

Unlike areas of Bobbin Head surface salinity does not seem to be an obvious issue for surface soils of Apple Tree Bay.

The hydrology of these compacted soil is likely to be unusual with the surface water running off quickly with high runoff coefficients, little water infiltration and consequent “droughtiness” of soils compounding the poor physical and chemical properties. Shallow root systems, unable to prenetratye the anoxic and dense lower soil layers will be prone to periodic drought stress.

Where the fill layers are not so impermeable and sandier layers may occur as is likely toward the rear of the park, roots may form a deeper system which is likely to be less prone to drought. At the foreshore areas with the most pedestrian traffic and greatest amounts of imported stony fill, density problems are likely to be most severe.

Soil Chemical Properties

It is commonly assumed that trees do not need special attention with regard to soil nutrients and that being long lived and slow growing they find all the nutrients they need over time. In a natural forest environment where nutrients are recycled through the litter layer this might be true. In an anthropic soil, made from subsoil and fill, where nutrients are constantly removed through mowing and leaf litter removal combined with compaction and erosion of surface soil this is certainly not true. It is perfectly obvious to any experienced person that trees are highly responsive to added soil nutrients and that poor or slow growth of trees in chemically poor soil can be greatly improved by the use of fertiliser.

Seldom do trees ever get fertilised in public parks. It is thus common to find soils in older parks acidic and severely nutrient depleted unless intelligent and informed soil nutrient replacement programs have been in place. Most often trees are the unintentional beneficiary of turf fertiliser programs but from examing the poor condition of turf in many areas of Apple Tree Bay it is likely that the trees have not even had this benefit.

Maintaining reasonable soil chemical properties will also help plants of all kinds growing in soils with poor physical properties. Thus plants with adequate nutrition produce better root systems in compacted dense soils than starving plants.

Chemical testing of existing soils at Apple Tree Bay is strongly recommended especially in areas where reconstruction will not occur so that appropriate corrective fertiliser programs can be devised. It is not possible to make such recommendations form the currently available information. This is also important for reconstructed areas if stripped existing soils are to be retained and reused.

Conclusions

Generally it must be concluded that the geological and maintenance history of the park area has resulted in several problems summarised as follows-

1. Compaction and erosion as a result of using fill and topsoil unsuited to areas receiving pedestrian traffic.

2. Consequent low permeability and rapid runoff or ponding meaning that rainfall is not effectively penetrating the surface soil. Rainfall is effectively lower than the average for the area under such conditions.
3. there is virtually no “A horizon” in many places where erosion has occurred. Tree roots grow essentially in the surface layer of fill resulting in poor growth rates.
4. Where alluvial topsoil was imported it has severely compacted into a massive unstructured mass preventing aeration and infiltration.
5. Likely neglect over many years of soil chemical properties resulting in severe nutrient deficiencies and imbalances. Trees and turf suffering nutrient deficiency are less able to cope with adverse physical properties also.

Solutions

This analysis leads to a number of possible interventions aimed at solving or at least alleviating the major problems facing turf and trees cover in the park. These interventions include both chemical (soil amelioration and fertilising) and physical improvements. The two are not mutually exclusive and in some areas both inverventions may be needed.

For areas to be reconstructed the existing soil conditions are not so relevant and recommendations are given below for such treatments. In order to finally decide what intervention is needed for areas not being reconstructed further site investigation work is required. The following provide the scope for the range of interventions that may be needed.

Remedial actions or interventions, in order of increasing cost and likely degree or permanence of amelioration can be summarised as follows-

1. **Chemical Soil Amelioration**. There is every expectation that turf and tree conditions could improve significantly in areas not so prone to compaction and where the topsoil is not so severely eroded using a combination of fertilising and mulching around trees. Lime or dolomite and a good quality high analysis NPK fertiliser with an appropriate NPK ratio are the basic requirements for turf and trees. To improve tree condition a mulched area around stems using composted green waste type mulch can show very significant benefit and is used in combination with the fertiliser program. Any recommendations for such fertilising <u>must be subject to soil testing.</u> For rough costing purposes allow 200 grams per square metre of lime or dolomite (similar cost) and 100 g/sqm of NPK fertiliser (allow around $ 750 per tonne) spread preferably in 2 applications 12 months apart. Allow annual additions of 20 g/sqm of NPK fertiliser for future maintenance for at least 5 years and thereafter every two years. For Mulch allow around $50 per cubic metre delivered and spread.
2. **Sand Slitting, Coring and Topdressing.** The simplest approach to improving surface compacted soil conditions for both trees and turf is to mechanically cut slits and cores and then topdress, filling the slits and cores as well as leaving 10-

20mm of the topdressing material on the surface, with a medium sand. Contractors are available to do this work that is commonly done on sports playing fields where similar physical problems occur. Mechanical aeration with spiked rollers is not suitable as it provides temporary relief only and is usually performed twice yearly consuming significant labour resources for no permanent relief. Sand slitting is usually combined with a fertiliser application in spring similar to that detailed above. Soil removed in the slitting and coring operation must be removed. The sand used must be a medium size sand with little or no fines and may have around 5-10% composted organic matter by volume added. Specifications can be provided. The operation can occur up to the critical rootzone (CRZ) of trees but not within it.

> Aside: **The Critical Rootzone of Trees**. Defined as the area close to the stem where any mechanical damage is unacceptable the CRZ varies but a general rule of thumb is a radius 7 times the trunk diameter. Shallow coring but not slitting can occur within the CRZ. Any root damage done outside the CRZ is quickly made up by the trees responding to the better physical environment.

This treatment will not be suitable if stony fill is within 100mm of the surface and will not be of much use where existing soil is permeable and sandy.

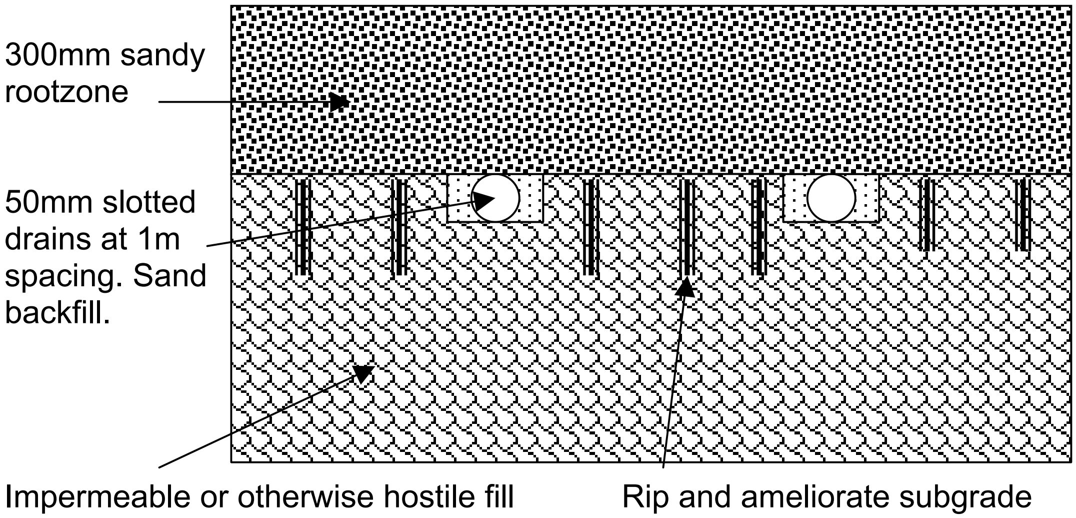
Existing trees can handle safely up to 50mm of sandy material being placed over their rootzones. Any deeper than this and the risk of suffocation and death of roots increases. Mulches must not be any deeper than 50mm around trees.

3. **Strategic Topsoil Replacement.** In strategic areas around severely stressed trees or grossly compacted high wear areas, complete replacement of the topsoil, or replacement in trenches radiating out from tree trunks (avoiding major root destruction ie manual soil removal within the CRZ) has been shown to produce sometimes dramatic improvements. Soil, again, should be a medium sand material with perhaps some allowance for fines (eg maximum 10% silt plus clay), some organic matter, and some fertiliser. Allow 200mm of soil replacement around trees and 250mm in the worst high wear areas.

4. **Complete Reconstruction**. This approach is virtually mandatory in areas to be reconstructed at Apple Tree Bay sea front area. The program fits in with the current notions of reconstructing sea front and boat ramp areas. Basically the approach is to provide at least 200 and preferably 300mm of sandy root zone soil over the subgrade fill. At the interface of the two soil layers a systematic drainage system should ideally be installed in a “herringbone”, “grid” or other drainage pattern. Ideally, branch drains of 50mm slotted agricultural drain pipe must be no more then 1m apart for best effect. Trunk drains are usually 100mm slotted ag drains and these must be connected to stormwater outlets.

Such drainage system is not absolutely necessary except in areas receiving the highest pedestrian traffic. In such areas it is absolutely vital that installed topsoil is very open and sandy to prevent compaction.

Figure 1. Reconstructed Park Soil Profile



Bring fill to minus 300m from finish level and apply any gypsum. Lime or other ameliorant as indicated by testing. Stripped and recovered soils can be used for the final subgrade layer prior to placing new topsoil. It is not considered at this stage that any recovered topsoil from the site would be suitable to the finish topsoil level.

Specifications for particle size distribution, organic matter content, fertiliser use and work procedures for the new sandy rootzone soils can be provided.

It is very likely that existing trees in reconstruction zones will not be able to cope with the changed soil levels associated with reconstruction and all plantings must occur again. There is little that can be done about this and removal of such trees is probably the only solution. Replacement of similar or identical species into the new improved soil conditions will provide a far more satisfactory solution. Most native or indigenous species would be suited to the new soil conditions and the choice is fairly wide open. However, in our experience Eucalypt species often do not perform well surrounded by turf and unless these are massed in beds may make poor specimens. Suitable indigenous species for in turf planting may be-

Ficus rubiginosa – Port Jackson Fig.
Livistona palms
Syzygium spp Lilli pilli species
Glochidion ferdinandi – Cheese tree
Ficus microcarpa – Small leaf fig

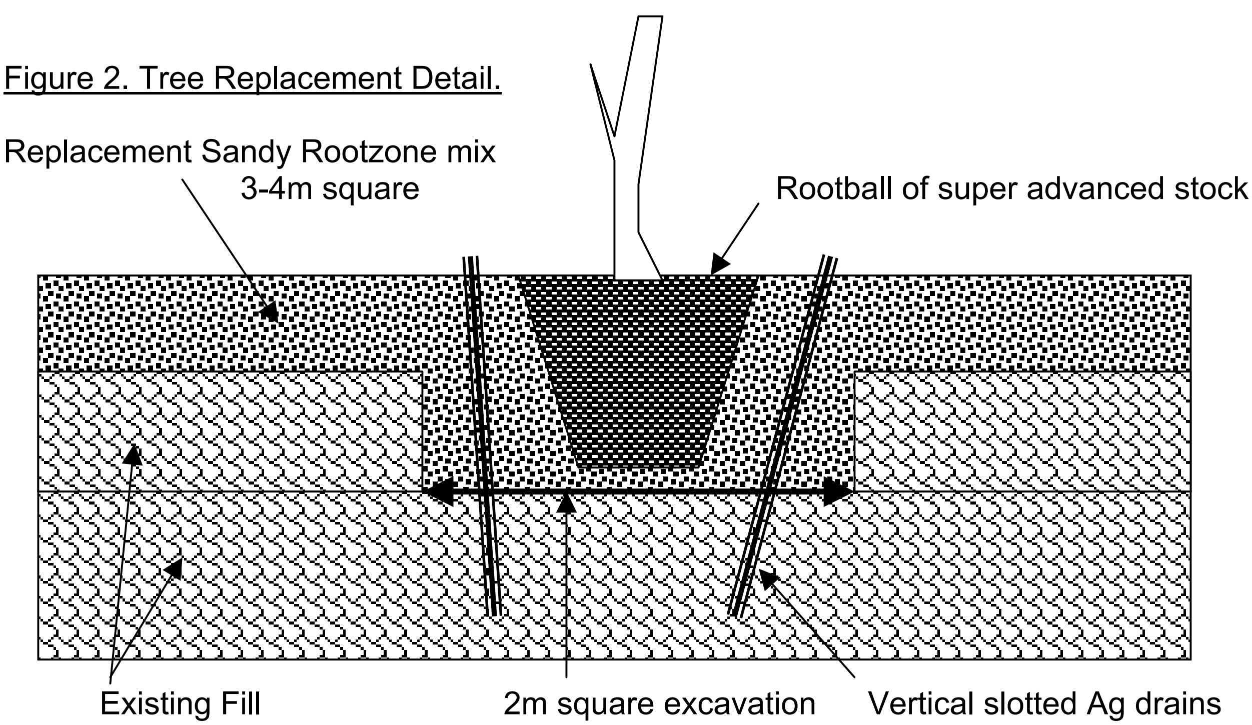
Some rainforest elements such as *Flindersia* or *Ceratopetalum* (Coachwood) may also be suitable.

It is not expected that salinity will be an issue, especially in these reconstructed soil profiles.

5. **Tree Replacement**. When replacing trees in areas not specifically reconstructed an opportunity to improve the soil profile exists. This should involve constructing a “planting vault” 2m by 2m by removal of all impermeable fill material down to at least 500mm and backfilling this excavation with sandy medium to within 300mm of surface and then use the “Sandy Rootzone” topsoil as specified under point 4 above to bring up to finish level. Remove and replace the surface 300mm within a 3m square with a sandy rootzone mix as specified for reconstruction areas. The installation of vertical slotted Ag lines is recommended to improve subsoil aeration and allow for watering and fertilising. The new profile is illustrated in Figure 2.

   The technique could be modified to improve existing trees by auguring 300mm holes around ailing trees and backfilling with Sandy Rootzone topsoil to allow better water infiltration and improved rootzone conditions. It is important to avoid major structural root damage if performing such work around trees.

Figure 2. Tree Replacement Detail.



Subgrade around the trees should be tested for any fertiliser requirement and loosened with a tyne prior to planting.

There is little point in simply replanting trees in the present hostile physical conditions and this localised topsoil reconstruction is considered mandatory for any long term improvement. Effort expended at the planting stage is rewarded with faster growth rates, better structured root systems and better resistance to future stress.

Again, in order for us to assist planners with making the final choice as to the most cost effective appropriate solution for any given area more site investigation by a competent urban soil scientist is required.

Summary

A range of easily identifiable soil related problems for both turf and trees can be found in Apple Tree Bay park related to the history of bay reclamation, subsequent compaction and neglect of soil fertility and general management of tree rootzone conditions both physical and chemical.

While the areas have not been subjected to a systematic soil survey focussed on the needs of trees and turf, broad conclusions and recommended solutions can be identified based on prior experience in similar situations. Choice and final design of a solution for a given area and particularly the choice of soil fertiliser recommendations, will require some further site specific analysis.

Adverse soil physical conditions, where variously stony fill and compacted topsoil appear virtually uniform across the site. The severity of the poor water infiltration and soil aeration resulting from the use of fill unsuited to urban horticulture may vary across the site but is identified as the chief issue for at least the seafront area.

Landscape technology or urban soil science has advanced greatly in the last 15 years so that reliable and tested solutions to these long term spoil sustainability problems for urban parks are now available.

A series of interventions can be identified ranging from simple improvement in soil chemical properties to full reconstruction of the entire soil profile. The particular choice of option for a given area depends on the interaction of several considerations not least of which is cost. Further detailed site investigation is required before the best option (ie the cheapest option with a good chance of success) can be chosen for a given area. Since full reconstruction of the seafront area is a likely scenario at this stage the full soil reconstruction program discussed above is deemed appropriate for those areas.

Progressing options should also be considered, eg fertilise now but plan to slit and core and replace individual trees within the next 5 years. The following Table attempts to provide a guide on the type and applicability of these interventions-

Intervention Program	Most applicable to-
1. Chemical Soil Amelioration (lime/dolomite and NPK fertiliser) or special corrections	Not so compacted areas of reasonable topsoil depth and reasonable tree and turf growth and performance with valued specimen trees and turf
2. Sand Slitting, Coring and Topdressing	Areas of worn turf, compacted tree rootzones and general improvement of all park areas
3. Strategic Topsoil Replacement	Stressed valued specimen trees, areas of compaction and desire line wear
4. Complete Reconstruction	Any area to be reconstructed including Apple Tree Bay seafront
5. Individual or Group Tree Replacement	Any location outside of reconstruction areas where new major tree specimens or massed planting is to occur.

Given the combined stresses of shade, compaction and very high traffic use it is viewed as consumptive of resources and probably impossible to maintain grass cover in certain areas. In particular, for the areas around intensively used picnic tables, barbeques desire lines hard or semi hard surfacing should be considered as the only practical solution. Options are artificial turf, pavers, stone flagging but all should be accompanied by drainage work.

Simon W. Leake BScAgr(HonsI) AIAST ASPAC ASSSI 13/4/06
Principal Soil Scientist

Attachments: Test Results Chiefly Relied Upon

4.2 GENERAL SOIL CONDITIONS – APPLE TREE BAY PARK

Soils at Apple Tree Bay are much more compacted to the extent that auguring by hand to gather samples is difficult. Much of the area is covered with a poor quality gravelly clay fill material, acidic and low in nutrients. These problems can be readily solved, but the compaction and aeration problems are likely to continue, and will be difficult to rectify permanently owing to the high pedestrian traffic usage.

One survey site near the sea wall (SS8) showed the presence of a saline water table; this should not extend far into the park area since in normal rainfall conditions it would be excluded by fresh water infiltration. This salinity should be borne in mind when plantings are made in the area, but increased rain infiltration after soil decompaction should relieve the problem. The surface to 500 mm samples were not saline, however, and most tree feeder roots would stay in the surface horizons.

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

CLIENT: Treescan David Ford

SAMPLE: Bobbin Head pH and Salinities.

DATE: 8-2-91

Sample Name	pH in water	pH in CaCl	EC 1:2 mS/cm	
S1 Surface A 100mm	4.9	4.7	0.05	
S1 Horizon B 200mm	5.1	4.8	0.03	
S1 Horizon C 300mm	5.1	4.7	0.02	
S1 Horizon D 700mm	8.6	8.4	0.04	shell grit
S1 Horizon E 1	7.0	7.5	0.02	
S1 Horizon E 2	8.5	7.6	0.02	
S1 horizon E 3	7.7	6.8	0.02	
S1 Horizon E 4	6.6	6.8	0.02	
S2 500mm organic	4.8	3.6	0.03	peaty
S4 Surface	6.2	5.3	0.05	
S5 Horizon A 100mm	6.0	5.9	0.42	salts
S5 Horizon B 300-500mm	6.2	5.3	0.34	salts
S5 Horizon C 500-600mm	7.4	6.7	0.57	slightly saline
S5 Horizon D 1000-1300	8.5	7.7	0.10	no salts
S5 Horizon D 800-1100mm	8.5	7.8	0.11	
S6 Horizon A Surface	6.2	5.7	0.32	some salts
S6 Horizon D 400-500mm	6.0	4.9	0.28	OK
S6 Horizon E 750-800mm	7.9	7.2	0.34	some salts
S6 Horizon E 800-900mm	8.2	7.5	0.13	OK
S6 Horizon F 900-1070mm	7.3	6.4	0.10	no salts
S7 Horizon A Surface	5.9	5.5	0.12	
S7 100-400mm	5.6	5.2	0.17	
S7 450-650mm	5.7	4.8	0.12	
S7 750mm	6.0	5.4	0.03	
S7 850mm	5.6	4.5	0.02	
S7 850-1000 water	4.4	4.1	0.17	
S8 Surface 100mm	5.0	4.3	0.10	
S8 Horizon C 300-500mm	5.1	4.6	0.08	
S8 900-1000mm	6.3	6.2	1.62	high salts
S8 1000-1200mm	6.6	6.4	2.75	saline
S8 1200-1500mm water	6.0	5.9	3.56	saline water table
S9 Surface 100mm	5.6	4.6	0.11	
S9 100-500mm	4.8	4.1	0.06	
S10 Surface 100mm	5.0	4.6	0.27	
S10 100-450mm	5.6	4.9	0.06	

Note saline conditions in profile 8 below 900mm depth.

All other profiles are salt free essentially. pHs vary and recommendations are made on the complete tests. Since salinity is only below 900mm in profile 8 it is not worth taking any action.

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SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

Client: Treescan

Sample: Bobbin Head sites 1 and 2 plus horizon E 51

Date: 1-2-91

TEST		Result	
Code		204	
pH in water		4.8	very acidic
pH in CaCl2		3.9	high exchangable acidity
Salinity mS/cm		0.05	very low nutrients
Chlorides ppm		1.4	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.05	11.0	some Na
Potassium	0.01	3.9	
Calcium	0.04	8.8	
Magnesium	0.01	1.0	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC
Sodium	0.08	18.4	1.4 OK
Potassium	0.07	25.4	2.4 very low
Calcium	2.05	410.0	86.8 high Ca
Magnesium	0.18	22.0	7.4 low Mg

* Sum of Exchangeable Cations 2.3

* Cation Exchange Capacity (CEC) 2.3

* Ca/Mg ratio 11.4 high

* Nutrient	ppm
Phosphorus	3.0 very low
N as ammonium	1.6
as nitrate	0.1 very low
Sulphate	3.0 very low
Iron	192.0 Ok

An extremely acidic and nutrient poor material. Ca is excessive and Mg is very low.

Apply- dolomite 3t/ha

cultivate in if possible.

Then apply- ABOSKA No 27 Red 150g/sqm (1.5t/ha)

This fertiliser is a very high analysis and contains a good blend of NPK for both trees and grassings. Around P sensitive trees use the same rate of ABOSKA Native plant food.

Given the very suboptimal conditions here I expect a profound improvement in condition of grassings from these fertilisers alone regardless of any relieving of physical conditions.

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SYDNEY ENVIRONMENTAL AND SOIL LABORATORY PTY LTD

Client: Treescan

Sample: Bobbin Head Sites 4, 5, & 6 surface

Date: 1-2-91

TEST		Result	
Code		205	
pH in water		6.2	pH good
pH in CaCl2		5.8	good
Salinity mS/cm		0.20	OK
Chlorides ppm		32.2	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.21	48.8	some Na
Potassium	0.03	10.9	
Calcium	0.06	12.0	
Magnesium	0.04	5.4	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC
Sodium	0.54	124.2	6.8 bit high
Potassium	0.17	66.3	3.0 low K
Calcium	3.44	688.0	70.4 OK
Magnesium	1.00	122.0	19.9 OK

* Sum of Exchangeable Cations 4.8

* Cation Exchange Capacity (CEC) 4.8

* Ca/Mg ratio 3.4 OK

* Nutrient	ppm
Phosphorus	14.5 some P
N as ammonium	2.4
as nitrate	0.6 low N
Sulphate	10.0 low
Iron	129.0 OK

pH and Ca/Mg ratio are good but a boost to nutrition is needed. Apply ABOSKA No 27 at 150g/sqm.

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AND SOIL
LABORATORY
PTY LTD

Client: Treescan

Sample: Bobbin Head Sites 6, 9, 10 surface

Date: 1-2-91

TEST		Result	
Code		206	
pH in water		5.4	pH low
pH in CaCl2		4.8	acidic
Salinity mS/cm		0.10	no salts
Chlorides ppm		14.7	
*Soluble Cations			
	meq/100g	ppm	
Sodium	0.10	23.0	some Na
Potassium	0.04	16.4	
Calcium	0.03	5.6	
Magnesium	0.02	2.4	

* Soluble plus Exchangeable Cations			
	meq/100g	ppm	% of CEC
Sodium	0.21	48.3	3.4 OK
Potassium	0.24	93.6	6.2 not bad
Calcium	2.27	454.0	70.1 OK
Magnesium	0.82	100.0	25.0 OK

* Sum of Exchangeable Cations	3.4
* Cation Exchange Capacity (CEC)	3.2
* Ca/Mg ratio	2.8 OK
* Nutrient	ppm
Phosphorus	9.5 bit low
N as ammonium	3.3
as nitrate	0.6 low
Sulphate	2.0 low
Iron	85.0 OK

Acidic and low nutrients. Apply lime at 2t/ha followed by ABOSKA No 27 Red at 150g/sqm.

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TELEPHONE
[illegible]

SYDNEY
ENVIRONMENTAL
AND SOIL
LABORATORY
· PTY · LTD ·

Client: G.H.D.
Attn: Peter Coe

Date: 12.2.91

	Sample	Test Result pH	EC mmhos/cm
	Bobbin Head		
(SH1)	1 0-100	5.7	2.7 saline
	1 100-200	5.0	3.1 saline
(SH2)	2 0-100	4.9	7.0 highly saline
	2 100-175	5.7	5.1 highly saline

As suspected this area is saline from marine inundation.

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AND SOIL
LABORATORY
PTY LTD

Client: GHD
Attn: John Chetham

Date: 4.3.91

	Sample		Test Result pH in water	pH in CaCl2	EC mmhos/cm
	Bobbin Head				
SS11	Sample 1	(500mm)	5.6	5.5	2.30 saline
SS12	2	(—"—)	6.1	6.1	2.63 saline
SS11	3	(1000mm)	7.0	6.7	1.01 saline
SS12	4	(—"—)	7.3	6.8	1.19 saline

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1.7 Marine and Structural Engineering Report (letters) - Taylor Lauder Bersten

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1st February, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: Bobbin Head and Apple Tree Bay Masterplan
Ku-ring-gai Chase National Park
Bobbin Inn at Bobbin Head

As requested, we briefly reviewed the condition of Bobbin Inn on Tuesday 31st January, 2006.

The building is two storeys high and is constructed with brickwork walls and a tiled roof. There is a framed and clad part of the building at the north-western corner.

We noted the following:-

1. There are two cracks in the brickwork forming the balustrade to the first floor balcony at the south-eastern corner. These cracks are not structurally significant;

2. There are plants growing out of the brickwork above the main entry fronting Bobbin Head Road. These plants should be removed to minimize the risk of mortar and brick damage caused by root growth;

3. There are several cracks in the sandstone foundation wall at the north-eastern corner, probably due to differential foundation settlement. These cracks are not structurally significant; and

4. There are cracks at the north-western corner of the sill brickwork around the first floor balcony at the north-western end of the building. These cracks are not structurally significant.

The biggest risk to this building is probably presented by the high cliff line in immediate proximity to the rear wall. We noted that areas had been bolted and meshed. We would recommend that a regular geotechnical monitoring programme be implemented.

Yours faithfully

Mark F Baker
Director

Directors: Peter J Taylor BE, ME, FIE Aust, MIStructE, CPEng
John F Lauder BE (Hons), MEngSc, MIE Aust, CPEng
Howard G Bersten BSc, BE (Hons), MIE Aust, CPEng
Mark F Baker BE (Hons), MIE Aust, CPEng
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1st February, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: Bobbin Head and Apple Tree Bay Masterplan
Ku-ring-gai Chase National Park
Level of Seawall and Park - Tidal Inundation

Further to our meeting to discuss the seawalls at your offices on Friday 20th January 2006, we visited Bobbin Head on Friday 31st January 2006 between 9.30am and 11.30am. The NSW tide charts showed that there was to be a high tide of 2.01m at 10.25am at Fort Denison. The charts also showed that this was to be the second highest tide for 2006, the highest being 2.02m on 30th January.

As previously explained, tide charts and tidal levels are stated relative to Zero on the Fort Denison Tide Gauge (ZFDTG). This datum is 925mm below Australian Height Datum (AHD). The survey drawings of Bobbin Head and Apple Tree Bay prepared by Bee and Lethbridge in 2005 show levels relative to AHD.

Tidal levels relative to ZFDTG are converted to AHD by subtracting 0.925m. Therefore, a tide level of 2.01m ZFDTG is equivalent to 1.085 AHD.

We estimate that tide times at Bobbin Head are approximately 30 to 40 minutes after the times stated in the tide charts for Fort Denison. This was confirmed during our visit on 31st January, with the high tide at Bobbin Head occurring at approximately 11.00am.

We measured the water level of the high tide as 290mm below the known deck level of Bobbin Head Wharf. From this, we calculate that the high tide at Bobbin Head reached a level of 1.620 – 0.290 = 1.33m AHD. This is 245mm above the tide level from the tide charts of 1.085m AHD. The difference in level is due to backwater effects from stream inflow, as Bobbin Head is close to the limit of tidal waters in Cowan and Cockle Creeks.

At this tide level, there were significant areas of tidal inundation in Orchard park, and Bobbin Head Road was covered in water over its full width.

The highest astronomical tide predicted for Sydney under any combination of astronomical conditions and average meteorological conditions is 2.10m ZFDTG or 1.175m AHD. At Bobbin Head, this level must be increased to allow for the backwater effects from stream inflow.

A maximum tide level at Bobbin Head cannot be accurately predicted without the results of a detailed flood study for the catchments of Cowan and Cockle Creeks. We have seen no reference to such a study in the list available documents you previously distributed. We have also asked Glen Crombie of NPWS if he is aware of such a study and he advised that he was not.

To allow a confident prediction of a maximum tidal level, we confirm our earlier recommendation to you that an appropriate flood study be undertaken by a suitably qualified organisation. This study should be undertaken as soon as possible to allow finalization of the previously discussed concept alternatives of raising the seawall and/or the park levels to avoid the problems caused by tidal inundation.

Yours faithfully

Mark F Baker
Director

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1st February, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: Bobbin Head and Apple Tree Bay Masterplan
Ku-ring-gai Chase National Park
Toilet Block at Bobbin Head

As requested, we reviewed the condition of the sandstone toilet block at Bobbin Head on Tuesday 31st January, 2006.

The toilet block consists of sandstone walls (rendered where internal), an elevated concrete floor and a timber framed tiled roof. It is located west of Apple Tree Bay Road near the base of a sandstone cliff line below Bobbin Head Road.

A previous geotechnical report by Douglas Partners Pty Ltd dated 22nd December 1998 concluded that the building was probably supported on shallow footings on well compacted fill over softer material (either poorly compacted fill or alluvium deposits).

There is cracking up to 10mm in width in the walls and floor of the women's toilet (south-east corner and south-west corner), and finer cracking in the wall of the men's toilet (north-east corner). The cracking appears to be due to differential foundation settlement. The settlement could be due to one or several of the following:-

1. Variable stiffness of foundation material profile across the building footprint, such as lower depth to rock at the north-western corner, with reduced filling depth and subsequent reduced settlement. The north-western corner is close to the sandstone cliff line; and

2. Differential footing settlement due to the action of water from broken service pipes. Roof downpipes enter the ground at the southern-eastern and north-eastern corners. There is a large raised septic tank adjacent to the western wall.

The cracking at this stage is not structurally significant. However, the cracking at the south-eastern corner should be regularly monitored until rectification has been completed.

If the building is to be retained with minimal risk of future cracking, the following options should be investigated further prior to detailed specifications:-

1. Underpinning the external walls to rock or a uniform, stable foundation. The risk with this method is that only the external walls are accessible for underpinning, and future differences in settlement of the external and internal walls may lead to cracking.

2. Grout injection of the ground below the entire building footprint to uniformly improve the foundation conditions. Normal cement grout or proprietary grout (such as "Uretek") can be used. The advantage of "Uretek" is that it may be possible for the settled footings to be lifted, partially closing existing cracks. There is a risk of the grout entering and blocking drainage pipes.

3. In conjunction with "1" or "2" above, the installation of stainless steel bed joint reinforcement into the cracked sandstone walls, such as "Helifix" masonry repair ties.

Regardless of the repair option selected, we would recommend that all water services and stormwater pipes and the septic tank be inspected and any breaks rectified. This could be done well in advance of building rectification and refurbishment.

This report should be considered as preliminary only. Further geotechnical investigation and advice and structural documentation will be necessary to finalise construction details.

Yours faithfully

Mark F Baker
Director

TLB

21st April, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: Bobbin Head and Apple Tree Bay Masterplan
Ku-ring-gai Chase National Park
Gibberagong Park Levels – Tidal Inundation

As requested, we provide comment on the finished surface levels at Gibberagong Park.

The survey drawings show that the existing ground levels at Gibberagong Park are generally slightly higher than Orchard Park, as summarised below

Location	**RL 1.50 AHD**		**RL 1.75 AHD**		**RL 2.00 AHD**	
	% park below this level	**Features below this level**	**% park below this level**	**Features below this level**	**% park below this level**	**Features below this level**
Orchard Park	70% approx	Most of seawall, pavilion, seating, parking, foreshore road, part KC road	80% approx	Plus rest of seawall and part ATB Road	100% approx	Plus most of remainder of ATB road
Gibberagong Park	20% approx	Lawn and bitumen adjacent to KC road, some short lengths of seawall and landward bitumen	50% approx	Plus large areas of lawn and bitumen and all of the seawall	75% approx	Plus more lawn and bitumen and the playground

From this comparison it is obvious that Gibberagong Park is generally higher than Orchard Park, and that landscaped areas and sealed surfaces are less likely to be affected by inundation. There are no structures affected by inundation.

Directors

Associate

Consultant

The real risk of inundation would best be appreciated by the results of a tidal / flood study. The risks could then be weighed against the importance of landscaped areas and their susceptibility to saline inundation, and the loss of amenity.

Yours faithfully

Mark F Baker
Director

TLB

21st April, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: **Bobbin Head and Apple Tree Bay Masterplan**
Ku-ring-gai Chase National Park
Wharf Area Levels – Tidal Inundation

As requested, we provide comment on the finished surface levels at the Wharf Area.

The survey drawings show that the existing ground levels at the Wharf Area are generally slightly higher than Orchard Park, as summarised below.

Location	**RL 1.50 AHD**		**RL 1.75 AHD**		**RL 2.00 AHD**	
	% park below this level	**Features below this level**	**% park below this level**	**Features below this level**	**% park below this level**	**Features below this level**
Orchard Park	70% approx	Most of seawall, pavilion, seating, parking, foreshore road, part KC road	80% approx	Plus rest of seawall and part ATB Road	100% approx	Plus most of remainder of ATB road
Wharf Area	1% approx	Lawn and bitumen adjacent to KC road, some short lengths of seawall and landward bitumen	35% approx	Plus large areas of lawn and bitumen and all of the seawall	70% approx	Plus more lawn and bitumen and the play-ground

From this comparison it is obvious that Wharf Area is generally higher than Orchard Park, and that landscaped areas and sealed surfaces are less likely to be affected by inundation. The wharf is the only structure potentially affected by inundation

Directors

Associate

Consultant

TLB

21st April, 2006

Conybeare Morrison International Pty Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Mr Colin Polwarth

Dear Colin

Re: Bobbin Head and Apple Tree Bay Masterplan
Ku-ring-gai Chase National Park
Apple Tree Bay Levels – Tidal Inundation

As requested, we provide comment on the finished surface levels at Apple Tree Bay.

The water levels experienced at Apple Tree Bay due to tides and stream-flow effects would be the practically the same as those experienced at Bobbin Head as they are not far apart

The survey drawings show that the existing ground levels at Apple Tree Bay are generally higher than Orchard Park, as summarised below.

Location	**RL 1.50 AHD**		**RL 1.75 AHD**		**RL 2.00 AHD**	
	% park below this level	**Features below this level**	**% park below this level**	**Features below this level**	**% park below this level**	**Features below this level**
Orchard Park	70% approx	Most of seawall, pavilion, seating, parking, foreshore road, part KC road	80% approx	Plus rest of seawall and part ATB Road	100% approx	Plus most of remainder of ATB road
Apple Tree Bay	1% approx	Some short lengths of seawall	5% approx	Plus some lawn and boatramp and bitumen at boatramp	40% approx	Plus about half of bitumen surface

From this comparison it is obvious that Apple Tree Bay is generally higher than Orchard Park, and large landscaped areas or important structures are less likely to be affected by inundation.

The real risk of inundation would best be appreciated by the results of a tidal / flood study. The risks could then be weighed against the importance of landscaped areas and their susceptibility to saline inundation and the loss of amenity.

Yours faithfully

Mark F Baker
Director

TLB

23rd May, 2006

Conybeare Morrison International Pty. Ltd
Level 1, 52-58 William Street
EAST SYDNEY NSW 2011

Attention: Ms. Michelle Yik

Dear Michelle

Re: **Bobbin Head and Apple Tree Bay Masterplan**
Ku-ring-gai Chase National Park
Landscaping Wall Setback

As requested, we have reviewed the existing seawall along Orchard Park based on the survey information prepared by Bee and Lethbridge and the seawall reconstruction report prepared by Patterson Britton & Partners, to advise on a suitable setback for the proposed new landscaping wall.

The setback is required so that:

1. Additional fill behind the landscaping wall does not add additional lateral load to the seawall; and

2. The fill behind the seawall can be locally excavated after construction of the landscaping wall, to effect seawall repairs, without affecting the stability of the landscaping wall.

Referring to the enclosed sketch, we advise that:

1. To ensure the new fill does not add additional lateral load to the seawall, the setback of the landscaping wall probably needs to be at least 5.0 metres; and

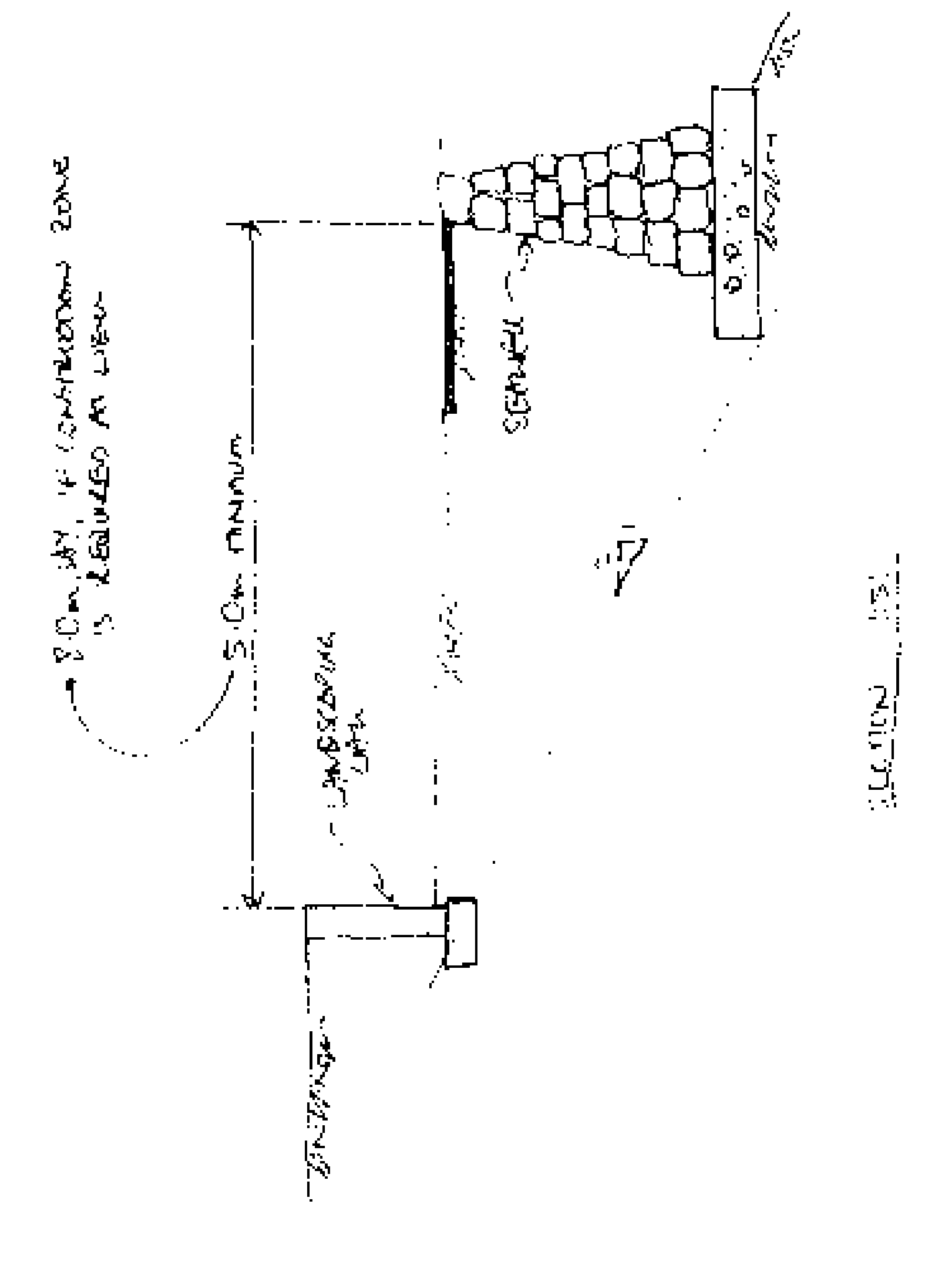
2. To allow for future local excavation behind the seawall, it may be preferable to increase the setback to allow a construction zone, giving a total setback of at least 8.0 metres.

Yours faithfully

Mark F. Baker
Director.

Encl

Project: ... Orchard Park	Calculations	Project #: 5...
Description: Landscape Wall Setback	Meeting	Date: ...06
	Disc. Notes	Page: 2
	✓ Sketch	Prepared by: ...



TLB

1.8 Quantity Surveying Report - Bay Partnership

The Quantity Surveying Report by Bay Partnership is held by NPWS, Sydney North Region and is not for distribution.

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Appendix 2 : Bobbin Head Seawall Advice Report - CM+

Bobbin Head Seawall Advice Report was produced by CM+ and Context with the assistance of Taylor Lauder Bersten and SESL for Department of Environment and Conservation consideration in February 2006.

During the Masterplanning of Bobbin Head, Department of Environment and Conservation decided to adopt Option 5 in the report. Sea levels stated in this report are estimates only, and subject to further investigation.

Please also refer to:

Appendix 1.6 - Improving Soil Conditions for Trees and Turf Report
Appendix 1.7 - Marine and Structural Engineering Report

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Conybeare Morrison

Bobbin Head + Apple Tree Bay Precincts
Ku-ring-gai Chase National Park
Bobbin Head Seawall Advice

February 2006

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Conybeare Morrison

Bobbin Head + Apple Tree Bay Precincts
Ku-ring-gai Chase National Park
Bobbin Head Seawall Advice

Prepared for Department of Environment + Conservation - Parks + Wildlife Division

February 2006

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Revision	Date	Description	By	Chk	App
01	Feb 06	Draft Report	CP/MY	WM	WM
02	Feb 06	FInal Report	CP/MY	WM	WM

EXECUTIVE SUMMARY

The Department of Environment and Conservation (DEC) and park management report an increase in sea water over-topping, resulting in the flooding of Bobbin Head parklands. Increased salinity and related soil quality degradation is impacting on general landscape and will continue to do so should seawall over-topping continue to occur. (Refer to Chapter 12.0 – Soils Report). This report provides information on:

1. Background information on seawall subsidence, overtopping, subsidence and soil conditions.
2. Heritage information regarding the significance of the seawall, materials and the living heritage of the parklands and seawall.
3. Results of a Value Management Workshop to investigate the seawall, park, landscape, and general amenity leading to a series of design options.
4. Recommendations for the parklands and seawalls that will be consistent with the Conservation Management Plans, Landscape Management Plans and Masterplanning 2006 vision, and Ku-ring-gai Chase National Park Plan of Management. This issue will be addressed in relation to Clause 4.1.6 of that plan.

The recommendations for the seawall and parklands seek a sustainable outcome, taking precautionary management principles and intergenerational equity into account. The recommendations in this report confirm the preference for long-term objectives to achieve the Masterplanning vision of an enhanced visual experience of the passive recreational and cultural landscape precincts of Bobbin Head. The enhancement of the cultural precinct requires considerable intervention into the seawall and the landscape. The recommendations mitigate the short term effects of construction and landscape establishment and include:

- Improving the general amenity and the general environment.
- Completing a flood study to ascertain correct flood prone levels.
- Reconstructing and raising the seawall above the King tide levels (assume RL.1.80 See TLB documents)
- Installing suitable geotechnical fabrics to prevent leaching of soil and to limit subsidence. (Geotechnical report required at detail design stage)
- Constructing new seawall foundations to slow and limit rotation and subsidence.
- Relocation of utilities and services.
- Removing of saline topsoil (300mm - Refer to Soils Report attached).
- Install drainage system above King Tide Level with suitable fill.
- Increasing parkland levels (300mm- Refer to Soils Report attached) above the King tide level with suitable soils.
- Upgrading and raising shelters and parkland amenities above the King tide levels, providing new scour protection
- Planting a new landscape sympathetic to the 1930's landscape design and interpret the heritage in Orchard Park area especially.
- Masterplanning new parking layouts to reduce the visual impact of motor vehicles on the park.
- Providing a suitable promenade, with seating and shade areas.

- **Summary**: Seawall LP RL1.02, Orchard Park is at RL1.33, LP park / road is at RL 1.02 - Remove 300mm topsoil, replace fill & soil to RL 1.80 (AFL) + drainage system + add 300mm sandy root zone above King Tide to RL2.10 – all subject to flood / tide study.

Options 4 and 5 presented in this report would achieve these objectives and would sustain and improve Bobbin Head landscape. This report has been prepared without a suitable tide / flood study, prior to community consultation and DEC management consideration. Consequently, this report should be regarded as a preliminary. The Masterplan reports (LMP and CMP) will update future decisions regarding the selection of a preferred option.

CONTENTS

BOBBIN HEAD SEAWALL ADVICE

1.0 Background

The parklands at Bobbin Head were created with fill on mud flats, constructed in stages from 1910 until 1940. Since this time, the parklands have subsided with detrimental effects to carparks, buildings and utilities. Seawall repairs and foreshore restoration continue due to subsidence and rotation of the seawall.

The Department of Environment and Conservation (DEC) reports an increase in sea water over-topping, resulting in the flooding of Bobbin Head parklands. Overtopping has been variously identified in Conservation Management Plans and, most recently, the Bobbin Head and Apple Tree Bay Management Plan (1991) by Gutteridge Haskins and Davey Pty Ltd.

Inadequate drainage and waterlogging of the parklands from sea water over-topping has resulted in an increase in soil salinity. The increased salinity and related soil quality degradation is affecting the existing trees and general landscape and will continue to do so should seawall over-topping continue to occur. (Refer to Chapter 12.0 – Soils Report).

The Patterson Britton Report (1997) on seawalls deals solely with the repair/restoration of the Bobbin Head seawalls. The report contains a detailed assessment, investigation of causes of seawall damage, and a restoration management plan. The report does not deal with overtopping or parklands landscape.

The seawall is an integral part of the landscape at Bobbin Head and, as such, it has to be addressed in the context of the Landscape Management Plan (LMP) and Conservation Management Plan (CMP). The longevity of Bobbin Head and especially, Orchard Park has been and will continue to be threatened until the seawall modification and soil conditions in the park are improved.

Bobbin Head with King-tide inundation (January 2006)

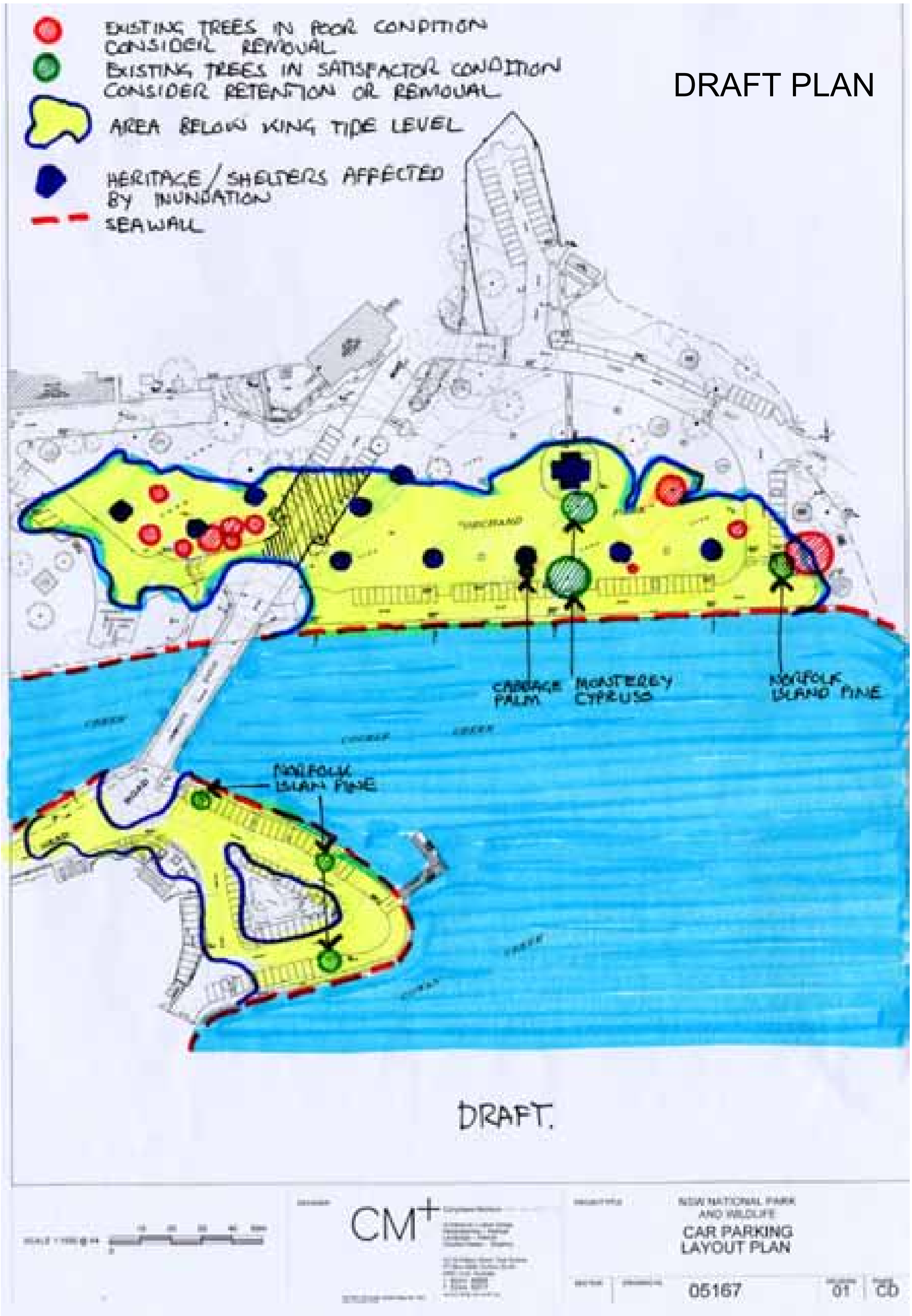


Figure 1: Car Parking Layout Plan

2.0 Report Objectives and Aims

The Primary Masterplanning Objective is to improve the visual amenity and environmental conditions of Bobbin Head and to enhance the heritage of the park. This report aims to provide options for the Department of Environment and Conservation to consider, that will improve the park environment including, but not limited to:

- Heritage
- Landscape
- Structural/seawall and other buildings
- Soil
- Geotechnical
- Additional drainage, parking and road services
- Services/utilities

This report is the first stage of an eight month Masterplanning program for DEC. This report is required to assist the development of a suitable strategy for the parklands CMP, LMP and general Masterplanning.

The report concludes with recommendations to DEC for the seawall and parklands. This report will be attached to the Masterplan for Bobbin Head as an appendix.

3.0 Observation and Analysis

Sea inundation at trees (January 2006)

Bobbin Head (Halvorsens), Orchard Park and the northern part of Gibberong Park are areas affected by seawall subsidence and sea over-topping. (Refer to Figure 1).

Figure 1 shows the areas of parkland below King-tide levels, which are inundated, approximately four times a year. It is possible that tidal levels will increase in the future, especially with increased stormwater run-offs from development in surrounding areas such as Turramurra and Terry Hills.

Drainage in Orchard Park is also poor. (Refer to Chapter 12.0 – Soils Report). Ponding occurs after heavy rainfall or inundation. Evaporation of the ponding water results in concentrated areas of salt deposits. The evaporation process is slow, during which lower lying areas of the park become unusable.

Flooding of the RTA owned and managed Bobbin Head Road and associated drainage (including surcharge) remain continual management and access problems at Bobbin Head (Halvorsens), Orchard Park and Gibberong Park.

Sea water around trees (June 2006)

Saline effects on soil conditions (January 2006)

4.0 Seawall Material and Construction

The existing Bobbin Head seawall was built at various times and stages of the development of Bobbin Head precinct (including Halvorsens parking area, Orchard Park and Gibberong Park). Bobbin Head seawalls were repaired at various stages and continue to be repaired. Repair and maintenance are subjects of other reports including Structural and Marine Reports and Conservation Management Plans.[1]

Visually, the seawall clearly represents a staged construction with continuous repairs due to subsidence and rotation. This patina of construction variation is regarded as a historically significant aspect of the seawall at Bobbin Head and Cowan Creek.

Despite the variations in the design, construction techniques and repairs of the seawall, the material – local and imported sandstone - is the unifying element. The integrity of the material is the critical structural and visual component of the seawall. The sandstone seawalls hold social, historic, environmental and aesthetic significance and as such it is preferable for the existing material to be retained and conserved on site.

Future works (including repairs and restoration) to the seawalls should continue to use this significant fabric (sandstone). Although contemporary construction techniques will need to be employed to allow for the retention of the sandstone seawalls, a 'repair and restore as you go' approach has already been established in the treatment of the seawalls since the parks' inception. It is therefore seen as appropriate to ensure the conservation of the sandstone seawalls utilising contemporary construction techniques and traditional materials; which is in-keeping with the history of the upkeep of the seawalls.

A number of representations have been made to DEC regarding other construction techniques and material use/selection for seawalls at Bobbin Head and Apple Tree Bay. DEC commissioned CM+, to investigate in a Value Management Workshop (VMW), the various issues associated with seawall construction. The outcomes of the VMW are considered necessary in advising future developments associated with seawalls at Bobbin Head and Apple Tree Bay. The VMW considered all known options for seawall construction including costing comparisons, constructability, structural suitability, labour effects, OHS, visual compatibility, heritage and material consistency implications.

Sandstone Seawall at Bobbin head

[1] Britton, Patterson (1997); *Bobbin Head and Apple Tree Bay Seawalls*.
Gutteridge Haskins and Davey Pty Ltd (1991); *Bobbin Head and Apple tree Bay [Management Plan]*. Prepared for the NPWS. Part 4 of 4 Proposed Lease for Redevelopment and Operation of Boating Facility. (9 drawings).
McGoverne, Anne (2003); Conservation Management Plan Gibberong Park, Bobbin Head, Ku-ring-gai Chase National Park. Prepared for the NPWS and the Faculty of Architecture, University of Sydney.
NPWS (2002); Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves Plan of Management. May 2002.
Bachmann, Rachelle, Maxine Bayley, Ralph Moore, Jeff Thompson, Rebecca Ward. Conservation Analysis [Management Plan] for Orchard Park Ku-ring-gai Chase National Park. Prepared for the NPWS and the Faculty of Architecture, University of Sydney.

5.0 Value Management Workshop

A Value Management Workshop (VMW) was conducted on 20 January 2006 by CM+ (Masterplanning) in association with Context (Landscape Management Plan), CM+ (Conservation Management Plan), Taylor Lauder Bersten (Marine and Structural Engineering) and Sydney Environment and Soils Laboratory (Soils) with the assistance of Douglas Partners (Geotechnical Engineering) to provide DEC with a series of design and management options for discussion at the PCG meeting on 8 February 2006.

A Value Management Workshop (VMW) was formed to develop strategies to address the seawall and sea inundation problems at Bobbin Head. The VMW decided to develop strategies leading to options for the seawall and parklands. Furthermore, a number of seawall materials and construction techniques were also evaluated. Consideration was given to seawalls built of:

1. Sandstone
2. Concrete blocks made to look like sandstone (factory and on-site variations)
3. Concrete blocks with pigments
4. Mass concrete with rock art to look like sandstone blocks
5. Mass concrete with sandstone facing

The seawall design options are covered in Chapter 9.0 of this report.

VMW outcomes

- Consideration was given to the financial implications of different construction techniques and materials. It appears (subject to further investigations) that concrete block and mass concrete seawall construction is considerably less expensive than traditional sandstone construction.
- Concrete mass walls of a variety of types including block and ‘mock-rock’ types appear to be simpler to construct than sandstone walls.
- All concrete types of seawalls (Items 2-5 inclusive listed above) appear to be easier and less expensive to construct than mass sandstone seawalls.
- Well-constructed concrete sea walls were regarded as having similar and possibly greater durability results than sandstone seawalls.
- Suitably treated concrete seawall options, including pigmented and decorated blocks (to look like sandstone) and mock-rock type constructions, do not achieve similar visual results nor match with natural or treated sandstone.
- Sandstone was considered an appropriate material to achieve material integrity, allow for the conservation of the historic, social and aesthetic significance of the existing sandstone seawalls and enable a continuation of an already established construction technique to be employed (‘repair and replace as you go’).
- A variety of sandstone options were considered including imported (non- local sandstone) dressed and treated sandstone. In all cases the sandstone material integrity was considered desirable.
- DEC management confirmed that labour costs for sandstone seawall construction were lowered through ordering appropriate block sizes which is compatible with OHS and DEC machinery availability.

- DEC management confirmed that seawall costs were effectively managed utilising internal DEC labour forces that undertook work during low-intensity work periods. External construction company costs were therefore capital intensive and required additional funding.

Economic considerations should be investigated further by DEC to determine the appropriate utilisation of public funds and the probable premium paid for the seawall being re-built in sandstone. Endeavours should be made to reduce costs associated with sandstone seawall construction, including the use of other labour forms, such as prison or subsidised labour. Consideration could be given to implementing a fund raising programmes such as “buy a block” community subsidy for example. It should be noted that by employing a ‘repair and replace as you go’ approach to the management of the existing seawalls ensures a distribution of funds over an extended period.

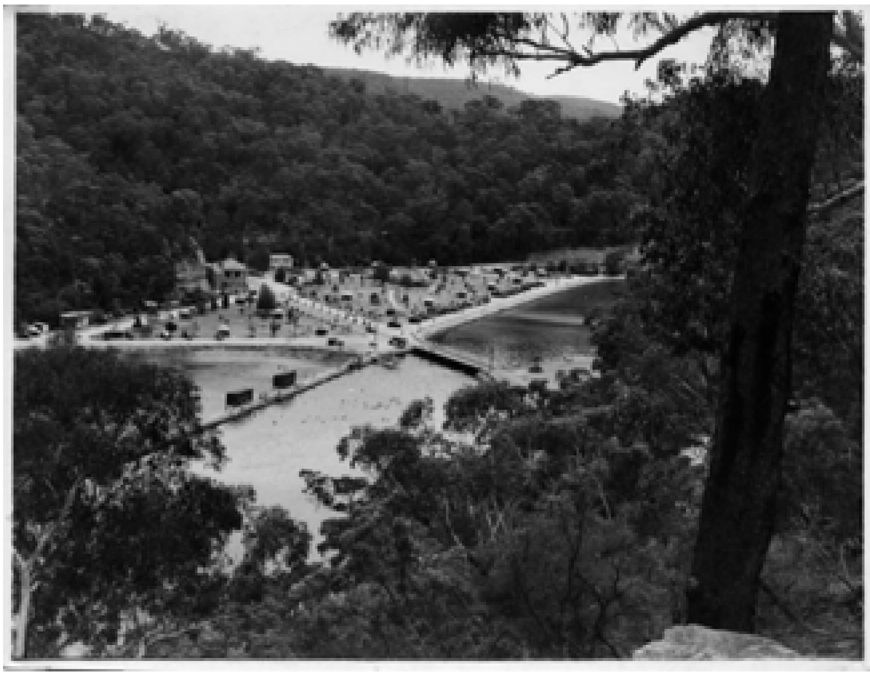
In the Masterplanning, reconstruction of the entire Bobbin Head seawalls is not under consideration. All options contained with in the Masterplan (other than Option 1 – do nothing) propose to reconstruct portions and raise portions of the sandstone seawall to conserve the heritage significance of the place.

6.0 Seawall Heritage Considerations

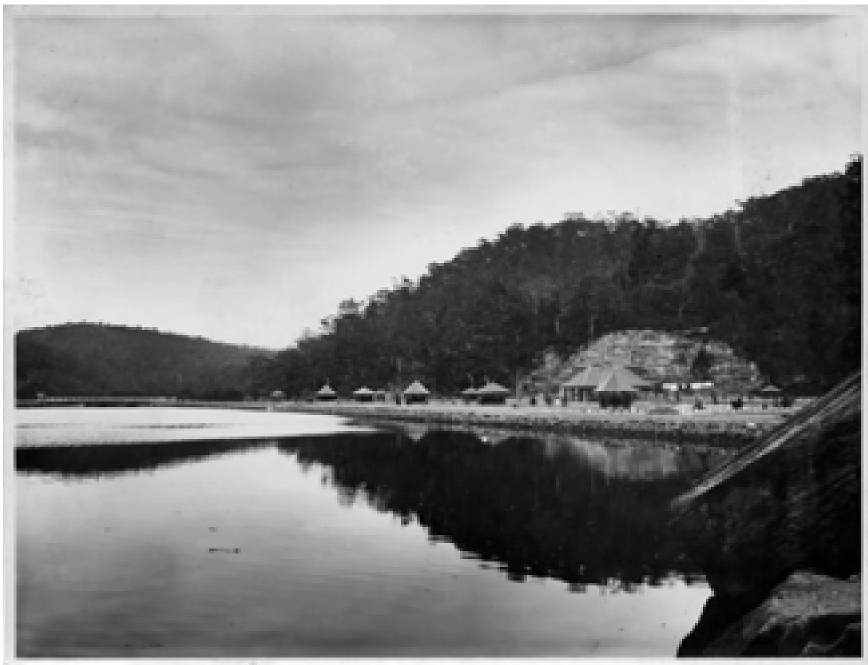
The history of the construction of the Bobbin Head seawall is being prepared and will be outlined in the CMP later in 2006. Various photographic and documented evidence of the construction and chronology of the seawalls will be identified.

- Ku-ring-gai National Park which includes the Bobbin Head area is historically significant as the second National Park created in Australia (1894).
- Bobbin Head and Orchard Park are socially significant as areas which demonstrate continual use as a recreation area for boating, fishing, bushwalking and swimming (amongst other activities) since the late 1800s.
- Opportunities exist for the interpretation of the history of recreational activities and leisure pursuits in NSW and within National Parks in particular.
- Histories already produced for the Bobbin Head area and Orchard Park indicate that reclamation of land and the construction of seawalls began as early as 1902-03.
- The early efforts in creating a useable and accessible recreation area (construction of seawalls and reclamation, combined with the construction of the road to Orchard Park-1902-03) indicate the high level of social significance afforded by the wider community from that period to the present.
- It is likely the seawalls were initially constructed of locally quarried sandstone (former quarry site now holds the Bobbin Head Inn). The seawalls are representative of the traditional material used in the construction of seawalls within the Sydney Basin, a material type that is particular to the place itself (Hawkesbury sandstone). It is therefore appropriate that sandstone for the restoration of the seawalls continues to be used.
- Historically a ‘repair, restore and replace as required’ approach has been adopted for the management of the seawalls, which demonstrates the history of construction techniques and solutions to the issues of subsidence and inundation. This approach allows for the interpretation of the history of the place to be read through its significant fabric.
- The construction of the seawalls and other infrastructure established within Orchard Park in the 1930s is socially and historically significant, as a large proportion of the work was conducted under a government unemployment relief grant to assist the jobless during the Depression era.
- Photographic and written resources show that Orchard Park was land-filled behind a sandstone revetment on mudflats. At no stage in the design of the seawall were suitable geotechnical fabrics incorporated into the seawall design to reduce the leeching of fines, until the Patterson Britton recommendations were made in 1997. Although contemporary construction techniques will be required to be adopted to ensure the conservation of the existing sandstone seawalls, utilising techniques appropriate to the time is part of the ‘repair and replace as you go ‘approach already established as part of the history of the site.
- The seawalls throughout Bobbin Head (including those located at Orchard Park) are historically and socially significant as part of the infrastructure of the second National Park established within Australia and as part of the built features of the area which allowed for the continual use of the Park as a site of recreation since the late 1800s.

The approach to be taken in upgrading Bobbin Head is to attempt to conserve the living heritage of the place. This is an approach whereby the layering of materials and construction techniques are revealed and allowed to communicate the history of the place to the users of the park. It is also an approach that respects the already established technique of ‘repair, restore and replace as required’ and continues to utilise the traditional material types as found on site. In this way, Bobbin Head as a place of historic and social significance is acknowledged and the significant aspects of its past are conserved and interpreted while allowing for the continued use of the place.



Orchard Park from Bobbin Head Road (c. 1940)



Orchard Park from the north end of the park at sea level (c. 1938 - 1940)

7.0 Seawall Function and Heritage Implications

While of heritage significance, the Bobbin Head seawalls (Halvorsens, Orchard Park and Gibberong Park) remain working and functioning elements. Material degradation, poor construction, subsidence and constant weathering by environmental forces have degraded the seawall function to the extent that the parkland and landscape longevity is threatened. This fact was recorded in the GHD Plan of Management 1991. Continuing degradation is evident and will continue to seriously threaten the parklands and public safety (limb and tree loss, seawall collapse), and consequently other heritage elements.

Seawall upgrade (and associated parkland upgrade) is necessary to ensure the longevity of the amenity. Consequently, repair and partial re-construction of the seawall is considered necessary and desirable. Other parkland soil and geotechnical and landscape modifications will also be necessary to prevent further degradation of the park. The modification options are covered in this report.

The Patterson Britton design for the seawall, which utilises similar construction techniques to that of the original wall, with the inclusion of a mass concrete foundation and geotechnical fabric, is regarded as a suitable design. This was confirmed by structural/marine, visual, heritage, marine and geotechnical assessments during the Value Management Workshop 2006.

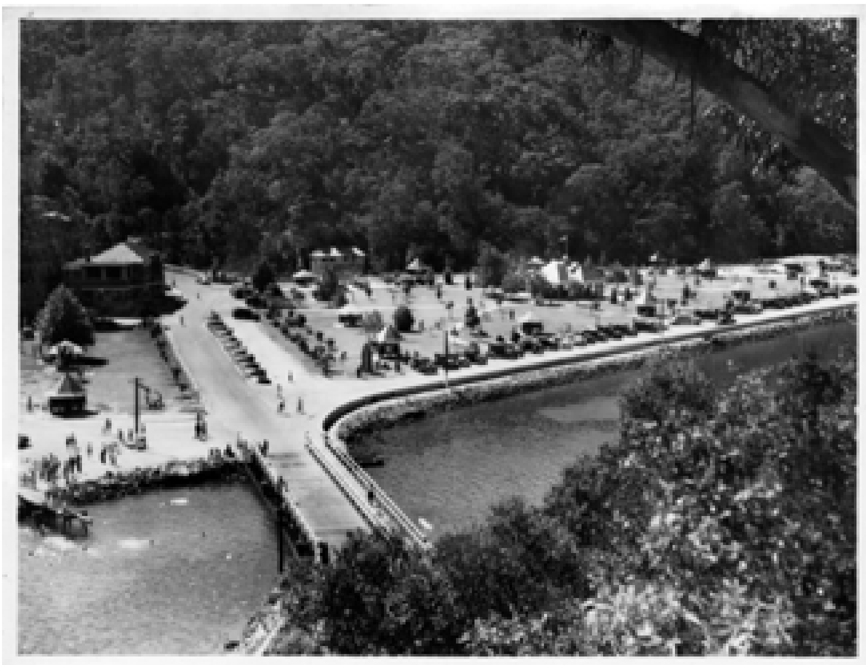
8.0 Landscape Implications

Refer also to Chapter 13.0 of this report. The soils report contains important information on the impact of salinity on the landscape.

Bobbin Head's landscape is in decline due to the increasing soil salinity. Inundation and resulting salinity is contributing to the death and poor performance of both trees and grass, consequently compromising the aesthetic, cultural and functional integrity of the landscape.

This is especially apparent in the Orchard Park precinct, which contains a concentration of cultural landscape elements particularly affected by inundation and salinity. An important landscape design objective will be to strengthen cultural landscape aspects through reinstating and interpreting the 1930's landscape design. Heritage input and Masterplanning combined with consideration of arboricultural issues are required to achieve the vision.

Strengthening the 1930's landscape design proposal should be carefully considered in relation to the Ku-ring-gai Chase National Park and Lion Island, Long Island and Spectacle Island Nature Reserves, Plan of Management 2002 Clause 4.1.6 Policies and Actions point 5, pg27, which states "However, no attempt will be made to replicate all the 1930's plantings or to reconstruct all the picnic shelters, pathways or other landscape features of the 1930's"
(See Figure 6)



Formalised landscape design at Orchard Park (c. 1938)

9.0 Options

The options covered range from a do-nothing approach through to a preferred outcome. Each option was conceptually evaluated as part of the Value Management Workshop 2006 to include the following:

- Analysis and limitations
- Impacts
- Budget framework
- Assessment
- Advantages and disadvantages
- Recommendation

The options covered include:

Option 1 –	Retain existing seawall
Option 2a –	Rebuild the existing seawall, height to remain at existing levels
Option 2b –	Retain the existing seawall and increase height to RL 1.80
Option 2c –	Rebuild the existing seawall and increase height to RL 1.80
Option 3 –	Rebuild the seawall to RL 2.10; raise the park level in stages
Option 4 –	Rebuild the seawall to RL2.10; raise the park level once to RL 2.10
Option 5 –	Rebuild the seawall to RL1.80 build a second retaining garden wall to RL 2.10, raise the park level once to RL 2.10

General

- All options except Options 1 and 2b will include the installation of a Geotechnical fabric at the seawall to prevent the leeching of fines.
- Options 3, 4 and 5 require rebuilding of the seawall along Orchard Park.
- One-way stormwater valves at the seawall are likely to be affected by oyster colonization, and are not recommended.
- Under current legislation, balustrading at new seawalls may be required.
- Under current legislation, balustrading may be required at level changes in excess of 1000mm at new retaining walls.
- A comparative analysis of the options is included in the conclusion to this report.
- Detailed flood and geotechnical reports are required for recommended options.

9.1 Option 1 – Retain existing seawall

This option is the “do nothing” option. Retain the existing seawall. Maintain parklands under current conditions.

Analysis and limitations of the option:

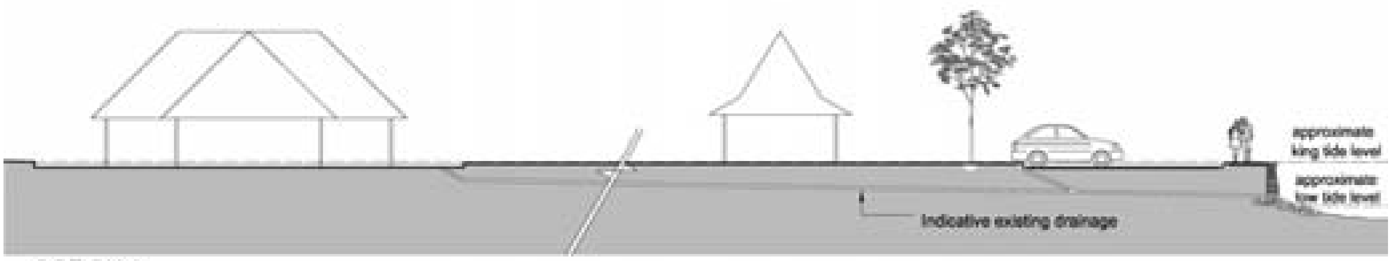
- Seawall continues to be overtopped by seawater.
- Soil conditions worsen due to poor drainage and increased salinity.
- Health of existing trees would continue to deteriorate.
- Limited landscaping that can cope with salt water eg: Casurina, Mangroves, and some species of Paperbark Eucalypts.
- May need to replace affected existing trees.
- Leeching of fines through seawall continues with further subsidence of Park levels.
- Continuing deterioration of structures, carpark, and infrastructure.
- Heritage quality of seawalls remains intact.
- Park function is affected four times a year.

Impact: Continuing structural environmental and visual degradation of park.

Budget framework: Minimal capital costs but significant on-going maintenance costs with the park could be anticipated.

Assessment: This is not regarded as a suitable and sustainable outcome. The situation was recorded in the Plan of Management 1991 and only minor improvements have occurred over the past 16 years.

Recommendation: Not recommended.



OPTION 1
RETAIN EXISTING SEAWALL / EXISTING CONDITION

9.2 Option 2 – Repairs & rebuild options

9.2.1 Option 2a - Rebuild the existing seawall, height to remain at existing levels

In this option, the seawall is rebuilt to Patterson Britton (PB) specifications to the existing seawall height. Maintain parklands under current conditions.

Analysis and limitations of the option:

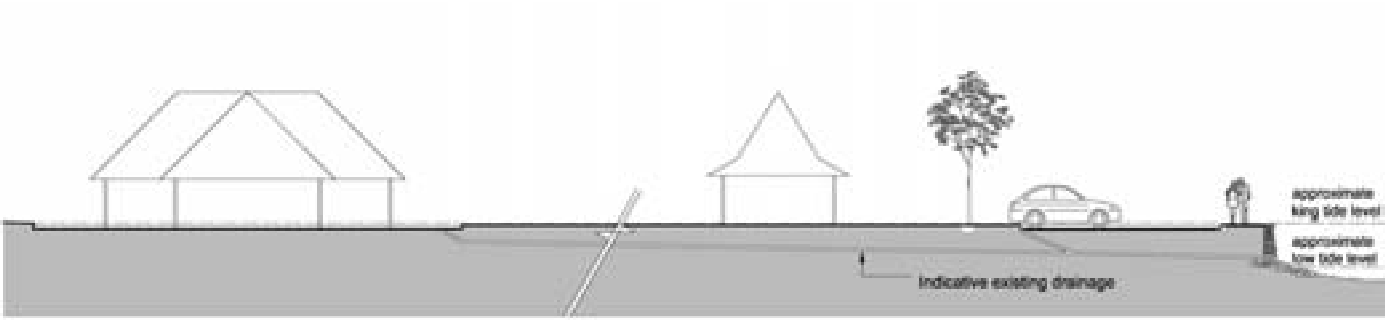
- Seawall continues to be overtopped by seawater.
- Soil conditions worsen due to poor drainage and increased salinity.
- Health of existing trees would continue to deteriorate.
- Limited landscaping that can cope with salt water eg: Casurina, Mangroves, and some species of Paperbark Eucalypts.
- May need to replace affected existing trees.
- Continuing deterioration of structures, carpark, and infrastructure.
- Heritage quality of seawall is altered by replacement.
- Park function is affected four times a year.

Impacts: This option will not prevent the overtopping of the seawall. Degradation of Orchard Park will continue even though structural, geotechnical and aesthetic improvements have been made to the wall.

Budget framework: Costs for the reconstruction of seawall would be incurred. Significant long-term maintenance costs will be incurred for Orchard Park and Gibberong Park.

Assessment: This is not regarded as a suitable and sustainable outcome and does not offer any long-term improvements for the landscape or amenity of the park.

Recommendation: Not recommended.



OPTION 2A
REBUILD EXISTING SEAWALL, HEIGHT REMAINS AT EXISTING LEVEL

9.2.2 Option 2b – Retain the existing seawall and increase height to RL 1.80

In this option, the seawall is retained, but increased to a new height above King tide levels RL1.80. Maintain parklands under current conditions.

Analysis and limitations of the option

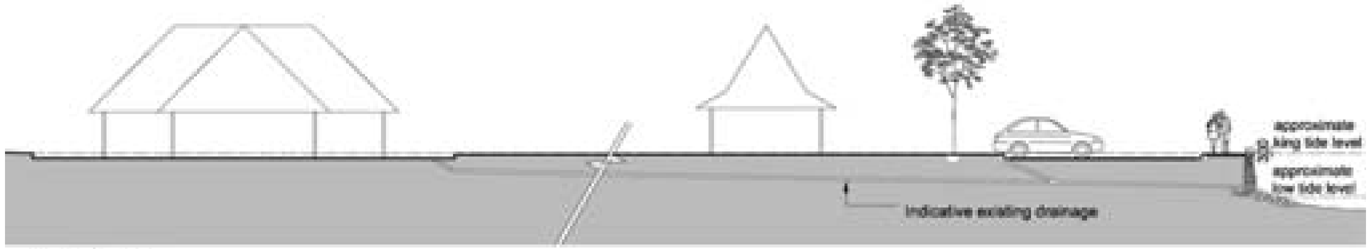
- Addition of material onto existing sandstone seawall structure, raise to RL 1.80.
- Existing footings and seawall structures unable to support additional loading.
- Seawall will rotate. Seawall will not prevent flooding of park by sea water.
- Heritage of seawall is altered by increased height.
- Heritage status of views to and from park is affected.
- Sea water will penetrate through seawall and flood park.
- Soil conditions worsen due to poor drainage and increased salinity.
- Health of existing trees would continue to deteriorate.
- Limited landscaping that can cope with salt water eg: Casurina, Mangroves, and some species of Paperbark Eucalypts.
- May need to replace affected existing trees.
- Continuing deterioration of structures, carpark, and infrastructure.
- Park function is affected four times a year.

Impacts: Views towards the water from the Park will be reduced. Structural modification to the seawall required to achieve stability.

Budget framework: Costs for additional material would be incurred. However structural instability may cost additional amounts to remediate.

Assessment: This option does not offer improvements in structural stability and does not satisfy any of the criteria set out in the objectives, such as preventing flooding or continuing degradation of park.

Recommendation: Not recommended.



OPTION 2B
RETAIN THE EXISTING SEAWALL, INCREASE HEIGHT BY 300MM

9.2.3 Option 2c - Retain the existing seawall and increase height to RL 1.80

In this option, the seawall is rebuilt to Patterson Britton (PB) specifications to a new height above King tide levels. The parklands are maintained under current conditions.

Analysis and limitations of the option:

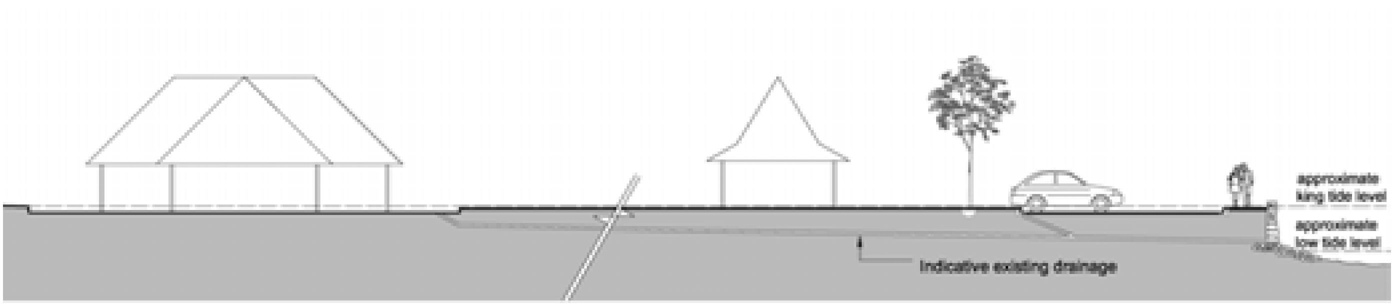
- Sea water will still enter park through drainage pipes.
- Heritage qualities of seawall are altered.
- Seawater would penetrate through the seawall and flood the park.
- Soil conditions worsen due to poor drainage and increased salinity.
- Health of existing trees would continue to deteriorate.
- Limited landscaping that can cope with salt water eg: Casurina, Mangroves, and some species of Paperbark Eucalypts.
- May need to replace affected existing trees.
- Continuing deterioration of structures, carpark, and infrastructure.

Impacts: Rebuilding the seawall to a new height, with new foundations, geotechnical fabric and back filling is required. Views towards the water from the Park will be modified. Without any intervention to the levels of the park, lower portions of the park will continue to be flooded through existing drainage systems (connected to the sea) especially during heavy rains and high tides. Ponding time could be reduced through additional drainage.

Budget framework: Substantial costs for the rebuilding of the entire seawall fronting Orchard and Gibberong Parks. Costs would be more than Options 1, 2a and 2b.

Assessment: The replacement of the entire seawall is a considerable operation that would require a longer timeframe. The improvement to the seawall does not offer a sustainable solution to the longevity of the Park, trees and structures, due to continued seawater flooding at the seawall and drainage system. Revisions to the drainage system in the park would be considerable.

Recommendation: Not recommended.



OPTION 2C
REBUILD EXISTING SEAWALL, INCREASE HEIGHT BY 300MM

9.3 Option 3 – Rebuild the seawall to RL 2.10; raise the park level in stages

In this option, the seawall is rebuilt to Patterson Britton (PB) specifications to a new height above King tide level RL2.10. The parklands are also raised in stages:

- Increase park levels locally between trees and shelters (undulating park).
- Install more stormwater drainage to drain tidal and stormwater discharge from the lower portions of the park.
- Future localised fill staged with improved soil mix at replacement trees. Install new soil drainage system above RL 1.80 to avoid King tide level (staged operation fill to RL2.10)
- Pavilions/shelters are raised when they undergo major maintenance works or in stages.

Analysis and limitations

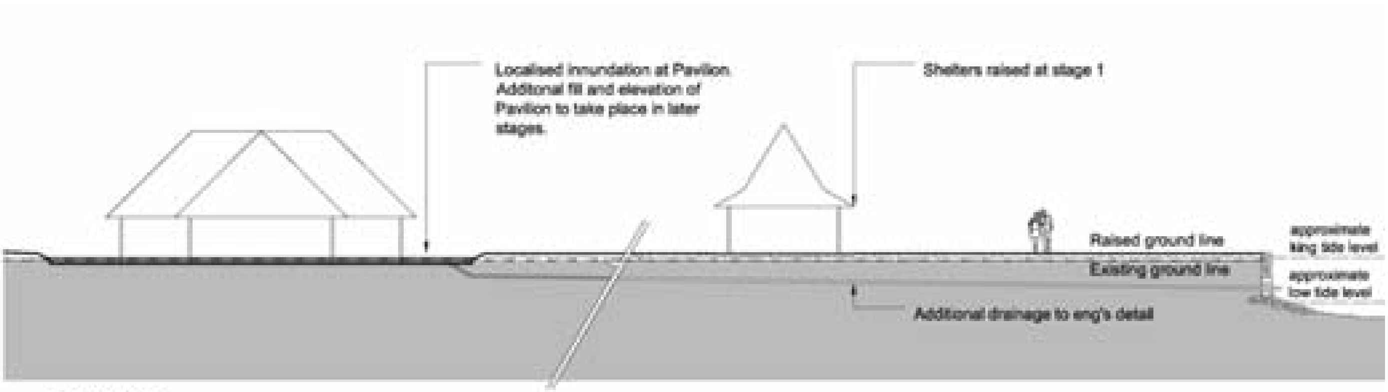
- Accept localised inundation around retained trees gravel or pave around trees where grass cannot grow.
- Pavilions/shelters may be raised when appropriate in a staged operation. Accept localised inundation around structures, gravel or pave around trees where grass cannot grow.
- Eventually, the staged operation would result in a park that is raised to RL2.10 throughout.
- RTA to raise Bobbin Head Road.

Impacts: Views to the water will be impacted from lower parts of the park (especially from pavilions and shelters) after seawall height is increased. Shelters and trees remain at current levels which may not be visually pleasing and would flood at King-tides, affecting function. The drainage system for park would have to be adjusted twice. Trees that are regarded as healthy will be retained, unhealthy ones removed. Limited immediate impact on existing landscape and heritage items. Historic layout of Orchard Park may not be possible due to level changes, until raised levels are complete.

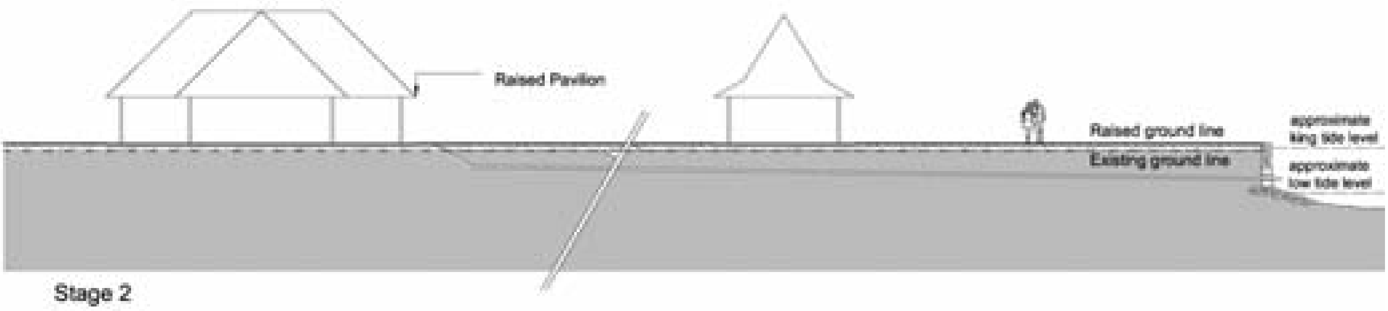
Budget framework: Significant cost of operation spread across stages thereby lowering upfront costs. Total costs could be more in the long-term due to staged operation.

Assessment: A staged solution leading to a sustainable outcome that improves the overall condition of the park with staged impacts to landscape and heritage items. However, short-term park experiences may be limited by restricted views and access to the water.

Recommendation: This option should be considered carefully and only if budget constraints apply. Not a readily supported option.



OPTION 3
REBUILD SEAWALL TO INCREASED HEIGHT, RAISE PARK LEVEL IN STAGES
Stage 1



Stage 2

9.4 Option 4 – Rebuild the seawall to an increased height; raise the park level once

In this option, the seawall is rebuilt to Patterson Britton (PB) specifications to a new height above King tide levels RL2.10. Provide a new promenade, and interpret the parking layout. The parklands and structures are also raised to RL 2.10.

Analysis and limitations of the option

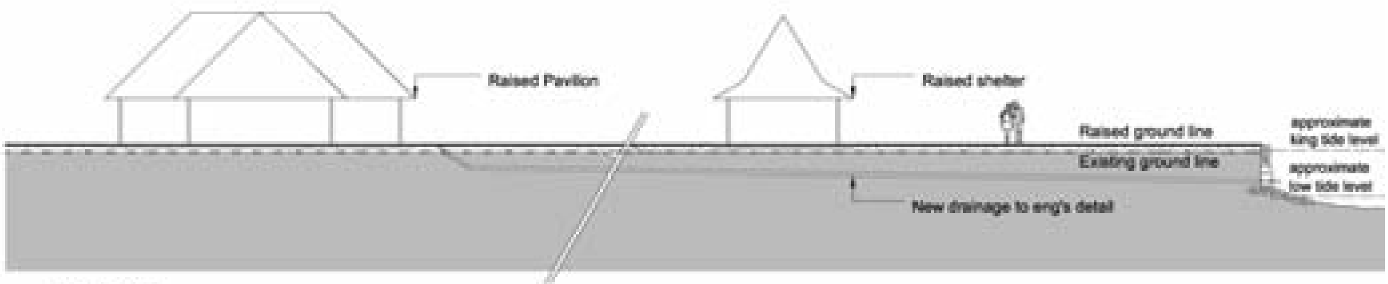
- Install new soil drainage system with new improved soil mixes.
- Install new irrigation system.
- Restore original landscape layout and interpret.
- Pavilions/shelters are raised once. Shelters at new level, pavilion on step.
- Improve parkland amenities / shelters and finishes.
- New Masterplanning to reduce vehicle parking impacts
- Repair or replace utilities and services
- RTA to raise Bobbin Head Road.

Impacts: Landscape impact is minimal due to the limited number of trees affected. Construction impacts are considerable. Landscape improvements would be significant, including 1930's design restoration. Built structure heritage would be impacted due to increased height of structures, but ultimately the amenities could be improved at the same time. Masterplanning to reduce vehicle parking at the foreshore would be possible, with a new grassed foreshore area with seating and a hard surface promenade. Visual and amenity restoration would be achieved. LMP, CMP and MP objectives would be achieved.

Budget framework: Considerable development costs with low ongoing maintenance.

Assessment: A considerable improvement to the condition of the park would be achieved, with heritage and landscape impacts due to increased height of the park, structures, paving, utilities and new plantings. Restoration of the 1930's landscape design is regarded as highly desirable. The outcome would be consistent with the long-term parkland vision; CMP, LMP and Masterplanning objectives. The longevity of Bobbin Head would be ensured.

Recommendation: This option should be considered in the light of a permanent solution to the problems of park inundation, park and amenity improvements. This recommendation would improve sustainability.



OPTION 4
REBUILD SEAWALL TO INCREASED HEIGHT, RAISE PARK LEVEL ONCE

9.5 Option 5 – Rebuild the seawall to RL1.80 build a second retaining garden wall to RL 2.10, raise the park level once to RL 2.10

In this option, the seawall is rebuilt to Patterson Britton (PB) specifications to the original seawall height. A second landscape retaining wall (second seawall) is constructed approx 5-7 metres behind the existing seawall. Construct a lowered and hard surface promenade. The original parking layout would be interpreted. The parklands and structures are also raised to RL 2.10 at once.

Analysis and limitations of the option

- A new hard surfaced promenade edged with a landscape wall would provide a new amenity for the park.
- The landscape wall would require drainage and foundation system, could be constructed of concrete or sandstone.
- Install new soil drainage system with new improved soil mixes.
- Install new irrigation system.
- Restore original 1930's landscape layout.
- Pavilions/shelters are raised once. Shelters at new level, pavilion on step.
- Improve parkland amenities / shelters and finishes.
- New Masterplanning to reduce vehicle parking impacts
- Repair or replace utilities and services
- RTA to raise Bobbin Head Road.

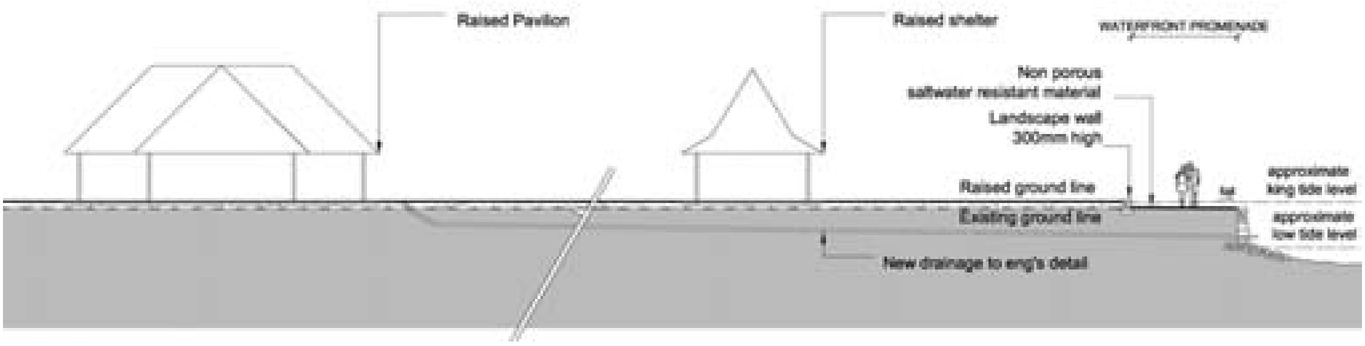
Impacts: The new landscape garden wall would provide interpretation for the original park levels. This wall would edge the new promenade and provide seating along the Orchard Park foreshore. Landscape impact is minimal due to the limited number of trees affected. Construction impacts are considerable. Landscape improvements would be significant, including 1930's design restoration. Built structure heritage would be impacted due to increased height of structures, but ultimately the amenities could be improved at the same time. Masterplanning to reduce vehicle parking at the foreshore would be possible, with a new grassed foreshore area with seating and a hard surface promenade. Visual and amenity restoration would be achieved. LMP, CMP and MP objectives would be achieved.

Budget framework: Considerable development costs with low ongoing maintenance. Additional costs over Option 4 for the construction of foundations for the new 300mm high landscape retaining wall.

Assessment: A considerable improvement to the condition of the park would be achieved, with heritage and landscape impacts due to increased height of the park, structures, paving, utilities and new plantings. Restoration of the 1930's landscape design is regarded as highly desirable. The outcome would be consistent with the long-term parkland vision; CMP, LMP and Masterplanning objectives. The longevity of Bobbin Head would be ensured.

Recommendation: This option is recommended. The new landscape retaining wall is a new seating and feature of the park.

The new landscape design would be considered a permanent solution to the problems of park inundation, park and amenity improvements. This recommendation would improve sustainability.



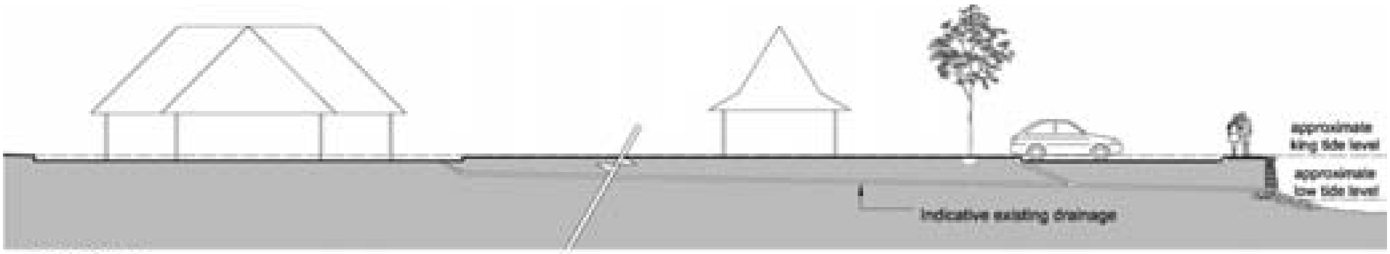
OPTION 5
REBUILD SEAWALL TO ORIGINAL HEIGHT, BUILD SECOND RETAINING GARDEN WALL, RAISE PARK LEVEL ONCE

10.0 Conclusion

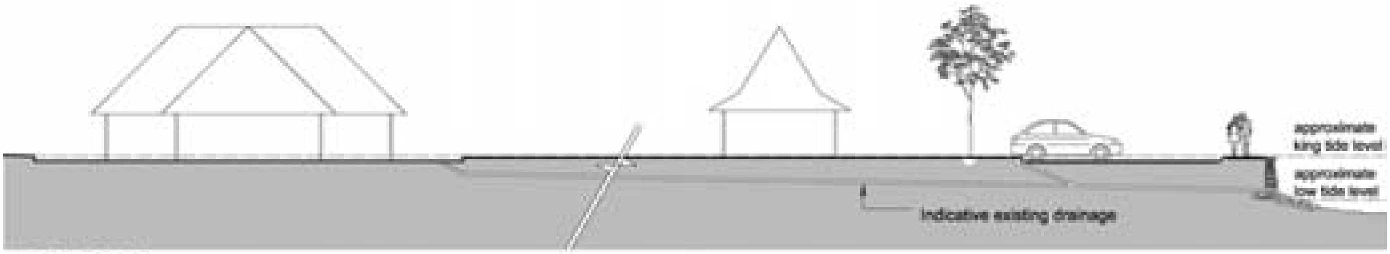
Options 1-5 present a number of advantages and disadvantages for DEC to consider. The long term improvement of the Bobbin Head parklands include:

- Improving the general amenity and the general environment.
- Reconstructing and raising the seawall above the King tide levels (RL1.80) subject to flood study.
- Installing suitable geotechnical fabrics to prevent leaching of soil and to limit subsidence.
- Constructing new seawall foundations to slow and limit rotation and subsidence, subject to further detailed geotechnical testing and reporting to confirm detail design.
- Providing suitable drainage, utility and irrigation systems.
- Removing of unsuitable saline topsoil (100mm-300mm – refer to soils reports).
- Increasing parkland levels above the King tide levels at least RL 1.80 installing drainage system and additional fill 300mm above suitable sandy rooting soils to RL 2.10.
- Upgrading and raising shelters and parkland amenities to RL 2.10, providing new scour protection for roof drip lines.
- Modifications to RTA road to raise to parkland levels.
- Planting a new landscape to the 1930’s landscape design and interpret the heritage.
- Masterplanning new parking layouts to reduce the visual impact of motor vehicles on the park.
- Providing a suitable promenade, with seating and shade areas.

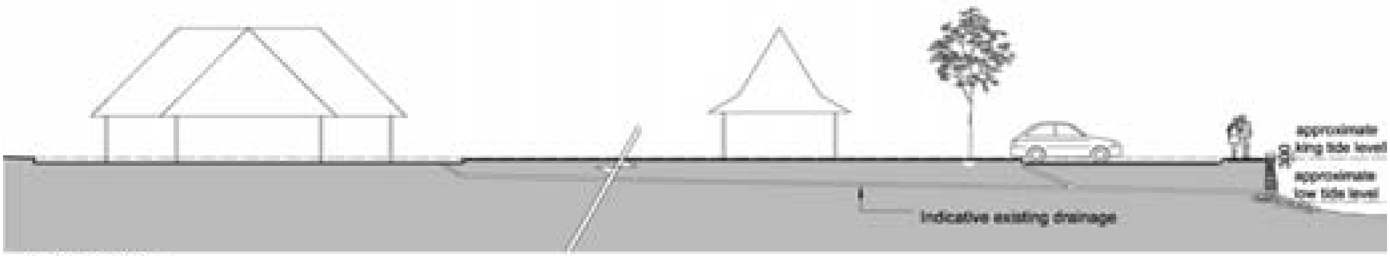
Figure 9 is a diagrammatic summary of the options with advantages and disadvantages listed.



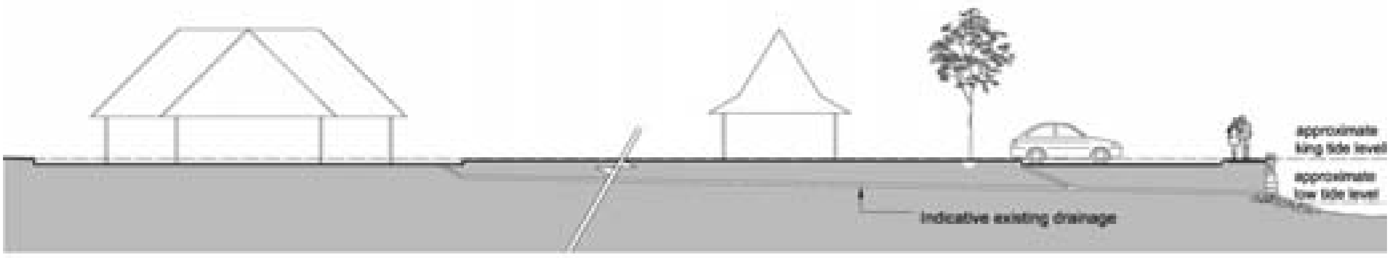
OPTION 1
RETAIN EXISTING SEAWALL / EXISTING CONDITION



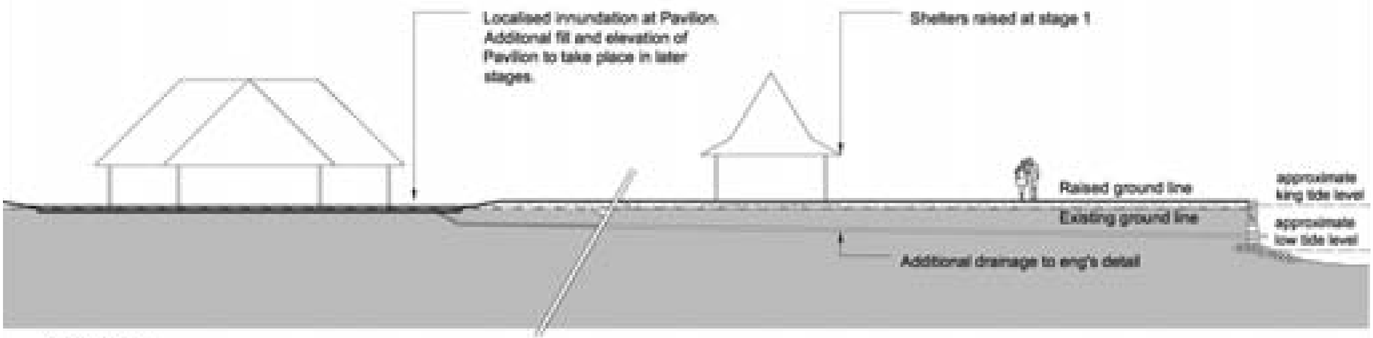
OPTION 2A
REBUILD EXISTING SEAWALL, HEIGHT REMAINS AT EXISTING LEVEL



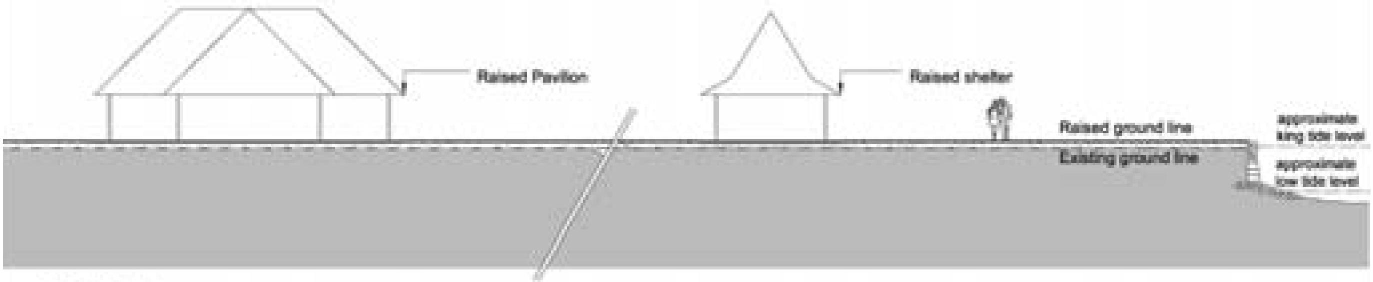
OPTION 2B
RETAIN THE EXISTING SEAWALL, INCREASE HEIGHT BY 300MM



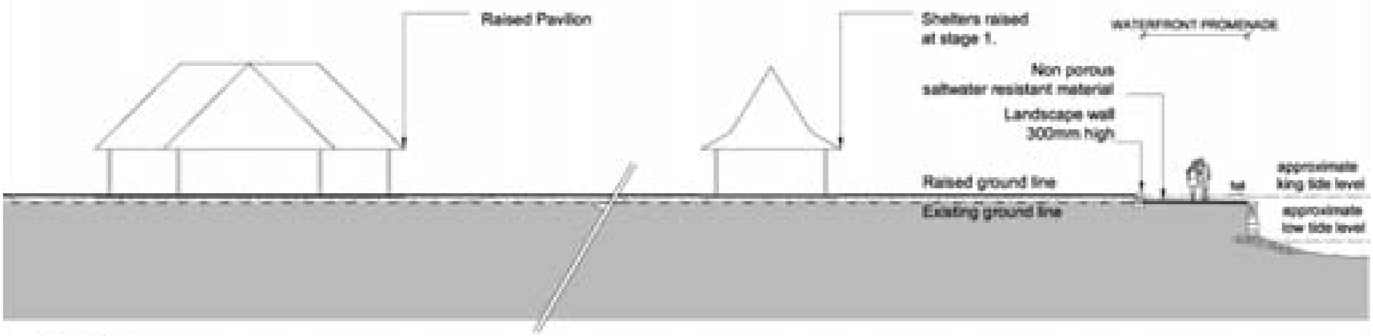
OPTION 2C
REBUILD EXISTING SEAWALL, INCREASE HEIGHT BY 300MM



OPTION 3
REBUILD SEAWALL TO INCREASED HEIGHT, RAISE PARK LEVEL IN STAGES



OPTION 4
REBUILD SEAWALL TO INCREASED HEIGHT, RAISE PARK LEVEL ONCE



OPTION 5
REBUILD SEAWALL TO ORIGINAL HEIGHT, BUILD SECOND RETAINING GARDEN WALL, RAISE PARK LEVEL ONCE

11.0 Documentary Sources

- Patterson Britton & Partners Pty Ltd; 1997; Bobbin Head and Apply Tree Bay Seawall Restoration and Management Plan.
- GHD; Plan of Management – Ku-ring-gai National Park Plan of Management.
- Various letters and correspondence.

12.0 Report Limitations

12.1 This report was produced without any information on flooding and tidal co-relation, a study and report is required to confirm suitable levels. All “RL” figures in this report are based on assumptions regarding sea tidal information only.

12.2 Additional geotechnical reports will also be required at detail design stage for:
- seawall
- pavilion and shelters
- toilet block
- Bobbin Inn
- retaining walls

12.3 Detail design documentation and other consultancy services would be required at a later stage of design development.

13.0 Soils Report (Sydney Environmental and Soil Laboratory Pty Ltd, 2006)

Please find attached report.

14.0 TLB Facsimile dated 6 February 2006 – review of Bobbin Head Seawall Advice

Improving Soil Conditions for Trees and Turf at Bobbin Head and Apple Tree Bay

January 2006

Scope

The following discussion is provided to Conybeare Morrison International Pty. Ltd., head contractor for the Bobbin Head and Apple Tree Bay Master Plan project for the National Parks and Wildlife Service (NPWS).

The discussion concerns the remediation of soil conditions for the Bobbin Head and Apple Tree Bay park areas based on a review of existing site observations, previous soil or geo-technical related studies and plans submitted to NPWS over several years. While none of the previous studies provides a complete picture of soil conditions for horticultural purposes the GHD report provides some. The direct first hand knowledge of the author in the Orchard Park area is used to provide some level of certainly to these preliminary opinions and advice.

Since the purposes of these previous studies was not necessarily focussed on the health of parks and gardens the conclusions and suggested remedial work herein should be considered tentative and subject to further site specific investigation prior to any precise specification of works programs.

Four documents are chiefly relied upon as well as first hand observations from TAFE student field days conducted with the aboriculture group run by Judy Fakes of Ryde TAFE in May 2005. These unpublished observations of student project write ups from Ryde TAFE conducted under the supervision of Sydney Environmental and Soil Laboratory are cited as TAFE 2005.
The documents chiefly relied upon are-

1. Bobbin Head and Apple Tree Bay Management Plan. Gutteridge Haskins and Davey Pty. Ltd. 1991.
2. Arborists Report: Bobbin Head and Apple Tree Bay Picnic Areas . The Tree Wise Men 2004.
3. Conservation Management Plan for Orchard Park. Bachman *et. al*. 2003.
4. Conservation Management Plan for Gibberagong Park. McGoverne 2003.
5. TAFE Arboriculture Certificate, Fakes, J. and Leake, S. (2005) Observations from field work component, Reasons for decline of *Metasequoia semperivens* Bobbin Head Orchard Park. Unpublished field notes and student submissions.
6. Douglas Partners 1998. Report on Preliminary Geotechnical Investigation, Damaged Toilet Block, Orchard Park. Bobbin Head.

In this report an attempt is made to identify the major soil related reasons for failure or poor condition turf and tree components of the park and to suggest remedial actions. The suggested actions are given in order of lowest to highest anticipated cost which is directly related to the likelihood of a permanent solution to the problems (ie lowest cost is least likely to provide permanent solution). Advice is offered on which is the most appropriate action for a given area but this must be subject to more detailed site specific investigation before any degree of certainly of improvement can be provided.

Background

Soil Physical Properties

All three areas of interest, Gibberagong, Orchard Park and Apple Tree Bay are formed on in-filled estuarine bays. While dredging of the adjacent waterways may have contributed to some of the infilling indications are that the surface metre or so is formed from imported material of, sometimes, foreign geology. Student work in Orchard Park (TAFE 2005) indicated layers and lenses of what appears to be clay soil of Wianamatta Shale origin at least in part. Douglas(1998) indicated highest penetration resistance in the first metre or so indicating highest density and compaction (and almost certainly lowest permeability). This observation fits with the findings of TAFE 2005. GHD indicated some areas where the surface fill is more sandy and silty but I would challenge their conclusion that this material is of suitable permeability. It could be that closer to the seawall or in locations where sandy fill was used the fill is more silty/sandy and of dredging origin but it is not a guarantee that the whole profile is composed of permeable material. I would also challenge a conclusion that this silty/sandy material is providing a suitable rootzone for trees. Chemically such sandy materials can be very nutrient deficient. Not having extensive survey work of the whole park the existence of dredged sandy materials close to the surface cannot be ruled out.

In Apple Tree Bay GHD indicate that the fill is of possible local Hawkesbury sandstone origin but still very stony and compacted. In our experience sandstone materials can be very unsuitable as soil, compacting to very high densities even if small clay contents are present.

Generally the picture is one of uncontrolled fill with little or no thought put into creating suitable tree rootzones during construction. This is hardly a criticism since most of the knowledge regarding tree rootzones has only emerged in the last 15 years or so.

GHD indicate that "white" sand was present in all bore logs at Orchard Park at around 1m. The student TAFE 2005 work confirmed this. The same level of detail is not available for Gibberagong and Apple Tree Bay, only that the surface soil at Apple Tree Bay is "gravely", very compact and stony (GHD). A sieve test analysis of sands found at depth in Orchard Park by TAFE students is attached. It is typical of water sorted sand in sandstone geology.

It is likely that alluvial silty loam, the most commonly available "topsoil" in Sydney, was used to cap the original fill, topdress, re-form and repair areas over time. This soil type shows an evenly graded particle size distribution (equal quantities of medium, fine and very fine sands, fine and coarse silts and some clay). Experience in other parks shows that it compacts to high densities with no structure and aeration and is particularly ill suited to resisting pedestrian traffic in busy parks.

In a significant portion of Orchard Park closest to the seawall occasional inundation by saline tidal water occurs by movement of very high tides up the stormwater drains. Today the areas affected by this can virtually be delineated by the absence of grass with bare soil areas showing salt efflorescence in dry weather. Trees in this area, particularly one of the original *Cupressus* (Tree 117 in Tree Wise Men Report) are showing dieback and decline. Many have been lost over time, most likely as a result of salinity. A number of other specimens, notably a Norfolk Pine have grown very poorly from inception, appear spare and unthrifty, with salinity being the most likely cause.

Work by GHD and TAFE (2005), in Orchard Park confirm that water tables at 1.0-1.5m are not saline until within about 10-15m of the seawall. In places both parties identified surface salinity as greater than salinity of the water table. This confirms a model of surface inundation of impermeable soils by saline water with subsequent evaporation of saline water leaving a "salt scald" surface. GHD correctly identify, in my view, that the salinity is not a result of rising saline water tables. Soil tests by TAFE (2005) showed hyper-saline (salinity higher than seawater) in surface soils where ponding of seawater occurs, confirming the evaporative model.

The hydrology of these areas is likely to be unusual with the surface water system arising from rainfall and tidal flooding essentially separate (although cross connections could occur) from the flux of ground water flowing from the base of the sandstone hills through the sandy subsurface layers, and at some point within 15 to 10 m of the seawall, meeting the saline tidal water. Surface soils, as a result of this system are likely to alternate between dry, saline and waterlogged, a very hostile environment for tree roots. In some cases tree roots may penetrate the impermeable layers through cracks and fissures to find a permanent fresh water table below but, given that soil oxygen levels are likely to be low in this saturated sand layer, the functioning of any such roots is likely to be limited.

Aside: The Functioning of Tree Roots

The roots of plants require oxygen to absorb water and nutrients, grow and indeed live. The atmosphere is 21% oxygen. Roots cannot absorb optimal water and nutrients below 15%, cannot grow below 12%, cannot function at all below 5% and cannot live below about 3% oxygen. This explains why, in the typical soils of forests the root system forms a "root plate" with 90% of the root within the surface 300mm. Notions of "root balls" and "tap roots" must be abandoned in soils with a heavy clay subsoil, there is insufficient oxygen for roots to live. Only special trees adapted to waterlogged soils, or trees growing in deep well aerated sand will produce root systems other than plates. In a normal soil with 200-300mm of loamy or sandy and well aerated A horizon the roots spread horizontally up to two or even three times the canopy height. Notions of roots extending to the "drip line" of the canopy must also be abandoned.

Where the fill layers are not so impermeable and are, as GHD indicate in places, sandier, roots may form a deeper system which is likely to be less prone to drought. It must be remembered, however, that if the roots of older plantings did develop to depth and then an inappropriate surface treatment, soil build up, or "blinding" of the surface sandy layers with silt and dust occurs, the subsoil oxygen levels will drop and these deep root systems can die. This is likely to occur in parks with a long history of ad-hoc surface changes.

Soil Chemical Properties

It is commonly assumed that trees do not need special attention with regard to soil nutrients and that being long lived and slow growing they find all the nutrients they need over time. In a natural forest environment where nutrients are recycled through the litter layer this might be true. In an anthropic soil, made from subsoil and fill, where nutrients are constantly removed through mowing and leaf litter removal this is certainly not true. It is perfectly obvious to any experienced person that trees are highly responsive to added soil nutrients and that poor or slow growth of trees in chemically poor soil can be greatly improved by the use of fertiliser.

Maintaining reasonable soil chemical properties will also help plants of all kinds growing in soils with poor physical properties. Thus plants with adequate nutrition produce better root systems in compacted dense soils than starving plants.

Aside: The Bioaccumulation of Limiting Nutrients

The chemical constituents in the geology are not necessarily optimal for plant growth, but universally we find that topsoils from differing geology are remarkably uniform chemically. The vegetation community seems to "bioaccumulate" nutrients that are limiting into a certain chemical "window of life". How does it do this? By recycling limiting nutrients through the intact litter layer. Thus even a sandstone derived topsoil will show phosphorus and potassium levels significantly higher than the underlying geology. This Bioaccumulation of Limiting Nutrients takes time, a stable litter layer and a closed nutrient system. Parks are open systems. Nutrients are lost through mowing, litter removal etc. The geology of this park is fill, not topsoil, the vegetation has had little time to bioaccumulate and the nutrient system is open. Thus nutrient ratios in the surface do not reflect optimal conditions. Intelligent use of fertiliser can make up for the open system losses and greatly shorten the bioaccumulation time, turning fill into topsoil.

Park trees are not "set and forget" installations. Park soils become depleted because of the constant removal of soil nutrients from mowing and removal of falling leaves and organic matter. Tree growth itself is net acidifying of soils as the alkaline or "basic" ions calcium and magnesium are taken up into the growing canopy. It is common to find soils in older parks acidic and severely nutrient depleted unless intelligent and informed soil nutrient replacement programs have been in place. Most often trees are the unintentional beneficiary of turf fertiliser programs but such programs are not necessarily balanced for making good the actual nutrient deficiencies occurring. For example turf fertilisers often emphasise nitrogen and phosphorus over potassium.

The attached test results from GHD and from TAFE 2005 addresses just two areas of the park but both show either significant soil acidity and/or deficiencies of potassium, phosphorus, nitrogen, sulphur and magnesium roughly in that order. In some places phosphorus is adequate in others deficient but potassium appears to be a common deficiency. Potassium deficiency is particularly common in older parks and results from constant removal of clippings and leaf litter. Potassium is also particularly prone to leaching losses.

Conclusions

Generally it must be concluded that the geological and maintenance history of the parks has resulted in several problems summarised as follows-

1. Subsidence resulting in levels prone to occasional tidal inundation,
2. An "inverted" soil profile with less permeable or impermeable material overlying coarse permeable sand. Natural soils never show this. Perched water tables will result following rain or tidal inundation.
3. A complete inability for saline water to leach or be otherwise removed (eg by "dams" formed by curbing and guttering) and hence evaporation is the only means of water being lost, leaving salt scalds behind.

4. Very low permeability and ponding meaning that rainfall and irrigation cannot function normally to desalinate the profile. In highly permeable soils a single 100mm rainfall event can completely desalinate 1 metre of saline soil.
5. In areas of the park not subject to salinity there is virtually no “A horizon”. Tree roots grow essentially in the surface layer of clayey fill.
6. Where alluvial topsoil was imported it has severely compacted into a massive unstructured mass preventing aeration and drainage.
7. Neglect over many years of soil chemical properties resulting in severe acidity, potassium and other nutrient deficiencies. Trees and turf suffering nutrient deficiency are less able to cope with adverse physical properties also. While adequate nutrition will not overcome physical problems it will certainly assist plants to cope better.

Solutions

This analysis leads to a number of possible interventions aimed at solving or at least alleviating the major problems facing turf and trees cover in the parks. These interventions include both chemical (soil amelioration and fertilising) and physical improvements. The two are not mutually exclusive and in some areas both inverventions may be needed.

Remedial actions or interventions, in order of increasing cost and likely degree or permanence of amelioration can be summarised as follows-

1. **Chemical Soil Amelioration**. There is every expectation that turf and tree conditions could improve significantly, in the non saline areas, using a combination of lime or dolomite and a good quality high analysis NPK fertiliser with an appropriate NPK ratio reflecting the soil nutrient deficiencies. The actual NPK formulation chosen should be subject to closer mapping of soil chemistry across all sites but generally a high analysis fertiliser with an NPK ratio around 8:4:12 should be considered with the aim of correcting potassium deficiency. There is not sufficient topsoil chemical analysis to be sure of the nutrient deficiencies prevailing in each section of the park and the general NPK mix suggested is notional only at this stage. Subject to more extensive soil testing additional amounts of potassium may be required around individual trees or particularly deficient areas. Special fertiliser blends can be made up if necessary. For costing purposes allow 200 grams per square metre of lime or dolomite (similar cost) and 100 g/sqm of NPK fertiliser (allow around $ 750 per tonne) spread preferably in 2 applications 12 months apart. Allow annual additions of 20 g/sqm of NPK fertiliser for future maintenance for at least 5 years and thereafter every two years.
2. **Sand Slitting, Coring and Topdressing.** The simplest approach to improving surface soil conditions for both trees and turf is to mechanically cut slits and cores and then topdress, filling the slits and cores as well as leaving 10-20mm of the topdressing material on the surface, with a medium sand. Contractors are

available to do this work that is commonly done on sports playing fields where similar physical problems occur. Mechanical aeration with spiked rollers provides temporary relief only and is usually performed twice yearly consuming significant labour resources for no permanent relief. Sand slitting is usually combined with a fertiliser application in spring before root growth commences. Soil removed in the slitting and coring operation must be removed. The sand used must be a medium size sand with little or no fines and may have around 5-10% composted organic matter by volume added. Specifications can be provided. The operation can occur up to the critical rootzone (CRZ) but not within it.

> Aside: **The Critical Rootzone of Trees**. Defined as the area close to the stem where any mechanical damage is unacceptable the CRZ varies but a general rule of thumb is a radius 7 times the trunk diameter. Shallow coring but not slitting can occur within the CRZ. Any root damage done outside the CRZ is quickly made up by the trees responding to the better physical environment.

This process will not relieve the saline areas and, naturally, will not be of much use where existing soil is permeable and sandy. It would certainly be appropriate, from existing knowledge, for all non saline areas in Orchard Park.

Existing trees can handle safely up to 50mm of sandy material being placed over their rootzones. Any deeper than this and the risk of suffocation and death of roots increases.

3. **Strategic Topsoil Replacement.** In strategic areas around severely stressed trees or grossly compacted high wear areas, complete replacement of the topsoil, or replacement in trenches radiating out from tree trunks (avoiding major root destruction ie manual soil removal within the CRZ) has been shown to produce sometimes dramatic improvements. Soil again should be a medium sand material with perhaps some allowance for fines (eg maximum 10% silt plus clay), some organic matter, and some fertiliser. Allow 200mm of soil replacement around trees and 250mm in the worst high wear areas.

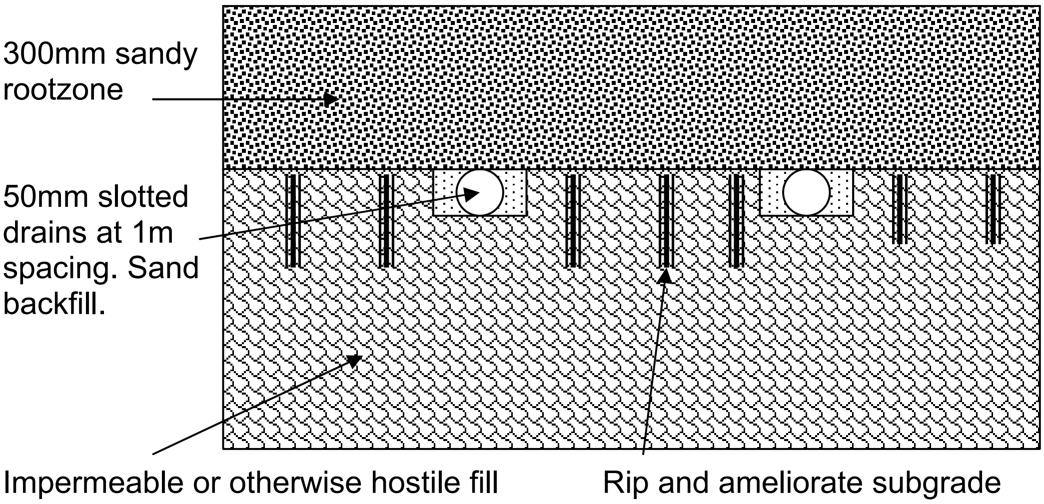
> **Aside: Soil Around Pavilions:** Topsoil replacement will not solve the problem of wear around picnic pavilions and intense desire lines. Shade, damp, drought and intense constant use leads to the inevitable conclusion that <u>no soil profile or turf will ever cope</u> and the consumption of resources attempting it will be money wasted. A number of “hard” surface options occur ranging from artificial turf to extension of sandstone flagging. Combine such hard surfacing with the installation of drains to remove water that tends to pond around the main pavilion.

4. **Complete Reconstruction**. This approach is virtually mandatory in the salinised areas of Orchard Park and in areas to be reconstructed at Apple Tree Bay. The program fits in with the current notions of increasing the soil elevation in Orchard

Park above the high tide levels. Basically the approach is to provide at least 200 and preferably 300mm of sandy root zone soil over the clay or impermeable base and install a drainage system. At the interface of the two soil layers a systematic drainage system must be installed in a “herringbone”, “grid” or other drainage pattern. Ideally, branch drains of 50mm slotted agricultural drain pipe must be no more then 1m apart for best effect. Trunk drains are usually 100mm slotted ag drains and these must beconnected to stormwater outlets.

Ideally, the system levels should be designed such that the very highest tidal inflows do not backflush up the drains. In such a situations the pallet of trees available is very wide and would include species not normally tolerant of salinty. This would probably require raising existing levels in orchard park by over 400mm. As a compromise, if drains are at such a levels that saline tides do reflux up the drains then highest tide level should not be allowed to come within 200mm of the surface. In this situation some salt tolerance in the trees plantings is essential. The diagram below illustrates the fundamentals of the system.

Figure 1. Reconstructed Park Soil Profile



In salinised areas removal of the surface 100-200mm of salinised fill will be required before topsoils are installed. Where this occurs subgrade levels can be brought up to within -300mm of finished RLs using clean, preferably sandy, fill. There is little advantage in making topsoils deeper than 300mm and in fact deeper layers of sandy rootzone soil than this can be “droughty” and lose cohesion in the surface resulting in loose sand at the surface.

Specifications for particle size distribution, organic matter content, fertiliser use and work procedures for the new sandy rootzone soils can be provided.

It is very likely that existing trees in reconstruction zones will not be able to cope with the changed soil levels of up to 300mm. There is little that can be done about this and removal of such trees is probably the only solution. Replacement of similar or identical species into the new improved soil conditions will provide a far more satisfactory solution. Trees chosen for this area must be tolerant of some, at least intermittent, salinity. Trees likely to cope with this situation, both indigenous and "heritage" are-

Ficus rubiginosa – Port Jackson Fig.
Araucaria hetrophylla – Norfolk Island Pine
Melaleuca quinquinerva and Melaleuca spp – Paperbarks
Casuarina glauca – Swamp She-oak.
Eucalyptus botryoides and robusta – Swamp mahogany
Livistona palms
Phoenix canariensis – Canary Island Date
Syzygium spp Lilli pilli species
Glochidion ferdinandi – Cheese tree
Pinus Halepensis – Allepo pine
Ficus microcarpa – Small leaf fig
Washingtonia filifera Washingtonia Palm

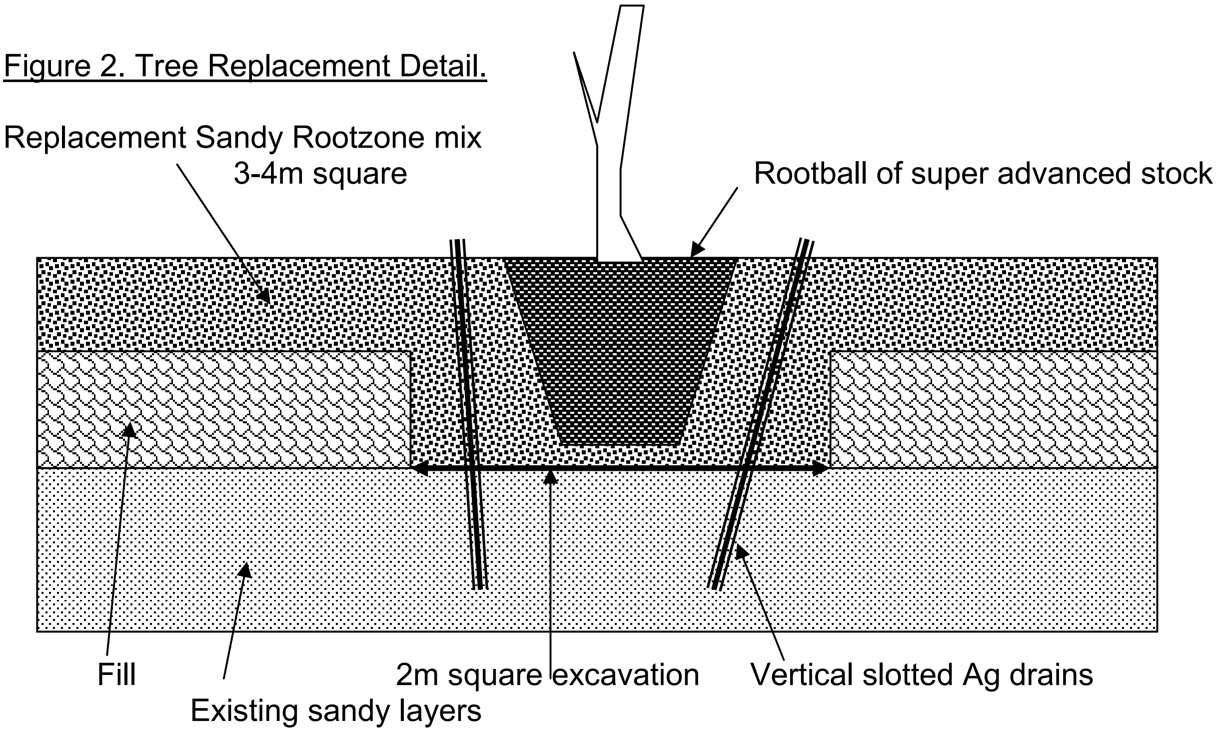
Note that in northern hemisphere texts *Populus spp* are generally considered tolerant of salts but *Cupressus* spp are considered intolerant except *C. arizonica* which is considered moderately tolerant. These lists are not definitive and local experience with the species should be used to draw up final lists of trees that will confidently cope with the intermittent salinity regime.

5. **Tree Replacement**. When replacing trees in areas not specifically reconstructed an opportunity to improve the soil profile exists. This should involve constructing a "planting vault" 2m by 2m by removal of all impermeable fill material down to the underlying sand and backfilling this excavation with sandy medium to connect the upper permeable layer with the lower dredged sand layer at depth. Remove and replace the surface 300mm within a 3m square with a sandy rootzone mix as specified for reconstruction areas. The new profile is illustrated in Figure 2.

   This technique of "connecting" surface sandy soil to sandy permeable subsurface layers has the advantage of allowing slow percolation of excess water, and better penetration of oxygen to depth allowing a deeper root system to develop, as well as connecting roots to a permanent water table of (mostly) fresh water. The technique may not be desireable in the areas of saline water table within 15m of the seawall unless species are know to be highly salt tolerant. The technique will prevent ponding but is not designed to cope with peak stormwater flows (ie is not a stormwater drain). It is always desireable to install 2 to 4 50mm slotted Ag drains leaving them open to the surface to further ensure good aeration at depth.

The technique could be modified to improve existing trees by auguring 300mm holes around ailing trees and backfilling with sand to allow slow salt removal and new effective rooting volume for sick trees. These well drained augur holes could then be connected with any surface trenches or slit drains to be installed.

Figure 2. Tree Replacement Detail.



In areas that are not salinised or prone to tidal inundation some compromise of this installation is possible, reducing topsoil sandy rootzone mix to say 200mm and reducing or even eliminating the 2m square “connection” replacing it with just two or three 300mm auger holes to allow some root penetration to depth.

Where no subsurface sandy layer exists that can practically be connected to, soil replacement and the reconstruction of A and B horizons will be required. Roughly this involves removal of surface 200-300mm, amelioration of the existing compacted subgrade buy ripping and application of ameliorants (eg lime and gypsum but subject to testing), and replacement of the A horizon with permeable sandy loam materials. There is little point in simply replanting trees in the present hostile physical conditions.

Effort expended at the planting stage is rewarded with faster growth rates, better structured root systems and better resistance to future stress.

6. **Apple Tree Bay.** The exact nature of the fill here is not known but surface conditions of turf and slow growth of trees indicate it is not favourable for park development. Since it is likely that considerable reconstruction is to occur at least on the bay front area the advice regarding reconstruction should be followed with 200-300mm of sandy rootzone soil installed. Drainage may not be required if some cross fall or slope occurs and/or slope lengths are less than 10m. Subgrade\s probably need amelioration by ripping and addition of ameliorants prior to replacement of topsoil. In other areas sand slitting, coring and fertilising may provide an adequate response for turf.

Summary

A range of easily identifiable soil related problems for both turf and trees can be found in Bobbin Head and Apple Tree Bay parks related to the history of bay reclamation, subsequent occasional tidal inundation and general management of tree rootzone conditions both physical and chemical.

While the areas have not been subjected to a systematic soil survey focussed on the needs of trees and turf, broad conclusions and recommended solutions can fairly confidently be identified based on the piecemeal work available. Choice and final design of a solution for a given area may in many cases require some site specific analysis.

Adverse soil physical conditions, where impermeable variously clayey fill overlies original sandy bay deposits, are virtually uniform across the sites. The severity of the poor drainage and soil aeration resulting from this inversion of the normal soil profile varies across the site with some areas having produced good growth of trees over the last 70-80 years and other areas virtual stunting suspension of plant growth.

Where these poor physical conditions have coincided with tidal inundation, trees have actually been killed or are in serious decline.

Landscape technology or urban soil science has advanced greatly in the last 15 years so that reliable and tested solutions to these problems are available. A series of interventions can be identified ranging from simple improvement in soil chemical properties to full reconstruction of the entire soil profile. The particular choice of option for a given area depends on the interaction of several considerations not least of which is cost. Further detailed site investigation is required before the best option (ie the cheapest option with a good chance of success) can be chosen. Progressing options should also be considered, eg fertilise now but plan to slit and core and replace individual trees within the next 5 years. The following Table attempts to provide a guide on the type and applicability of these interventions-

Intervention Program	Most applicable to-
1. Chemical Soil Amelioration (lime/dolomite and NPK fertiliser) or special corrections	Non saline areas of reasonable tree growth and performance and acceptable soil physical properties with valued specimen trees and turf
2. Sand Slitting, Coring and Topdressing	Non saline areas of worn turf, compacted tree rootzones and general improvement of all park areas
3. Strategic Topsoil Replacement	Stressed valued specimen trees, areas of compaction and desire line wear
4. Complete Reconstruction	All salinised areas and any area to be reconstructed including Apple Tree Bay
5. Individual or Group Tree Replacement	Any saline or non saline location outside of reconstruction areas where new major tree specimens are to be planted

It is not proposed that the reconstruction of salinised areas will completely cure the problem as subgrades may remain saline. Additional confidence will be provided by choosing tree species with some salt tolerance. In reconstructed areas the limitations of salt tolerance mean that some of the original, now heritage species, notably *Cupressus* species, may not be worth replanting.

Given the combined stresses of shade, compaction and high traffic use it is viewed as consumptive of resources and probably impossible to maintain grass cover in certain areas. In particular, for the areas around the heritage pavilions and intensively used desire lines hard or semi hard surfacing should be considered as the only practical solution. Options are artificial turf, pavers, stone flagging but all should be accompanied by drainage work to remove saline water after flooding occurs.

Simon W. Leake BScAgr(HonsI) AIAST ASPAC ASSSI 3/2/06
Principal Soil Scientist

Attachments: Test Results Chiefly Relied Upon

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FACSIMILE TRANSMISSION

Project:	**Bobbin Head and Apple Tree Bay Masterplan**	Date:	**6 Feb 2006**
	Ku-ring-gai Chase National Park	Project No:	**05231**
Subject:	**Review of Conybeare Report**	Page: 1 of	2
	"Bobbin Head Seawall Advice" Feb 2006	From:	**Mark Baker**

Addressee:	Attention:	Facsimile No:
Conybeare Morrison International	**Colin Polwarth**	**9380 7766**

Colin

As requested, we have reviewed the structural and maritime aspects of your report noted above.

Our only comments relate to the height by which it is proposed to raise the seawall and / or park in options2b, 2c, 3, 4 and 5, as follows (with all levels reduced to AHD):

1. As previously advised, we measured on 31st January 2006 that the tide reached a level approximately 245 mm higher than the predicted general high tide level. The level reached was about RL 1.33. The difference is due to stream inflow effects.

2. If the same difference was recorded at a highest astronomical tide (HAT) event, the tide would reach a level of about RL 1.42.

3. The lowest point of the seawall at Bobbin Head is at RL 1.37. We assume that this was at the top of a stone, as the 1.33 tide level went just over those parts of the capping stones near the perpend joints. The seawall level at Orchard Park in the stretch north of Bobbin Head Road varies from RL 1.37 to RL 1.60.

4. The lowest point of the asphalt parking area behind the seawall is at RL 1.02.
   The lowest levels of the landscaped park behind the seawall are at RL 1.15 (adjacent to the parking area behind the seawall) and RL 1.25 (near the pavilion).

5. There is no available flood study information to provide quantitative guidance on the probabilities of the water reaching different levels. We have recommended that such a study be undertaken.

6. If we allowed for a difference in water level (between tide chart height and that at Bobbin Head) of 50% more than what we measured on 31st January 2006, (to account for higher creek flow after storms), then a HAT event at Bobbin Head would reach RL 1.55.
   If we allowed twice the previous measurement, then the water would reach RL 1.675.

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7. Wharves and seawalls in Sydney Harbour are typically constructed at RL 1.575. This allows for 400mm freeboard above a HAT level, giving protection from wave overtopping.
   Given that Bobbin Head is reasonably sheltered, and that the possibility of a large vessel wave coinciding with an extreme tide is low, you might accept a freeboard of 100mm.
   This coincides with the maritime structures code prediction of sea level rise over 25 years.
   This gives levels of RL 1.65 (for 50% increase) and 1.775 (for 100% increase).

8. Without the flood study, we can not provide definitive guidance on the extent of raising necessary.
   However, a reasonable first guess may be to raise the seawall and land behind it to at least RL 1.80.
   This is a seawall rise of up to 330mm at Orchard Park.
   Note that the required minimum finished level of the landscaped areas of the park may be governed by the recommendations in the soil report that the agricultural drainage lines should be above the maximum predicted water level.

9. Your preliminary report to DEC should very clearly state that this level is a starting point for discussion purposes only, and that it needs to be verified by a flood study.
   Your report might also be better worded to note raising to a particular minimum level, rather than raising a set distance

Regards

Mark Baker.

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Appendix 3: Apple Tree Bay Seawall Advice Report - CM+

Apple Tree Bay Seawall Advice Report was produced by CM+ and Context with assistance of Taylor Lauder Bersten and SESL for DEC consideration in February 2006.

During the Masterplanning of Apple Tree Bay, DEC decided to adopt Option 3 in the report. Sea levels stated in this report are estimates only and subject to further investigation.

Please also refer to:

Appendix 1.6 - Improving Soil Conditions for Trees and Turf Report
Appendix 1.7 - Marine and Structural Engineering Report

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Conybeare Morrison

Bobbin Head + Apple Tree Bay Precincts
Ku-ring-gai Chase National Park
Apple Tree Bay Seawall Advice

February 2006

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Bobbin Head + Apple Tree Bay Precincts
Ku-ring-gai Chase National Park
Apple Tree Bay Seawall Advice

Prepared for Department of Environment + Conservation - Parks + Wildlife Division

February 2006

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Revision	Date	Description	By	Chk	App
01	Feb 06	Draft Report	CP/MY	WM	WM
02	Feb 06	FInal Report	CP/MY	WM	WM

EXECUTIVE SUMMARY

The Department of Environment and Conservation (DEC) and park management requested that Apple Tree Bay eastern parkland revetment / boat launch of Apple Tree Bay parklands be investigated as part of the 2006 Masterplan. Early advice on heritage, seawall and water edge design conditions are considered in this report. The construction of a seawall on a revetment is currently proposed by DEC for the 2006 financial year (end May 2006). Confirmation of the DEC proposal is required as part of the Conservation Management Plan, Landscape Management Plan and 2006 Masterplan. This report provides information on:

1. Background information on the landscape design and parking conditions, revetment, boat launch, land reclamation, safety conditions, vehicle and pedestrian conflict areas.
2. Heritage information regarding Apple Tree Bay, revetments, materials, natural and cultural heritage of the parklands.
3. Results of a Value Management Workshop to investigate the revetment, park landscape, and general amenity leading to a series of design options for this area of Apple Tree Bay parklands.
4. Recommendations for the parklands and seawalls that will be consistent with the Conservation Management Plans, Landscape Management Plans and Masterplanning 2006 vision, and Ku-ring-gai Chase National Park Plan of Management.

The water edge, parklands, launch area and parking construction should result in sustainable outcomes; taking precautionary management principles, intergenerational equity and best practice into account. The recommendations in this report confirm the preference for long-term objectives to achieve the Masterplanning vision of an enhanced visual experience of the passive recreational and landscape area at Apple Tree Bay. The recommendations include:

- Providing new amenities, improving existing amenities and the general environment.
- Providing a new canoe launching area and maintaining the boat launch facility.
- Ensuring the park is above the King tide levels.
- Constructing a new water front / edge
- Providing suitable drainage, utilities and irrigation systems.
- Creating a new informal landscape.
- Interpretation of heritage.
- Masterplanning new parking layouts to reduce the visual impact of vehicles on the park.
- Providing a safe, durable, enhanced water edge, with seating and shade areas.

Options 2, 3 and 4 presented in this report would achieve these objectives. This report has been prepared prior to community consultation and DEC management consideration. Consequently, this report should be regarded as preliminary. The Masterplan reports (and LMP / CMP) will be updated with future decisions regarding the selection of a preferred option.

CONTENTS

EASTERN WATER EDGE TREATMENT

1.0 Background

Apple Tree Bay parkland was reclaimed with fill on mud flats between 1955 and 1962. The park is generally used as an overflow parking area for boat trailers and cars from Bobbin Head. The northern edge of the park, along Apple Tree Creek, is formed by a sandstone seawall. The eastern edge comprises a jetty seawall, ramped concrete boat launch and a rubble revetment area leading to the water edge.

The Department of Environment and Conservation (DEC) reports safety concerns associated with the gently raking eastern revetment area. Rubble comprising reinforcing rods, broken brick and concrete blocks form the revetment. The revetment is unsightly and presents public safety concerns. DEC propose that a seawall should be erected to replace the existing revetment. Early advice is required regarding heritage, structural and geotechnical matters prior to works commencing (proposed in mid 2006).

The Patterson Britton Report (1997) on seawalls deals solely with the repair/restoration of the Bobbin Head seawalls. This report includes four options for the water edge treatment (eastern revetment area) at Apple Tree Bay. The Masterplanning vision proposes that Apple Tree Bay should be characterized as an informal parkland with increased grassed water edge areas for public amenity, seating and shade. The vision also proposes that the landscape design is naturalistic to ensure that Apple Tree Bay has a distinctly different quality to that of Bobbin Head. Optional designs are proposed to provide a distinctive water edge for this area of the precinct.

This Masterplanning approach would appear to be consistent with general environmental requirements of the Ku-ring-gai National Park Plan of Management 2002.

Water's edge at Apple Tree Bay (31/01/06)

Figure 1: Car Parking Layout Plan Apple Tree Bay

2.0 Report Objectives and Outcomes

This report provides early advice on options for the Department of Environment and Conservation to consider. The aim is to improve various aspects of the park environment including:

- Landscape design and outcomes
- Structures, revetments and seawalls
- Water edge treatments and amenities
- Heritage
- Additional drainage, parking and road services

This report is the first stage of an eight month Masterplanning program for DEC. This report is required to assist the development of a suitable strategy for the parkland CMP, LMP and general Masterplanning.

The report concludes with recommendations to DEC for the water edge / seawall and parkland treatments. This report will be attached to the Masterplan for Apple Tree Bay as an Appendix.

3.0 Observation and Analysis

The eastern water's edge of Apple Tree Bay comprises a flat raked stone and rubble revetment approximately 10-12m wide at low tide. Between the asphalt parking area and the revetment is a grassed parkland edge approximately 15-20m wide with an occasional tree plantings. This primary viewing and parkland area occurs at the entrance to the park and in front of the currently unoccupied kiosk and amenities.

The north-eastern portion of the revetment area terminates at a 20m wide (approximately) concrete boat launch ramp. The jetty seawall, bridge to the Birrawana Track and information board are located at the north eastern part of the ramp.

There are a number of conflicts in this area, some of which have public safety issues associated with them:

- Boat and canoe launching (and associated traffic) conflicts with pedestrian movements, jetty location, bridge / track commencement area, and the park foreshore.
- Traffic and vehicle movements conflict with park recreation and rest areas.
- Park entrance and recreation areas conflict with parking areas.

Some of these conflicts may be eased through careful Masterplanning and Landscape design, including relocation of parking, increasing park area, and relocating road and boat launching areas.

A proposal for an additional sand canoe launch area (raked) Apple Tree Bay should also be considered. This requirement should be regarded as desirable, but not mandatory, and subject to further consultation with stakeholders.

Jetty and boat ramp 2006

3.1. Revetment Material and Construction

Apple Tree Bay revetments were constructed of dumped sandstone rock, rubble and fill. Apple Tree Bay seawalls were constructed on the stone revetments, also consistent with seawall construction at Bobbin Head with repairs at various stages. See section 5.0 of this report for a historic outline. Additional historic research is currently being undertaken for Apple Tree Bay Conservation Management Plan.

The eastern edge revetment at Apple Tree Bay appears to have been modified or added to in later construction stages (possibly 1970). This is assumed from the appearance of brick, rubble concrete, reinforcing rods and other building rubble which can be seen in the revetment.

Sandstone has been used as the Seawall construction material at the water's edge at Apple Tree Bay. Although contemporary construction techniques will need to be employed to allow for a suitable water edge treatment, the retention and reinstatement of the sandstone is recommended. It is therefore appropriate to conserve existing sandstone, utilise contemporary construction techniques and traditional materials (sandstone) in-keeping with the historic precedent.

A number of representations have been made to DEC regarding other construction techniques and material use/selection for seawalls at Bobbin Head and Apple Tree Bay. DEC commissioned CM+ to investigate (through a Value Management Workshop (VMW)) the various issues associated with water edge and seawall construction. The outcomes of the VMW are considered necessary in advising future developments associated with seawalls at Apple Tree Bay. The VMW considered all known options for seawall construction including costing comparisons, constructability, structural suitability, labour costs, OHS, visual compatibility, heritage and material consistency implications.

Revetment area 2006

4.0 Value Management Workshop

A Value Management Workshop (VMW) was conducted on 20 January 2006 by CM+ (Masterplanning) in association with Context (Landscape Management Plan), CM+ (Conservation Management Plan), Taylor Lauder Bersten (Marine and Structural Engineering) and Sydney Environment and Soils Laboratory (Soils) with the assistance of Douglas Partners (Geotechnical Engineering) to provide DEC with a series of design and management options for discussion at the PCG meeting on 8 February 2006.

A Value Management Workshop (VMW) was formed to develop strategies to address the eastern water edge at Apple Tree Bay. The VMW decided to develop strategies leading to options for the water edge and parklands. Furthermore, a number of seawall, revetment and trafficable materials and construction techniques were evaluated. Consideration was given to seawalls and revetments built of:

1. Sandstone
2. Concrete blocks made to look like sandstone (factory and on-site variations)
3. Concrete blocks with pigments
4. Mass concrete with rock art to look like sandstone blocks
5. Mass concrete with sandstone facing

Design options are covered in Chapter 8.0 of this report.

4.1. VMW Outcomes

- Consideration was given to the financial implications of different construction techniques and materials. It appears (subject to further investigations) that concrete block and mass concrete seawall construction is considerably less expensive than traditional sandstone construction.
- Concrete mass walls of a variety of types including block and ‘mock-rock’ types appear to be simpler to construct than sandstone walls.
- All concrete types of seawalls (Items 2-5 inclusive listed above) appear to be easier and less expensive to construct than mass sandstone seawalls.
- Well-constructed concrete sea walls were regarded as having similar and possibly greater durability results than sandstone seawalls.
- Suitably treated concrete seawall options, including pigmented and decorated blocks (to look like sandstone) and mock-rock type constructions, do not achieve similar visual results nor match with natural or treated sandstone.
- Sandstone was considered an appropriate material to achieve material integrity, allow for the conservation of the historic, social and aesthetic significance of the existing sandstone seawalls and enable a continuation of an already established construction technique to be employed (‘repair and replace as you go’).
- A variety of sandstone options were considered including imported (non- local sandstone) dressed and treated sandstone. In all cases the sandstone material integrity was considered desirable.
- DEC management confirmed that labour costs for sandstone seawall construction were lowered through ordering appropriate block sizes which is compatible with OHS and DEC machinery availability.
- Economic considerations should be investigated further by DEC to determine the appropriate utilisation of public funds and the probable premium paid for the seawall being re-built in sandstone.

4.2. Recommendation Regarding the Selection of an Optional Design

Apple Tree Bay eastern water edge provides an opportunity for an alternative water edge treatment to the existing.

The VMW concluded that the gentle rake of the landform to the water edge was highly desirable and provided an opportunity for this primary viewing area to have distinctive qualities unique to Apple Tree Bay. Therefore a variety of design options, with a recommended preferred design, would be presented to DEC at the next PCG meeting for consideration.

Depending on the outcome of the option selection, materials could be ordered and the design documented in advance to achieve the management requirements for this area to be made safe during the current financial year.

5.0 Revetment Heritage Considerations

The history of the construction of the Apple Tree Bay reclamation is being prepared and will be outlined in the CMP later in 2006. Various photographic and documented evidence of the construction and chronology of the seawalls will be identified. The following chronology indicates the development of the site from the early 1900s:

- Apple Tree Bay was also known as “Burnside” and Apple Tree Flat. From the early 1900s Apple Tree Flats was accessed by a carriage track from Hornsby and Mt Colah (in part following the Birrawana Track) for recreational activities including picnicking, fishing, swimming and camping. From Hawkesbury Station steamers conveyed passengers on a five-hour round trip along the Hawkesbury River sometimes taking in Cowan Creek.
- In 1927 mention is made of baths at Apple Tree Bay being washed away.
- Map from 1927 shows a footbridge crossing at Apple Tree Bay (see Figure x)
- Road built from Bobbin Head to Apple Tree Bay in 1937-38. A kiosk is reported to be in use at Apple Tree Bay with plans showing a kiosk located along the connecting road.
- In 1941 mention is made for plans for Cottage for Chief Ranger on the site
- Plans dating to February 1949 show the Proposed Reclamation at Apple Tree Bay, Cowan Creek, for Ku-Ring-Gai Chase Trust. Reclamation works start in 1955 and continues until 1962.
- An undated plan shows reclaimed area at Burnside, Apple Tree Bay, Ku-Ring-Gai Chase with remains of “old retaining wall” at the eastern water’s edge with backfill. Change rooms and toilet are located on the eastern side of Apple Tree Creek, accessed by way of a timber bridge.
- Undated plans show camping and caravan areas with toilet facilities along Apple Tree Creek.
- Proposed Garages, Office and Amenities at Apple Tree Bay - Plans Elevations and Sections; are prepared by RC Smith & Assoc in December 1962 and the Kiosk and Toilet block completed in 1963.
- Existing boat ramp on the southwest side of the beach constructed in 1970.
- Site surveys of 1973 show boat ramp, toilet, garage and kiosk and beach with dumped hard fill.

Figure 2: Broken Bay Parish Map 1927

6.0 Revetment Heritage Implications

For over 100 years Apple Tree Bay has been used for outdoor recreational pursuits including picnicking, fishing, camping and boating. Access was initially by track built in the early 1900s, with a road constructed in 1937-38. Apple Tree Bay was developed following reclamation of land in the mid-1950s when seawalls were built 1955-1962 along Apple Tree Creek and at the mouth of the creek to create Apple Tree Bay's extended recreation area. It is unclear whether any causeway structure was built at an earlier phase. The seawall has been modified since the 1955 – 1962 period and numerous schemes have been prepared and implemented to deal with parking, boating and picnicking. The eastern water's edge has been modified and boat ramps relocated thereby reducing the heritage significance of this element. This provides opportunities for future changes and developments to the water's edge treatment of the revetment area.

7.0 Landscape Design Intentions

Apple Tree Bay's amenities and landscape design are proposed to be enhanced. The landscape design intention is to make a distinctive landscape; informal, naturalistic, with endemic planting and varying topographic form.

New amenities and facilities should be designed be integrated with the naturalistic parklands atmosphere.

The landscape design intention is to reduce the visual impact of parking and boat launching facilities, while maintaining these important facilities. Hard surfaces will be reduced, and grassed water edge treatments increased. Seating and shade areas at the water's edge will be increased.

The parkland grassed areas and plantings will integrate with the surrounding bushland, creeks, sea and skyline.

Foreshore area Apple Tree Bay 2006

8.0 Options

Four design options are presented in this report. Each option has specific visual and amenity outcomes, which are also presented in this report for consideration and include the following:

- Analysis and limitations
- Impacts
- Budget framework
- Assessment
- Advantages and disadvantages
- Recommendation/s

The options covered include:

Option 1 – Seawall edge
Option 2 – Jetty edge
Option 3 – Rocks and tidal edge
Option 4 – Relocated boat launch and rock edge

General

- Under current legislation, balustrading at new seawalls may be required, dependant on water depth and height at jetty edge.
- Balustrades may be required at level changes in excess of 1000mm at new retaining walls.
- A comparative analysis of the options is included in the conclusion to this report.

8.1. Option 1 – Seawall edge (currently proposed)

- DEC currently propose to build a vertical seawall of sandstone on top of the current revetment area.
- Continues the water edge condition located along Apple Tree Creekline.

Analysis and limitations of the option:
- Meets timing / financial obligations.
- Increases grassed area.
- Allows for a raised public interface with the water edge.
- Low maintenance solution.
- May require a 1000mm high balustrade.
- Provides new canoe launch area.
- Does not resolve the vehicle / pedestrian conflict.
- Provides a potential pedestrian connection to Bobbin Head.

Impact: New structural foundations and seawall construction. Removal of the existing revetment and rubble. Additional fill is required.
Budget framework: Finances allocated in the current financial year for this proposal.
Assessment: Other options should be considered which are consistent with a naturalistic park edge and offer additional amenity.
Recommendation: Not recommended.

Figure 3: Option 1

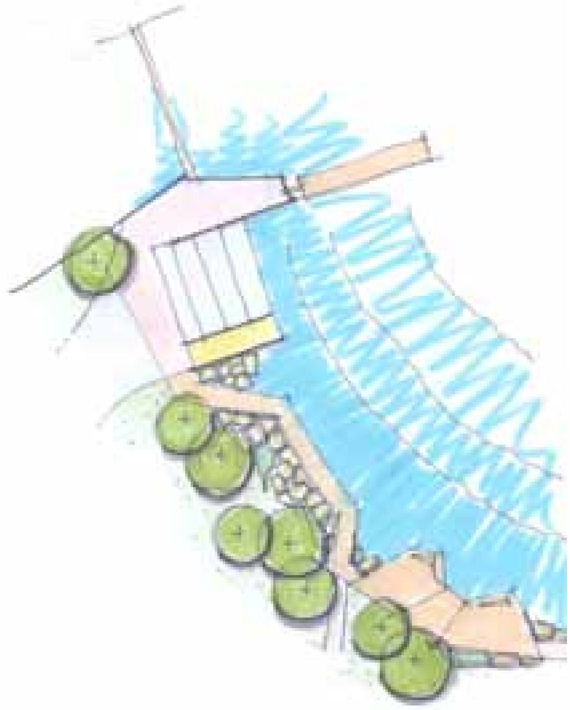
8.2. Option 2 – Jetty edge

- This design option proposes the construction of a timber deck with boulders in an informal design. A baluster may be required at the deck edge.

Analysis and limitations of the option:

- Possible higher costs and maintenance than Options 1 and 3.
- Increases grass and public domain area.
- Provides a varied recreation area at the water's edge.
- Naturalistic edge to the park which compliments the environment.
- Provides new canoe launch area.
- Does not resolve the vehicle / pedestrian conflict.
- Provides a potential pedestrian connection to Bobbin Head.
- Increases access to and relationship with water.

Impacts: New foundations, superstructure and decking. Adds variety to the parkland edge. A balustrade forms a new visual element in the landscape.
Budget framework: Consideration should be given to higher maintenance and capital costs.
Assessment: This option should be considered as it provides an enhanced user and park experience.
Alternative: The decking could extend out over the water's edge as a jetty. This alternative design would require an REF. A balustrade would not be required if the jetty overhangs the water. A jetty would provide boat mooring opportunities.
Recommendation: This option should be considered.



PLAN

Figure 4: Section – Option 2a

8.3. Option 3 – Rocks and tidal edge

- This option proposes large sandstone boulders laid in tiers and terraces as differing levels, inclined into the water, forming rock pools, with an informal track winding through the rocks.

Analysis and limitations

- Possible to meet timing and financial objectives with this design.
- Increases grassed area.
- Provides an opportunity at the water edge which compliments the environment.
- Sandstone rocks echo the geological and natural sea edge seen in the area – and are consistent with the sandstone seawall of the park.
- Provides new canoe launch area.
- Does not resolve the vehicle / pedestrian conflict.
- Provides a potential pedestrian connection to Bobbin Head along the sea edge.
- Provides a low cost maintenance and design solution.
- Colonisation of tidal areas by oysters and sea molluscs should be considered.

Impacts: Additional fill is required. Existing revetment is to be removed. Large sandstone boulders would be transported and located on site. New pathway is required. Detail design development required to achieve construction in this financial year.

Budget framework: Minor cost increases over Option 1 - seawall due to size of boulders required.

Assessment: This design option provides an excellent opportunity to utilise sympathetic materials in a naturalistic setting for the edge treatment. The design would be consistent with Landscape Design intentions for the rest of Apple Tree Bay.

Recommendation: This is the preferred design option for the eastern water edge treatment.

Figure 5: Option 3

Option 3 – Sketch of water's edge

8.4. Option 4 – Relocated boat launch and rock edge

- The boat and canoe launch area (ramps) are proposed to be relocated to the southern end of the eastern revetment area.

Analysis and limitations of the option

- The relocated boat and canoe launch area minimises pedestrian and vehicle conflict areas and severance of the parklands.
- Additional Masterplanning would be required to resolve boat launching requirements at the entrance to the park.
- The boat launch area would mark the beginning of the potential pedestrian track to Bobbin Head.
- Links the parklands at the water edge continuously.
- Reduced sustainability indexing due to reconstruction.

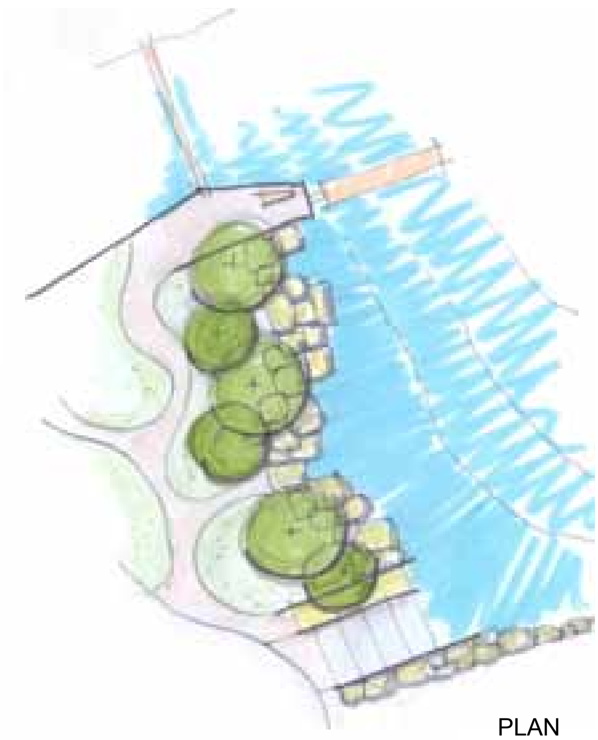
Impacts: Masterplanning redevelopment is required to ensure this proposal resolves conflict areas, especially potential traffic conflicts at the park entrance. Additional costs include relocation of the boat ramp. REF may be required.

Budget framework: High capital costs due to relocation of existing facility. Low on-going maintenance.

Assessment: A considerable improvement to the condition of the park which resolves the conflict and safety concerns associated with vehicle movements in a park. Potential conflicts at the entrance area to the park would require further design investigation. The outcome would be consistent with the parkland vision, and Masterplanning objectives.

Recommendation: We recommend this option be considered for a permanent solution to the problems of parking and pedestrian movement conflicts at the water edge at Apple Tree Bay.

Figure 6: Option 4



9.0 Conclusion

Options 1-4 present a number of advantages and disadvantages for DEC to consider for the eastern water edge / boat launch area at Apple Tree Bay. The long term improvement of the Apple Tree Bay parklands, amenities and environment require additional stakeholder and community consultation input.

The existing revetment area should be redeveloped to provide a safe and interesting water edge that extends the park to the water, preferably both physically and visually. There is a history of on-going revetment alteration, which would allow for the redevelopment of this area of the parklands. Environmental considerations, especially marine conditions at the water's edge should also be taken into account

Masterplanning new parking layouts to reduce the impact of vehicles on the park and to reduce vehicle and pedestrian conflicts – especially at the boat launch area should be given serious consideration and further design development.

The selection of the preferred option should be consistent with the landscape design proposal for Apple Tree Bay.

Options 2, 3 & 4 provide an alternative eastern water edge treatment that is consistent with the landscape design intentions.

10.0 Documentary Sources

- Patterson Britton & Partners Pty Ltd; 1997; Bobbin Head and Apply Tree Bay Seawall Restoration and Management Plan.
- GHD; Plan of Management – Ku-ring-gai National Park Plan of Management.

11.0 Report Limitations

11.1 This report was produced without any information on flooding and tidal conditions.

11.2 Additional detail design will also be required including the involvement of geotechnical, structural, drainage, soil and utility engineers with detail documentation by the landscape architects.

11.3 Soil testing at Apple Tree bay is required to establish conditions for landscaping.

11.4 Drainage engineering, in association with Masterplanning and traffic engineering is required to reduce vehicle impact, pedestrian conflicts.

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Appendix 4: Summary Submissions Report

This report was prepared by CM+ on behalf of Department of Environment and Conservation and National Parks and Wildlife Services. The report is a summary of all submissions received in relation to the Masterplanning process and especially the public exhibition of the Draft Masterplan in July 2006.

The Summary Submissions Report is supported by the Detailed Submissions Report (stand alone document) which includes all submissions received by National Parks and Wildlife Services and tabulated responses. The detailed submissions were presented to the External Stakeholders and Project Control Group in July 2006. The Summary Submissions Report contains the recommendations for the masterplan improvements, which were incorporated in the final documents.

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Summary Submissions Report - Bobbin Head and Apple Tree Bay

2006 Draft Masterplan

NSW National Parks and Wildlife Service

Department of Environment and Conservation NSW

Bobbin Head + Apple Tree Bay Masterplans
Ku-ring-gai Chase National Park

Summary Submissions Report - Bobbin Head and Apple Tree Bay 2006 Draft Masterplan Summary

July 2006

Prepared for:
Department of Environment + Conservation

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Revision	Date	Description	By	Chk	App
01	04/06/06	Draft	CP	MW	CP
02	24/07/06	Final	CP	MW	CP

NSW National Parks and Wildlife Service

Department of Environment and Conservation NSW

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Masterplanning
Conservation Management Plan

Context Landscape Design

Landscape Management Plan

Sub-Consultants:

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Flora Report and Fauna Information

AMBS
Aboriginal Research and Analysis

Arup
Traffic and Transport Planning

Bay Partnership
Quantity Surveying

Douglas Partners
Geotechnical Engineering

PPM Consultants

Community Consultation

Stratcorp
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Contents

Acknowledgements and thanks

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Graeme Mitchell	Assistant Regional Manager, LHA	NPWS
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Melanie Tyas	Assistant Area Manager	NPWS
Yma ten Hoedt	Planning Coordinator	DEC
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Mark Withford	Regional Works Coordinator, Sydney North Region	NPWS
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Glen Crombie	Ranger, Ku-ring-gai Chase National Park	NPWS
Joanna Edney	Assistant Area Manager	NPWS
Michele Cooper	Senior Ranger, Neighbour + Community Relations Officer,	NPWS
Vince Moult	Assistant Area Manager	NPWS
Peter Milgate	Senior Field Supervisor (KCNP)	NPWS

CM+ and the Consulting Team wish to extend their special thanks to Chris McIntosh, Graeme Mitchell, Oriana Senese, Glen Crombie, Robyn Aitkin and Mark Withford for their great assistance with this project. Michele Cooper assisted with all liaison with the general public in relation to the Masterplanning process.

The Consultant Team Personnel were:

Bill Morrison	Company Director	Conybeare Morrison (CM+)
Colin Polwarth	Associate in charge of design	CM+
Lynette Gurr	Senior heritage specialist	CM+
Kate Denny	Heritage specialist	CM+
Michelle Yik	Urban designer	CM+
Rohini Mehta	Project administrator	CM+
Oi Choong	Company director	Context
Ben Dungey	Landscape architect	Context
Astrid Brokamp	Landscape architect	Context
Alan Duncan	Company director	Bay Partnership (Quantity Surveying)
Leesi Lo	Quantity surveyor	Bay Partnership
Mark Baker	Company director	Taylor Lauder Bersten (Structural, marine & heritage engineering)
Andrew Sutton	Engineer	Taylor Lauder Bersten
Andrew Hulse	Associate	ARUP Traffic and transport engineering
Brett Maynard	Traffic and transport engineer	ARUP
Carolyn Stone	Company director	PPM Consultants (Facilitator)
Richard Simon	Company director	Stratcorp Recreational Planners
Brendon Ryan	Senior Project Manager	AMBS (Flora and Fauna)
David Thomas	Sub-contractor (botanist)	AMBS (Flora)
Dr Melissa Carter	Project Manger	AMBS (Aboriginal heritage)
Alison Nightingale	Senior Project Manager	AMBS

Simon Leake	Company director	SESL (Soils consultant_
Peter Oitmaa	Associate	Douglas Partners (Geotechnical engineering)

The project was directed by Bill Morrison and Oi Choong; the Masterplans were authored by Colin Polwarth with the assistance of Michelle Yik. The Conservation Management Plans were authored by Lynette Gurr with assistance from Kate Denny, and the Landscape Management Plans were authored by Ben Dungey with assistance from Astrid Brokamp. CM+ wish to extend their thanks to the entire consulting team for their efforts and goodwill.

Special thanks goes to the community who assisted at various workshops and community consultation days, and for reading, reviewing and commenting on the Masterplan and for being involved in the process.

External Stakeholders

The External Stakeholders gave freely of their time, their enthusiasm and intimate knowledge of the parklands which was of enormous benefit to the Masterplanning team. The External Stakeholders included:

NAME (no order)	**Organization**
Pam Goldie	Chase Alive
Margarita Clayton	Coast Alive
Kurt Henkel	Landscape Coordinator, Hornsby Shire Council
Veronica Cook	Bobbin Inn Lessee
Miranda Heath	SNR Bobbin Head Information Centre
Stephen Smith	Empire Marina Bobbin Head
Stephen Black	Regional Manager, NSW Waterways
Alan Catford	National Parks Assoc.
John Roberts	Hornsby Shire Historical Society
Gordon Limburg	Hornsby Conservation Society
David Martin	Hornsby Conservation Society
Cindy Budai	Kayak and Canoe Inc.
John Stefas	Kayak and Canoe Inc.
Rodney Brown	Whittley Motor Boat Club of NSW
John Blundell	Apple Tree Bay Boat Owners Assoc.
Coral Blundell	Apple Tree Bay Boat Owners Assoc.
Geoff Gauslar	Apple Tree Bay Boat Owners Assoc.
Terrie Jenner	Boat Owners Association
Peter Stanford	Bobbin Head Cruising Lions Club Inc
Lavinia Schivella	Boating Industry Association
Bruce Foot	Gibberagong Field Studies Centre
Steven Head	Director, Open Space Ku-ring-gai Council
Jennifer Davis	District Officer, NSW Fisheries
Patricia Giles	SNR Advisory Committee
Lynn Parker	River Canoe Club

Abbreviations

AMBS
Australian Museum Business Services
AHIMS
Aboriginal Heritage Information and Management Systems
CMP
Conservation Management Plan
COAG
Council of Australian Governments
DDA
Disability Discrimination Act
DEC
Department of Environment and Conservation
DMR
Department of Main Roads
EMP
Environmental Management Plan
EP&A
Environmental Planning and Assessment
EPBC
Environment Protection and Biodiversity Conservation Act
EPRD
Environmental Protection and Regulation
ICOMOS
Australian Charter for the Conservation of Places of Cultural Significance
IDA
Integrated Development Approvals
KCNP
Ku-ring-gai Chase National Park
KCT
Ku-ring-gai Chase Trust
KCLC
Ku-ring-gai Chase Local Committee
LEP
Local Environmental Plan
LMP
Landscape Management Plan
MLALC
Metropolitan Local Aboriginal Land Council
NPWS
National Parks and Wildlife Service
NSW
New South Wales
REF
Review of Environmental Factors
SESL
Sydney Environmental and Soils Laboratory
TSC
Threatened Species Conservation Act

SUBMISSIONS SUMMARY REPORT

Background
This is a summary of the consultation process and submissions received in response to the public exhibition of the 2006 Draft Masterplans for Bobbin Head and Apple Tree Bay.

This Summary Report identifies general comments and matters raised by the general public regarding the Draft Masterplans for Bobbin Head and Apple Tree Bay. Recommendations are included in this report to improve the final Masterplans as a result of the public exhibition and submissions made in response to the Draft Masterplans.

The “Detailed Submissions Report” for Bobbin Head and Apple Tree Bay 2006 Draft Masterplan supports this summary report and provides a comprehensive assessment of the submissions received. Reference to this report is required to view copies of the original submissions.

Advertisement of the Masterplaning process and consultation
The Masterplanning process included considerable consultation with various public interest groups. The detail of this consultation process is captured in the Masterplanning documents (Volumes 1-3 inclusive) as part of the design methodology. The Draft Masterplan public exhibition period was widely advertised from the outset of the Masterplanning process in January / February 2006.

Paid advertising of the Draft Masterplan public exhibition period (May / June 2006) was undertaken in newspapers with a readership estimated to be in excess of half a million people.

Availability of Masterplans for comment
The Draft Masterplans, including the Draft Masterplan Summary and illustrative drawings were made available to the public and stakeholders for comment, with pre-prepared feedback forms on the DEC website from 26 May 2006 for a period of 26 days; the submission period was closed on Monday 19 June 2006.

The Draft Masterplan documents were released in stages as follows:

22 May 2006	Masterplan Summary, illustrative drawings and pre-prepared feedback forms were posted on the DEC website.
26 May 2006	Volumes 1-3 inclusive (reports and drawings) were available on the DEC / NPWS website for downloading, reference and printing. Although time consuming (due to the size of the files) the documents could be downloaded and printed.
30 May 2006	Volumes 1-3 inclusive (reports and drawings) were available for public comment at the following locations:

- Ku-ring-gai Chase National Park, Bobbin Inn
- DEC Parramatta Office
- Hornsby Council
- Hornsby Library
- Ku-ring-gai Council Offices
- Ku-ring-gai Library

There were no known or recorded impediments to the submissions being received by DEC / NPWS. DEC / NPWS regard the period that the documents were available and the period for the submissions to be made to be adequate; based on previous experience with similar processes and projects.

Submissions received

Eight submissions were received in various written formats by email, fax and by post:

- Four submissions complimented and endorsed the Masterplan with minor recommendations,
- One criticised the Draft Masterplans completely.
- Three submissions criticised limited aspects the Masterplans and made minor recommendations.

The low submission rate is ascribed to the following factors:

- A thorough community and stakeholder consultation process was undertaken during the Masterplanning of Bobbin Head and Apple Tree Bay, with all major issues incorporated into the Draft Masterplan.
- General availability of DEC / NPWS personnel and the Consulting Team (5 months) to resolve issues raised by interest groups and the general public during the whole of the Masterplanning process, including two External Stakeholder Meetings and two Community Workshops and presentations. Minutes of these meetings are available in a detailed submissions report.
- Extensive consultation with DEC / NPWS personnel and especially the KCNP rangers, which helped the Masterplanning team understand the issues associated with the parklands.
- Stage 1 Community consultation concluded with 211 responses with most issues incorporated into the Draft Masterplan.
- Stage 2 Presentation of the Preliminary Draft Masterplan to community groups and external stakeholders in a workshop format with most issues incorporated into the masterplan. A minute of this meeting is available in the detailed submissions report.
- Consultation with RTA.
- Consultation with the NPWS Advisory Committee.
- The continuous availability of pre-prepared Feedback Forms to the general public regarding the Masterplan.
- A carefully considered consultation and Masterplanning process designed and managed by DEC and NPWS.
- Masterplans that achieve the project objectives.

Consequently, the extensive consultation and associated design resolution has led to general acceptance of the content of the Draft Masterplans. The low submission response supports this conclusion.

In respect of the eight submissions received regarding the Draft Masterplans, approximately 51 questions / comments were raised, some with recommendations:

- 32 of the queries or comments were of a detailed nature, and did not propose any changes to the planning of the parklands.
- 9 comments were inconsistent with the Masterplanning objectives and process.
- 18 questions required clarification only.
- 3 comments were related to maintenance matters.

The detailed comments and queries were presented to the Project Control Group and External Stakeholders at presentations on 5 July 2006.

As a consequence of the quality of the submissions received, the following amendments to the text in the Masterplans are recommended:

RECOMMENDATIONS

Recommendation 1

Both Bobbin Head and Apple Tree Bay Masterplans should make reference to emergency planning procedures for the safety of the parkland assets and users.

Recommendation 2

Three submissions objected to the re-planting of exotic and non-indigenous tree species in Bobbin Head. However, there was general community support, DEC concurrence and notably a substantive requirement and policy in the CMP for:

1. Exotic tree species to be re-planted in the Wharf Area, Orchard Park North and South to ensure the heritage characteristics of this cultural landscape are sustained.
2. Native trees of non-local provenance continue to be planted in Gibberagong Park North and South to enhance the existing characteristics of the parklands.

Consequently, and due to general support for the draft policy, no change is required to the Masterplan. The policy regarding tree planting is to be clarified, and a specific amendment to the Ku-ring-gai Chase National Park Plan of Management 2002 Clause 4.1.6 is to be updated accordingly.

Recommendation 3

Apple Tree Bay will be planted with native trees of local provenance only. Turf would be the only exotic plantings permitted in Apple Tree Bay. This policy will create distinctive parkland characteristics.

Recommendation 4

32 minor amendments and clarifications will be made to the Masterplan (as identified in the detail submission report) to ensure that future stages of the parkland improvements do not overlook submissions and related recommendations.

Recommendation 5

In general, the Draft stage of the Masterplans is regarded as complete. The Masterplan is generally accepted by the Project Control Group and the External Stakeholders as a successful, and includes resolved and thoroughly considered Masterplans.

The recommendations listed above should be incorporated and endorsed by DEC, and the Masterplan updated, finalised and adopted.

DEC / NPWS Management responses and professional editing

Amendments to the Draft Masterplan will occur under the direction of DEC Management to achieve final Masterplan status. The Draft Masterplan will also be professionally edited to achieve final Masterplan status. The results will be reported to the External Stakeholders in Meeting No 4 in August 2006, when the Masterplan is completed and presented.

Consultancy Team
The Consultancy Team and DEC will ensure that the sprit and general undertakings included in the Draft Masterplan will not be materially altered, to ensure that the final Masterplan represents the Vision and Objectives established in the Draft Masterplan.

NPWS Advisory Committee
Presentation of this report and the submissions made in response to the Draft Masterplan are to be presented to the NPWS Advisory Committee for committee approval.

Final Masterplan
The final Masterplan with amendments is recommended to be endorsed by DEC / NPWS in August 2006.

Advisory Committee Comments:

Appendix 5: Other Consultant Reports

These reports were commissioned prior to the commencement of the Masterplan process.

Arborist Report - The Tree Wise Men

During detailed stages of the implementation of the Masterplan it was recommended that the 2004 arborists report be updated to include the following.

1. Consistent plan and report numbering of trees
2. Correct naming and identification of trees
3. Updated SULE values of trees

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THE TREE WISE MEN
AUSTRALIA PTY LTD

TREE CARE AND CONSULTANCY

Arborist's Report
(Tree Hazard Management Report)
For
Bobbin Head and Apple Tree Bay Picnic Areas
Ku-ring-gai Chase National Park
Bobbin Head NSW

Prepared for:

NSW National Parks and Wildlife Service
Central Service Office
PO Box 1967
HURSTVILLE NSW 2220

Ref: 1443HazMangt **July, 2004**

DISCLAIMER

This Report has been prepared for the exclusive use of the Client and Tree Wise Men Australia Pty Ltd (TWM) accepts no responsibility for its use by other persons.

The Client acknowledges that this Report, and any opinions, advice or recommendations expressed or given in it, are based on the information supplied by the Client and on the data, inspections, measurements and analysis carried out or obtained by Tree Wise Men Australia Pty Ltd (TWM) and referred to in the Report. The Client should rely on the Report, and on its contents, only to that extent.

Peter Castor
Director

BSc (For.)
Member: AIH, NAAA, ISAA, IACA

30 July, 2004

TABLE OF CONTENTS

ATTACHMENTS

1. BACKGROUND

1.1 This Tree Hazard Management Report (THMR) was prepared for NSW National Parks and Wildlife Service in relation to trees located in Bobbin Head and Apple Tree Bay Picnic Areas within Ku-ring-gai Chase National Park. (the subject site) The Bobbin Head area comprises three areas: Orchard Park, Gibberagong and Public Wharf areas.

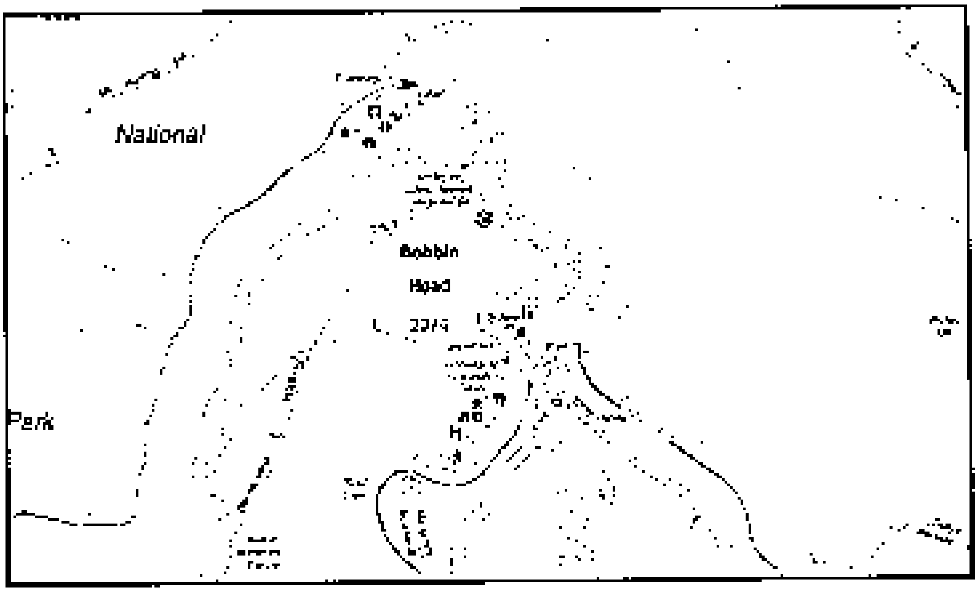


Figure 1: Indicative location of subject site[1].

1.2 This THMR should be read in conjunction with *Preliminary Advice for Urgent Works.* (Ref 1443PA.) prepared by Tree Wise Men Australia Pty. Ltd. 28 July, 2004 which identified the H5 (Very High Hazard Trees). In general the subject site was well managed and hazard free.

The purpose of this THMR is to update the existing tree data contained in GHD report of 1999 and to provide tree hazard abatement recommendations for the trees within and adjacent to the subject site. Regular hazard assessments are required due to the constantly changing nature of the tree defects and the exposure to storms. The frequency of assessment also needs to reflect the people movements (targets) within the fall zone of the trees. This THMR will provide an independent assessment to supplement the assessments routinely undertaken by NSW National Parks and Wildlife Services Staff.

[1] UBD Sydney and Blue Mountains Digital Street Mapping on CD-ROM (Mapping data derived from UBD Sydney & Blue Mountains Street Directory 39th Edition).

1.3 The Hazard Ratings and recommended remediation works are based on the assessor's years of collective study and practical experience in this field. The additional bushland trees adjacent to the picnic areas contained most of the problem trees of concern.

1.4 The tree numbering system from the GHD report has been adopted. Trees which have been removed have been deleted, resulting in a non - consecutive numbering system. New trees have been given the number of the closest tree with an alpha suffix added. For example Tree 76A is a new tree in the vicinity of Tree 76.

1.5 The subject site comprised various public recreation areas and facilities, carparking and carriageway surrounded by bushland and waterways. Refer to the attached Tree Plans (X4) for tree locations. Note the Tree Schedules on the supplied GHD Tree Survey plans have been deleted as this data has been superseded by the current Tree Schedules (Attachment D)

1.6 A total of two hundred and ninety one (291) trees have been included in this assessment: one hundred and eighty six (186) in Bobbin Head and one hundred and five (105) in Apple Tree Bay. The additional trees were made up of new plantings within the turfed areas and adjacent bushland trees deemed hazardous during the assessment. Trees with trunk diameter (DBH) <150mm were excluded given their limited hazard potential. The additional trees have been plotted by hand on the supplied plans and should be accurately surveyed if the survey is to be used for construction or landuse planning purposes. Additional trees were tagged with white plastic 75mm x 75mm billets to assist location.

1.7 This THMR acknowledges and complies with the *Guidelines for Tree Assessment and Maintenance*, prepared by NSW National Parks and Wildlife Service, 2001. Refer to Section 3, *Discussion of Tree Hazard* for discussion on the Tree Hazard Rating and tree hazard issues.

2. METHODOLOGY

2.1 In preparation of this THMR ground level, visual tree assessments (VTA)[7] were undertaken on 5th and 6th July, 2004. No aerial (climbing) inspections, woody tissue testing or tree root mapping were undertaken as part of these assessments. All trees were visually assessed including a walk around the base of each tree to ensure no external trunk defects were missed (Photo A), Tree 86, Grey Gum, *Eucalyptus punctata*, Apple Tree Bay). Brief discussions were held on-site with NSW National Parks and Wildlife representatives including Peter Milgate, a qualified Arborist.

2.2 The terms, Diameter at Breast Height (DBH), Age Class, Vigour, Condition, Primary Root Zone (PRZ), Safe Useful Life Expectancy (SULE),Hazard Rating Landuse have been used throughout this Report and in the Tree Schedules. Refer to the footnotes to the Tree Schedules for further detail.

2.3 Tree heights have been estimated and trunk diameter at breast height (DBH) was estimated at 1.4 metres above ground level with a fabric diameter tape and rounded to the nearest 0.1 metre. Primary Root Zones (PRZ) have been rounded to the nearest 0.5 metre. The vigour of the trees was rated Good, Fair or Poor and Safe Useful Life Expectancy (SULE) estimated.

All tree offsets mentioned in this Report are to centre of trunk unless otherwise stated.

2.4 The Site Photographs (Attachment A) were taken by the author at the site inspection.

2.5 The Work Schedule recommendations are based on the findings from the site inspections, the arboricultural experience of the assessor and acknowledgement of the *Guidelines for Tree Assessment and Maintenance*.

2.6 It should be noted in the Tree Schedule for Apple Tree Bay included in the *Preliminary Advice for Urgent Works* that Trees 89 – 94 inclusive were wrongly identified as Sydney Peppermint, *Eucalyptus piperita*. These trees were in fact Grey Gum, *Eucalyptus punctata* and this information has been corrected in this document.

[7] VTA-Visual Tree Assessment undertaken by tree professionals, is a recognised (International Society of Arboriculture) systematic method of identifying tree characteristics and hazard potential. Journal of Arboriculture, Vol. 22, No. 6, Nov. 1996. VTA is also an assessment method described by Claus Mattheck in *The body language of trees – A handbook for failure analysis*. The Stationery Office London (1994)

3. DISCUSSION OF TREE HAZARD

3.1 The degree to which a tree was hazard rated involved three different components.

1. a tree with a potential to fail (limb or whole tree)
2. an environment that may contribute to that failure (tree exposed to storms)
3. a person or object that would be injured or damaged by a failure(target)

3.2 Features which collectively or alone can create a potential for tree or limb failure are many and varied and includes:

- tree species
- exposure to storms
- soil depth and proximity of rock or structures
- offset to recent earthworks or construction
- trunk lean (Photos A, C)
- wood decay
- cavities (Photo B)
- deadwood formation
- poor trunk or branch taper
- end loading of horizontal limbs
- weak or unusual branch attachment
- bark inclusions within branch junctions (Photo D)
- bushfire damage
- termite activity (Photo B)
- insect or cockatoo damage (Photo E)
- stock quality at planting
- planting density

All these features have been considered in assigning the Hazard Rating

3.3 The above ground natural environment in which the trees stand for all intents cannot be altered. The ground conditions can to some degree be managed (e.g soil decompaction and or fertilizer usage). The ground (root zone) features have been considered in assigning the Hazard Ratings.

3.4 Assumptions have been made relating to people movements (targets) based on soil compaction, turf condition, location of sealing, picnic facilities and carparking. No detailed people movement study has been made and no study has been referred to. For the purposes of this report High or Extreme people movement have been assumed within the fall zones of the assessed trees. Detailed knowledge of people movements adjacent to trees may justify the reduction of or increase Hazard Ratings. If there is no target there is no hazard.

3.5 Hazard Assessments need to be undertaken at a frequency to match the probability of injury or damage which arises from the three components identified at 3.1 above. It should be acknowledged that all standing trees have a degree of inherent hazard potential which needs to be considered against other tree values. Visual Tree Assessment (VTA) undertaken from ground level is, in most instances, adequate to identify hazards.

3.6 More detailed assessments require aerial (climbing) inspections, trunk or limb drilling to assess decay and hollows (stem strength loss) and root crown excavation to assess structural root damage. These more detailed assessments should be applied if retention of H5 and H4 trees is sought.

Root crown assessment needs to be undertaken by a qualified Arborist with knowledge of the common wood decay fungi. Litter and topsoil should be removed to 200-300mm to reveal the structural roots at the base of the tree. If decay is suspected drilling using a small diameter drill or Resistograph® should be undertaken to determine extent of decay.

To determine status of trunk hollows, the trunk at near ground level is to be drilled to measure dimension of sound wood. If sound wood thickness is less than 30% of the trunk radius, at the drill level, tree removal or drastic lopping is required (Mattheck, 1997, *The Body Language of Trees*, p38).

3.7 Assessment of subterranean termite colonies (*Coptotermes acinaciformis*) should be undertaken as part of the trunk drilling. This termite species generally has a nest at the base of the tree. The assessor should be familiar with this species of termite. Termite investigations should be undertaken routinely as part of tree hazard monitoring. Arboreal nests (*Nasutitermes walkeri*) are indicators of possible internal defects resulting from the internal feeding of this termite species.

The structural status of trees and parts of trees can be degraded rapidly due to termite activity.

3.8 Tree Removal decisions making must be justified. The habitat, historical, anthropological, social and amenity landscape values need to be considered prior to removal.

Removal of trees may be avoided by moving the target, prohibiting people movements within the drop zone or fall zone. the fall zone is equivalent to the radius of the height of the tree. The demand for picnic facilities and recreational space must be factored against the value of tree retention.

Heavy lopping of the tree may avoid removal. This may however result in unacceptable amenity given the resulting disfigured form. The comparable costs of removal versus lopping and ongoing monitoring needs to be considered. It is often cheaper to fall a tree than to lop one or two limbs given the labour and machinery costs. T76G, (Bobbin Head) Sydney Red Gum, *Angophora costata* (H4) has a fall zone radius of 25m into picnic areas in Gibberagong. Given the trunk lean, limb removal required and number of picnic areas which would otherwise need to be moved it may be better to remove this tree completely. The pruning required would further reduce the already sparse canopy of this over-mature tree.

All pruning works should comply with AS 4373, 1996, Pruning of Amenity Trees and the WorkCover NSW Code of Practice for the Amenity Tree Industry, 1998. Where nesting hollows are to be retained in branch stubs or hollow trunks a variation to the pruning requirements is justified.

Propping, guying, cabling or other engineering solutions to enable tree retention have not been considered in this THMR. There may be select trees of exceptional value which justify such works.

3.9 Tree pruning to be undertaken needs to reflect the potential for failure and the likelihood of injury or damage. Major deadwood >30mmØ only needs to be removed overhanging public areas. Pruning of live limbs or co-dominant trunks should only be undertaken where clearly identifiable defects exist (e.g bark inclusions T32B, Blackbutt, *Eucalyptus pilularis* in Bobbin Head).

3.10 Other arboricultural treatments which will indirectly reduce tree decline and tree hazard potential include:

- Soil decompaction and organic mulching within Primary Root Zone (Photo F). Although this will reduce turf areas, mulched areas can still be used for recreation purposes, will reduce incidence of mower damage and improve tree health.
- Select tree species proven to be good performers on the subject site.

3.11 Appropriate tree species selection will, over time, reduce potential tree hazard. The recent removal of Coral Trees, *Erythrina x sykesii* will significantly reduce tree hazard as this species has a predisposition for unexpected major limb failure.

Tree species selection for replanting needs to reflect the aims and objectives of subject recreation areas. Non-indigenous tree species (especially deciduous) can be used especially where winter solar access is a priority. All Selected species should not be listed as weeds or potential weeds in Ku-ring-gai National Park or in neighbouring municipalities.

Tree species which were observed to be performing well in the subject area were:

- Cheese Tree, *Glochidion ferdinandi*
- Sydney Peppermint, *Eucalyptus piperita*
- Southern Mahogany, *Eucalyptus botryoides*
- Grey Gum, *Eucalyptus punctata*
- Grey Ironbark, *Eucalyptus paniculata*
- Broad-leaved Paperbark, *Melaleuca quinquenervia*
- Brushbox, *Lophostemon confertus*
- Hoop Pine, *Araucaria cunninghamii*
- Swamp Sheoak, *Casuarina glauca*

Non-indigenous tree species which could be considered include:

- London Plane Tree, *Platanus x hybrida*
- Queensland Kauri Pine, *Agathis robusta*
- Jacaranda, *Jacaranda mimosifolia*

4. HAZARD REDUCTION WORKS SCHEDULE

ACTIVITY	TIMING SCHEDULE	HAZARD CATEGORY				
		H5	H4	H3	H2	H1
Barricade and signpost dropzone/fallzone. Consider permanent removal of targets (including facilities) to allow tree retention.	Immediately	✓	✓			
Action recommended pruning or removal works. ○ The size of part likely to fall is as described in Tree Hazard Classification (indicators column) Guidelines for *NSW NPWS Tree Assessment and Maintenance*. ○ The 1, 2 and 5 year timing options are generalized and reflect the severity of the hazard and expected budgets. For cost efficiency reasons it is often better to undertake all pruning works under a single contract. ○ All pruning to comply with AS4373 unless habitat values require retention of hollows.	Within 1 calendar year	✓	✓			
	Within 2 years			✓		
	Within 5 years				✓	✓
If H5 or H4 tree to be retained further detailed assessment (aerial, root crown, trunk drilling, termite) of the defective part required within 1 calendar year. Aerial (climbing) assessment can be undertaken during pruning works. Root crown, drilling and termite assessments should precede pruning/removal. If tree deemed to be adequately sound hazard Rating should be downgraded.	Within 1 calendar year			✓		
Re-assessment of Hazard Ratings following pruning works. (Hazard Ratings should be down graded)	Immediately following work	✓	✓	✓	✓	
Undertake independent hazard assessments (all trees) in addition to routine NPWS assessments	Annually	✓	✓	✓	✓	✓
Other arboricultural treatments which indirectly will reduce tree hazard for trees in turf & heavy traffic areas: ○ Consider soil decompaction within dripline with replacement of turf with organic mulch.	For consideration				✓	✓
Selection of appropriate tree species for new plantings (See 3.11 of attached report)	For consideration					

ATTACHMENT A: SITE PHOTOGRAPHS

Photo A: Root crown assessment Tree 86 Grey Gum.

Photo B: Tree 32E Sydney Peppermint, multiple defects (H5 Bobbin Head).

Photo C: Tree 76G Sydney Red Gum (Over-mature, lean and 25 metre fall radius. H4)

Photo D: Tree 328 Blackbutt Bark inclusion potential failure point.

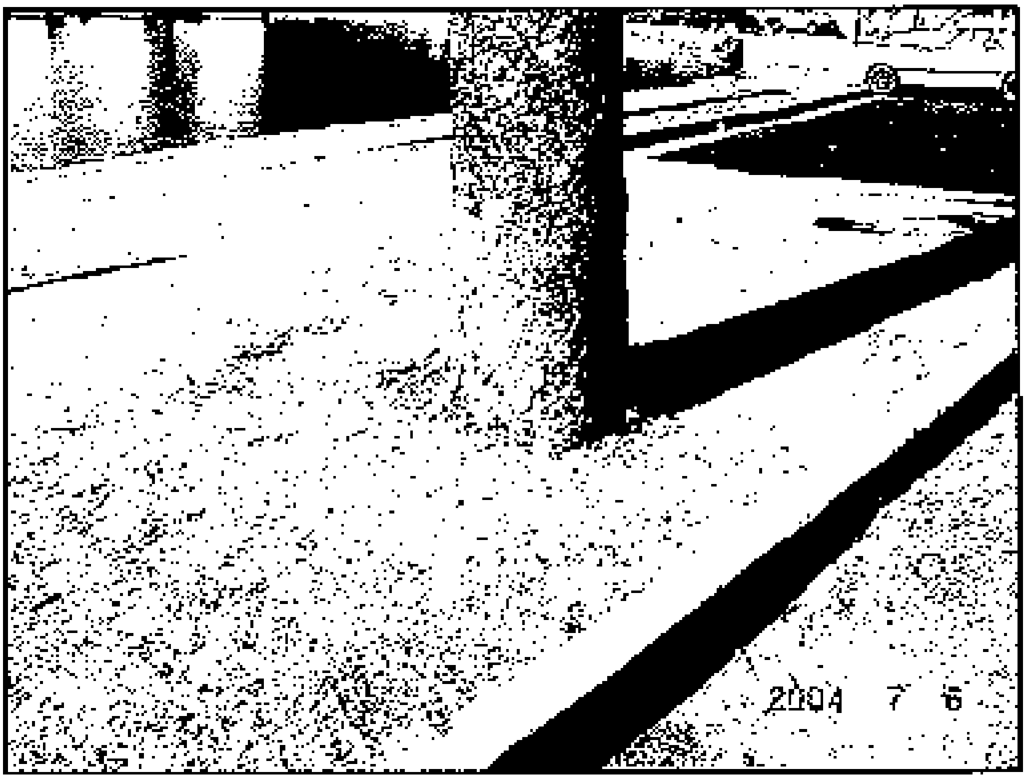


Photo E: Tree 143 Norfolk Island Pine (Bobbin Head).

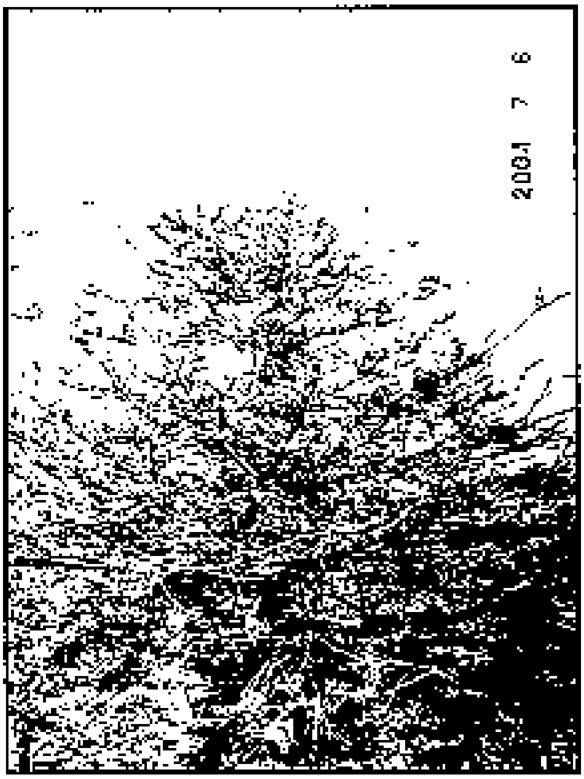


Photo F: Tree 47 Norfolk Island Pine (Bobbin Head) Cockatoo damage.

ATTACHMENT B: TREE SCHEDULE – BOBBIN HEAD

Tree Schedule - Bobbin Head Picnic Area: Ku-ring-gai Chase National Park

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
1	Sydney Red Gum, *Angophora costata*	0.4	10	4	SM	G	G	4.0	L	H1					B	T						*Basal wound.*
1 A	Sydney Peppermint, *Eucalyptus piperita*	0.6	18	6	M	G	F	6.0	L			H3			B	T				P		*Termite workings, branch hollows.*
2	Southern Mahogany, *Eucalyptus botryoides*	0.5	19	6	M	G	G	5.0	L	H1						T						*Termite workings.*
2 A	Sydney Red Gum, *Angophora costata*	0.5	15	6	SM	F	F	5.0	L		H2				B							*Deadwood to 100mm.*
2 B	Sydney Peppermint, *Eucalyptus piperita*	0.5	24	6	M	G	G	5.0	L		H2				B	T				P		
3	Southern Mahogany, *Eucalyptus botryoides*	0.6	24	6	M	G	G	6.0	L	H1						T			CP			
3 A	Sydney Peppermint, *Eucalyptus piperita*	1.0	23	6	M	G	F	10.0	L		H2					T			CP	P		*Termite workings.*
3 B	Sydney Red Gum, *Angophora costata*	0.9	20	8	M	F	F	9.0	L				H4		B	T				P		*Remedial pruning required.*
3 C	Sydney Red Gum, *Angophora costata*	1.1	20	6	OM	P	P	11.0	M				H4		B	T				P		*Remedial pruning required.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
4	Broad-leaved Paperbark, *Melaleuca quinquenervia*	Multi	12	4	M	G	G	4.0	L		H2					T			CP			
4 A	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	9	2	SM	F	F	3.0	M	H1						T						
6	Southern Mahogany, *Eucalyptus botryoides*	0.5	16	4	M	G	F	5.0	L		H2					T			CP			
7	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	8	3	SM	G	G	3.0	L	H1						T						
8	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.1	5	1	IM	F	F	2.0	M	H1						T						
10	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.4	10	4	SM	G	G	4.0	L	H1						T			CP	P		*Soil compaction evident.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
11	Southern Mahogany, *Eucalyptus botryoides*	0.5	17	5	M	G	G	5.0	L		H2					T			CP	P		
11 A	Sydney Red Gum, *Angophora costata*	0.3	13	2	SM	F	F	3.0	M	H1						T			CP	P		
12	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.5	11	3	M	G	G	5.0	L	H1						T			CP			*Soil compaction evident.*
12 A	Sydney Peppermint, *Eucalyptus piperita*	0.3	9	4	SM	G	G	3.0	L	H1						T			CP	P		
14	Southern Mahogany, *Eucalyptus botryoides*	0.5	22	3	M	G	G	5.0	L			H3				T	PD		CP	P		*Deadwood to 150mm.*
15	Cheese Tree, *Glochidion ferdinandi*	Multi	7	3	M	G	G	4.0	L	H1						T			CP			
16	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	6	3	SM	F	G	3.0	L	H1						T			CP			
18	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	8	2	SM	G	G	3.0	L	H1						T			CP	P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
19	Swamp Sheoak, *Casuarina glauca*	0.3	9	3	M	G	G	3.0	L	H1						T	PD		CP	P		
20	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	6	3	SM	P	F	3.0	S				H4			T	PD		CP			
21	Swamp Sheoak, *Casuarina glauca*	0.3	13	3	M	G	G	3.0	L	H1						T	PD		CP			
22	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	8	4	SM	G	G	3.0	L	H1						T	PD		CP			
23	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.3	7	3	SM	G	G	3.0	L	H1						T	PD		CP			
24	Cheese Tree, *Glochidion ferdinandi*	0.1, 0.1	4	2	IM	F	F	2.0	M	H1						T	PD					*Soil compaction evident.*
25	Broad-leaved Paperbark, *Melaleuca quinquenervia*	Multi	6	3	SM	G	F	4.0	L		H2					T	PD		CP			*Soil compaction evident. Lean over path.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
26	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.4	8	4	M	G	G	4.0	L	H1						T	PD		CP			
27	Silky Oak, *Grevillea robusta*	0.4	13	3	M	F	G	4.0	M	H1						T			CP			
27 A	Blackbutt, *Eucalyptus pilularis*	0.3	10	3	SM	G	G	3.0	L	H1						T			CP			
27 B	Blackbutt, *Eucalyptus pilularis*	0.3	10	2	SM	G	G	3.0	L	H1						T			CP			
27 C	Sydney Blue Gum, *Eucalyptus saligna*	0.3	7	2	SM	G	G	3.0	L	H1						T			CP			
27 D	Tuckeroo, *Cupaniopsis anacardioides*	Multi	3	3	SM	F	P	4.0	S		H2					T						
27 E	Swamp Sheoak, *Casuarina glauca*	0.2	6	3	SM	G	G	2.0	L	H1						T	PD					
27 F	Swamp Sheoak, *Casuarina glauca*	0.2	5	2	SM	G	G	2.0	L	H1						T	PD					
27 G	Sydney Peppermint, *Eucalyptus piperita*	0.3	6	4	SM	G	G	3.0	L	H1						T						*Within current work zone.*
27 H	Sydney Blue Gum, *Eucalyptus saligna*	0.3	6	3	SM	F	F	3.0	S		H2					T			CP			*Borers & soil compaction evident.*
27 I	Grey Gum, *Eucalyptus punctata*	0.3	9	4	SM	G	G	3.0	L	H1						T			CP			

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
27 J	Swamp Sheoak, *Casuarina glauca*	0.2 - 0.3	6 - 8	2 - 3	SM	G - F	G	3.0	L	H1						T			CP			*Surface roots adjacent kerb.*
29	Eucalypt, *Eucalyptus spp.*	0.6	24	6	M	F	F	6.0	L				H4			T			CP	P		*Major deadwood over picnic area & significant trunk lean.*
29 A	Coachwood, *Ceratopetalum apetalum*	Multi	16	5	M	G	F	4.0	L		H2				B	T				P		
29 B	Cheese Tree, *Glochidion ferdinandi*	Multi	12	4	M	G	G	4.0	L	H1						T				P		
29 C	Blueberry Ash, *Elaeocarpus reticulatus*	0.4	12	3	M	F	F	4.0	M		H2					T				P		
29 D	Sydney Peppermint, *Eucalyptus piperita*	0.6	24	6	OM	F	P	6.0	Remove					H5	B	T				P		*Arboreal Termite nest, major deadwood.*
31	Sydney Red Gum, *Angophora costata*	1.0	25	8	OM	F	F	10.0	M				H4		B					P		*On rock ledge. Major deadwood, lean over picnic area.*
31 A	Coachwood, *Ceratopetalum apetalum*	0.3, 0.3	14	3	M	F	F	4.0	L		H2				B	T				P		*Adjacent gas storage.*
31 B	Cheese Tree, *Glochidion ferdinandi*	0.3	13	2	SM	G	F	3.0	L	H1										P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
31 C	Cheese Tree, *Glochidion ferdinandi*	0.3	14	3	M	G	G	3.0	L	H1										P		
31 D	Cheese Tree, *Glochidion ferdinandi*	0.3	14	3	M	G	F	3.0	L	H1										P		
32	Cheese Tree, *Glochidion ferdinandi*	0.4	14	4	M	G	F	4.0	L	H1						T				P		
32 A	Sydney Red Gum, *Angophora costata*	0.3	11	2	SM	P	F	3.0	S		H2					T				P		*Borer & deadwood to 100mm.*
32 B	Sydney Peppermint, *Eucalyptus piperita*	Multi	13	5	SM	G	F	4.0	L				H4			T			CP	P		*Bark inclusion.*
32 C	Swamp Mahogany, *Eucalyptus botryoides*	0.3	14	3	SM	G	F	3.0	L	H1						T				P		
32 D	Cheese Tree, *Glochidion ferdinandi*	0.3	12	3	M	G	G	3.0	L	H1						T				P		
32 E	Sydney Peppermint, *Eucalyptus piperita*	0.7	27	5	OM	F	P	7.0	Remove					H5	B					P		*Termites, trunk lean & major deadwood. Trunk hollow.*
32 F	Sydney Red Gum, *Angophora costata*	0.6	26	4	M	F	F	6.0	M		H2				B					P		
32 G	Sydney Red Gum, *Angophora costata*	0.6	24	5	M	G	F	6.0	L		H2				B	T				P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
33	Tuckeroo, *Cupaniopsis anacardioides*	0.5	9	6	M	G	G	5.0	L		H2					T			CP	P		*Soil compaction evident*
34	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.7	11	4	M	G	G	7.0	L		H2					T				P		
34 A	Sydney Peppermint, *Eucalyptus piperita*	0.4	13	5	M	G	F	4.0	L			H3			B					P		*Deadwood.*
34 B	Sydney Red Gum, *Angophora costata*	1.2	23	10	M	F	F	12.0	L			H3			B	T						
35	Broad-leaved Paperbark,	0.9	12	5	M	G	G	9.0	L		H2					T			CP			
35 B	Sydney Peppermint, *Eucalyptus piperita*	0.5	25	5	M	F	F	5.0	L			H3			B	T						
35 C	Sydney Red Gum, *Angophora costata*	0.9	17	8	M	P	F	9.0	L			H3			B	T				P		*Overhanging picnic area.*
36	Norfolk Island Pine, *Araucaria heterophylla*	0.5	10	4	M	F	F	5.0	L		H2					T			CP		O	*Top missing.*
38	Norfolk Island Pine, *Araucaria heterophylla*	0.6	20	4	M	G	G	6.0	L		H2					T		CW			O	
39	Grey Gum, *Eucalyptus punctata*	0.3	9	4	SM	F	G	3.0	L		H2					T		CW		P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
41	Norfolk Island Pine, *Araucaria heterophylla*	0.7	13	4	M	G	F	7.0	L		H2					T			CP	P		*Top missing. Cockatoo damage.*
43	Norfolk Island Pine, *Araucaria heterophylla*	0.6	14	4	M	G	G	6.0	L		H2					T			CP	P	O	*Top missing. Cockatoo damage.*
45	Norfolk Island Pine, *Araucaria heterophylla*	0.5	13	4	M	F	F	5.0	L		H2					T			CP	P	O	*Dwarfing of foliage.*
47	Norfolk Island Pine, *Araucaria heterophylla*	0.5	12	4	M	F	F	5.0	L		H2					T		CW		P	O	
48	Norfolk Island Pine, *Araucaria heterophylla*	0.5	7	4	M	P	F	5.0	S		H2					T			CP	P		*Top missing. Soil compaction evident.*
50	Cottonwood, *Populus deltoides*	1.0	22	8	M	G	F	10.0	M				H4			T					O	*Scaffolds over play gym, soil compaction evident.*
51	Norfolk Island Pine, *Araucaria heterophylla*	0.7	14	5	M	G	F	7.0	L		H2					T			CP			*Top damaged, cockatoo damage, soil compaction evident.*
53	Norfolk Island Pine, *Araucaria heterophylla*	0.6	15	4	M	G	F	6.0	L		H2					T			CP			*Cockatoo damage.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
56	Norfolk Island Pine, *Araucaria heterophylla*	0.6	16	4	M	G	F	6.0	L		H2					T			CP			*Cockatoo damage.*
58	Norfolk Island Pine, *Araucaria heterophylla*	0.6	19	4	M	F	F	6.0	L		H2					T			CP			*Cockatoo damage. Soil compaction evident.*
59 A	Red Bloodwood, *Corymbia gummifera*	0.3	11	3	SM	G	G	3.0	L		H2					T						
60	Norfolk Island Pine, *Araucaria heterophylla*	0.6	18	4	M	G	F	6.0	L		H2					T			CP	P		*Soil compaction evident.*
62	Norfolk Island Pine, *Araucaria heterophylla*	0.6	18	4	M	F	G	6.0	L		H2					T			CP	P		
63	Cottonwood, *Populus deltoides*	0.5	15	6	M	G	F	5.0	M			H3				T				P		*Deadwood to 150mm.*
64	Norfolk Island Pine, *Araucaria heterophylla*	0.5	17	4	M	F	G	5.0	L		H2					T			CP			
65	Red Bloodwood, *Corymbia gummifera*	0.4	13	4	SM	G	G	4.0	L		H2					T						*Soil compaction evident.*
66	Norfolk Island Pine, *Araucaria heterophylla*	0.5	13	4	M	G	F	5.0	L		H2					T			CP			*Cockatoo damage.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
68	Norfolk Island Pine, *Araucaria heterophylla*	0.5	15	4	M	G	F	5.0	L		H2					T			CP	P		
70	Norfolk Island Pine, *Araucaria heterophylla*	0.6	10	5	M	G	F	6.0	L		H2					T			CP	P		*Top missing.*
72	Norfolk Island Pine, *Araucaria heterophylla*	0.7	13	5	M	G	F	7.0	L		H2					T			CP	P		*Top missing.*
74	Norfolk Island Pine, *Araucaria heterophylla*	0.6	12	5	M	G	F	6.0	L		H2					T			CP	P	O	
75	Norfolk Island Pine, *Araucaria heterophylla*	0.5	12	5	M	F	F	5.0	L		H2					T			CP	P	O	
76 A	Norfolk Island Pine, *Araucaria heterophylla*	0.6	11	5	M	F	F	6.0	M		H2					T			CP		O	
76 B	Sydney Red Gum, *Angophora costata*	0.7	13	8	M	F	F	7.0	L				H4		B							*Base not inspected, further investigation required.*
76 C	Sydney Peppermint, *Eucalyptus piperita*	0.8	12	5	OM	F	P	8.0	Remove					H5	B				CP	P		
76 D	Sydney Red Gum, *Angophora costata*	0.5	8	-	-	-	-	-	Remove					H5	B					P		*Dead.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
76 E	Grey Gum, *Eucalyptus punctata*	0.6	16	4	OM	P	P	6.0	M				H4		B	T				P		*Remedial pruning required.*
76 F	Sydney Red Gum, *Angophora costata*	0.5	14	5	M	F	F	5.0	L			H3			B	T				P		*Deadwood to 150mm.*
76 G	Sydney Red Gum, *Angophora costata*	1.2	25	5	OM	F	P	12.0	L				H4		B	T				P		*Major limb removal required.*
76 H	Sydney Red Gum, *Angophora costata*	1.0	23	8	M	F	F	10.0	L			H3			B	T				P	O	*Pavilion within fall zone.*
76 I	Sydney Red Gum, *Angophora costata*	0.8	20	4	OM	P	P	8.0	M			H3			B	T				P	O	
76 J	Sydney Peppermint, *Eucalyptus piperita*	0.6	16	5	OM	F	P	6.0	L			H3			B	T				P	O	*Deadwood removal required.*
77	Swamp Mahogany, *Eucalyptus robusta*	0.4	13	4	SM	F	G	4.0	L		H2					T			CP	P		
78	Pepper Tree, *Schinus areira*	0.4	4	3	M	P	P	4.0	Remove				H4			T						
79	Swamp Mahogany, *Eucalyptus robusta*	0.3	11	3	SM	P	G	3.0	M			H3				T			CP			
81	London Plane Tree, *Platanus x hybrida*	1.0	27	8	M	G	G	10.0	L		H2					T			CP	P	O	
83 A	Sydney Red Gum, *Angophora costata*	0.7	18	5	M	F	F	7.0	M		H2				B					P		*Base not inspected, further investigation required.*
84	Jacaranda, *Jacaranda mimosifolia*	0.4	11	3	M	G	F	4.0	L		H2					T			CP	P	O	

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
85	Magenta Lillypilly, *Syzygium paniculatum*	0.6	18	5	M	P	F	6.0	L			H3				T			CP	P		*90% defoliated (possum).*
85 A	Sydney Red Gum, *Angophora costata*	0.9	22	8	OM	P	P	9.0	Remove				H4		B	T			CP	P		*Recent pruning, branch hollows.*
86	Illawarra Flame Tree, *Brachychiton acerifolius*	0.5	13	3	M	F	F	5.0	L		H2						PD		CP			*Monitor trunk junction/inclusion.*
86 A	Sydney Peppermint, *Eucalyptus piperita*	0.7	24	6	M	G	F	7.0	L				H4		B		PD		CP			*Major deadwood.*
86 B	Dead	0.3	7	-	-	-	-	-	Remove					H5	B	T				P		
87	Jacaranda, *Jacaranda mimosifolia*	0.4	13	4	M	G	F	4.0	L			H3				T	PD					*Lean.*
88	*Yellowwood,*	0.8	9	4	M	G	G	8.0	L		H2					T			CP	P		*Soil compaction evident.*
92	Swamp Sheoak, *Casuarina glauca*	0.3	13	4	M	G	G	3.0	L		H2					T				P		*Soil compaction evident.*
93	Swamp Sheoak, *Casuarina glauca*	0.4	15	4	M	G	G	4.0	L		H2					T			CP	P		
94	Swamp Sheoak, *Casuarina glauca*	0.4	13	4	M	G	G	4.0	L		H2					T			CP	P		
94 A	Swamp Sheoak, *Casuarina glauca*	0.1 - 0.2	6 - 12	1 - 3	IM	F - G	F -G	2.5	L	H1						T		CW				
95	Swamp Sheoak, *Casuarina glauca*	0.4	14	5	M	G	F	4.0	L				H4			T		CW	CP	P		*Inclusion at 2m, remove one leader.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
96	Swamp Sheoak, *Casuarina glauca*	0.3	10	3	SM	G	G	3.0	L		H2					T		CW				
97	Swamp Sheoak, *Casuarina glauca*	0.4	17	4	M	G	G	4.0	L				H4			T		CW		P		*Soil compaction evident, inclusion at 4m.*
98	Swamp Sheoak, *Casuarina glauca*	0.4	16	4	M	G	G	4.0	L		H2					T		CW		P		*Soil compaction evident.*
99	London Plane Tree, *Platanus x hybrida*	1.2	19	7	M	G	F	12.0	L			H3				T				P		*Trunk hollow, not likely to be critical.*
101	Grey Gum, *Eucalyptus punctata*	0.5	25	4	M	G	G	5.0	L		H2					T		CW	CP	P		
102	Jacaranda, *Jacaranda mimosifolia*	0.4	10	4	M	G	F	4.0	L		H2					T		CW	CP			
103	Norfolk Island Pine, *Araucaria heterophylla*	0.6	24	4	M	G	G	6.0	L		H2					T		CW	CP	P		*Cockatoo damage.*
104	Silver Poplar, *Populus alba*	0.5	12	6	M	G	G	5.0	L			H3				T				P		*Minor trunk hollow.*
105	Claret Ash, *Fraxinus raywood*	0.4	5	3	M	F	P	4.0	S			H3				T	PD	CW				
105 A	Cedar, *Cryptomeria spp.*	0.3, 0.3	5	4	M	G	F	4.5	L		H2					T		CW		P		
105 B	Jacaranda, *Jacaranda mimosifolia*	0.4, 0.3	11	6	M	G	G	5.5	L	H1						T		CW		P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
106	Silver Poplar, *Populus alba*	0.5, 0.5	11	7	M	G	F	7.5	M			H3				T		CW		P		*Recent limb drop & pruning.*
106 A	Norfolk Island Pine, *Araucaria heterophylla*	0.2	6	2	IM	G	G	2.0	L	H1						T		CW				
107	Liquidambar, *Liquidambar styraciflua*	0.5	17	5	M	G	G	5.0	L		H2					T				P		
108	Bhutan Cypress, *Cupressus torulosa*	0.1	4	1	IM	G	G	2.0	L	H1						T	PD					
109	Bhutan Cypress, *Cupressus torulosa*	0.1	4	1	IM	G	G	2.0	L	H1						T	PD					
110	Bhutan Cypress, *Cupressus torulosa*	0.1	4	1	IM	G	G	2.0	L	H1						T	PD					
111	Bhutan Cypress, *Cupressus torulosa*	0.1	4	1	IM	G	G	1.0	L	H1						T	PD					
112	Monterey Cypress, *Cupressus macrocarpa 'cv'*	0.8	23	4	M	F	F	8.0	M			H3				T	PD			P		
114	London Plane Tree, *Platanus x hybrida*	0.7	17	5	M	G	G	7.0	L		H2					T						*Soil compaction evident.*
115	Monterey Cypress, *Cupressus macrocarpa 'cv'*	0.7	10	6	M	F	F	7.0	L		H2					T				P		*Soil compaction evident.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
116	Cabbage Tree Palm, *Livistona australis*	0.3	16	2	M	G	G	3.0	L	H1							PD	CW	CP			
117	Monterey Cypress, *Cupressus macrocarpa 'lei'*	0.7	7	5	M	P	F	7.0	S		H2					T			CP			
117 A	Cypress, *Cupressus spp*	0.2	4	2	IM	F	G	2.0	L	H1						T						Possum forage.
118	Queen Palm, *Arecastrum romanzoffianum*	0.3	11	2	M	G	G	3.0	L	H1						T			CP			
119	Broad-leaved Paperbark, *Melaleuca quinquenervia*	1.1	12	6	M	G	G	11.0	L	H1						T						Soil compaction evident.
120	Coast Redwood, *Sequoia sempervirens*	1.2	28	4	M	F	G	12.0	L		H2							CW		P		
120 A	Norfolk Island Pine, *Araucaria heterophylla*	0.2	6	2	IM	G	G	2.0	L	H1						T		CW				
120 B	Norfolk Island Pine, *Araucaria heterophylla*	0.1	4	1	IM	G	G	2.0	L	H1						T		CW				
121	Coast Redwood, *Sequoia sempervirens*	1.2	28	4	M	F	G	12.0	L		H2							CW		P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
122	Cabbage Tree Palm, *Livistona australis*	0.3	12	2	M	G	G	3.0	L		H2				B			CW				
122 A	Cabbage Tree Palm, *Livistona australis*	0.3	8	2	M	G	G	3.0	L		H2					T		CW	CP			
123	Prickly-leaved Paperbark, *Melaleuca styphelioides*	Multi	13	3	M	G	G	4.0	L		H2					T			CP			
123 A	Sydney Peppermint, *Eucalyptus piperita*	0.7	26	6	M	G	F	7.0	M			H3			B				CP	P		*Trunk lean & deadwood.*
123 B	Grey Gum, *Eucalyptus punctata*	0.6	23	6	M	F	F	6.0	M			H3			B			CW		P		*Adjacent road. Major deadwood, upslope of picnic area*
123 C	Norfolk Island Pine, *Araucaria heterophylla*	0.1	4	1	IM	G	G	2.0	L	H1						T		CW				
123 D	Norfolk Island Pine, *Araucaria heterophylla*	0.1	4	1	IM	G	G	2.0	L	H1						T		CW				
126	Blackbean, *Castanospermum australe*	0.3	8	3	M	F	F	3.0	M		H2					T	PD	CW				
127	London Plane Tree, *Platanus x hybrida*	0.8	22	6	M	G	F	8.0	M		H2					T			CP			*Basal cankers to be monitored. Surface root damage.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
127 A	Norfolk Island Pine, *Araucaria heterophylla*	0.2	6	2	IM	G	G	2.0	L	H1						T		CW				
128	Swamp Sheoak, *Casuarina glauca*	0.5	24	4	M	G	G	5.0	L		H2					T			CP			
129	Rough-barked Angophora, *Angophora floribunda*	0.3	12	3	M	F	F	3.0	L			H3				T			CP			
129 A	Grey Gum, *Eucalyptus punctata*	1.0	25	6	M	F	P	10.0	M					H5	B				CP			*Termites, major deadwood & trunk lean.*
129 B	Port Jackson Fig, *Ficus rubiginosa*	0.5, 0.3	17	5	M	G	G	6.5	L	H1					B						O	*Over hanging toilet block.*
129 C	Rough-barked Angophora, *Angophora floribunda*	0.5	14	4	M	F	F	5.0	M				H4		B				CP			*Basal hollows.*
129 D	Grey Gum, *Eucalyptus punctata*	0.6	23	6	M	F	F	6.0	M				H4		B						O	*Upslope of toilet block.*
130	Sydney Peppermint, *Eucalyptus piperita*	0.5	20	5	M	P	F	5.0	S				H4			T		CW	CP	P		*Dieback.*
130 A	Rough-barked Angophora, *Angophora floribunda*	0.7	20	5	M	G	G	7.0	L		H2				B	T				P		

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
131	Yellowwood, *Podocarpus falcatus*	1.0	12	6	M	G	G	10.0	L		H2					T				P		*Soil compaction evident.*
132	Norfolk Island Pine, *Araucaria heterophylla*	0.6	18	4	M	G	G	6.0	L		H2					T		CW	CP	P		
133	Small-fruited Fig, *Ficus microcarpa var Hillii*	Multi	14	6	M	P	F	4.0	S				H4			T		CW		P		
134	Willow Bottlebrush, *Callistemon salignus*	0.3	7	3	M	F	F	3.0	L		H2					T				P		*Soil compaction evident.*
135	Norfolk Island Pine, *Araucaria heterophylla*	0.3	13	4	SM	F	F	3.0	L	H1								CW	CP			*Mulch required to minimise compaction within carpark.*
136	Norfolk Island Pine, *Araucaria heterophylla*	0.4	14	4	SM	F	F	4.0	L		H2							CW	CP			
137	Swamp Mahogany, *Eucalyptus botryoides*	0.4	12	6	SM	G	G	4.0	L		H2							CW	CP			*Termite workings.*
138	Swamp Mahogany, *Eucalyptus botryoides*	0.3	12	6	SM	G	G	3.0	L		H2							CW	CP			
139	Swamp Mahogany, *Eucalyptus botryoides*	0.3	13	4	SM	P	P	3.0	S				H4					CW	CP			*Decline symptoms.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
140	Swamp Mahogany, *Eucalyptus botryoides*	0.3	13	4	SM	G	G	3.0	L		H2							CW	CP			
141	Swamp Mahogany, *Eucalyptus botryoides*	0.3	12	5	SM	G	G	3.0	L		H2							CW	CP			
142	Swamp Mahogany, *Eucalyptus botryoides*	0.3	11	5	SM	G	F	3.0	L		H2							CW	CP			
143	Norfolk Island Pine, *Araucaria heterophylla*	0.4	19	4	M	F	F	4.0	L		H2					T		CW	CP			
144	Norfolk Island Pine, *Araucaria heterophylla*	0.4	17	4	M	F	F	4.0	L			H3						CW	CP			*Vehicle damage*
145	Sydney Red Gum, *Angophora costata*	0.5	18	4	M	F	P	5.0	Remove					H5				CW	CP			*90% Ringbarked by Borers. Lean over carpark.*
146	Swamp Sheoak, *Casuarina glauca*	0.3	12	3	SM	G	F	3.0	L			H3						CW	CP			
147	Swamp Sheoak, *Casuarina glauca*	0.1 - 0.2	8 - 12	2 - 3	SM	G	F	2.5	L		H2					T		CW	CP		O	
148	London Plane Tree, *Platanus x hybrida*	0.4	16	5	SM	G	G	4.0	L	H1						T		CW		P	O	
186										54	82	23	20	7	38	151	22	45	92	91	18	

ATTACHMENT C: TREE SCHEDULE – APPLE TREE BAY

Tree Schedule - Apple Tree Bay Picnic Area: Ku-ring-gai Chase National Park

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
1	Rough-barked Angophora, *Angophora floribunda*	0.3	11	4	M	P	F	3.0	M			H3				T		CW			O	*Vehicle damage to trunk over carriageway.*
2	Rough-barked Angophora, *Angophora floribunda*	0.4	13	5	M	F	G	4.0	L		H2					T		CW			O	
2 A	Rough-barked Angophora, *Angophora floribunda*	0.3	7	4	SM	G	G	3.0	M		H2										O	*Located in garden adjacent kiosk/pergola. Within 1m of slab.*
4	Willow Bottlebrush, *Callistemon salignus*	0.4	9	4	M	G	G	4.0	L		H2					T		CW				
4 A	Scribbly Gum, *Eucalyptus racemosa*	0.3	5	3	SM	G	G	3.0	L	H1						T						
4 B	Grey Gum, *Eucalyptus punctata*	0.3	7	4	SM	G	F	3.0	L		H2					T						*Storm damage.*
7	Queensland Firewheel Tree, *Stenocarpus sinuatus*	0.1	2	1	IM	G	F	2.0	M	H1						T						

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
8	Willow Bottlebrush, *Callistemon salignus*	0.4	6	4	M	F	F	4.0	M			H3				T			CP			
9	Scribbly Gum, *Eucalyptus racemosa*	0.2	5	2	SM	G	F	2.0	L		H2					T			CP			
10	Rough-barked Angophora, *Angophora floribunda*	0.7	14	5	M	P	F	7.0	M			H3				T		CW				
11	Prickly-leaved Paperbark, *Melaleuca stypheloides*	0.4	12	4	M	F	F	4.0	L		H2					T		CW				
12	Rough-barked Angophora, *Angophora floribunda*	0.5	14	4	M	F	F	5.0	L			H3				T		CW				
13	White Kurrajong, *Brachychiton discolor*	0.3	10	3	M	G	G	3.0	L		H2					T		CW				
14	Bottlebrush, *Callistemon viminallis*	0.3	6	3	M	F	F	3.0	M		H2					T			CP			
15	Swamp Sheoak, *Casuarina glauca*	0.3	12	3	M	G	F	3.0	L		H2					T			CP			*Storm damaged limb.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
16	Swamp Sheoak, *Casuarina glauca*	0.4	15	3	M	G	G	4.0	L		H2					T			CP			
17	Swamp Sheoak, *Casuarina glauca*	0.3	14	3	M	G	F	3.0	L		H2					T		CW				
17 A	Red Bloodwood, *Corymbia gummifera*	0.2	9	2	IM	G	G	2.0	L		H2					T			CP			
20	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.7	15	4	M	G	G	7.0	L		H2					T		CW				
21	Hoop Pine, *Araucaria cunninghamii*	0.6	20	5	M	G	G	6.0	L		H2					T			CP			
21 A	Grey Gum, *Eucalyptus punctata*	0.3	10	5	SM	G	G	3.0	L		H2					T						
21 B	Scribbly Gum, *Eucalyptus racemosa*	0.3	6	4	SM	G	G	3.0	L		H2					T				P		*Bark wound north side.*
27	Sydney Peppermint, *Eucalyptus piperita*	0.5	11	5	M	F	F	5.0	L			H3				T		CW				
27 A	Grey Ironbark, *Eucalyptus paniculata*	0.3	10	3	SM	G	G	3.0	L	H1						T			CP			
27 B	Grey Gum, *Eucalyptus punctata*	0.3	8	4	SM	G	G	3.0	L		H2					T		CW				

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
27 C	Grey Gum, *Eucalyptus punctata*	0.3	8	4	SM	F	G	3.0	L		H2					T		CW				
27 D	Sydney Peppermint, *Eucalyptus piperita*	0.4, 0.3	11	6	M	G	G	5.0	L		H2					T			CP			*Soil compaction.*
27 E	Grey Ironbark, *Eucalyptus paniculata*	0.3	7	3	SM	G	G	3.0	L	H1						T						
27 F	Grey Gum, *Eucalyptus punctata*	0.2	7	2	SM	F	F	2.0	L	H1						T						
27 G	Grey Gum, *Eucalyptus punctata*	0.3	7	3	SM	F	G	3.0	L		H2					T						
27 H	Grey Gum, *Eucalyptus punctata*	0.3	8	4	SM	G	G	3.0	L		H2					T						
27 I	Grey Ironbark, *Eucalyptus paniculata*	0.3	9	3	SM	G	G	3.0	L	H1						T						*Good specimen.*
27 J	Grey Gum, *Eucalyptus punctata*	0.3	7	3	SM	P	G	3.0	M		H2					T						*Leaf eating insects.*
27 K	Grey Gum, *Eucalyptus punctata*	0.3	6	4	SM	F	G	3.0	M		H2					T			CP			
27 L	Grey Ironbark, *Eucalyptus paniculata*	0.3	11	3	SM	G	G	3.0	L	H1						T				P		*Good specimen.*
29	Sydney Peppermint, *Eucalyptus piperita*	0.4	11	4	M	G	G	4.0	L		H2					T		CW				

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
29 A	Sydney Red Gum, *Angophora costata*	0.3	8	3	SM	G	G	3.0	L	H1						T						*Good specimen.*
30	Sydney Peppermint, *Eucalyptus piperita*	0.4	13	4	M	G	G	4.0	L		H2					T		CW				
30 A	Grey Gum, *Eucalyptus punctata*	0.3	8	4	SM	G	G	3.0	L		H2					T		CW				
31	Kurrajong, *Brachychiton populneum*	0.3	6	3	M	G	G	3.0	L	H1						T						
32	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.5	12	4	M	G	G	5.0	L		H2					T			CP	P		
32 A	Sydney Red Gum, *Angophora costata*	0.2	6	2	SM	G	G	2.0	L		H2					T						
32 B	Sydney Red Gum, *Angophora costata*	0.3	7	3	SM	G	G	3.0	L	H1						T				P		
35	Brushbox, *Lophostemon confertus*	0.3	6	2	SM	G	G	3.0	L	H1						T			CP			
35 A	Sydney Peppermint, *Eucalyptus piperita*	0.3	5	3	SM	G	G	3.0	L	H1						T						
37	Sydney Peppermint, *Eucalyptus piperita*	0.3	7	3	SM	G	G	3.0	L	H1						T			CP			

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
37 A	Brushbox, *Lophostemon confertus*	0.3	9	3	SM	G	G	3.0	L	H1						T			CP			
37 B	Sydney Peppermint, *Eucalyptus piperita*	0.4	12	4	SM	G	G	4.0	L		H2					T			CP			
42	Brushbox, *Lophostemon confertus*	0.4	10	5	M	G	G	4.0	L		H2					T			CP			
42 A	Silvertop Ash, *Eucalyptus siberi*	0.4	10	5	SM	G	F	4.0	L			H3				T						
43	Spotted Gum, *Corymbia maculata*	0.6	16	6	M	G	G	6.0	L		H2					T			CP			
44	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.4	9	3	M	G	G	4.0	L	H1						T			CP			
45	Bracelet Honey Myrtle, *Melaleuca armillaris*	0.4, 0.3	7	5	OM	F	F	5.0	S			H3				T			CP			
45 A	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.5	10	4	SM	G	G	5.0	L	H1						T			CP			

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
46 B	Bracelet Honey Myrtle, *Melaleuca armillaris*	0.5	8	4	OM	P	P	5.0	S			H3				T			CP			
46 C	Brushbox, *Lophostemon confertus*	0.4	10	4	M	G	G	4.0	L		H2					T			CP			*Good specimen*
47	Brushbox, *Lophostemon confertus*	0.4	9	4	M	G	G	4.0	L		H2					T				P		
49	Willow Bottlebrush, *Callistemon salignus*	0.3	6	2	M	P	F	3.0	S			H3				T		CW				
49 A	Angophora, *Angophora leiocarpa*	0.3	5	2	SM	G	G	3.0	L	H1						T						
49 B	Grey Gum, *Eucalyptus punctata*	0.4	14	3	M	G	G	4.0	L			H3				T			CP			
49 C	Grey Gum, *Eucalyptus punctata*	0.3	9	2	SM	G	G	3.0	L		H2					T			CP			
49 D	Sydney Red Gum, *Angophora costata*	0.2, 0.1	5	2	SM	G	G	2.5	L		H2					T						
49 E	Scribbly Gum, *Eucalyptus racemosa*	0.3	4	4	SM	G	F	3.0	L		H2					T						
49 F	Rough-barked Angophora, *Angophora floribunda*	0.3	5	4	M	F	F	3.0	L		H2					T		CW				

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
49 G	Rough-barked Angophora, *Angophora floribunda*	Multi	8	5	M	P	F	4.0	S				H4			T		CW				
51	Broad-leaved Paperbark, *Melaleuca quinquenervia*	0.5	10	3	M	G	G	5.0	L	H1						T		CW		P		
52	Lemon-scented Gum, *Corymbia citriodora*	0.2	17	5	M	G	G	2.0	L		H2					T		CW	CP			
52 A	Black She Oak, *Casuarina littoralis*	Multi	6	2	M	F	F	4.0	S		H2					T						
53	Lemon-scented Gum, *Corymbia citriodora*	0.2	10	3	SM	G	F	2.0	L	H1						T				P		
54	Brushbox, *Lophostemon confertus*	0.4	7	4	M	G	G	4.0	L	H1						T			CP			
55	Sydney Red Gum, *Angophora costata*	0.2	6	2	SM	P	P	2.0	Remove				H4			T			CP			
57	Red Bloodwood, *Corymbia gummifera*	0.3	12	2	SM	G	G	3.0	L		H2					T			CP			

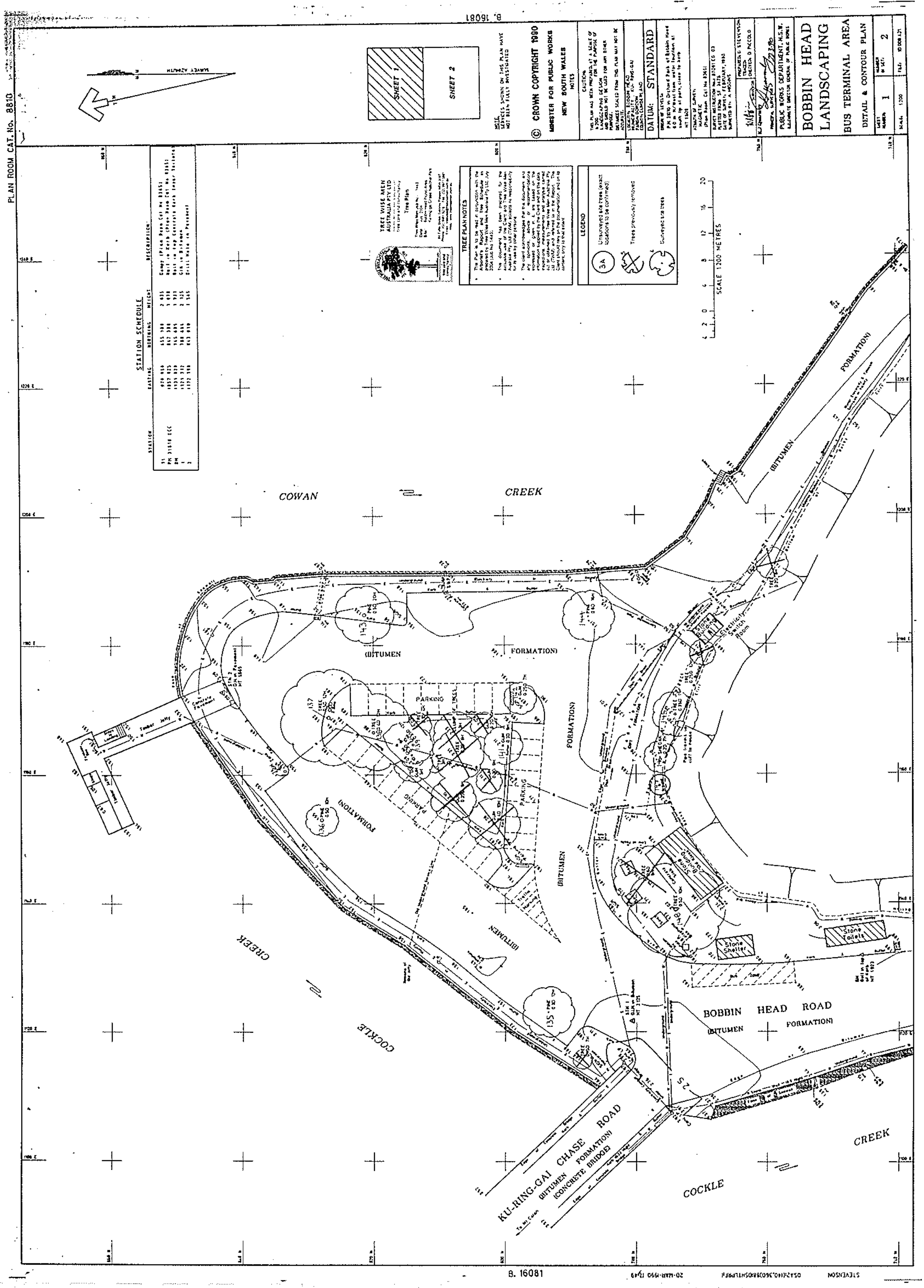
TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
59 A	Rough-barked Angophora, *Angophora floribunda*	0.4	9	5	M	G	G	4.0	L			H3				T						
59 B	Grey Gum, *Eucalyptus punctata*	0.2, 0.2	6	2	SM	G	P	3.0	M			H3				T			CP			*Inclusion. Remove one leader*
59 C	Grey Gum, *Eucalyptus punctata*	0.3	8	2	SM	G	P	3.0	M			H3				T			CP			*Wound from failed co-dominant leader*
59 D	Scribbly Gum, *Eucalyptus racemosa*	Multi	4	3	SM	F	G	4.0	L		H2					T						
60	Grey Gum, *Eucalyptus punctata*	0.3	11	3	SM	G	G	3.0	L		H2					T			CP			
60 A	Sydney Peppermint, *Eucalyptus piperita*	0.3, 0.3	10	3	SM	F	G	4.5	L			H3				T			CP			
62	Southern Mahogany, *Eucalyptus botryoides*	0.4	12	4	M	G	G	4.0	L		H2					T			CP			
62 A	Sydney Peppermint, *Eucalyptus piperita*	0.4	9	4	SM	G	G	4.0	L		H2					T			CP			
62 B	Sydney Peppermint, *Eucalyptus piperita*	0.3	8	2	SM	G	G	3.0	L		H2					T			CP			

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
71	Broad-leaved Paperbark, *Melaleuca quinquenervia* (x15)	0.2 - 0.4	8 - 11	2 - 3	SM	G	F	4.0	L		H2							CW				
72	Grey Gum, *Eucalyptus punctata*	0.5	8	6	M	G	F	5.0	L			H3			B			CW				*Deadwood to 100, lean over carriageway.*
73	Grey Gum, *Eucalyptus punctata*	0.3	8	3	M	G	F	3.0	M			H3			B			CW				*Trunk lean; limited soil depth.*
74	Rough-barked Angophora, *Angophora floribunda (DEAD)*	0.3	12	-	-	-	-	-	Remove					H5	B			CW				*Termites.*
75	Bhutan Cypress, *Cupressus torulosa (Dead)*	0.3	-	-	-	-	-	-	Remove					H5	B			CW				*Fallen tree snagged in Broad-leaved Paperbark over road.*
76	Grey Gum, *Eucalyptus punctata*	0.8	16	8	M	F	F	8.0	L				H4		B			CW				*Major deadwood to 150mm to edge of carriageway. (not tagged).*
77	Rough-barked Angophora, *Angophora floribunda*	0.3	12	3	M	F	F	3.0	L		H2							CW				*Trunk lean away from Tree 78*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
78	Grey Gum, *Eucalyptus punctata*	0.4	16	5	M	G	F	4.0	L			H3			B			CW				
79	Dead Stump	0.4	6	-	-	-	-	-	Remove					H5	B			CW				*Termitus.*
80	Grey Gum, *Eucalyptus punctata*	0.3	14	2	SM	F	F	3.0	M			H3			B			CW				
81	Sydney Red Gum, *Angophora costata*	0.3	6	3	SM	F	F	3.0	M			H3			B			CW				*Deadwood overhanging carriageway.*
82	Red Bloodwood, *Corymbia gummifera*	0.4	13	3	M	F	F	4.0	L			H3			B			CW				*Deadwood overhanging carriageway.*
83	Red Bloodwood, *Corymbia gummifera*	0.3	10	1	M	P	P	3.0	Remove					H5	B			CW				*Arboreal termites nest over carriageway.*
84	Grey Gum, *Eucalyptus punctata*	0.4, 0.3	13	4	M	F	F	6.0	M			H3			B			CW				*Deadwood overhanging carriageway.*
85	Grey Gum, *Eucalyptus punctata*	0.4	13	4	M	F	F	4.0	L			H3			B			CW				*Deadwood overhanging carriageway.*
86	Grey Gum, *Eucalyptus punctata*	0.3	10	3	M	F	F	3.0	M			H3			B			CW				*lean, deadwood overhanging carriageway.*
87	Grey Gum, *Eucalyptus punctata*	0.4	14	4	M	F	F	4.0	L			H3			B			CW				*Deadwood overhanging carriageway.*
88	Grey Gum, *Eucalyptus punctata*	0.3	13	2	SM	F	F	3.0	L			H3			B			CW				
89	Grey Gum, *Eucalyptus punctata*	0.3	9	5	SM	G	F	3.0	L		H2				B			CW				*Deadwood overhanging carriageway.*

TREE No.	COMMON NAME/ GENUS SPECIES	DBH (m)	HEIGHT (m)	CANOPY SPREAD RADIUS (m)	AGE CLASS	VIGOUR	CONDITION	PRZ RADIUS (m)	SULE	HAZARD RATING					LANDUSE							SPECIFIC COMMENTS
										H1	H2	H3	H4	H5	B	T	PD	CW	CP	P	O	
90	Grey Gum, *Eucalyptus punctata*	0.3	12	3	SM	G	G	3.0	L		H2				B			CW				
91	Grey Gum, *Eucalyptus punctata*	0.3	10	2	SM	G	F	3.0	L		H2				B			CW				
92	Grey Gum, *Eucalyptus punctata*	0.3	11	3	SM	G	G	3.0	L		H2				B			CW				
93	Grey Gum, *Eucalyptus punctata*	0.3	11	2	SM	G	F	3.0	L		H2				B			CW				
94	Grey Gum, *Eucalyptus punctata*	0.3	11	3	SM	G	F	3.0	L		H2				B			CW				*Fungal bracket.*
105										20	53	25	3	4	22	80	0	44	35	7		

ATTACHMENT D: TREE LOCATION PLANS (X4 SHEETS)


PLAN ROOM CAT. No. 8810
B. 16081
SHEET 1
SHEET 2
© CROWN COPYRIGHT 1990
MINISTER FOR PUBLIC WORKS
NEW SOUTH WALES
DATUM: STANDARD
PUBLIC WORKS DEPARTMENT, N.S.W.
BOBBIN HEAD
LANDSCAPING
BUS TERMINAL AREA
DETAIL & CONTOUR PLAN
STATION SCHEDULE
TREE WISE MEN AUSTRALIA PTY LTD
TREE PLAN NOTES
LEGEND
Unsurveyed site trees (exact locations to be confirmed)
Trees previously removed
Surveyed site trees
SCALE 1:200 METRES
COWAN CREEK
COCKLE CREEK
PARKING
FORMATION
(BITUMEN FORMATION)
Timber Jetty
Concrete Pavement
Electricity Switch Room
Stone Shelter
Stone Toilets
BOBBIN HEAD ROAD
(BITUMEN FORMATION)
KU-RING-GAI CHASE ROAD
(BITUMEN FORMATION)
(CONCRETE BRIDGE)
STEVENSON

TREE WISE MEN
AUSTRALIA PTY LTD
tree care and consultancy

Tree Plan

Date: July 2004

TREE PLAN NOTES

- This Plan is to be read in conjunction with the Arborist's Report and Tree Schedule as prepared by Tree Wise Men Australia Pty Ltd, July 2004.
- This document has been prepared for the exclusive use of the Client and Tree Wise Men Australia Pty Ltd (TWMA) accepts no responsibility for its use by other persons.
- The client acknowledges that this document, and any opinions, advice or recommendations expressed or given in it, are based on the information supplied by the Client and on the data inspections, measurements and analysis carried out or obtained by Tree Wise Men Australia Pty Ltd (TWMA) and referred to in the Report. The Client should rely on the documentation and on its content, only to that extent.

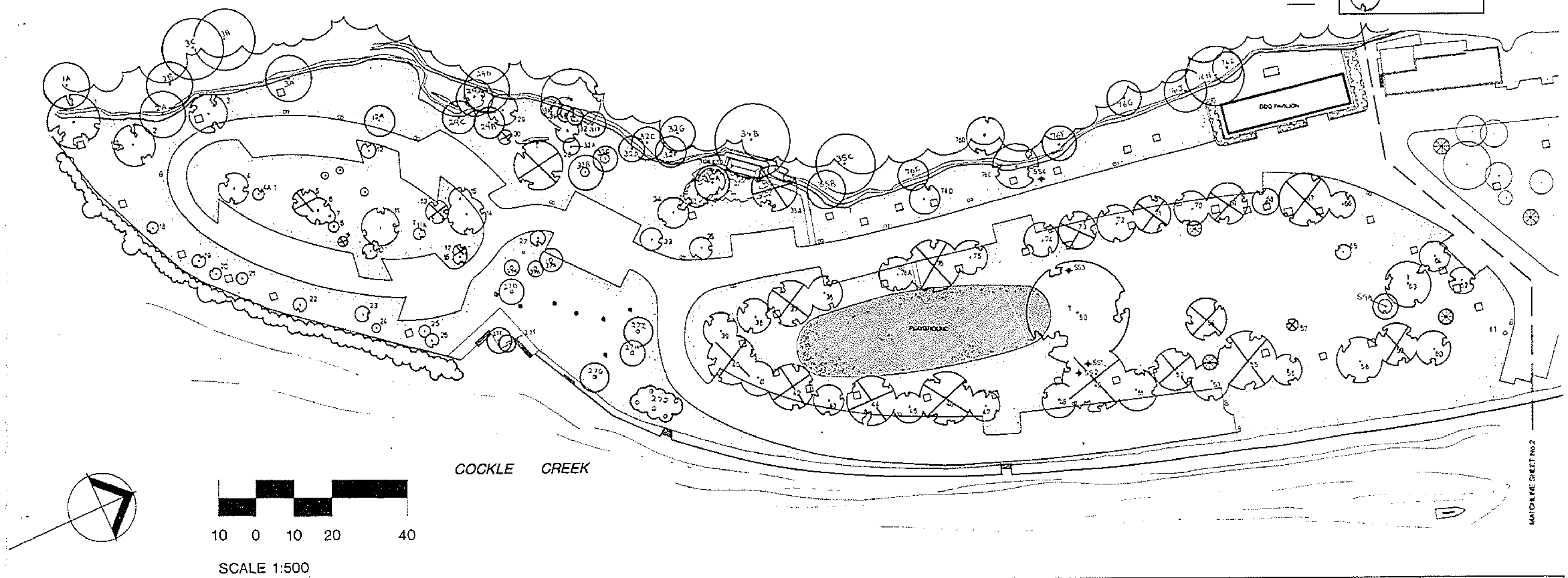
LEGEND

3A Unsurveyed site trees (exact locations to be confirmed)

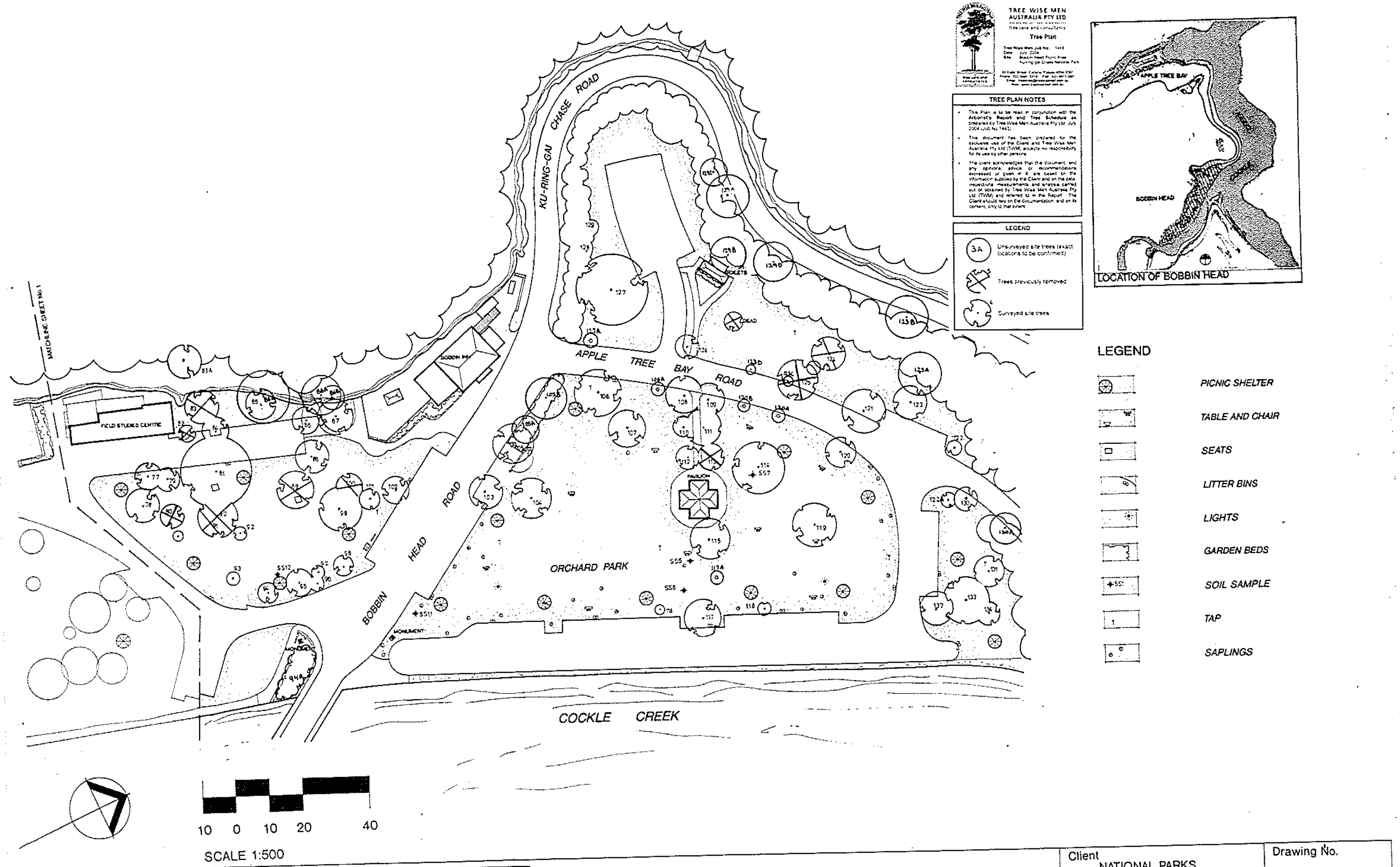
Trees previously removed

Surveyed site trees

Previous GHD Schedule attached to this drawing superseded by Tree Schedule (Attachment A) of Arborist's Report, July 2004



NATIONAL PARKS & WILDLIFE SERVICE	**BOBBIN HEAD**	Client NATIONAL PARKS AND WILDLIFE SERVICE	Drawing No. L4
	MANAGEMENT PLAN TREE SURVEY	Gutteridge Haskins & Davey Consulting Engineers Project Managers Planners Surveyors GHD 39 Regent St. Railway Square	Job No. 213/023141/01



BOBBIN HEAD

MANAGEMENT PLAN — TREE SURVEY

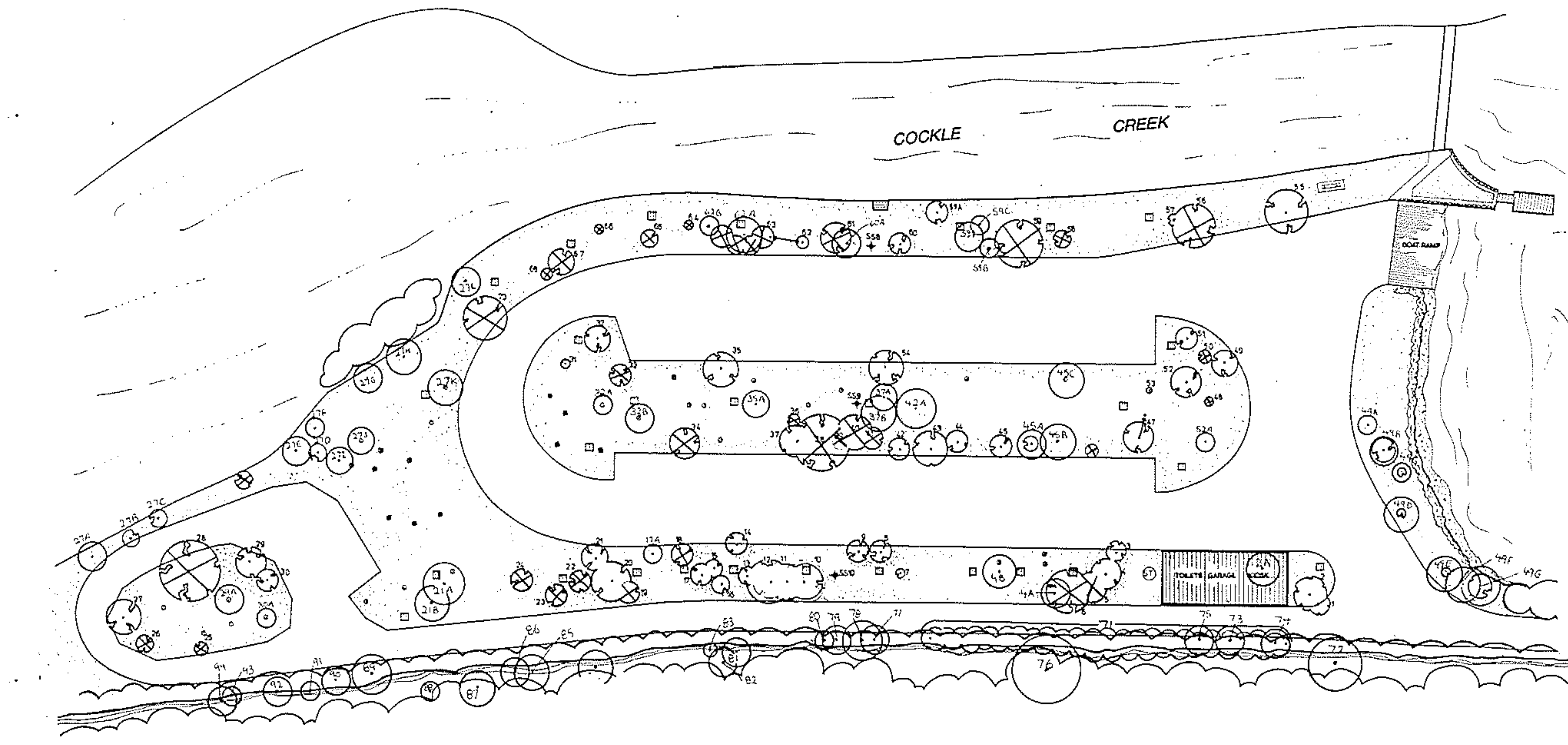
NATIONAL PARKS & WILDLIFE SERVICE

Client: NATIONAL PARKS AND WILDLIFE SERVICE

Gutteridge Haskins & Davey
Consulting Engineers
Project Managers Planners Surveyors
GHD
39 Regent St., Railway Square

Drawing No. L5

Job No. 213/023141/01



Previous GHD Schedule attached to this drawing superseded by Tree Schedule (Attachment A) of Arborist's Report, July 2004

TREE WISE MEN AUSTRALIA PTY LTD

Tree Plan

TREE PLAN NOTES

LEGEND

3A Unsurveyed site trees (exact locations to be confirmed)

Trees previously removed

Surveyed site trees

10 0 10 20 40

SCALE 1:500

NATIONAL PARKS & WILDLIFE SERVICE

APPLE TREE BAY

MANAGEMENT PLAN TREE SURVEY

Client
NATIONAL PARKS
AND WILDLIFE SERVICE

Gutteridge Haskins & Davey
Consulting Engineers
Project Managers Planners Surveyors

Drawing No.
L6

Job No.

Appendix 6: Supporting Documents

The following reports and letters were received by CM+ from External Stakeholders during the 2006 Masterplanning process prior to the Draft Masterplan stage:

6.1 Canoeing and Kayaking at Bobbin Head
6.2 Hornsby Conservation Society

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6.1 Canoeing and Kayaking at Bobbin Head

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Canoeing & Kayaking

at

Bobbin Head

Submission to;

Bobbin Head and Apple Tree Bay
Master Plan

From;

Kayak & Canoe Inc.

February 2006

"There is nothing - absolutely nothing - half so much worth doing as simply messing about in boats ... In or out of 'em, it doesn't matter. Nothing seems really to matter, that's the charm of it" (Kenneth Grahame, The Wind in the Willows, 1908)

Canoeing and kayaking

Definition

A canoe is paddled using single blade paddles and a kayak double blade paddles. Both can be used on flatwater, moving water (whitewater), and sea. Canoeing is generally used to denote paddling in kayaks or canoes.

Diversity

Few recreations offer the diversity of activities that modern kayaking and canoeing offers to people of all ages.

Canoeing has one of the lowest environmental impacts of all outdoor activities. Paddlers learn quiet appreciation of the natural environment.

Paddling opportunities are endless, from relaxing on a quiet creek, experiencing the exhilaration of wind and wave at sea or the power of a whitewater river.

From group or family trips to solitary sojourns with nature, or all of the above.

Safety and Instruction

All K&C members are offered an initial introductory course and are encouraged to advance their paddling skills by doing Australian Canoeing (AC) certified courses conducted by the club.

The introductory and AC flatwater courses to instructor level are conducted in the shelter of quiet Cockle Creek at the 'Canoe Launch' at Bobbin Head. Courses include risk management, safety, weather, skills and environmental impact.

Paddling Opportunities

With the right foundations a whole new world of paddling possibilities opens up.

"A Canoe across the water leaves no trace"

About Kayak & Canoe

Founded in 1990 as 'Lane Cove Valley Canoe Club', K&C Inc. is a not-for-profit incorporated association. Our membership comprises people of all ages, singles, couples and families from diverse backgrounds, who share a common love of all facets of canoeing and the natural environment. Our objectives are to provide a diversity of canoeing activities in an environmentally friendly way.

In 2001 K&C qualified as an AC National Training Provider (NTP). All K&C instructors hold AC instructor qualifications. K&C encourages all paddlers to complete our introduction to kayaking or canoeing course to improve skills, increase safety and get more pleasure from paddling. AC courses in Flatwater, Surf, Sea, and Whitewater are also available. In addition, skill development and eskimo rolling clinics are conducted from time to time. Club rules require a Personal Flotation Device (PFD) to be worn on all club activities.

The club organises many recreational activities including; regular quietwater paddles and weekend camps, whitewater and sea trips, fitness and aerobic paddles, lazy social paddles, nature paddles, video nights, barbecues and social events.

Paddling at Bobbin Head

Brief History

People have probably been paddling at Bobbin Head since the Guringai people lived in the area many thousands of years ago.

K&C was formed in 1990 and began taking advantage of the sheltered nature of Bobbin Head's Cockle Creek for instructional purposes. The 'Canoe Launch' at Bobbin Head is also used as launching point for recreational paddles particularly for novices. The club arranges regular paddles from Bobbin Head on the first Saturday and third Sunday of the month and conducts introductory courses on the first Saturday of the month as well. Flatwater Instructor and rescue courses have also been a feature of the clubs activities at Bobbin Head.

In late 2002 the club entered into an agreement with Gibberagong Environmental Education Centre. The club made available to Gibberagong three trailer loads of canoes and kayaks in return for storage in three garages under the Centre. The Centre is able to use the boats on weekdays and the club at weekends.

Current Canoe Usage at Bobbin Head

K&C is indebted to NPWS for providing such an ideal launch point for canoeing. The club's philosophy is in tune with the values espoused by National Parks i.e the preservation and quiet enjoyment of a recreation in a natural setting.

"4.2.2.9 Commercial and Organised Activities
... organised activities have many benefits. They increase the opportunity for public participation in nature-based activities and provide opportunities for professional instruction in the safety and minimal impact aspects of various recreational pursuits. Guided activities also have potential to interpret and promote the natural and cultural values of the park. (Plan of management KCNP, 2002)"

Unlike power boaters, walkers and picnickers the only resources needed by canoeists are a launch point and nearby parking. Once launched the canoeist has almost zero environmental impact. The club has an environmental impact, safety and risk management policy in place with which all club members must comply.

General Public

The 'Canoe Launch' and Cockle Creek are used by a significant number of people during the week and weekends. Solo paddlers and families from canoes to sea kayaks take advantage of the quiet creek.

Kayak & Canoe

The club uses the area to conduct beginner and AC courses. Course numbers are restricted to AC recommended ratios of 6 paddlers to one instructor with a minimum of two instructors. A maximum of two groups would use the area at any one time.

Regular social paddles, at least twice a month, to various destinations such as the head of Cockle Creek on the tide, upstream of the marina to the head of Cowan Waters, Smiths Creek, Jerusalem Bay and to Patonga with overnight camping at the caravan park.

Social paddles would consist of a maximum of 12 paddlers.

All K&C members must pass an AC Basic Skills Audit before venturing outside Cockle Creek without an instructor.

Advantages of the 'Canoe Launch' at Cockle Creek

Cockle Creek is narrow, shallow, sheltered from most winds and power boat washes. This makes it ideal for beginners, novices, supervision of children and introductory courses.

The absence of power boats is an added bonus as no dangerous encounters occur.

Proximity to the canoe storage at Gibberagong means boats are easily transported to the ‘Canoe Launch’. This also means that children visiting Gibberagong can walk to the put in point.

Canoes can be car or trailer transported to within meters of the launch site obviating the need for extensive carrying. An enhancement to the area would be a 10 minute loading zone in the two parallel car parking spaces facing the ramp (see later).

Enhancements

Currently the Canoe Launch works well for K&C, Gibberagong and the general public. If no changes were made this would not affect the amenity of the facility. However there are some minor improvements that could be made with a very modest cost and encourage canoeing. These include;

1. The creation of a 10 minute canoe loading zone as mentioned earlier. The existing double parallel parking bay adjacent to the ramp could be used now. This would help to alleviate the hazard of off loading and carrying craft through pedestrian and picnic areas.

2. The construction of a washing bay consisting of two log rails about 50 cms high, 2 m wide and 3 m apart adjacent to the loading zone. This has proved successful at Blackman Park on the Lane Cove River. The rails would allow boats to be washed down free of the ground before loading onto trailers or car tops. An extension of the water pipe to a tap adjacent to the rails would be an added bonus and prevent water loss.

3. The provision of a sign with map showing distances as far as Jerusalem Bay and some safety hints such as wear a PFD, beware winds, check a weather forecast etc.

4. K&C in conjunction with NPWS could produce a brochure ‘Paddling in Ku-ring-gai Chase’ with safety and environmental information similar to walking track brochures.

Such enhancements would cost little, serve a large number of people and demonstrate NPWS’s commitment to people who use the park for its natural values.

Apple Tree Bay

Currently some paddlers use Apple Tree Bay boat ramp as a launch point. For experienced paddlers this is not a problem. They launch into deep water and are quickly out of the bay away from power craft. There is no need to add to this facility, however a beach type launch area away from the ramp would be a bonus. It would allow easier access to and from the water and separate canoeists from power boats.

Apple Tree Bay is totally unsuitable for novices and beginner canoeists. Canoeists could not easily be segregated from powered craft entering or leaving the area creating a very dangerous hazard to both parties. Lack of control and wind could easily set novices among the powered craft. Shoreline supervision particularly of children would be vastly inadequate. Courses would be impossible to conduct. A further hazard is the short distance from the ramp to open water where gusts of wind have been known to capsize paddlers. Once capsized canoes/kayaks blow down wind far faster than paddlers can swim. Exits of capsized paddlers over oyster encrusted rocks would present a further risk factor.

Commercial Canoe Hire

In our opinion commercial hire on an hourly basis should not be encouraged. Experience has shown (e.g above the weir at Lane Cove National Park) the activity to be prone to boisterous noisy behaviour. The Australian and North American experience has shown this kind of activity to be accident prone. Paddle injuries from water fights leading the list.

Supervised half day and full day tour groups (with a NSW Maritime Kayak/Canoe Tours License) should be encouraged and are in keeping with the 'Plan of management KCNP, 2002', *4.2.2.9 Commercial and Organised Activities.*

In Conclusion

As far as canoeing is concerned present facilities are adequate and in our view should be maintained. As a wish list the minor improvements suggested above would be welcomed.

K&C is more than willing to enter into any further discussions or provide more information. Email enquiries@kayakandcanoe.com.au or Chairman Alan Jones (02) 9449 4718. Our web site is www.kayakandcanoe.com.au.

6.2 Hornsby Conservation Society

HORNSBY CONSERVATION SOCIETY INC.

PO Box 1643
HORNSBY WESTFIELD 1635
Tel: 02 9489 5997
Fax: 02 9487 5554

Ranger Glen Crombie
Ku-ring-gai Chase National Park
Parks and Wildlife Division (NPWS)
Department of Environment and Conservation

Bobbin Head and Apple Tree Bay Master Plan

Thank you for the reminder of the next "Stakeholders" meeting at Bobbin Head.

The following comments on the material made available at this stage are offered for consideration.

- Suggested native trees for planting adjacent to sea wall, assuming the soil to be used will match their nutrient requirements:

Eucalyptus amplifolia
Eucalyptus botryoides
not *Eucalyptus botryoides X saligna*
Eucalyptus robusta
Eucalyptus tereticornis

Ecological details are attached.
These are long-lived trees, each one with some qualities that make it preferable to the others.
All are evergreen. Most require care and watering for several years to ensure their establishment as minimal care mature specimens.
Eucalyptus tereticornis would grow much larger than indicated with the high rainfall at Cowan Creek.

- Main Road.
  After the major problems presented by the sea walls and soil quality and ground levels behind them, the next subjects for concern appear to involve limitations on management of a busy road through the Park by NPWS officers.

The natural environment of Ku-ring-gai Chase National Park suffers continuing degradation through runoff from upslope infrastructure, first from the rail corridor and highway, then on a larger scale from construction and operation of the freeway. More insidious, but cumulative damage by polluted runoff and erosion , results from streets and road surfaces such as the main road to and from the Bobbin Head precincts.

Apple Tree Bay is one of many sites that have been affected by major, unintended modifications imposed by the F3 Freeway.

An attempt to quantify the scale of some of these effects is available in:

Rooney, W. S. (1991) **An Environmental Audit of the F3 Freeway: Wahroonga to Berowra, New South Wales.** Paper G91305 originally presented at the 1989 National Environmental Engineering Conference Sydney 20-23 March 1989. *Volume GE 15 No.* 2 December 1991. 127-133

The major bushfire season coincides with likely days of major visitor use, and over-capacity traffic conditions.
A risk management plan for protection of crowds when the road is closed by dangerous smoke conditions presents a challenge.
At least two days of rapidly developing dangerous fires are on record within the past five years, when it would have been difficult to foresee the danger in time to exclude the public from the Park, and to maintain access by emergency vehicles.

Use of the main road after dark is known to result in unacceptably high frequencies of road kills of the native fauna which Ku-ring-gai Chase was established to protect. Some action to dramatically reduce these frequencies needs to be incorporated in the Master Plan, if it is not possible to exclude road traffic when the native fauna are at most risk.

Ideally, access to the road by native fauna would be excluded by fencing, specifically designed for protection of all species identified in routine Park records of road kills to date.
It can be assumed that the Species Impact Study essential for management of such a road will identify several Scheduled species under threat from ongoing use of the road.

The anticipated fencing program is further complicated by the necessity for crossings that allow fauna to travel safely under or over the road.

- Vegetation and soil studies.

We also look forward to an opportunity to comment on the implications of these studies when they become available.

5th April 2006

Gordon E Limburg

Vice President

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Appendix 7: Conservation Management Plan Appendices

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7.1 Heritage Listing

Ku-ring-gai Chase National Park

Item

Name of Item: Ku-ring-gai Chase National Park

Other Name/s: Bushland, including railway dams, Brooklyn including Bobbin Inn

Type of Item: Landscape

Group/Collection: Parks, Gardens and Trees

Category: Reserve

Primary Address: Newcastle Expressway (east of) to Cockle Ck, (not given), NSW 2077

Local Govt. Area: Hornsby

Property Description:

Lot/Volume Code	Lot/Volume Number	Section Number	Plan/Folio Code	Plan/Folio Number

All Addresses

Street Address	Suburb/Town	LGA	Parish	County	Type
Newcastle Expressway (east of) to Cockle Ck	(not given)	Hornsby			Primary

Statement of Significance

Long established national park on the edge scenically renowned Broken Bay conserving rugged sandstone topography indigenous plant communities noted for wildflowers native fauna and for the wealth of Aboriginal relics such as rock engravings and cave paintings. Of state significance.

Note: There are incomplete details for a number of items listed on the State Heritage Register. The Heritage Office intends to develop or upgrade statements of significance for these items as resources become available.

Description

Physical Description: Northwestern section of long established national park dedicated in 1894 with an area of approximately 1400 Ha (approximately 1/3 within Hornsby Shire). The park is situated on rugged Hawkesbury Sandstone Bedrock up to 225 million years old which was gradually uplifted from 10 million years ago then was subsequently eroded by Creeks forming the steep valley sides. These were later flooded by the sea during the melting of the last Ice Age 1200 years ago forming Broken Bay Cowan Inlet and Coal and Candle Creek. The rugged sandstone country rises to about 200 metres above sea level at Mt.Ku-Ring-Gai. The park is noted for its rugged natural beauty particularly its cliffs and rock formations. Also characteristics of significance within the park include Aboriginal rock engravings and cave paintings scenic views walking tracks (some built in 1930#s by relief labour) secluded beaches native flora and fauna which includes many plant communities (over 800 species) being particular for areas of spring season wildflowers. The park gives its dedication to Eccleston Dufaur in Turramarra and spent much time exploring Cowan Creek to the north. He built a road through the bush to Bobbin Head and eventually persuaded the government to dedicate the land.

History

Historical Notes:

Assessment Criteria Items are assessed against the **State Heritage Register (SHR) Criteria** to determine the level of significance. Refer to the Listings below for the level of statutory protection

Recommended Management

Listings

Heritage Listing	Listing Title	Listing Number	Gazette Date	Gazette Number	Gazette Page
Local Environmental Plan			22 Jul 94		

Study Details

Title	Year	Number	Author	Inspected by	Guidelines Used
Hornsby Shire Heritage Study	1993		Perumal Murphy Wu Pty Ltd	WA	No

References, Internet links & Images

None

Note: Internet links may be to web pages, documents or images.

Source of information for this entry

Name: Local Government

Email: Contact Local Council

Web Page: **www.dlg.nsw.gov.au/**

Administration

Database Number: 1780725

Every effort has been made to ensure that information contained in the State Heritage Inventory is correct. If you find any errors or omissions please send your comments to the **Database Manager**.

Australian Heritage Database

Place Details

edit search | new search | about the Australian Heritage Database | Heritage home | Australian Heritage Council home

Send Feedback

Ku-ring-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves, Ku-ring-gai Chase Rd, Bobbin Head, NSW

Photographs:	None
List:	National Heritage List
Class:	Natural
Legal Status:	Listed place (15/12/2006)
Place ID:	105817
Place File No:	1/13/016/0003

Summary Statement of Significance:

Ku-ring-gai Chase National Park and Long Island, Lion Island and Spectacle Island Nature Reserves contain an exceptional representation of the Sydney region biota, a region which is recognised as a nationally outstanding centre of biodiversity. The place contains a complex pattern of 24 plant communities, including heathland, woodland, open forest, swamps and warm temperate rainforest, with a high native plant species richness of over 1000 species and an outstanding diversity of bird and other animal species. This diversity includes an outstanding representation of the species that are unique to the Sydney region, particularly those restricted to the Hawkesbury Sandstone landform. The place is an outstanding example of a centre of biodiversity.

Official Values:

Criteria	**Values**
A Events, Processes	The Sydney region contains an outstanding concentration of biodiversity and is recognised as a centre of biodiversity when compared to other areas across Australia. Ku-ring-gai Chase National Park, Long, Lion and Spectacle Island Nature Reserves contain an exceptional representation of the Sydney region biota with high species richness across many groups and a representative range of ecosystems. The place contains a complex pattern of 24 plant communities, including heathland, woodland, open forest, swamps and warm temperate rainforest and is important for its species richness, with over 1,000 native plant species in a wide array of families including heaths (Epacridaceae), wattles (Mimosaceae), grevilleas and banksias (Proteaceae) and members of the eucalypt family (Myrtaceae). The place also has an outstanding diversity of birds and other animal species notably perching birds (Passeriformes), including the families scrubwrens (Acanthizidae), honeyeaters (Meliphagidae), Australasian robins (Petroicidae) and fantails, drongos and monarchs (Dicrudidae). The place exemplifies the biodiverse Hawkesbury Sandstone environment and is an outstanding example of a centre of biodiversity (Benson & Howell

	1994, Braby 2000, DEH 2006a, DEH 2006b, NSW NPWS 2002 and Thomas and Benson 1985)
A Events, Processes	Ku-ring-gai Chase National Park, Long, Lion and Spectacle Island Nature Reserves contain an outstanding representation of the species that contribute to the high endemism value of the Sydney region (NSW NPWS 2002, DEH 2006a, DEH 2006b), in particular, those restricted to the Hawkesbury Sandstone landform.

Description:

Ku-ring-gai Chase National Park has been a conservation area since 1894. It is located within the Sydney metropolitan area, approximately 20 kilometres north of the centre of Sydney and receives over 2 million visitors a year. The National Park includes Barrenjoey Head, the site of an early customs house and a lighthouse complex with two cottages. Lion Island (6 hectares) is situated just inside the entrance to Broken Bay and is entirely included in the nature reserve. Long Island is situated near the town of Brooklyn. Most of the island (73 hectares) is included in the nature reserve while a small area at the eastern end of the island is managed by the State Rail Authority and includes a railway tunnel and several buildings. Spectacle Island (36 hectares) is situated near the junction of the Hawkesbury River and Mooney Mooney Creek and is entirely included in the nature reserve (NSW NPWS 2002).

Covering an area of 14,882 hectares, Ku-ring-gai Chase National Park is located on the dissected Hornsby Plateau near the centre of the sedimentary Sydney basin and demonstrates a range of landscapes, including drowned river valley estuaries, steep sandstone cliffs and plateaus (Thomas & Benson 1985). Lion Island, Long Island and Spectacle Island Nature Reserves are all located in the lower Hawkesbury River close to Ku-ring-gai Chase National Park.

Three major sedimentary formations dominate the geology within the area namely, Wianamatta shale, Hawkesbury sandstone and Narrabeen Group sandstones and shales. These formations were created during the early Jurassic and late Triassic (approximately 190 to 225 million years ago). The last major rise in sea level occurred during the Holocene and drowned the valleys of Cowan, Coal and Candle and Smiths Creeks to form the current foreshore. This rise in sea level also resulted in several peaks becoming islands, including Lion, Long and Spectacle Islands.

The place is within the Hawkesbury-Nepean catchment, an area with a very rich and distinctive assemblage of species that thrive on poor soils (Benson et al 1996, NSW NPWS 1996). The non-tree component is especially rich and contributes the major part of the plant biodiversity (Benson et al 1996). The place includes a complex pattern of vegetation communities such as heathland, woodland, open forest, swamps and warm temperate rainforest. The attributes and distribution of the vegetation communities within the National Park are strongly related to geology, soil, drainage and aspect. Species from the Proteaceae family are common in the understorey of the Hawkesbury sandstone (Howell and Benson 2000). Wet heathland occurs over Wianamatta shale platforms that remain on some ridge tops. The Narrabeen shales found in gullies and sheltered valleys support open forest communities of taller trees including some rainforest species.

The vegetation communities of most conservation significance in the place are those that are poorly reserved elsewhere (Thomas and Benson 1985). These tend to be associated with uncommon or remnant geological features or specific habitats and therefore tend to be small in area. Of special interest is the vegetation found on Wianamatta Shale that is generally open forest with dominant species being common name silvertop ash

(*Eucalyptus sieberi*), myrtle wattle (*Acacia myrtifolia*) and spiny bossiaea (*Bossiaea obcordata*). The diatreme vegetation communities at Campbells Crater and Smiths Crater along with the vegetation growing on volcanic dykes at West Head are other products of unusual underlying geology. Three ecological communities listed on the New South Wales Threatened Species Conservation Act 1995 are also present, namely Duffys Forest, Pittwater Spotted Gum Forest, and Sydney Coastal River-flat Forest.

There are over 1,000 plant species recorded from the place (NSW NPWS 2002), including several species protected under the NSW Threatened Species and Conservation Act 1995: Caley's grevillea (*Grevillea caleyi*), Bynoe's wattle (*Acacia bynoeana*), a shrub (*Haloragodendron lucasii*), a shrub (*Persoonia hirsuta*), a shrub (*Persoonia mollis* spp. *maxima*) and a shrub (*Asterolasia elegans*). Additionally the following species have been listed as vulnerable: a shrub (*Kunzea rupestris*), a shrub (*Darwinia biflora*), Camfield's eucalypt (*Eucalyptus camfieldii*), an orchid (*Cryptostylis hunteriana*) and a shrub (*Tetratheca glandulosa*) (NSW NPWS 2006a).

The place is recognised as containing a rich vertebrate fauna, a reflection of the diversity of vegetation communities and habitats in the area and the Park's location in one of the most diverse parts of Australia, the Sydney basin. There are over 160 species of avifauna recorded. There are 28 mammals recorded in the park and reserves of which 11 are bats. The herpetofauna (reptiles and frogs) is diverse with about 62 species record, including about 20 species of frogs. There is also a rich though poorly recorded invertebrate fauna, including over 100 species of butterfly and moths (NSW NPWS 2002; DEH 2006b; Ku-ring-gai Council 2005).

There are 13 animals found in the place listed under the NSW Threatened Species and Conservation Act 1995. Regionally significant populations of several fauna species occur within the National Park including the spotted-tailed quoll (*Dasyurus maculatus*), the southern brown bandicoot (*Isoodon obesulus obesulus*), the koala (*Phascolarctos cinereus*), and the eastern bent-wing bat (*Miniopteus schreibersii*) (NSW NPWS 2002).

Lion Island, at the entrance to Broken Bay, provides breeding habitat for several *Environment Protection and Biodiversity Conservation Act 1999* (EPBC) listed Marine and Migratory bird species; including the wedge-tailed shearwater (*Puffinus pacificus*), the sooty shearwater (*Puffinus griseus*) and the little penguin (*Eudyptula minor*) (DEH 2006a). The breeding colony of little penguins on Lion Island has been the subject of long term research (Rogers et al 1995; Knight and Rogers 2004). Almost all breeding little penguins in the Sydney region are to be found on Lion Island, and long term studies have shown the reproductive success to be higher and more stable than populations at other locations.

The place is an important scientific and educational resource used by many universities and research institutions in the Sydney Region. Pollen and charcoal analysis from South Salvation Creek Swamp provide an indication of the change in species composition over the last 6,000 years and records from moist scrublands and swamps within the place indicate that they may be representative of a cycle of swamps built up, scoured and destroyed and reformed over thousands of years.

Extensive evidence of Aboriginal use and occupation occurs in the place, with over 800 sites or locations with physical evidence of Aboriginal use recorded (NSW NPWS 2002, NSW NPWS 2006b). Shell middens along the foreshore are the most common type of evidence recorded. Other evidence includes rock engravings and paintings, grinding grooves, stone arrangements, burials and occupation sites. No systematic survey has been undertaken across the park, and it is likely that additional sites occur within the park.

The Great Mackeral rock shelter has been excavated within the park. Dates for the site range from 3,670 ± 150 to 220 ± 120 Before Present (McDonald 1992a). McDonald suggests that the art in this shelter was made from 600 years ago until just prior to contact. Attenbrow also states that temporal changes in the proportions of the dominant shellfish were documented at Great Mackerel Beach, near the estuary mouth, where radiocarbon determinations indicate the shell-bearing layer extends from about 560 to 220 years ago (Attenbrow 2002:68).

Rock art within the place has been investigated by McDonald (1994) as part of a broader analysis of rock art in Sydney Basin. Specific features of the Sydney Basin rock art include: pecked intaglio motifs, interpreted as being a 'residual Panaramittee' assemblage (predating the majority of art and occupation in the Sydney region); shelter art sites present in large numbers across the entire sandstone landscape, while engraving sites are more geographically confined, with a dense core of engraving sites in the central coastal area; and a small number of engravings found on vertical boulders in close proximity to major waterways. There are striking similarities in the motif preferences of both art forms, as well as several major differences (e.g. marine depictions in engravings but not in the shelter art). Stylistic differences in both engravings and paintings across the region may demonstrate the nature of contacts between language groups. There was generally less stylistic homogeneity in pigment art than engravings; however the Ku-ring-gai area was a sharp contrast, as it had a core and highly homogenous engraving assemblage while the pigment art was highly heterogenous. There is no evidence for a change in motif forms over time, with the exception of change from early to later style engravings.

The mainland areas of the park include wharves associated with recreational use as well as walking tracks, such as that built to Perry's Lookout on Pittwater, and roads. The two main roads are from North Turramurra to Bobbin Head (1901) and from Mount Colah railway station to the Bobbin Head road via a causeway (1903). There are also roads to Illawong and Apple Tree Bay.

The park was originally established under management by the Ku-ring-gai Chase Trust. Properties originally purchased or managed by the Trust include 'The Basin' on Pittwater (purchased 1915), 'Beechwood Cottage' (erected in 1882), 'Bobbin Inn' as well as jetties, boatsheds and a swimming enclosure.

A number of observation posts and other defence emplacements were constructed at West Head. Between 1924/1925, a small replica of the Great Sphinx was carved out of sandstone near Turramurra. The monument is flanked by two small pyramids inscribed in memory of AIF comrades who died during World War I.

History:

Early historical evidence indicates Ku-ring-gai Chase National Park, Lion Island, Long Island and Spectacle Island Nature Reserves fell within the boundaries of two local clans - the Garrigal people, who occupied an area around Broken Bay and the Terramerragal, who occupied an area around the Turramurra area (NSW NPWS 2002, Attenbrow 2002). It is understood that these clans belonged to the Guringgai language group. Evidence for the past activities of these people is found at a number of sites in the park. They including shell middens, rock shelters, artefact scatters, grinding grooves, stone arrangements, burials, rock engravings, rock paintings and hand stencils (NSW NPWS 2002)

Within six weeks of his arrival at Port Jackson in 1788, Governor Arthur Phillip explored Brisbane Water and Cowan Creek. He commented on the friendliness of Aboriginal people in each of the bays and inlets who came out in their canoes to greet him (NSW NPWS 1996). In August 1788, Phillip and his party travelled overland to Pittwater and back, walking along Aboriginal tracks and exploring the southern shores of Pittwater and around McCarrs Creek.

Governor Phillip and others described Aboriginal engravings at Broken Bay (Attenbrow 2002). These observers do not mention painted images and they provide no information about the role of the art in Aboriginal society. In 1789, during a second exploratory trip of Broken Bay by Phillip, the Aboriginal people were less welcoming. There was also clear evidence of Aboriginal deaths from smallpox, with skeletons and bodies in rock hollows along the harbour (Attenbrow 2002).

During subsequent conflict between Aboriginal people and white settlers in the upper reaches of the Hawkesbury, many Aboriginal people were displaced and moved to Pittwater. Skirmishes were also recorded in the Pittwater area during 1805. While many Aboriginal people had moved away by the 1840s, a few Aboriginal people were reported as still living in the western foreshores of Pittwater and in Ku-ring-gai Chase in 1900 (NSW NPWS 1996).

In the early days of the colony the Ku-ring-gai area was used mainly for timber extraction and boat building. Soda ash, salt and shell lime were also collected and manufactured in the area. A navigation light on Barrenjoey Head (1855) was replaced in 1868 by the Stewart Towers and in 1881 by the present lighthouse designed by Colonial Architect James Barnet. A customs house also operated at Barrenjoey Head from 1843 to 1904. In the late 1870s, construction began on the railway to the Hawkesbury River. By the 1880s a number of boatsheds were in place and the Hawkesbury Railway Bridge (1886-1889) was completed (NSW NPWS 2002).

From the 1880s, there was concern about the loss of native vegetation and the degradation of bushland in and around Sydney. Eccleston Frederic Du Faur successfully lobbied the NSW Government to establish a park near Turramurra to protect native flowers from a rapidly expanding neighbourhood. The conservation area "Ku-ring-gai Chase" was established in 1894 covering 13,500 hectares and administered by the Ku-ring-gai Chase Trust with Du Faur as managing trustee from 1894 until his death in 1915 (Australian Dictionary of Biography 1972, NSW NPWS 2002).

Du Faur was an influential figure in colonial society being a government surveyor, the founder of the Art Gallery of NSW as well as the founder of Ku-ring-gai Chase conservation area. In the 1870s he conducted artists' camps in the Blue Mountains promoting natural values, parts of which were already set aside for forest reserves and as water catchment areas.

The Pittwater area was closely associated with the writing of the Australian Constitution. In March 1891, the Drafting Committee (including Samuel Griffith, Edmund Barton, Charles Kingston and John Downer) revised the draft Constitution on board the paddlesteamer *Lucinda* when it anchored in The Basin. Although this 1891 draft was not implemented, it later served as the starting point for the Convention of 1897-98 (Deane 2000, Pittwater Council 2002).

In 1967, following 73 years of management by the Ku-ring-gai Chase Trust, the Chase was declared a national park under the NPWS Act 1967. Spectacle Island was dedicated as a reserve for public recreation in 1919 and as a nature reserve in 1972. In 1891 Long Island was reserved for public recreation and in 1972 became a nature reserve except for railway uses. Lion Island, dedicated as a fauna reserve in 1956, was also dedicated as a nature reserve under the NPWS Act 1967.

Condition and Integrity:
Although large areas within Ku-ring-gai Chase National Park, Lion Island, Long Island and Spectacle Island Nature Reserves are in natural or near natural condition, the popularity of the park along with its location within an urban-fringe environment means that the conservation of the area requires considerable and ongoing management of weeds and pests, fire risk as well as other impacts caused by recreational activities.

The sections of the place where introduced plants cause the greatest problem are along watercourses, in areas adjacent to urban development, in areas of past habitation and in some areas of high public usage (NSW NPWS 2002). Two hundred and thirty-six exotic plant species have been recorded within the park (Thomas and Benson 1985). A number of introduced animals have been recorded within the park with foxes (*Vulpes vulpes*) considered to cause the greatest impact (NSW NPWS 2002).

Over the past fifty years, most of Ku-ring-gai Chase National Park has been subject to a fire frequency of ten to fifteen years, particularly on the ridges and upper slopes. During this period the park has had on average ten small fires a year with extensive fires (over 500 hectares) occurring approximately twice a decade. A fire in January 1994 burnt almost half the park and it is estimated that only about 1% of the park contained vegetation that was more than twenty-one years old (NSW NPWS 2002 and Conroy 1996). A Fire Management Plan is currently in place for the National Park (NSW NPWS 2005).

The place also plays an important role in providing protection for a proportion of the lower Hawkesbury catchment area. Urban development surrounding the park has resulted in accelerated siltation and pollution of watercourses within the park which has lead to increased weed growth. Recreational use of the waterways has also led to deteriorating water quality. The deterioration of the park's waterways has been recognised by the NSW NPWS as having a significant impact on native plants and animals (NSW NPWS 2002).

NSW NPWS plans to negotiate with the State Rail Authority to establish a conservation agreement over the part of Long Island managed by that Authority (NSW NPWS 2002).

Condition assessed 2006.

Location:
About 15000ha, Bobbin Head Road, Bobbin Head, comprising Ku-ring-gai Chase National Park, Lion Island Nature Reserve, Long Island Nature Reserve and Spectacle Island Nature Reserve.

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Report Produced: Thu Feb 1 12:04:10 2007

Australian Heritage Database

Place Details

Ku-ring-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves, Ku-ring-gai Chase Rd, Bobbin Head, NSW

Photographs: None
List: National Heritage List
Class: Natural
Legal Status: Nominated place
Place ID: 105817
Place File No: 1/13/016/0003
Nominator's Summary Statement of Significance:

Ku-ring-gai Chase National Park is the second oldest national park in Australia and the oldest national park established primarily for nature conservation (NPWS 2005a). It is one of the top ranking biodiversity reserves.
Ku-ring-gai Chase National Park is one of a number of sandstone national parks in the Sydney region that form part of one of the two temperate hotspots for plant endemism and richness in temperate Australia (the other being south-west Western Australia).
Ku-ring-gai Chase National Park (Sydney Basin) is recognised as a species rich area on a national scale. The Sydney map sheet is the most species rich region in Australia for birds and within the top 1% for species richness (and in some genera, endemism) of several families and genera of plants.
Ku-ring-gai Chase National Park is within the top 5% of areas important for eucalypts in terms of species richness, structural representation, primitive species and endemism.
Ku-ring-gai Chase National Park has been identified as one of Australia's richest and significant terrestrial and freshwater biodiversity hotspots for a number of different groups of species, ranked third in Australia behind the Daintree and Wet Tropics.
Ku-ring-gai Chase National Park is ranked in the top ten natural heritage hotspots identified for its importance for Gondwanan or primitive species
Ku-ring-gai Chase National Park is an important adjunct to the Blue Mountains as a world heritage property for eucalypt diversity.
Ku-ring-gai Chase National Park and the associated reserves have great cultural and spiritual importance for Indigenous Australians. This importance lies both in its general landscape, and in the many Aboriginal sites found in the area. There are more than 800 Aboriginal sites remaining in the Ku-ring-gai Chase National Park today and a significant amount in the associated reserves. These relics

of the area's rich, living Aboriginal culture include rock engravings, burial sites, axe grinding grooves and places that show evidence of Aboriginal occupation such as middens and shelters (NPWS 2005a, NPWS 2002).
Ku-ring-gai Chase National Park and the associated reserves are also known for their breathtaking scenery and as a large natural area in the Sydney metropolitan area providing an escape from the city (Higgins et al. 1986, Cronin 2000, NPWS 2002, NPWS 2005a).
The natural and cultural heritage of Ku-ring-gai Chase National Park and the associated reserves and their location within the Sydney metropolitan area, provide significant opportunities for education and research (NPWS 2002).
Ku-ring-gai Chase National Park and the associated reserves provide a refuge from the city for a large number of rare, uncommon and threatened fauna, flora and ecological communities (NPWS 2002, NPWS 2005a).
Ku-ring-gai Chase National Park contains important historic sites associated with early recreational use, transport, navigation and defence (NPWS 2002, NPWS 2005a).
Ku-ring-gai Chase National Park and the associated reserves are listed on the Register of National Estate. The national park is listed for its aesthetic value, for its scientific importance as a remnant of the natural environment of Sydney and for its abundance of Aboriginal sites. Lion Island is listed because it provides important breeding habitat for a number shearwaters and little penguins; Long Island for its unique and diverse vegetation; and Spectacle Island for its particularly diverse vegetation (NPWS 2002).

Official Values: Not Available
Description:

The area is highly valued for its breathtaking views and beautiful landscape. Descriptions provided under criterion e demonstrate these aesthetic values.
Ku-ring-gai Chase National Park and the associated nature reserves form a vast area of bush land and a tight cluster of winding creeks, sheltered beaches, hidden coves and wide expanses of deep blue water. Vegetation communities include heath lands on the sandstone ridges, dense forests on the slopes, and mangroves on the tidal mudflats. Wildflowers are abundant in winter and spring. Hundreds of honeyeaters feed on banksias, crimson and eastern rosellas are often seen in flocks and native ducks are abundant in swamps and freshwater pools. Mammals including echidna, bats, koalas, possums, gliders, bandicoots, swamp wallabies, wallaroos, marsupial mice, and antechinus are abundant but are nocturnal and rarely seen. The tidal waterways are breeding and feeding grounds for a diverse range of aquatic life including sharks, bream, blackfish, mullet, jewfish and leatherjacket (Cronin 2000).
Over 800 Aboriginal sites are scattered throughout the area. These include rock engravings, burial sites, axe grinding grooves and places that show evidence of Aboriginal occupation such as middens and shelters. Sites with more recent historic value include 'Beechwood' holiday cottage, roads constructed to provide access to a recreation area at Bobbin Head, several sandstone structures of importance, the Bobbin Jim, a sandstone war memorial near Turramurra, military observation posts, defence emplacements, and the lighthouse, keeper's cottage and roadway at Barrenjoey Head.
There is a visitor centre at Kalkari (Bobbin Inn) and a number of walking tracks throughout the park. These tracks take visitors through a variety of vegetation types and past a number of Aboriginal sites such as rock art and shelters. There is a camping area at The Basin on Pittwater and kiosks at Bobbin Head, Appletree Bay, Akuna Bay, and Cottage Point. Picnic areas, toilets and fireplaces are located in various places. Boat ramps are situated at Akuna Bay, Appletree Bay, Brooklyn and Cottage Point.

Ku-ring-gai Chase National Parks covers 14,882 ha. The Lion Island Nature Reserve covers the entire Island, which is approximately 8ha. The Long Island Nature Reserve covers over 73ha of the island. The Spectacle Island Nature Reserve covers the entire island which is approximately 36ha (NPWS 2002).

History:

Before the European colonisation of Australia in 1788, the Guringai people lived from Broken Bay in the north, to Port Jackson in the south, to Lane Cove River in the west. Two Guringai clans occupied the area that is now Ku-ring-gai Chase National Park and the associated reserves — the Garrigal people lived around West Head and the Terramerragal lived in the Turramurra area (NPWS 2002, NPWS 2005a).

Within 6 weeks of the arrival of the British First Fleet, Governor Phillip went camping at Resolute Beach. He commented on the friendliness of the Aboriginal People in the area. However when he returned a year later they all fled from him (NPWS 2005a).

By 1790 over half the Guringai people had been wiped out by smallpox and conflict with white settlers (NPWS 2005a).

Between the 1790 and 1840s Pittwater was a haven for escaped convicts, liquor smugglers and ships seeking shelter from storms. There were several ship wrecks before the Barrenjoey lighthouse was built in the late 19th Century (NPWS 2005a).

By the 1840s most of the Guringai people had disappeared and their traditional lands had been taken over by white settlers (NPWS 2005a).

By the late 1800s Pittwater was popular as a place of leisure for the wealthy. Coach and ferry services brought picnickers and campers to places like The Basin. Large steamboats offered trips along the waterways. When the car and omnibus were invented visitor numbers increased. Holiday and retirement homes were built and people began to settle in the area permanently (NPWS 2005a).

In the late 1800s, a man by the name of Eccleston Du Faur began lobbying for a "National Park for North Sydney". As a result Ku-ring-gai Chase was established in 1894. The park included 13,000ha and was placed in the care and control of Mr Du Faur as the managing trustee. Its name was adapted from the original inhabitants, the Guringai people (NPWS 2002).

In 1911, 73 ha of Long Island was set aside as a reserve for public recreation (NPWS 2002).

In 1919 Spectacle Island was set aside as a reserve for public recreation (NPWS 2002).

In 1929 an up market country club, casino, golf club and hotel was proposed for West Head.

These plans never went ahead and instead the area was used by the navy during the Second World War. Fortifications and gun emplacements were built on the headland. Then in 1951 West Head was added to Ku-ring-gai Chase (NPWS 2005a).

In 1956 Lion Island was set aside as a fauna reserve (NPWS 2002).

In 1967 Ku-ring-gai Chase became a national park when the National Parks and Wildlife Act (NPW Act) was proclaimed. It was placed in the care and control of the NPWS. Since then, additions have been made to the park, making it now 14,882ha in size. In the same year Lion Island was reclassified under the NPW Act as a Nature Reserve (NPWS 2002).

In 1972 the Long Island and Spectacle Island were reclassified as Nature Reserves under the NPW Act (NPWS 2002).

Today, Aboriginal people live close to Ku-ring-gai Chase National Park and the associated reserves. The area has great cultural and spiritual significance to them (NPWS 2002, NPWS 2005 a).

Condition and Integrity:

While areas of Ku-ring-gai Chase National Park and the associated reserves are relatively untouched there are various threats that can impact on their condition.

Many of the threats to the national park result from the high rate of visitation. Horse riding trails occur in some areas of the park. Evidence has indicated that horse riding in the park has an impact on sandstone areas (Lord 2002) as they can cause erosion, despoliation and weed invasion. Powerboats are permitted in all inlets of the park. They have the potential to disturb water birds as well as the peaceful setting of the area (Lord 2002). Vandalism and graffiti has damaged a number of aboriginal sites within the park and associated reserves (NPWS 2002).

Introduced plants are a major problem along watercourses, in areas adjacent to urban development, in areas of past habitation and in areas of high public usage. At least 236 introduced species have been recorded in Ku-ring-gai Chase National Park. Introduced animals include cats, dogs, foxes, black rats, mice, European honey-bees and rabbits. They cause a number of problems including soil erosion, disturbance of native vegetation and natural pollination processes, competition with native animals and predation of native animals (NPWS 2002).

Location:

About 15000ha, Bobbin Head Road, Bobbin Head, comprising Ku-ring-gai Chase National Park, Lion Island Nature Reserve, Long Island Nature Reserve and Spectacle Island Nature Reserve.

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Australian Heritage Database

Place Details

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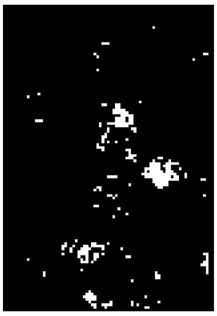
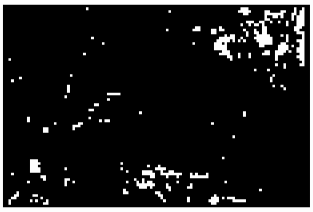
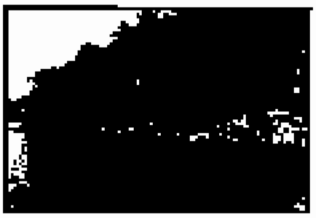
Send Feedback

Ku-ring-gai Chase National Park (1980 boundary), Ku-ring-gai Chase Rd, Bobbin Head, NSW

Photographs:

List:	Register of the National Estate
Class:	Natural
Legal Status:	Registered (25/08/1981)
Place ID:	2608
Place File No:	1/13/016/0003

Statement of Significance:

Ku-ring-gai Chase National Park, established in 1844, has long been an important natural recreation area close to Sydney. The Park has a very diverse flora (over 900 species) and rich fauna. Ku-ring-gai has a number of trails to give visitors a good insight into the diversity of the area.

Indigenous values are known to exist in this area. As yet these have not been identified, documented or assessed for National Estate significance by the Australian Heritage Commission.

(The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.)

Official Values: Not Available

Description:

Park has rainforest, wet and dry sclerophyll forests, woodlands, scrub and heath communities. There are over 900 plant species recorded including thirty eucalypts, four angophoras, six casuarinas and thirty-one acacias. The incised sandstone topography with the diversity of flora and indented coastline makes this park a significant landscape area.

History: Not Available
Condition and Integrity:
Near natural.
Location:
Approximately 14713ha, on the northern side of Sydney. Located on southern shore of Broken Bay and comprising much of the catchment of Cowan Creek. Generally bounded by Broken Bay in north, Pitt Water in East, Sydney suburbs in south and main north railway in west.
Bibliography: Not Available

Report Produced: Mon Mar 6 16:10:20 2006

LANDSCAPE CONSERVATION AREA

TERRY HILLS	KU-RING-GAI	SYDNEY
Location	Name or identification of listing	Region

Proposer	I. ARMSTRONG K. BOOTLE R. McDOUGALL	Crown Land: X	Freehold: X	Map reference: HAWKESBURY RIVER CMA
Date of Proposal	AUGUST 1988	Local Govt Area/s: KU-RING-GAI MUNICIPALITY HORNSBY SHIRE WARRINGAH SHIRE		Owner/s: VARIOUS CROWN AND FREEHOLD
Suggested Listing Category	CLASSIFIED			
Committee (Trust use)	LAC			
Council (Trust use)	19/9/88			

Reasons for Listing

1. The Ku-Ring-Gai Landscape Conservation Area is an outstanding example of a sharply dissected Hawkesbury sandstone landscape with contrasting steep tree clad hills and calm waterways.

2. The Area contains a great variety of plant life ranging from mangrove swamps to wet and dry sclerophyll forests.

3. The plant communities of the area support a rich wildlife population, particularly birds.

4. The species diversity of the area is very high with over 566 species of plant including 12 rare species, two endangered species, and two vulnerable species of flora.

5. There is a wealth of Aboriginal relics in the form of occupation and art sites.

6. Ku-Ring-Gai Chase National Park is Australia's second oldest national park.

7. The Conservation Area contains sites which provide evidence of the early period of European Settlement of the area, and features which are demonstrative of changing modes of recreation during the Twentieth Century.

RECOMMENDATIONS

The National Trust of Australia (NSW) is most concerned at the recent alienation and destruction of parts of Ku-ring-gai Chase National Park for roadworks. The Trust believes that lands within National Parks generally should not be alienated by conflicting land uses or for use by special interest groups. Accordingly the Trust is strongly opposed to any further loss of lands within Ku-ring-gai Chase National Park. To compensate the destruction of significant plant communities by the Sydney-Newcastle freeway development three of the four areas recommended by Benson (1985) should be acquired and added to the Park. These are:

(i) A large population of rare and threatened species including Grevillea caleyi, near Tumbledown Dick Hill, Terrey Hills.

(ii) The area around the quarry at Duffys Forest containing a large representation of open forest.

(iii) The area north of the Park boundary between the railway line to Brooklyn, containing important heath communities associated with the rare species Micromyrtis blakelyi.

Further, consistent with the recommendations for the Classified Hawkesbury Reserve, Brooklyn, this area under lease to the National Trust should also be added to the Park.

Special emphasis should be given in any Environmental planning instrument to the control of encroaching urban development and to the implementation of appropriate visual and architectural standards on such developments within the visual catchment of the Park. Special attention should be given by local councils and the National Parks and Wildlife Service to minimise visual, weed, fire and water impacts on the Park. Particular attention should be given to developments along water frontages at Cottage Point, Cowan Water and along the western shore of Pittwater. While these settlements do not currently present a significant impact, their close subdivision or more intensive development would be a matter of concern and should be resisted by Council.

The significant and aesthetically pleasing population of trees on St. Ives Showground should be protected by Council planning provisions.

The Ku-ring-gai Wildflower Garden is an important recreational and cultural site which should be maintained and managed in sympathy with the objectives established by Ku-ring-gai Municipal Council and S.G.A.P., North Shore Group.

AUGUST, 1988.

DESCRIPTION

Ku-Ring-Gai Chase National Park is wholly contained within the Classified Area, which is generally delineated by the Park boundary with the following exceptions: in the west it follows the Sydney to Newcastle railway line and the expressway; to the south it includes St. Ives Showground, the Ku-Ring-Gai Wildflower Garden and the areas recommended by Benson (1985) for addition to the Park at Mona Vale Road, Tumbledown Dick Hill and Duffys forest; and the foreshores of Pittwater/Broken Bay are included in the north/east.

The Area is contiguous with the Narrabeen Lakes Western Catchment Landscape Conservation Area Classified in July 1986.

GEOLOGY AND LANDFORM

The Ku-ring-gai Landscape Conservation Area is situated near the centre of a large sedimentary basin - the Sydney Basin, which was developed during the Permian and Triassic periods. The main rock strata are mainly sandstones and shales with minor developments of conglomerate. Three main rock types of the Triassic Period are found in the area. The oldest are the sandstones and shales of the Narrabeen Group which crop out along the foreshores. Red brown (chocolate) claystones are typical of this group.

The Hawkesbury sandstone is the predominant rock unit exposed and while it is composed predominently of sandstone, shale interbeds also occur.

Shales of the Winnamatta Group occur on the higher points of the area, which are the youngest of the Triassic Period sediments; for example, Cowan Trig Station.

Intrusions of dolerite, exemplifying igneous activity, are found at West Head. Unconsolidated sediments occur mainly along the foreshores and creeks. Secondary ironstone formations occur throughout the area and surface laterization is commonly developed on the overlying shales of the Wianamatta group; for example, in the Terrey Hills and Duffys Forest area.

In the Pliocene Period, 2 to 12 million years ago, the area was uplifted and streams eventually formed deep valleys through the sandstone. In more recent times, after the last ice age, the deeper valleys were partially flooded, forming the existing waterways.

FLORA

Ku-ring-gai Chase National Park is particularly important in conserving a large area of undisturbed vegetation of the type which gives Sydney bushland its distinctive character. It is also important for conserving vegetation types which are significant in a local and regional context. These tend to be of limited size and are associated with unusual or remnant geological and topographical features.

Benson (1985) identified 21 plant communities in his survey of the Park ranging from closed forest to open forest and low open forest to

Head is the Bobbin Inn, which was built in 1936-37, and the Orchard Park and its pavilions. These features and their associated elements and detailing represent an important aspect of the history of the development and use of the park.

The development of Ku-ring-gai Chase represents a change in philosophy from that of Royal National Park, which was seen as more Arcadian and in the nature of an English park, to a more natural setting. It was for this reason that the name "Chase" was chosen to distinguish it from the earlier form of "park".

ABORIGINAL HISTORY

The Aborigines who lived in the general region from North Sydney to Gosford belonged to a number of "language/locality" groups including Guringai, Gareingal, Bayimai, Cameraigal, Walumeda, Buruburongal and Dharuk.

Archaeological evidence from Aboriginal occupation includes middens, engravings and cave paintings. There are a large number of engraving areas within Ku-ring-gai Chase and include in all a thousand or more figures. Cave paintings are not as common and most often are in the form of hand stencils.

KU-RING-GAI WILDFLOWER GARDEN

The first formal resolution to establish the Garden came in 1961 under Robert S Turner, then an Alderman of Council. The North Shore Group of The Society for Growing Australian Plants had requested Turner to submit a Notice of Motion which investigated the development of the Garden project. In 1963, following a recommendation of the special investigating committee, the Council adopted the name "Ku-ring-gai Wildflower Garden" together with the objects and aims:

> "The growing of plants from all parts of Australia for preservation and public display and by these means the attraction of tourists and visitors to the Ku-ring-gai Municipality".

The Garden was officially opened by the Governor of New South Wales, His Excellency, Sir Roden Cutler, on 4th October, 1968.

Numerous walks and trails provide easy access for those people wishing to see the great range of Australian wildflowers and native shrubs at the Garden which is an important recreational and cultural site in the municipality.

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Ku-Ring-Gai Council/North Shore Group S.G.A.P. (1979) Ku-Ring-Gai Wildflower Garden Guide Book.

woodland and sedgeland/shrubland. In this survey, 366 species and 119 families of plants were recorded, and included:

Twelve rare species:- Lomandra brevis 2RC,
Genoplesium baeuri 3RC,
Leucopogon amplexicaulis 3RC,
Austromyrtus tenuifolia 3RC,
Darwinia biflora 2RC,
Darwinia procera 2RC,
Eucalyptus luehmanniana 2RC,
Eucalyptus squamosa 3RC,
Grevillea caleyi 2RC,
Boronia fraseri 2RC,
Rulingia hermannifolia 3RC,
Tetratheca glandulosa 2RC,
Two Endangered Species:- Cryptostylis hunterana 3EC,
Eucalyptus camfieldii 2EC,
Two Vulnerable species:- Blechnum ambiguum 3V,
Kunzea rupestris 3V,
In addition there are several other species of unusual distribution.

CULTURAL VALUE

Ku-ring-gai Chase National Park, which comprises the majority of the area, was the second National Park dedicated in Australia.

Originally the land occupied by the Park was part of the territory of Ku-ring-gai, an aboriginal group belonging to the Dharug tribe. The Ku-ring-gai area was first explored by Governor Phillip in 1793; however, the land proved generally inhospitable to European settlement which established itself at Port Jackson.

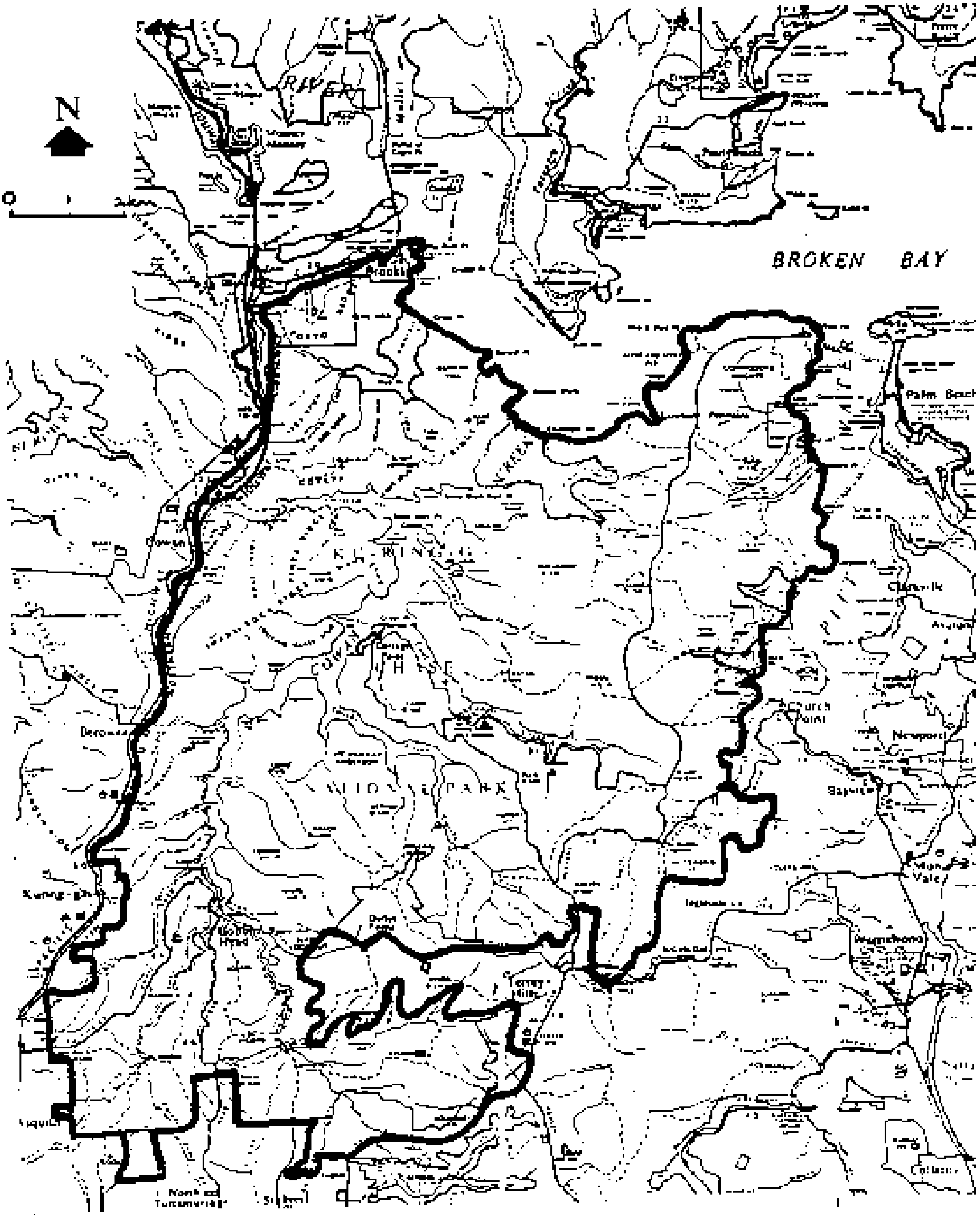
The area received little attention until the end of the 19th Century, when in 1892 a proposal was made by Eccleston du Faur to declare the waters of Cowan Creek and the adjacent lands a National Park for North Sydney.

In 1894 nine trustees were appointed for the temporary control of about 35,000 acres (14,164.01 ha) of foreshores and wild bushland. This was made permanent in 1900 when the land was vested in the trustees by way of a Crown Grant and the trustees were instructed to permit the land to be used for recreation of the inhabitants of the colony.

Areas of land were continually added to the original dedication. Due to management problems an act was introduced in 1961 to revoke the Crown Grant and dedicate the land as public park again under the management of trustees. This rationalised the increasing discrepancies between the land reserved, the gazettal of regulations and trustee appointments.

In October, 1967 the Park was reserved under the National Parks and Wildlife Act and later in November transferred to the care, control and management of the Director of the National Parks and Wildlife Service. The Park now occupies an area of 14,712 ha.

Ku-ring-gai Chase contains evidence from periods of European visitation to the area. Much of this evidence is concentrated at Bobbin Head. A road was developed to this site in 1901, and subsequent development was dependent upon the reclamation of land from Foley's Bay which was begun in 1911. The major feature at Bobbin



Ku-ring-gai Landscape Conservation Area

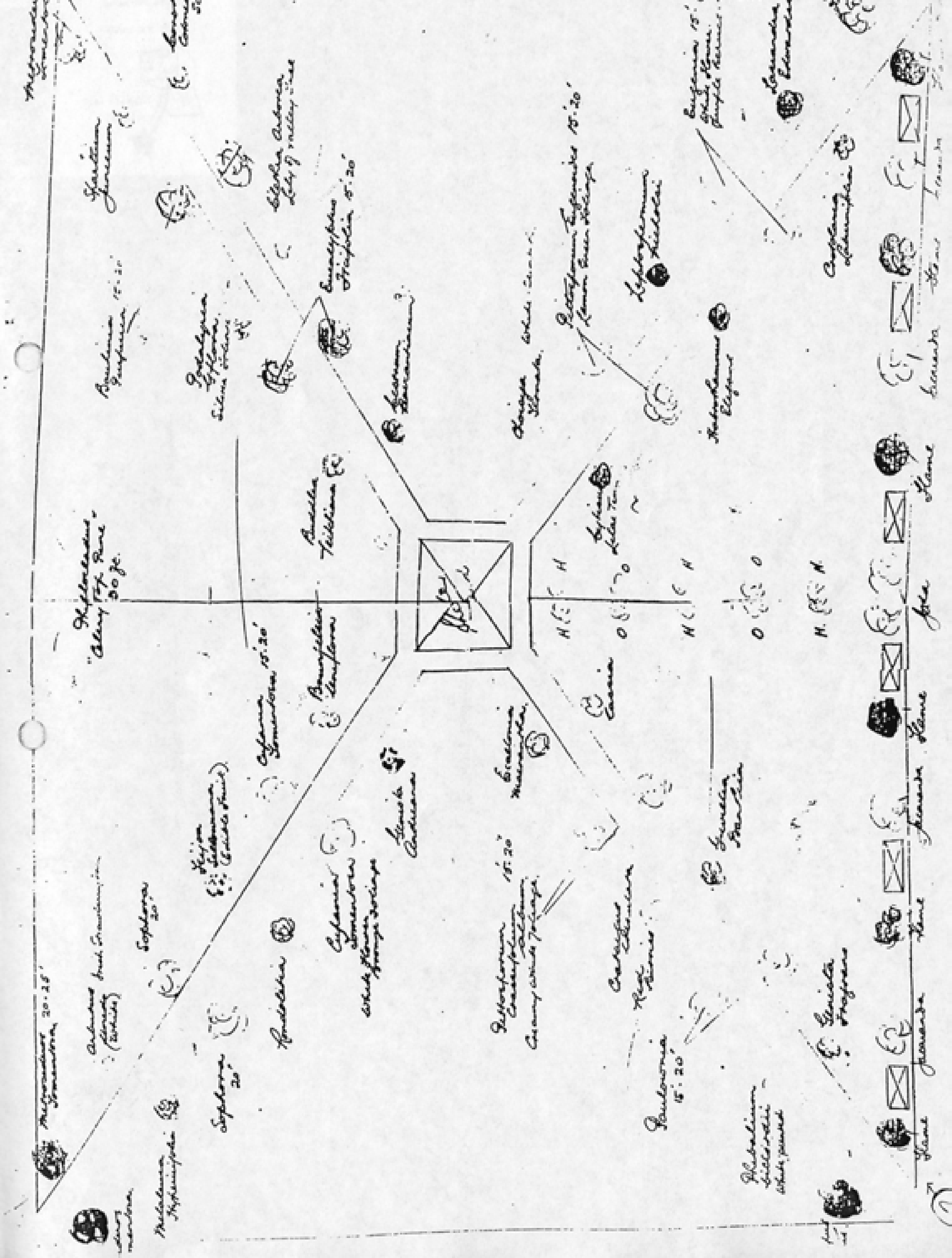
7.2 Concept Planting Plan

There is no available evidence that this planting plan was implemented; we know nothing of its provenance, nor whether it was associated with Orchard Park. The following trees were listed on the plan[1]:

- Jacaranda
- Flame Tree
- Irish Strawberry Tree, white
- Melaleuca
- Japanese Pagoda Tree
- Pineapple Guava
- Butterfly or Orchid Tree
- Scarlet Flowers
- Lilly of the Valley Tree
- Red Flowering Gum, WA
- Lilac Tree
- Tarata, NZ
- Tea Tree
- Brush Tree (white and purple varieties)
- Firewheel Tree
- Karo, NZ (creamy white foliage)
- Hawthorn Family (red berries)
- Silky Oak
- Deciduous Chinese Tree
- Celery Topped Pine

[1] Bachmann, R et al, (2003), Conservation Management Plan for Orchard Park, Ku-ring-gai Chase National Park, Appendix 3

Fig.19. Orchard Park - original layout planting plan.



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