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Geotechnical Environmental & Resource Consultants
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LANDSCAPE MANAGEMENT PLAN (Including Quarry Closure, Rehabilitation and Post Extraction Land-use)

EXISTING SAND AND SOIL EXTRACTION OPERATIONS

**Lot 32 DP 635271 and Lot 22 DP 833317
Macarthur Road, Spring Farm**

Prepared for:

M Collins and Sons Holdings Pty Ltd

Job Reference 75/256/4

11th December 2018

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Revisions register

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2	27/06/2011	Minor typographical revisions
3	07/07/2011	Final draft
4	12/07/2011	Report finalised
5	25/07/2011	Minor revisions following client review
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		Updated outdated abbreviations for governing authorities – EPA, DPE, DPIW
		Removal of past tense phrasing to reflect definitive commitments (eg
		Added date of CAA to Appendix 3
		Various typographical errors corrected
		Updated Section 2.1 to include Section 8.9.5 of Mod 3 EA
		Rehabilitation phase program included in Section 5.12
		Added monitoring, reviewing and implementation responsibilities and reporting
		Added Section 5.5.4 Bushfire Management
		Added Section 5.5.5 Landscaping
		Added Section 5.5.6 Final Land Form
		Added 5.7.5 Rehabilitation/Revegetation potential risks/controls
13	31/10/2016	Final Submission to DPE for approval
14	1/3/2017	Modifications to address NSW Dept Planning letter dated 7/12/2016
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17	11/12/18	Document updated to reflect new approval conditions under Modification 4 – see Appendix 4.

EXECUTIVE SUMMARY

M Collins and Sons Holdings Pty Ltd (MCS) owns and operates the Spring Farm Quarry located at Lot 22 DP833317 and Lot 32 DP 635271 at Spring Farm, in the Camden Local Government Area (LGA). Development consent (DA 75/256) for the extraction and processing of sand and soil was originally granted by the Minister for Planning in 1988 and the consent was modified in 1998 to extend the quarry's life. The site is a major source of products for the Sydney region and comprises part of the regionally significant resource identified in the Sydney Regional Environmental Plan No 9 (Extractive Industry).

On the 22 May 2009 MCS was granted a further Section 96(2) Modification for the Continuation of Operations by the Department of Planning for extraction within an 8 hectare portion of the subject site and for the continued processing of extracted materials onsite. That approval was to allow operations to continue for a further 10 year period until 2019.

On the 25th October 2012 MCS was granted a further modification under Section 75W of the Environmental Planning and Assessment Act (1979) (NSW) to extend sand and soil extraction activities onto an adjacent portion of land at Lot 32 DP 635271. This approval enabled the following activities:

- Extraction of sand and soil within a 6.8 hectare (approximate) portion of land within Lot 32 DP 635271.
- Stockpiling, dry screening of sand and soil within the quarry floor on Lot 22 but not on Lot 32;
- Active extraction within Lot 32 DP635271 on 1 hectare portion of land at a time and concurrent rehabilitation works within an additional 1 hectare portion of land.
- On Lot 22 DP833317 permission exists to open and work five hectares at any one time;
- Extraction and rehabilitation works to occur in concert over an 8 year period (completion in 2019);
- Placement of tailings from the sand wash-plant for land-forming and rehabilitation purposes; and
- Rehabilitation maintenance activities to occur over an additional 2 year period.

On 2 August 2018, MCS was granted a further modification (Mod 4.) under Section 75W of the Environmental Planning and Assessment Act (1979) NSW to extend current approved activities under Quarry Consent (DA 75/256) Lot 22 (No. 186) DP) 833317 and Part Lot 32 (No. 172) DP 635271

Based on the well-established programs and protocols together with the recently approved modification, it is concluded that:

- This LMP provides MCS, contractors, Council and relevant Government Authorities with a common document that clearly sets out the performance targets, restoration principles, monitoring and maintenance procedures required for the long term sustainable management of the ecological plantings and their surrounding environment; and
- Lot 32 zone 3 open paddock area will have the capacity for use as 'Class 1' Agricultural land.

Importantly, implementation of this LMP will produce a sustainable post-extraction landscape, including enhanced biodiversity outcomes beyond those directly occasioned by extraction activities. Such landscapes will ultimately be little different to distant observers in a visual sense to that which is currently prevailing.

TABLE OF CONTENTS

	Page
REVISIONS REGISTER	(i)
EXECUTIVE SUMMARY	(ii)
TABLE OF CONTENTS	(iii)
1 INTRODUCTION	1
2 LMP OVERVIEW	4
3 SITE DESCRIPTION	6
4 QUARRY CLOSURE	10
5 RESTORATION PROGRAM	11
6 POST EXTRACTION LAND-USE AND AGRICULTURAL CLASSIFICATION	27
7 LIMITATIONS TO THIS REPORT	28
8 CONCLUSION	29
9 REFERENCES	30

Figures

Figure 1	Location of Sand and Soil Extraction and Processing
Figure 2	Existing Site Layout
Figure 3	Final Landform and Rehabilitation Management Plan
Figure 4	Extraction and rehabilitation Staging Plan

Tables

Table 1	Maximum and Minimum Temperature History for Camden
Table 2	Potential Risks and Mitigation Controls for Rehabilitation and Re-vegetation
Table 3	Plant Schedule for Revegetation Program
Table 4	Inside Dimensions of Nest Boxes
Table 5	Noxious weeds recorded in the Camden LGA area
Table 6	Specific Restoration Actions for Zone 1 Nepean River (eastern bank)
Table 7	Specific Restoration Actions for Zone 2 Dry River Anabranch
Table 8	Specific Restoration Actions for Zone 4 Riparian Linkage (non-agricultural production)
Table 9	Performance Completion Criteria
Table 10	Environmental Monitoring Parameters

Appendices

Appendix 1	Modification of Consent - 2018
Appendix 2	Controlled Activity Approval (CAA)
Appendix 3	Bush Regeneration and Ecological Restoration Report by Bowantz Bushfire & Environmental Pty Ltd
Appendix 4	Final Landform Design
Appendix 5	Summary of weed control techniques
Appendix 6	Example field monitoring sheet
Appendix 7	Agricultural Assessment – Reconstructed Agricultural Landform

Abbreviations

CAA	Controlled Activity Approval
CC	Camden Council
CMA	Catchment Management Authority
CRZ	Core riparian zone
DEHWA	Department of Environment, Heritage, Water and the Arts
DPE	Department of Environment & Planning
EECs	Endangered Ecological Communities
EP&BC Act	Environment Protection and Biodiversity Act 1999
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environmental Protection Authority
ESCP	Erosion and Sediment Control Plan
LGA	Local government area
LMP	Landscape Management Plan
NRAR	Natural Resource Access Registrar
NES	National environmental significance
DPIW	NSW Department of Primary Industries Water
TSC Act	Threatened Species Conservation Act 1995
VB	Vegetated buffer
WMA	Water Management Act 2000
WM & ESCP	Water Management and Erosion and Sediment Control Plan

1. INTRODUCTION

1.1 Overview

M Collins and Sons Holdings Pty Ltd (MCS) owns and operates the Spring Farm Quarry located at Lot 22 DP833317 at Spring Farm, in the Camden Local Government Area (LGA). Development consent (DA 75/256) for the extraction and processing of sand and soil was originally granted by the Minister for Planning in 1988 and the consent was modified in 1998 to extend the quarry's life. The site is a major source of products for the Sydney region and comprises part of the regionally significant resource identified in the Sydney Regional Environmental Plan No 9 (Extractive Industry).

Preparation of this Landscape Management Plan (LMP), is one of several environmental and regulatory reports required by the NSW Department of Planning and Environment for the efficient management of the Spring Farm Quarry. These companion documents can be accessed from the Collins website [here](#).

On the 22 May 2009 MCS was granted a further Section 96(2) Modification for the Continuation of Operations by the Department of Planning for extraction within an 8 hectare portion of the subject site and for the continued processing of extracted materials onsite. That approval was to allow operations to continue for a further 10 year period until 2019. On the 25th October 2012 MCS was granted a further modification under Section 75W of the Environmental Planning and Assessment Act (1979) (NSW) to extend sand and soil extraction activities onto an adjacent portion of land at Lot 32 DP 635271. This approval enabled the following activities:

- Extraction of sand and soil within a 6.8 hectare (approximate) portion of land within Lot 32 DP 635271.
- Dry screening of sand and soil excluded from Lot 32;
- Stockpiling and dry screening of sand and soil within the quarry floor on Lot 22, not on Lot 32;
- Active extraction within Lot 32 DP635271 on 1 hectare portion of land at a time and concurrent rehabilitation works within an additional 1 hectare portion of land.
- On Lot 22 DP833317 permission exists to open and work five hectares at one time; Extraction and rehabilitation works are proposed to occur in concert over an 8 year period (completion in 2019);
- Placement of tailings from the sand wash-plant for land-forming and rehabilitation purposes; and
- Rehabilitation maintenance activities are proposed to occur over an additional 2 year period.

The LMP dated 30 October 2016 required MCS to include additional mitigation measures being, these being:

- Enhanced visual screening by the establishment of the Dry River Annabranche vegetation;
- Staged retention of existing screening south of the extraction site;
- Staged retention of vegetation cover on areas not being extracted and progressive rehabilitation of extracted areas;
- Rehabilitation of the Nepean River Riparian Zone and
- Application of recessive colours to visually intrusive plant, equipment and fencing.

On 2 August 2018, MCS was granted an extension of quarry life extraction from 20 June 2019 to 20 June 2021. Harvest Scientific Services Pty Ltd (HSS) has been engaged by MCS to review and update the Landscape Management Plan (LMP) to address Consent Modification 4 (Appendix 1), which was approved under Section 75W of the Environmental Planning and Assessment Act (1979).

1.2 Aims and objectives

The LMP aims to provide a clear, concise and practical framework for the restoration of the vegetation impacted by the activity and in accordance with relevant legislation and the DG requirements. The objectives of the LMP are to:

- summarise local vegetation characteristics;
- describe the restoration activities necessary to ensure an appropriate growing medium and progressive re-vegetation with local provenance vegetation and/or pasture species.
- describe the maintenance program to ensure vegetation establishment;

- ensure that re-vegetation activities are consistent with the rehabilitation works on the adjacent Lot 22 DP 833317, as outlined in this LMP;
- Establish practical plans and guidelines for the ongoing management of species richness and ecosystem function;
- Implement a monitoring program that will effectively guide adaptive management rather than prescriptive management;
- Facilitate regeneration of structural diversity and complexity of the adjacent endangered ecological community, River-Flat Eucalypt Forest on Coastal Floodplains;
- Describe the restoration activities necessary to progressively restore native vegetation throughout the designated restoration zone;
- Describe the maintenance program to ensure vegetation establishment;
- Protect adjacent remnant 'River-Flat Eucalypt Forest on Coastal Floodplains' and 'Alluvial Woodland on Coastal Floodplains' from human disturbance regimes within 2 years;
- Restoration zones 1 and 2 containing forbs and indigenous grass cover of 55% cover or greater;
- Progressive rehabilitation Lot 22 zone 4 open paddock, gentle slope towards the Nepean River with native grasses and agricultural pasture species;
- Create specialised habitat attributes for arboreal marsupials by 2 years post extraction;
- To assess the capacity of the restoration program to return Lot 32 zone 3 agricultural production areas to 'Class 1' agricultural land; and
- Provide an outline of the proposed post-extraction land-use.

1.3 Relevant legislative policies

The LMP has been prepared in accordance with the provisions contained in relevant legislation and policy guidelines, including but not limited to those listed in the following sections.

1.3.1. Water Management Act 2000

Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. This LMP, and the subsequent implementation of recommended restoration works, has considered the implications of the Water Management Act (WMA) 2000.

A controlled activity approval under the WMA is required for certain types of developments and activities that are carried out in or within 40 metres of the high bank of a river, lake or estuary. This includes the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise. The EPA is required to assess the impact of a controlled activity to ensure that minimal harm will be done to any waterfront land, i.e. the bed and a distance inland of 40 metres from a river, lake or estuary.

The soil extraction activities and associated re-vegetation works involve works within 40 metres of a water course (i.e. the Nepean River and the Dry Anabranche) and are therefore considered to be a controlled action under the *Water Management Act* (WMA) 2000.

MCS has a current Controlled Activity Approval (CAA), which is administered by the NSW Department of Primary Industries Water (DPIW). The expiry date of the CAA is the 21 November 2021. A copy of the CAA is attached as Appendix 2.

1.3.2 Threatened Species Conservation Act 1995

The Threatened Species Act (TSC Act) 1995 includes schedules that list threatened species, populations and ecological communities and key threatening processes. The objectives of the TSC Act are to:

- Conserve biological diversity and promote ecologically sustainable development, to prevent the extinction and promote the recovery of threatened species, populations and ecological communities;
- To protect the critical habitat of those threatened species, populations and ecological communities that are endangered;

- To eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities;
- To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed; and
- To encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The activity is not expected to impose a significant negative effect on any other local populations of native biota, including threatened species, EECs and their habitats listed on the TSC Act, which occur on the study site or in adjoining habitats.

1.3.3. Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act) makes it an offence for a person to undertake an action that has the potential to significantly impact on a matter of 'national environmental significance' (NES) without first obtaining a permit from the Commonwealth Minister for Environment and Heritage. Matters of national environmental significance include: declared World Heritage areas; declared Ramsar wetlands; listed threatened species and ecological communities; listed migratory species; listed marine species; nuclear actions; and the environment of Commonwealth marine areas.

The activity is not expected to impose a significant negative impact on any other local populations of native biota, including threatened species, EECs and their habitats listed on the EPBC Act, which occur on the study site or in adjoining habitats.

1.3.4. Noxious Weed Act 1993

This LMP also considers the landowner's obligations to control weeds listed as noxious and/or environmental in the Camden LGA. During the revegetation activities, site owners are legally obliged to 'fully and continuously suppress and destroy' any noxious weed colonisation.

Several listed noxious weed species were found during the flora assessment. Weed control methodologies outlined in this plan will be implemented upon initiation of clearing works to decrease the chances of site infestation by invasive noxious weed species.

1.4. Project team

The following personnel all contribute to the upkeep and relevance of the Landscape Management Plan.

Name	Position	Qualifications	Relevant experience
Alan Seidenkamp	Quarry Manager	Certified Practicing Quarry Management Certificates issued by Quarry Institute of NSW and Institute of Quarrying Australia Underground Mine Managers Certificate	30 + years in quarry development and management
Mart Rampe	Principal – Harvest Scientific Services (HSS)	Bachelor of Science in Applied Geology	40 + years in Earth Sciences, including 22+ years in quarry and mine site rehabilitation.
Daniel Anderson and Jordan Pont	Environmental restoration and planning consultants (Bowantz Bushfire and Environmental Pty Ltd (Bowantz))	Tertiary qualifications in planning, ecology and conservation biology	Engaged by Collins on the Spring Farm site since 2008

2. LMP OVERVIEW

2.1. Site opportunities and constraints

The rehabilitation of the Dry River Anabranh and the Nepean River embankment provide opportunities in riparian system restoration. Opportunities embraced in the restoration program include:

- Revegetating large areas of native vegetation associated with both the Nepean River and the Dry River Anabranh;
- Rehabilitating areas of existing native vegetation;
- Integrating ecological function and engineering design to achieve balanced landscape outcome and riparian function;
- Improving vegetation cover throughout the site and surrounds;
- Enhance visual screening by embellishment of the anabranh vegetation;
- Staged retention of existing screening south of the extraction site;
- Staged retention of vegetation cover on areas not being extracted and progressive rehabilitation of extracted areas;
- Rehabilitation of the Nepean River riparian zone;
- Use of recessive colours for visually intrusive plant, equipment, fencing and the like;
- Removing heavy weed infestations throughout the old river anabranh and along the eastern 'bank' of the Nepean River; and
- Improve water quality leaving the development site and entering Nepean Catchment.

Constraints encountered during project design include:

- The resources required to implement such a comprehensive rehabilitation program; and
- The seasonality of some of the works to be undertaken.

2.2. Project tasks and objectives

This LMP has been prepared giving consideration to the current EPA guidelines (*"How to Prepare a Vegetation Management Plan, Version 6"*). This requires the LMP to address the following issues:

- Site assessment and determination of constraints (eg. flora and fauna, habitat and corridor values, hydrology, fire issues, services, drainage, topography, weeds, etc);
- Definition of project tasks (description of all tasks necessary to implement the plan);
- Preparation of a program of works;
- Liaison with other consultants, landscape architects, government agencies and local Bush-care groups, as required;
- Preparation of a plant species lists, and maps and diagrams;
- Details on site preparation (protection of existing plants, erosion control, site works, weed control, soil amelioration, seed collection, etc);
- Description of planting program and methodology;
- Description of maintenance program;
- Description of monitoring and review process; and
- Addressing other potential issues (signage, other relevant legislation, other site areas, public relations, community involvement, etc).

2.3. Description of key terms

The following key terms are used throughout the description of the restoration program.

- **Regeneration** - Refers to natural regeneration of the vegetation community.
- **Bush regeneration** - Refers to techniques used to assist and promote natural regeneration without utilising plant material propagated in nurseries.
- **Revegetation** - Refers to the planting of tube stock or similar grown from local provenance seed to re-establish vegetation.
- **Restoration** - Refers to a combination of restoration activities and management techniques to restore native vegetation.
- **Forb**. An herbaceous plant that is not a grass.
- **Biodiversity** - The diversity of plant and animal life.
- **Remnant Vegetation** - Where there are no maps available, remnant vegetation is defined as vegetation where the dominant canopy has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy.
- **Local** - means local environment or site type.
- **Practical completion** - Refers to the completion of installation of revegetation activities.
- **Establishment** - Refers to the minimum 24 month maintenance program (two-years proposed for this project) applied to re-vegetation work to ensure plant establishment.
- **Final Completion** - Refers to the successful completion of the entire restoration program.

2.4. Legislative requirements and work guidelines

2.4.1. Implementation guidelines

All work to be performed on site will be in accordance with the following guidelines:

- DEC *Recovering Bushland: Best Practice Guidelines for Vegetation Restoration on the Cumberland Plain*, 2005;
- Florabank *Seed Collection and Management Guidelines*, updated July 2006;
- DIPNR's *Best Practice Guidelines for Bush Regeneration on the Cumberland Plain*, 2004; and
- Greening Australia NSW Best Practice Revegetation Guidelines, 1999.

3. SITE DESCRIPTION

3.1. Site location

The original combined area for sand and soil extraction was approximately 23 Ha (16 hectares on Lot 22 and 6.8 hectares on Lot 32). It is bound by the Camden Bypass to the north, a dry river anabranch on the East, the adjoining Collins property Lot 22 DP83317 and Lot 1 DP 5877631 on the South and the Nepean River on the West (Figure 1). Currently the approximate extraction area is a combined 7 hectares (2 ha on Lot 22 and 5 Ha on Lot 32)

The extraction area is bound to the east by a Dry River anabranch (which parallels the flow of the Nepean River), the west by the Nepean River, the north by Camden Bypass and the south by former and active extraction areas (Figure 2) that are under-going rehabilitation works and active extraction works, respectively.

Vegetation within the extraction area has been extensively modified through historic clearing and ongoing agricultural activities. The extraction area was previously utilised for Lucerne paddocks.

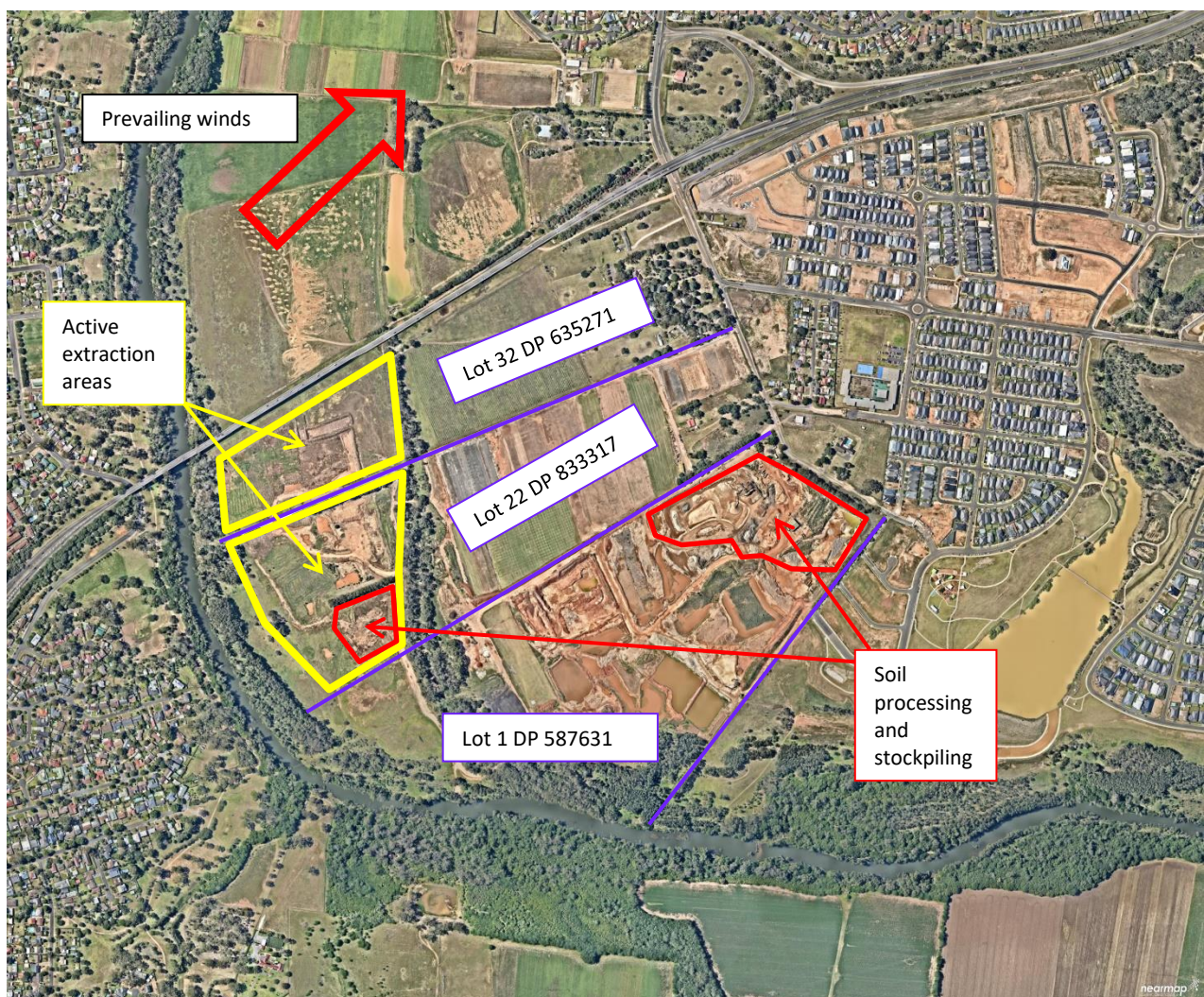
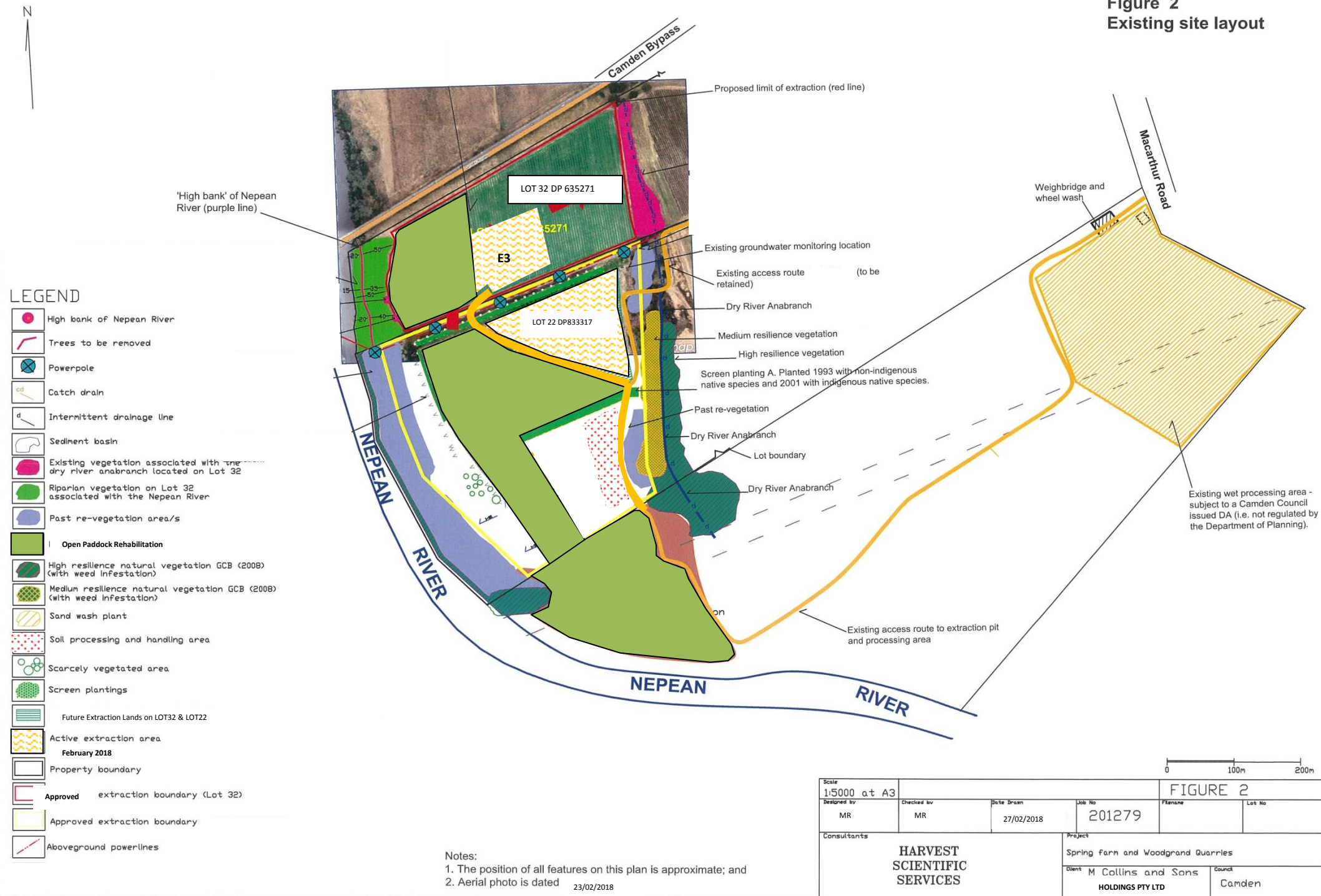


Figure 1. Plan of stockpiling, extraction and processing locations (December 2018)

Figure 2
Existing site layout



3.2. Climate

A well documented climatic history for Camden is available from the Meat and Livestock Australia website- see <http://weather.mla.com.au/climate-history/nsw/camden>. A summary is provided in Table 1.

Table 1: Maximum and Minimum Temperature History for Camden

Max temp history

Hottest Ever This Month	43.1°	17/12/2009
Hottest This Year	45.7°	07/01/2018
Hottest This Month	33.6°	02/12/2018
Long Term Average	28.5°	
Average This Month	28.4°	
Hottest December On Record	Avg. max. temp. 32.4°	1979

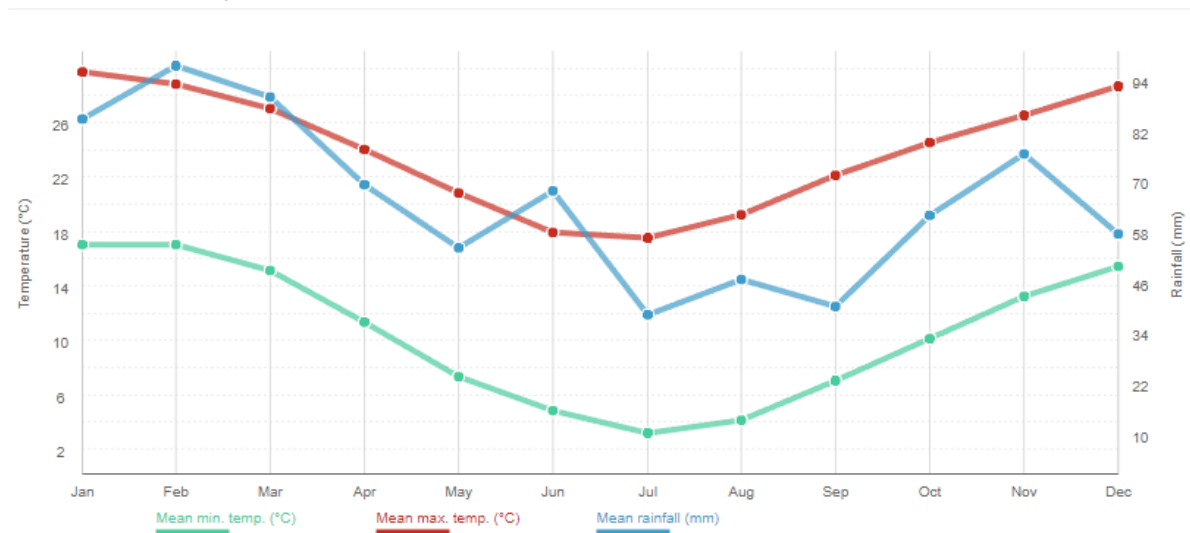
Camden maximum temp history (34.0546°S, 150.6957°E, 109m AMSL)

Min temp history

Coldest Ever	5.7°	19/12/2005
Coldest This Year	-4.9°	16/07/2018
Coldest This Month	11.7°	07/12/2018
Long Term Average	15.2°	
Average This Month	15.3°	
Coldest December On Record	Avg. min. temp. 13.0°	1984

Camden minimum temp history (34.0546°S, 150.6957°E, 109m AMSL)

Mean rainfall and temperature



Vegetation

The extraction area (Figure 2) resembles a landscape consistent with most alluvial agricultural landscapes in the Macarthur district, including a long history of agricultural activities. The vegetation in and around the extraction area includes the features outlined below.

Lucerne paddock

Vegetation within the extraction area has been extensively modified through historic clearing and ongoing agricultural activities. The extraction area was previously utilised for the growing of Lucerne.

Bank of the Nepean River

Vegetation immediately to the west of the extraction area and on the bank of the Nepean River is mapped by Actinotus (2011) as 'Riparian Forest on Coastal Floodplains'.

This vegetation is a mature stand of tall forest structure to 25m in height, dominated by River Peppermint and Broad-leaved Apple, with River Sheoak common along the edge bank of the river. Common associated shrub and twiner species include Wonga Wonga Vine (*Pandorea pandorana*) and Tree Violet (*Melicytis dentatus*), with Scurvy Weed occurring in the ground cover, the forest occurring on periodically flooded, undisturbed deep Quaternary alluvial sediments along the banks of the Nepean River. The extent of the distribution of this assemblage in the subject area is about 7,100 m². The assemblage has long been infested with woody weeds and with a high frequency of occurrence of Wandering Jew in the ground cover probably as a result of historical clearing of a natural understorey stratum.

Dry River Anabranch

Vegetation immediately to the east of the extraction area along the dry banks of the anabranch is mapped by Actinotus (2011) as 'Alluvial Woodland on Coastal Floodplains'.

This vegetation is a mature stand of tall woodland structure to 30m in height, dominated by River Peppermint, Broad-leaved Apple and River Sheoak. Common associated shrub species include Blackthorn (*Bursaria spinosa* var *macrophylla*), Twiggy Heath-myrtle (*Sannantha pluriflora*), Scrubby Spurge (*Phyllanthus gunnii*) and Tree Violet (*Melicytis dentatus*), with Spiny-headed Mat-rush (*Lomandra longifolia*) and Bamboo Grass (*Austrostipa ramosissima*) occurring in the ground cover. The woodland is established on a dry drainage course on periodically flooded, undisturbed Quaternary alluvial sediments. The extent of the distribution of this assemblage in the subject area is about 5,000 m². The assemblage has long been infested with woody weeds with Wandering Jew in the ground cover.

3.3. Proposed impacts to native vegetation

The activity is not expected to impose a significant negative impact on any other local populations of native biota, including threatened species, EECs and their habitats listed on the TSC Act and EP&BC Act, which are restricted to adjoining habitats and are not found in the area of extraction.

Impacts to vegetation will be limited to the removal of two isolated River Peppermint trees. These trees were assessed by Actinotus (2011) and were found to be of poor condition and their removal would not constitute a significant impact. The area of extraction has been designed to ensure impacts to native vegetation is minimal and does not constitute a 'significant impact'.

The project includes the restoration of native vegetation along the eastern 'bank' of the Nepean River and either side of the Dry Anabranch as described in this LMP. It is anticipated that this restoration program, through time, will significantly improve the cover and condition of native vegetation throughout these riparian zones when compared to existing conditions and thus improve migration of fauna and flora (transported in fauna droppings etc) and into restoration areas.

3.4. Topography, geology and soils

The site area is characterised by gently sloping to flat (0 - 5%) undulating rises on Terresa Park Soil Landscape group, which is a fluvial unit associated with Tertiary and Quaternary flood plains and terraces of the Nepean River. Soil types include brown sandy loam, reddish brown sandy clay, and light clay. Quaternary alluvial deposits of the Nepean River Valley underlie the flat-lying area. The Quaternary alluvial deposits of the Nepean River are mainly derived from weathering of Permian and Triassic bedrock and comprise typically grey-brown medium grained quartz sand with layers of silt and humic clay.

3.5. Hydrology

The study area is located within the Cumberland sub-region of the Hawkesbury-Nepean Catchment Management Authority (CMA). The site includes the old river Anabranch, which parallels the flow of the Nepean River. The sand extraction activities, which involve works within 40 meters of this waterway and the Nepean River, is considered a controlled action under the WMA 2000.

3.6. Adjacent land use

The site is primarily set in a rural area with surrounding land uses as follows:

West – Nepean River and Camden South residential area

North – Camden Bypass and agricultural lands on flood prone land

East – Spring Farm residential area

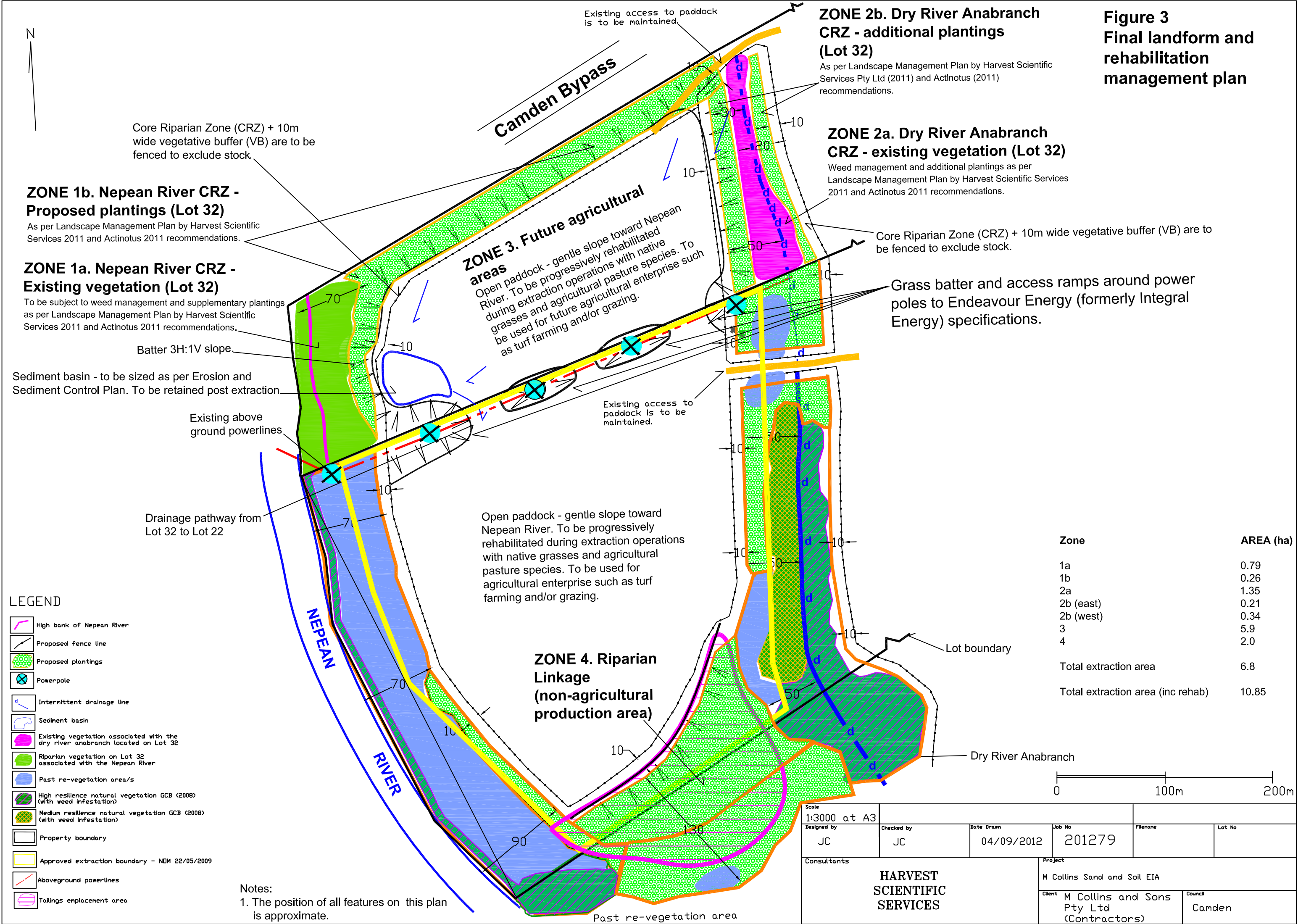
South – M Collins operations on flood prone land adjacent the Nepean River

4. QUARRY CLOSURE

At quarry closure, the site will be composed of a number of zones, the locations of which are illustrated in Figure 3. These zones are described as follows:

- **Nepean River Riparian Vegetation.** Approximately 1.05 hectares of riparian vegetation adjacent to the Nepean River. This area will be made up of 0.79ha (**Zone 1a**) of restored existing vegetation and 0.26 hectares of additional plantings (**Zone 1b**);
- **Dry River Anabranh Vegetation.** Approximately 1.06 hectares of riparian vegetation adjacent to the Nepean River. This area will be made up of 0.51ha (**Zone 2a**) of regenerated existing vegetation and 0.55 hectares of additional plantings (**Zone 2b**);
- **Agricultural production land (Zone 3).** Approximately 5.9 hectares of 'Class 1' Agricultural production land. This land will be relatively flat and will slope gently to the south-west, draining towards the Nepean River to ensure free draining compatibility of the final land form with surrounding land uses ;
- **Terminal sedimentation pond.** The terminal sedimentation pond is to be retained as a long-term sediment control measure. This feature will therefore result in long-term water quality improvements from surface waters draining from the agricultural land beyond the life of the extraction project; and
- **Riparian Linkage Zone (Zone 4).** This zone will develop a broad linkage between the Dry River Anabranh and the Nepean River riparian corridor. Works programmed for this area involve the integration of habitat structures, revegetation and weed control.
This land will be a combination of north facing batters rising to provide a feature on the landscape with associated bio-diversity outcomes.
The southern side comprises of existing batters that are vegetated and adjoin the existing riparian vegetated corridor.

Figure 3
Final landform and
rehabilitation
management plan



5. RESTORATION PROGRAM

5.1. Restoration zones

The following information provides a detailed description of all activities required to implement the LMP. The required activities were determined using field investigations to visually assess, record (photograph) and identify the different native vegetation zones at the site, any threatened or endangered species and the current habitat and wildlife corridor connectivity, as well as assess soil types and on site hydrology for potential erosion hazards. This information was supplemented by desktop research of existing reports pertaining to the site, and current vegetation maps and restoration guidelines. As indicated on Figure 3, the site is divided into four distinct zones that will require different vegetation management approaches, viz:

A detailed timetable indicating what rehabilitation measures have been completed and those that are to be implemented in the short term is included as Table 2 in the Bowantz Report (Appendix 3).

Zone 1a-b (Nepean River) – This zone incorporates a block of remnant Riparian Forest alongside the Nepean River. This area requires a combination of bush regeneration (sub-zone ‘a’) and revegetation (sub-zone ‘b’).

Zone 2a-b (Dry River Anabranh) – This zone is located in the Dry River Anabranh, the area supports degraded Riparian Forest impacted from cattle and invasive plant species. Restoration in this area involves a combination of bush regeneration (sub-zone ‘a’) and revegetation (sub-zone ‘b’).

Zone 3 (agricultural production areas) – This zone is located in the open paddock area between the Dry River Anabranh and the Nepean River riparian zone. This zone is to be continued to be used for agricultural production land-uses.

Zone 4 Riparian linkage (non-agricultural production areas) – This zone links the Nepean River Riparian Corridor at the Dry River Anabranh. It will be permanent bushland that will provide a landscape feature due to the raised platform above the batters that join agricultural land.

The restoration program has been undertaken by Bowantz Bushfire and Environmental Pty Ltd (Bowantz) who has been commissioned by Collins to manage and implement the environmental actions and recommendations described in this LMP and other supporting documents. Activities undertaken by Bowantz are reported in Appendix 3 and should be read in conjunction with the following sections of this LMP.

5.2. Staging of extraction and rehabilitation

Extraction and rehabilitation is to be staged subject to the following controls:

- Further to approval from Council, 5 hectares can be open at any one time, however the ration of 1 hectare active extraction to 1 hectare rehabilitation will be applied;
- Active extraction on Lot 32 within a 1 hectare portion of land at a time and concurrent rehabilitation works within an additional 1 hectare portion of land; and
- Extraction and rehabilitation works are proposed to occur in concert over the extended life of the quarry (completion in 2021).

The staging proposal is illustrated in Figure 4.

5.3. Noise generating re-vegetation activities

No noise generating activities are to be under-taken outside of standard hours of extraction.

5.4. Riparian corridor zones of the Water Management Act

The WMA describes two distinct management zones associated with riparian vegetation, these being the Core Riparian Zone (CRZ) and the Vegetated Buffer (VB).

- A Core Riparian Zone (CRZ) is the land contained within and adjacent to the channel. The Department will seek to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees). The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse, merits of the site and long-term use of the land. There will be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the CRZ.

Figure 4
Extraction and
rehabilitation staging
plan

LEGEND

- Staging boundary
- Trees to be removed
- Powerpole
- Catch drain
- Intermittent drainage line
- Sediment basin
- Existing vegetation associated with the dry river anabranch located on Lot 32
- Riparian vegetation on Lot 32 associated with the Nepean River
- Past re-vegetation area/s
- High resilience natural vegetation GCB (2008) (with seed infestation)
- Medium resilience natural vegetation GCB (2008) (with seed infestation)
- Open Paddock Rehabilitation
- Soil processing and handling area
- Scarcely vegetated area
- Screen plantings
- Current Extraction Area – Lot 32
- Extraction Area – Lot 22
- Existing internal fence-line
- Property boundary
- Proposed extraction boundary (Lot 32)
- Approved extraction boundary - NDH 22/05/2009
- Aboveground powerlines
- Sediment Pond

Notes:
1. The position of all features on this plan is approximate: and
2. Aerial photo is from 23/02/2018

YEAR	REHABILITATION CELLS	EXTRACTION CELLS
2015	R1	E1
2016	R2	E2
2017	R3	E3
2018	R5	E5
2019	R7	E7 (extraction complete)
2019	R8 (rehabilitation complete)	
2020	Maintenance R6 and R7	
2021	Maintenance R6 and R7	

Scale 1:3000 at A3		Figure 4			
Designed by MR	Checked by MR	Date Drawn 26/02/2018	Job No 201279	Flameur	Lot No
Consultants HARVEST SCIENTIFIC SERVICES			Project M Collins Sand and Soil EIA		
			Client M Collins & Sons Holdings PtyLtd	Council Camden	

- A Vegetated Buffer (VB) protects the environmental integrity of the CRZ from weed invasion, micro-climate changes (edge effects), litter, trampling and pollution. There will be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the VB. The width of the VB is 10 metres.

5.5. Site preparation

5.5.1. Site protection

Fencing

When establishing or recovering riparian vegetation to maintain land based ecosystems and to conserve biodiversity, an essential management method is to incorporate the protection of riparian vegetation. This requires some form of fencing or other means of controlling the access of heavy machinery, human influences and domestic stock.

Restoration zones 1 and 2 (Figure 3) all require protection during the quarry extraction process and for future access management. These areas are fenced with a 5 strand barbwire fence for the long term protection of the rehabilitated riparian areas. Gates and Cattle Ramps are installed as required for access to extraction areas. The protection of these areas with permanent fencing ensures the long term effective management of the rehabilitated and re-vegetated riparian habitat and its wildlife linkages.

Permanent fencing provides conservation and protection to ameliorate threats such as grazing and human disturbance. On completion this will meet a number of priority actions listed as key strategies in EPA and the DEHWA recovery plans for the 'River Flat Eucalypt Forest on Coastal Floodplains'.

Signage is utilised as a tool to identify the restricted vegetation systems to staff, contractors and visitors. It is intended that fencing will not impact on bulk earthworks and extraction activities. All fencing allows for the extraction operation to continue outside these areas as part of the extraction process for some time.

5.5.2. Native and feral animal protection

Damage can occur to some or all of the species and can vary from mild to severe. There are several options to prevent the grazing or browsing of plantings. In the event that the revegetation is suppressed through herbivore activities the following methods will be utilised depending on the severity and type of pest problem.

Tree guards will be utilised as a standard procedure to protect young plants from browsing. The use of 1L milk carton, or equivalent to, tree guards generally gives protection from most herbivores during the plant establishment stage even though they may browse the tops of the plants. If the herbivores continue to suppress revegetation plants, very tall tree guards of rigid corrugated plastic will be used in some areas. Smaller guards are effective in stopping rabbits or hares from destroying young plants.

Reducing populations prior to planting - Rabbit and hare populations will be controlled in an attempt to reduce their numbers at the site prior to planting. Any rabbit burrows will be ripped and existing animals will be poisoned or shot. The Department of Primary Industries (DPI) can advise on effective and humane methods to control rabbits.

Deterrents - There are a number of options available to deter animals from entering a site, D-Ter is one product available for the protection of vegetation. This product is supplied in a powder form and is mixed with water and simply sprayed on plants. This product will be reapplied at regular intervals and after rain.

5.5.3. Litter removal

Currently the sound management of extraction operations has lead to a clean site with little to no litter polluting the natural areas and extraction sites.

During the rehabilitation process all litter is removed by hand systematically as part of the management of natural areas. Litter created in the process of revegetation is removed as an ongoing process and at completion of planting.

5.5.4 Bushfire Management

Ongoing management of undergrowth and removal of accumulated debris is conducted as a fire prevention measure. Suitable fire fighting and first aid equipment is available to respond to fires on site. These include fire hose reels, hoses, water access, pumps and fire extinguishers which are identified by means of installed signage. Bushfire management is integrated on site as part of Emergency Response procedures. In case of a bush fire or fire on site personnel are to assist fire services and emergency services as much as possible, when safe to do so.

5.5.5 Landscaping

Currently implemented measures to minimise visual impacts through landscaping, in addition to those mentioned in Section 2.1 include;

- Not removing vegetation or material from the river frontage;
- 45metre setback from Camden By-Pass to extraction hole top bund;
- No vegetation stripping until cells are activated;
- Working behind extraction face to limit bypass visibility;
- Lot 32 extraction to be 1Ha extraction to 1Ha rehabilitation;
- Landscape areas of native vegetation associated with both the Nepean River and the Dry River Anabranh;
- Landcape areas of existing native vegetation;
- Integrating ecological function and engineering design to achieve balanced landscape outcome and riparian function;
- Improving vegetation cover throughout the site and surrounds;
- Enhance visual screening by embellishment of the anabranh vegetation (as set out within vegetation tables 4 to 6);
- Staged retention of existing screening south of the extraction site where existing tree lines are maintained and coordinated within the extraction schedule;
- Staged retention of vegetation cover on areas not being extracted and progressive rehabilitation of extracted areas, with concurrent rehabilitation/extraction;
- Rehabilitation of the Nepean River riparian zone as per Figure 4;
- Construction of perimeter bunds as per ESCP ESP1 using site soil tailings and existing grass runners and additional seeding as required to minimise visual impact with additional 1 metre height and limiting site within the extraction cell;
- By-products from the extraction program including striping's, tailing, and rejects will be utilised in the rehabilitation and landscaping process, as is the current practice on adjoining land;
- Selection of denser understory as a screen minimizing visual impact;
- Selection of taller native species as a screen minimizing visual impact; and
- Selection and installation of recessive coloured fencing and fixed equipment applicable to the surrounds and area. Use of recessive coloured plant and equipment applicable to the surrounds to minimise visual impacts in conjunction with existing visually minimizing controls.

The LMP now includes MCS additional mitigation measures which include:

- Enhanced visual screening by the establishment of the Dry River Anabranh vegetation;
- Stated retention of existing screening south of the extraction site;
- Staged retention of vegetation cover on areas not being extracted and progressive rehabilitation of extracted areas;
- Rehabilitation of the Nepean River Riparian Zone' and
- Application of recessive colours to visually intrusive plant, equipment and fencing.

5.5.6 Final Landform

Achieving free draining and final landform levels with surrounding land uses will occur by following modelled final landform designs attached as Appendix 4. Progressive surveyor levels are obtained during rehabilitation and landscaping to gauge accuracy with approved final level designs. The objective for Lot 32 is to rehabilitate approximately 5.9 ha of it to Class 1 Agricultural land use. The objective for Lot 22 on the other hand, is for the rehabilitation of the final landform to agricultural land use (not Class 1). Ongoing monitoring and annual review of achieved levels and progress are conducted to this LMP performance criteria.

5.6. Erosion control

At the completion of earthworks in and surrounding Restoration Zones 1 and 2, appropriate sediment control fencing will be installed as necessary and maintained throughout the duration of the extraction program. Installation will be in accordance with bulk earthworks 'Water Management and Erosion and Sediment Control Plan' (WM & ESCP) as prepared by Harvest Scientific Services .

5.6.1. Soil preparation – Refer to Figure 3

Zones 1b (Nepean River – proposed plantings), 2b (Dry Anabranh – proposed plantings) and 4 (Riparian Linkage)

All battered re-vegetation areas are to be covered to a minimum depth of 500 mm with a clean weed free top soil. In non-battered areas, weeds are to be sprayed out and vegetation is to be planted directly into the natural top-soil horizon.

Ground preparation will consist of deep ripping to a depth of 300 to 400 mm, no further than 300 mm apart. The first stages of ripping will run down any batters or contours followed by a cross ripping along the contours. The cross-rip is to be undertaken to reduce the chance of incisions after periods of rain and help retain moisture on sloping surfaces. The fractured soil between rip lines eliminates glazing of the undisturbed soil interface and reduces air pockets and trench effects.

Following ripping, the soil surface may be rotary hoed, if necessary, to create a looser soil surface making it easier to plant tube-stock, encourage good root development and create a larger volume of soft soil which encourages rapid early growth.

Zone 3 Agricultural production areas

At the completion of extraction within any given extraction cell that is to be utilised for future agricultural production (Zone 3), the ground is to be prepared by ripping to a depth of 300 to 400 mm, no further than 300 mm apart. First stages of ripping will run down any batters or contours followed by a cross ripping along the contours. The cross rip will reduce the chance of incisions after periods of rain, help retain moisture on sloping surfaces, fracture soil between rip lines, eliminate glazing of the undisturbed soil interface and reduce air pockets and trench effects.

The entire area is then to be covered to a minimum depth of 500 mm with stockpiled top-soil (stored in the bunded mound around the extraction pit). Pasture grasses are then to be re-established by either natural re-generation from grass seed stored in the topsoil stock-pile or seeding with pasture species.

Zones 4 (Riparian Linkage)

These lands comprise of batters and a ridge that is to be capped with at least a 2 metre depth of clean topsoil extracted from the approved extraction areas and including dry tailing soils that remain after the topsoil has been processed.

Ground preparation will consist of deep ripping to a depth of 300 to 400 mm, no further than 300 mm apart. The first stages of ripping will run down any batters or contours followed by a cross ripping along the contours. The cross-rip is to be undertaken to reduce the chance of incisions after periods of rain and help retain moisture on sloping surfaces. The fractured soil between rip lines eliminates glazing of the undisturbed soil interface and reduces air pockets and trench effects.

Following ripping, the soil surface may be rotary hoed, if necessary, to create a looser soil surface making it easier to plant tube-stock, encourage good root development and create a larger volume of soft soil which encourages rapid early growth.

5.7. Re-vegetation program

Zones 1 (Nepean River – proposed plantings) and 2 (Dry Anabranh – proposed plantings)

To implement the LMP and achieve recommended targets, a combination of revegetation techniques will be employed throughout Restoration Zones 1 and 2. Each of the techniques are described below, with Table 1 outlining which species are suited to each revegetation technique.

All revegetation tasks in post extraction areas will commence upon completion of final landform levels. Additional planting in past revegetation sites and bush regeneration areas will commence as soon a plant stocks are available.

The aim of revegetation in this LMP is to restore the natural species composition and structures, combining this with other principles in this report, a self-sustaining ecosystem should result - one that will require minimum human intervention to maintain over time.

Planting locations will generally mimic where species would have naturally grown. This means plant species will be matched with the site conditions. The desired revegetation structure is one that cannot be seen through, creating a natural effect with clumps of vegetation, small clearings which predominantly are planted with ground layer species, and different heights of vegetation species.

To achieve this planting structure, revegetation planting will provide a high composition of ground cover plantings, typically growing less than 1.5 m, making up 50% of the overall planting composition. These plant species will eventually stabilise soils and provide vegetative habitat, food and nesting material for fauna species over a short period. Planting of these plants will range from 4 to 8 plants per m².

This structural layer will then be complemented by planting of mid-canopy species. This layer will again provide a good source of habitat and stability to ground soils. Plants in this structural layer will be planted as a general cover plant and clumped close together for habitat purposes. Taking these principles into account, planting distances will range from 4 plants per m² to 1 plant every 2 m².

The canopy structural layer will be planted with Angophora, Casuarina and Eucalyptus species; this layer will develop with time to dominate the revegetation structure. Planting this layer of vegetation structure at a rate of 1 plant per 5 to 10 m² will allow for thinning revegetation at a later date if required.

Zone 3 Agricultural production areas

In the areas that are to be used for future agricultural production (Zone 3), pasture grasses are then to be re-established by direct seeding with pasture species.

Zone 4 Riparian Linkage (Non-agricultural production area)

To implement the LMP and achieve recommended targets, a revegetation program is to be employed throughout Restoration Zone 4. Each of the techniques are described below, with Table 1 outlining which species are suited to each revegetation technique.

All revegetation tasks will commence upon completion of final landform levels. Within this area it is intended to spread mulch and forest residues to stabilise soils and prevent erosion whilst the tree canopy matures.

The aim of revegetation in this LMP is to restore the natural species composition and structures, combining this with other principles in this report, a self-sustaining ecosystem should result - one that will require minimum human intervention to maintain over time.

Planting locations will generally mimic where species would have naturally grown. This means plant species will be matched with the site conditions. The desired revegetation structure is one that cannot be seen through, creating a natural effect with clumps of vegetation, small clearings which predominantly are planted with ground layer species, and different heights of vegetation species.

To achieve this planting structure, revegetation planting will provide a high composition of ground cover plantings, typically growing less than 1.5 m, making up 50% of the overall planting composition. These plant species will accentually stabilise soils and provide vegetative habitat, food and nesting material for fauna species over a short period. Planting of these plants will range from 4 to 8 plants per m².

This structural layer will then be complemented by planting of mid-canopy species. This layer will again provide a good source of habitat and stability to ground soils. Plants in this structural layer will be planted as a general cover plant and clumped close together for habitat purposes. Taking these principles into account, planting distances will range from 4 plants per m² to 1 plant every 2 m².

The canopy structural layer will be planted with Angophora, Casuarina and Eucalyptus species; this layer will develop with time to dominate the revegetation structure. Planting this layer of vegetation structure at a rate of 1 plant per 5 to 10 m² will allow for thinning revegetation at a later date if required.

5.7.1. Seed collection

To allow for enough lead-in time for the propagation of local provenance species, seed collection will start as soon as practical. Experienced and qualified bush regeneration staff with a Section 132C Scientific Licence and Florabank seed collection training will perform seed collection activities. All seed collection, management, cleaning and storage will be in accordance with the *Florabank Seed Collection Guidelines* (prepared by Greening Australia and now accepted as industry best practice).

When collecting seed, priority will be placed on sourcing seeds from a site with the same physical characteristics as the site vegetation. Preferably a large population base which is geographically as close as possible to the proposed extraction site. Local genetic material is well adapted to local environmental conditions - including soil, slope, aspect, rainfall and wind. Thus the best long term survival will be achieved by using this local genetic material.

5.7.2. Plant propagation

Plant propagation refers to the germinating of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes. All plants will be produced from local provenance seed. This activity will be managed by experienced and qualified bush regeneration staff with a Section 132C Scientific Licence and Florabank seed collection training.

5.7.3. Installation of native tube stock

The vegetation to be restored on site will consist of appropriate mixes of canopy, mid-storey and groundcover species from the suggested plant species shown in Table 1. The general percentage structural composition of canopy to middle storey to groundcovers in these communities is approximately 20%: 30%: 50%.

Most plants will be planted as hiko, enviro cells or tube stock. All tree and shrub species will be suitably guarded to prevent herbivory and weed competition, and to encourage optimum growing conditions. Guards will comprise of a recycled 1 L milk carton tree guard and two bamboo stakes, or equivalent to.

All plants planted as part of the revegetation program will require mulching to approximately 75 to 100 mm in depth at a 400 mm radius from the centre of the plant. This will retain soil moisture, temperature, assist in controlling weed growth and reduce the off target killing of native species during weed controlling activities.

In general, autumn is the best season for planting as summer temperatures can be too high for young plants to establish and frosts in winter impede survival rates. Planting in early spring can be effective as long as a suitable watering regime is implemented. All plants will be installed by hand.

5.7.3.1 Hand installation

After immersion for half an hour in a bucket of water, each plant is planted into a hole that is a minimum of 25% larger than the planting container and its edges will be suitably 'roughed' prior to plant installation. A soil additive, such as Terracottom may be added to provide nutrient, water holding crystal, high cation exchange and root stimulators. This product will significantly increase the survival and establishment rate of plant species if applied at the recommended rate. Soil is then to be filled into the hole and firmed to bring the soil in contact with the plant root zone. An earth saucer is then shaped around each plant, large enough to hold 5 to 10 litres of water and then filled after planting.

All tree or shrub species extending from the tree guard after planting will be planted as deep as possible or until the plant leaves are protected by the tree guard. This will stop any herbivores from pulling the plants out of the ground when grazing on the plant. It is also recommended when planting larger specimens to add a grass species in the same hole and guard.

5.7.3.2 Hand broadcasting of native seed

In managing post extraction rehabilitation areas, the first aim is to establish and maintain a continuous indigenous groundcover, with enough vegetation to protect the soil surface from heavy rain and to provide a filtering capacity where this is required. Hand broadcasting seed is one method utilized to achieve this outcome.

In a bid to develop a robust and resilient groundcover, predominantly native grass seed mixed with seed of suitable species which are readily available and germinate easily (see Table 1) will be hand broadcast throughout the maintenance period of the restoration program. This will add further diversity to the site, particularly ground covers, and assist in achieving recommended targets for planting densities in 3A permit works when required.

5.7.4. Brush matting

This is the practice of laying cut stems/branches (containing ripe fruit) on the soil surface. This technique has two aims - to spread seed and to reduce erosion. This will be a useful technique when local native seed is in abundant supply. The most suitable species for brush matting are those that retain seed capsules on the plant but which shed seed when the branch dries, e.g. (*Leptospermum* spp.), (*Eucalyptus* spp.), She Oak (*Casuarina cunninghamiana*), (*Callistemon salignus*) and Broad-Leaved Apple (*Angophora subvelutina*).

This method of vegetation establishment will be utilised throughout the development of the vegetation in bushland areas and in revegetation. Stems and branches will be laid in thick patches rather than spreading materials thinly over large areas. This will help achieve the development of the micro climates needed for the establishment of seedlings, and in turn reducing high water velocities and the level of maintenance required around seeding areas. Areas which have been brush matted will predominantly be maintained by hand weeding. When placing the materials out the maintenance capacity of the program will be considered.

5.7.5 Rehabilitation/Re-Vegetation potential Risks and Mitigation Controls

Table 2: Potential Risks and Mitigation Controls for Rehabilitation and Re-vegetation	
Potential Risk	Mitigation Controls
Native animals	Provide guarding
Weed competition	Guarding, mulch, spraying
Weather conditions	Increased watering, irrigation, mulching
Failed plantings	Regular maintenance and monitoring, re-planting
Damaged guarding	Regular monitoring, maintenance, replacement
Final Levels	Regular surveying, review Design plans and progress

5.8. Species for use in re-vegetation activities

The species outlined in Table 3 are for use in the rehabilitation program (from Actinotus, 2012). The list also includes which species suit the various techniques described to re-establish native vegetation.

Table 3: Plant schedule for revegetation program

Botanical Name	Common Name	Density	Revegetation Activity
Canopy:			
<i>Angophora subvelutina</i>	Broad-leaved apple	1 per 5m2	Planting/ brush matting/ broadcasting
<i>Casuarina cunninghamiana</i>	River-oak	1 per 5m2	Planting/ brush matting/ broadcasting
<i>Eucalyptus amplifolia</i>	Cabbage gum	1 per 10m2	Planting/ brush matting/ broadcasting
<i>Eucalyptus elata</i>	River peppermint	1 per 10m2	Planting/ brush matting/ broadcasting
<i>Eucalyptus tereticornis</i>	Forest red gum	1 per 10m2	Planting/ brush matting/ broadcasting
<i>Melia azedarach</i>	White Ceder	1 per 10m2	Planting/ brush matting/ broadcasting
Middle Storey:			
<i>Acacia parramattensis</i>	Parramatta green wattle	1 per 2m2	Planting/ brush matting/ broadcasting
<i>Acacia floribunda</i>	Sally Wattle	1 per 2m2	Planting/ brush matting/ broadcasting
<i>Acacia decurrens</i>	Sydney Green Wattle	1 per 2m2	Planting/ brush matting/ broadcasting
<i>Backhousia myrtifolia</i>	Grey Myrtle	1 per m2	Planting
<i>Baeckea linifolia</i>		1 per m2	Planting/ brush matting /clumps
<i>Bursaria spinosa</i>	Black thorn	1 per m2	Planting/ brush matting /clumps
<i>Callistemon salignus</i>	Willow bottlebrush	1 per m2	Planting/ brush matting /clumps/ broadcasting
<i>Commersonia fraseri</i>	Native Hemp	1 per 10m2	
<i>Dodonaea triquetra</i>	Hop Bush	1 per m2	Planting
<i>Ficus coronata</i>	Creek Sandpaper Fig	1 per 10m2	Planting close to river bank
<i>Hymenanthera dentata</i>	Tree violet	1 per 2m2	Planting/ clumps
<i>Kunzea ambigua</i>	Tickbush	1 per 2m2	Planting/ brush matting /clumps/ broadcasting
<i>Leptospermum morrisonii</i>	Tea-tree	1 per m2	Planting/ brush matting /clumps/ broadcasting
<i>Leptospermum polygalifolium</i>	Lemon-scented tea-tree	1 per m2	Planting/ brush matting /clumps/ broadcasting
<i>Pomaderris ferruginea</i>	Rusty Pomaderris	1 per 2m2	Planting
<i>Prostanthera lasianthus</i>	Victorian Christmas bush	1 per 2m2	Planting
<i>Trema aspera</i>	Native Peach	1 per 5m2	Planting
Groundcovers:			
<i>Aristida ramosa</i>	Purple wiregrass	8 per m2	Planting/broadcasting
<i>Aristida vagans</i>	Blown Grass	8 per m2	Planting/broadcasting
<i>Austrostipa ramosissima</i>	Stout Bamboo Grass	4 per m2	Planting/broadcasting
<i>Clematis aristata</i>	Old man's beard	1 per m2	Planting
<i>Commelina cyanea</i>	Scurvy weed	4 per m2	Broadcasting (cuttings)
<i>Cymbopogon refractus</i>	Barbed wire grass	4 per m2	Planting/broadcasting
<i>Desmodium varians</i>		4 per m2	Planting
<i>Dichelachne crinata</i>	Longhaired plume grass	4 per m2	Planting/broadcasting
<i>Dichelachne micrantha</i>	Shorthair plumegrass	4 per m2	Hand broadcasting
<i>Dichondra repens</i>		4 per m2	Broadcasting (cuttings)
<i>Einadia hastata</i>		4 per m2	Planting
<i>Entolasia marginate</i>	Bordered panic grass	8 per m2	Planting/Broadcasting
<i>Eustrephus latifolius</i>	Wombat Berry	1 per m2	Planting
<i>Geranium homeanum</i>		4 per m2	Planting
<i>Glycine clandestina</i>	Twining glycine	2 per m2	Planting
<i>Hardenbergia violacea</i>	False sarsaparilla	1 per m2	Planting
<i>Hydrocotyle peduncularis</i>	Penny Wort	2 per m2	Planting
<i>Imperata cylindrica</i>	Blady Grass	4 per m2	Planting
<i>Lomandra longifolia</i>	Mat rush	4 per m2	Planting
<i>Microlaena stipoides</i>	Weeping meadow grass	4 per m2	Planting
<i>Opercularia aspera</i>	Coarse stink weed	1 per m2	Planting
<i>Oplismenus aemulus</i>		4 per m2	Planting (cuttings)
<i>Phyllanthus gunnii</i>		1 per m2	Planting

<i>Pratia purperescens</i>		4 per m2	Planting (cuttings)
<i>Poa labillardieri</i>	Large tussock grass	2 per m2	Planting/ broadcasting
<i>Pteridium esculentum</i>	Bracken	4 per m2	Planting (cuttings)
<i>Sigesbeckia orientalis</i>	Indian Weed	4 per m2	Planting
<i>Stellaria flaccida</i>	Forest starwort	4 per m2	Planting (cuttings)
<i>Stephania japonica</i>	Tape Vine	4 per m2	Planting
<i>Stypantra glauca</i>	Nodding Blue Lily	4 per m2	Planting
<i>Themeda australis</i>	Kangaroo grass	4 per m2	Planting/ broadcasting
<i>Urtica incisa</i>	Scrub Nettle	2 per m2	Planting
<i>Viola hederacea</i>	Native violet	4 per m2	Planting
<i>Wahlenbergia gracilis</i>	Native bluebell	4 per m2	Planting

5.9. Maintenance program – re-vegetation

The completion of the revegetation (planting works) and target weed control activities will be considered the date of 'Practical Completion' for the restoration works and will signal the commencement of the two year plant maintenance program. The completion of the two year maintenance program will be considered as 'Final Completion' for the revegetation works. Maintenance activities will include such things as watering, herbicide spraying and general maintenance. Practical completion will occur on a staged basis and the maintenance period will commence as each stage reaches practical completion.

5.9.1. General maintenance

General maintenance activities will include repairing damaged tree guards, monitoring survival rates, installing replacement plants where required, weeding inside the tree guards and continued follow-up spot spraying. Over the first year all plant losses will be replaced and any remaining plants will be planted into the existing site as infill plantings to increase the density of the overall revegetation.

5.9.2. Watering

All plants will be 'watered in' on installation, with each plant receiving a minimum of five litres. All plantings will then receive a further three applications of water during the first 8 weeks, if required, to assist plant establishment. Should weather conditions remain dry for an extended period of time follow-up watering may be required. If so, discussion between client and contractor may be necessary to cover the cost of additional watering.

5.9.3. Maintenance spraying

To ensure the success of the revegetation activities it is essential to control weed infestation. Weeds compete with the newly installed plants for nutrients and water thereby limiting their survival and growth rates.

The revegetation will be continually maintained to a weed free state through a weed spraying program which is guided by the weather conditions, season and site monitoring. The site will be monitored for weed growth after extended rain and at the start and the end of seasons.

Areas where revegetation activities are dominated by hand planting, spraying of Round-up® and Biactive herbicides will occur using 'back packs'. Suitably qualified bush regeneration contractors will carry out all spraying.

5.10. Bush regeneration and weed control

Bush regeneration of the riparian remnant will meet a number of priority actions listed as key strategies in EPA and the DEHWA recovery plans for the 'River Flat Eucalypt Forest on Coastal Floodplains' and 'Alluvial Woodlands on Coastal Floodplains'.

The greatest likelihood of colonisation by native understorey (woody and herbaceous) will be from adjacent remnant vegetation. The riparian areas range from healthy resilient sections to heavily impacted and degraded areas. Through a comprehensive bush regeneration program, working from resilient riparian forest areas to more degraded vegetation, native vegetation will be restored to a resilient and robust plant community. Rehabilitating the riparian forest will provide the revegetation with the source of native propagules it requires, enhancing genetic exchange between the existing remnant forest and revegetation.

To meet statutory obligations listed in the Noxious Weeds Act, a weed control program targeting noxious weeds will be implemented prior to any revegetation work and all remaining weeds will be included in the bush regeneration program. All weed control and bush regeneration activities are to be completed by a suitably qualified contractor.

The suitably qualified contractor will make monthly observations. Annual reporting will be supplied by the contractor (using the criteria outlined in Appendix 5 regarding bush regeneration practices and rehabilitation) as listed below;

- Re-vegetation Activities minimum survival rate criteria 85%. All re-vegetation observations less than 85% triggers replacement of vegetation; and
- Weed Re-Growth cover observations above 15% trigger implementation of appropriate weed control activities.

5.10.1. Improving habitat value

Different fauna species require different structures as habitat for living, nesting and roosting. places to hide from predators, food and water, protection from weather, and opportunities to find mates. Most of these elements that make up this habitat take a long time to develop in a revegetated site, such as tree branches, hollows, dense or open shrubs, a complex ground layer, a range of bark types, different litter and root types. While leaf litter is often present after one year, fallen logs may take decades to develop and tree hollows may not form for up to 100 years. Thus, the more of these structures that are present, the greater the diversity of fauna that can be supported. Many plant species are also dependent on having a range of fauna species for services such as seed dispersal, pollination and distribution of symbiotic organisms.

When implementing the restoration of the post extraction sites, strong emphasis will be placed on a range of plant species to provide structural diversity for the development of a resilient ecosystem, providing habitat for a range of species. Developing this habitat value increases the extent of the native vegetation and therefore adds to its value as habitat. Revegetation may increase the viability of small flora and fauna populations and provide a buffer to existing remnants. In addition, the remnants will provide habitat features such as hollows and high roost sites, which will not be present in the revegetation site until it is much older (Ryan, 1999). Although revegetation will be used as a basic building block for the development of ecosystem function and habitat, it alone cannot provide all required habitat values for one to a hundred years. Combining revegetation with the integration of logs, trunks, organic matter, artificial hollows and nesting boxes will significantly advance the ecological function of the site and the value of revegetation as habitat.

Plant species utilised in the revegetation program will offer a variable set of habitat establishment properties. Planting large quantities of forbs, grasses and scrambling plants will provide initial habitat for some ground dwelling fauna. Plantings of shrub species particularly the spiky Blackthorn (*Bursaria spinosa*) in dense thickets and clumps throughout the revegetation site will provide shelter opportunities for small bird species. Planting species which provide food and a source of nesting material will encourage the use of the revegetation site as a resource to fauna residing in adjacent remnants. (See Table 1)

Woody material including logs, trunks, branches and sticks is to be placed throughout the areas to be revegetated. Utilising these materials can possibly advance habitat value by many years. The logs will provide instant habitat and a source of nutrients. They will provide possible roosting sites, provide niches for the retention of moisture and shelter from sun, wind and frost. They will help retain soil and nutrients through periods of heavy rain and trap pockets of organic matter for the succession of soil organisms and invertebrates.

Any sterile dead woody weeds removed as part of the bush regeneration are to be placed as stacks of timber or layered across the contours of the vegetation sites. All trees removed from the property or debris of trees after storms or alternatively, trunks and branches from off-site tree removal can be brought to the site and dispersed a minimum of 5 metres into the revegetated areas. Once large trees, branches or trunks are dispersed into the revegetated areas, suitable plants are to be planted to strengthen the habitat potential of the material. To allow enough lead time for the collection of suitable materials, companies involved in tree removal and site clearing are contacted and stock piles of large trees, branches or trunks will be accumulated. All plantings are to be mulched with recycled greenwaste. A minimum of one barrow load or a radius of 500mm around plants will provide the usual mulch benefits and support the advancement of many soil organisms and invertebrates by providing a source of food and shelter. The developments of these organisms will in turn provide benefits to the environment and the fauna species which interact with it.

5.10.1.1 Nesting Boxes

The installation of nesting boxes for fauna habitat will be one method utilised as compensation for lack of habitat availability in the revegetation. Nesting boxes in the revegetation will target arboreal marsupials as some members of this group can recolonise revegetation areas if hollows are present or provided. This group of fauna are considerably less mobile than other species (Birds, Bats, and Macropods) placing a greater reliance on localised habitat availability. The boxes will artificially increase the amount of locally available hollows for these arboreal marsupials, increasing the value of revegetation as a habitat resource. (Cunningham *et al*, 2007).

Nest Box Location

The location of the nesting box can be critical. A north-east to south-east aspect appears to be preferred by most species. Various orientations and exposure will be trialled. The entrance is to face away from prevailing winds and rain. Boxes are to be at a height to meet the species needs, and out of reach of human hands, to avoid vandalism, and potential predators, such as cats (Platt, 1999).

Ten (10) nesting boxes are to be placed in revegetation areas adjoining remnant riparian forest. The boxes will be located a minimum of 6m into vegetation in amongst areas of placed logs, trunks and branches with dense vegetation planted around. The boxes will be fixed to a 3600 mm x 200 mm treated pine pole. The poles will be placed 1000 mm into the ground and the earth will be rammed around the base firmly. The boxes will then be attached from 200 mm to 2600 mm above ground level. A summary of the dimensions are detailed in Table 4.

Table 4: Inside dimensions of nest boxes for some species that will use the general nest box design*				
	A (height)	B (depth)	C (width)	D (entrance)
Brushtail Possum (also suits ducks)	500	250	290	100-120
Ringtail Possum	400	240	200	70-80
Feather-Tailed Glider	400	240	200	32-35/ 35-40
Rosellas	400	240	200	70
*Note: All measurements are in mm and all depths are minimum				

5.10.2. Targeted weed control

This component of the restoration program refers to the control of listed noxious weeds such as Alligator Weed, Green Cestrum, African Box Thorn, Small-leaved Privet, Large-leaved Privet, Blackberry Complex and Bridal Creeper. This program requires specialised equipment and chemicals and will be managed by appropriately trained and experienced staff. Appendix 5 provides a summary of the most appropriate weed treatments. Control of these plants usually requires several treatments and is most effective during summer.

5.10.3. Noxious weeds

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds in local government areas. Landowners and occupiers must control noxious weeds according to the control category specified in the Act. Public authorities must control noxious weeds according to the control category to the extent necessary to prevent their spread to adjoining land.

The study area contains six species declared as noxious weeds in Camden LGA as shown in Table 5, below.

Table 5: Noxious weeds recorded in the Camden LGA area

Common name	Scientific name	Control category*
Green Cestrum	Cestrum parqui	3
Alligator Weed	Alternanthera philoxeroides	3
African Box Thorn	Lycium ferocissimum	4
Small-leaved Privet	Ligustrum sinense	4
Large-leaved Privet	Ligustrum lucidum	4
Blackberry complex	Rubus fruticosus sp. agg.	4
Bridal Creeper	Asparagus asparagoides	5

*Summary of responsibilities for treatment:

- For Category 3 ‘the plant must be fully and continuously suppressed and destroyed’.
- For Category 4 ‘the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority’; and
- For Category 5 ‘the requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with’.

5.11. Bush regeneration program

Restoration zones 1a and 2a (Figure 4) are subject to a comprehensive and continuous bush regeneration program. All bush regeneration continues with the extensive weeding program in line with the extraction and concurrent rehabilitation program set out in Figures 3 and 4. All rehabilitation targets are set annually and reported within the AEMR. The site has scattered specimens of woody weeds are strategically controlled at the discretion of the bush regenerator. Weeds to be targeted include large woody weeds such as Southern Nettle Tree (*Celtis australis*), Large-leaved Privet (*Ligustrum lucidum*) and Small-leaved Privet (*Ligustrum sinensis*), Honey Locust (*Gladitsia triocanthus*) and a variety of other environmental and noxious weeds.

The bush regeneration program continues to recover resilient areas which are supporting a diversity of native plant species which demonstrate structural complexities characteristic of riparian forest. Work is graduating along these areas to assist limits of riparian forest which are in a state of decline. Working in this manner allows the program to utilise the local ecosystem functions as a fundamental tool to stimulate natural resilience, providing necessary recovery mechanisms required for the colonisation of adjacent revegetation areas with remnant flora and fauna.

The bush regeneration program continues to run for the entire length of the overall restoration program. The primary bush regeneration sessions has occurred during in the previous 24 month period. This has involved an average of 7 visits in each site during the previous 24 months. From this stage, there will be 14 visits scheduled per year for all areas and it is anticipated that this will occur for the next 2 years where the number of visits will eventually reduce to 6 maintenance visits per year for the whole site.

A 2 year maintenance program is running concurrently with the bush regeneration program. Tables 6 to 8 below indicates the specific restoration actions to be incorporated into zones 1, 2 and 4, with Table 9 outlining specific performance criteria – see also Figure 3. All work sessions are based on a two person team.

Table 6: Specific Restoration Actions for Zone 1 Nepean River

Item	Description of Rehabilitation Actions Completed & Continuing - Zone 1(a) – 0.79 ha	Previous Targets
1.	Target Weed control	2 days
2.	Bush regeneration program	
2.1.	Primary bush regeneration works	12 sessions first 2 years
2.2.	Secondary bush regeneration program	12 sessions remaining 2 years
3.	Monitoring and reporting program throughout two year maintenance period	2 reports
Item	Description of Rehabilitation Actions Continuous - Zone 1(b) – 0.26 ha	No. required (indicative)
1.	Installation of protective fencing surrounding Zone 1(a) and litter removal	As required
2.	Seed collection, cleaning and storage	9 days
3.	Plant propagation	1,600
4.	Installation of plants	
4.1.	Hand Installation	1,600
5.	Brush Matting	1 day
6.	Report at practical completion	1 report
7.	Commence maintenance program	14 visits (all tasks)
8.	Broadcast seeding	1 days

Table 7: Specific Restoration Actions for Zone 2 Dry River Anabranh

Item	Description of Rehabilitation Actions Continuous – Zone 2(a) – 0.51 ha	No. required (indicative)
1.	Target Weed control	1 day
2.	Bush regeneration program	
2.1.	Primary bush regeneration works	12 sessions first 2 years
2.2.	Secondary bush regeneration program	12 sessions remaining 2 years
3.	Monitoring and reporting program throughout two year maintenance period	2 reports
Item	Description of Rehabilitation Actions Continuous - Zone 2(b) – 0.55 ha	No. required (indicative)
1.	Installation of protective fencing surrounding Zone 1(b) and litter removal	As required
2.	Seed collection, cleaning and storage	9 days
3.	Plant propagation	12,400
4.	Installation of plants	
4.1.	Hand Installation	12,400
5.	Brush Matting	1 day
6.	Report at practical completion	1 report
7.	Commence maintenance program	20 visits (all tasks)

Table 8: Specific Restoration Actions for Zone 4 Riparian Linkage non-agricultural production area

Item	Description of Rehabilitation Actions Continuous – Zone 2(a) – ~2.0 ha	No. required (indicative)
1.	Installation of protective fencing surrounding Zone 1(b) and litter removal	As required
2.	Seed collection, cleaning and storage	9 days
3.	Plant propagation	12,400
4.	Installation of plants	
4.1.	Hand Installation	12,400
5.	Brush Matting	1 day
6.	Report at practical completion	1 report
7.	Commence maintenance program	20 visits (all tasks)

Table 9: Performance Completion Criteria

Final Landform	Progressive and final surveyor levels
Class 1 Agricultural land use – approximately 5.9 Ha on Lot 32 (Ground cover for pasture/future agricultural area)	NSW Agricultural Land Suitability Classification System. Figure 3 Zone 3 - Minimum 80% - ground cover for pasture grasses to ensure Zone 3 is re-established as a viable future agriculture area
Agricultural riparian lands – Lot 22 and the balance of Lot 32	Figure 3
Plantings	Minimum 85% survival rate for tubestock Appendix 5
Weed control	Triggered at 15% weed regrowth – Section 5.10 Appendix 1 Appendix 5

5.12. Monitoring and reporting

In order to accurately evaluate the progress and performance success of the rehabilitation and restoration works to the LMP performance criteria and objectives, an initial report will be prepared at 'Practical Completion' and then progress summary reports be prepared every twelve months throughout the two year maintenance period and rehabilitation phase. These reports will be brief, approximately one page, and include a copy of the field monitoring sheet (or similar) in Appendix 6. These reports will be provided to the client and Camden Council.

The monitoring and evaluation program will address the following:

- ▶ Plant growth, percentage cover and survival rates;
- ▶ Plant losses through herbivory, disease, vandalism, storm damage or other factors;
- ▶ Weed regrowth and control measures;
- ▶ Plant replacement;
- ▶ Achieved extraction, rehabilitation and levels;
- ▶ Guard repair and weeding inside guards; and
- ▶ Maintenance watering regime.

The above items will be monitored and evaluated through the establishment of one representative quadrant in each of the major vegetation communities at the practical completion stage. It is also essential to keep regular accurate photo-records of the progress of the restoration works by setting up an appropriate number of representative fixed photo-points across all restoration zones. Photos will be taken by digital camera and recorded in the project file by date and discrete photo-point number. Photo-point locations will be clearly marked on site and mapped by GPS.

Initial implementation ongoing monitoring and review are the responsibility of the EMR. The Landscape Contractor will provide monthly rehabilitation, maintenance and progress observation reports, to ensure compliance with the LMP performance criteria, which include photo evidence pre and post works. The monthly observation reports are provided to the client EMR for internal progress monitoring, review and project management to ensure compliance with the performance objectives and criteria within this LMP. The observation reports also contain recommendations by the Landscape Contractor to the client in regard to issues affecting the ongoing success, or otherwise, of the rehabilitation and restoration works, and the possible need for additional activities that may be required outside the normal maintenance program. It is the responsibility of the Production Manager for monitoring, reviewing and ongoing implementation of the LMP in consultation with the EMR and Landscape Contractor on a monthly and annual basis.

The Landscape Contractor will also complete an annual report outlining rehabilitation completed, where the next annual schedule will be prepared. Although these recommendations are to be on the annual report, these recommendations will be noted by the contractor as and when applicable. The above reporting requirements are summarised below as Table 10.

Table 10: Environmental monitoring parameters				
Monitoring parameter	Monitoring Frequency	Parameters to be measured and equipment required	Responsible Person	Reporting
Water Quality				
Groundwater	Monthly	pH, EC, depth to groundwater (m). Field pH and EC meters, water sampling device, tape measure.	Appropriately qualified consultant.	AEMR
Noise				
Ambient audible noise	Daily	Awareness of noise sources and controls. No routine parameters to be measured	EMR	AEMR
After an investigated noise related complaint warrants monitoring.	If directed by DPE, EPA and/or Camden Council	LA10 (15 minute)	Qualified acoustic consultant.	AEMR
Air quality				
Dust deposition	Monthly	Dust deposition. (g/m ² /month) - Dust monitoring station.	Appropriately qualified consultant.	AEMR
Particulate Matter	Following legitimate dust related complaint thereafter.	TSP and PM ₁₀ Hi Vol sampler with TSP and PM10 head.	Appropriately qualified consultant.	AEMR
Sediment controls				
All sediment controls, including, bunds, straw bale filters and sedimentation basin/s	After each rain event	Visual inspection of sediment control devices by EMR.	EMR.	AEMR
	Monthly monitoring	Visual inspection of sediment controls.	EMR	AEMR
Rehabilitation Works				
Rehabilitation Progress (until practical completion stage)	Monthly monitoring	Visual inspection of re-vegetation progress. Notes on maintenance requirements, including spraying for weeds and replacement of trees / shrubs, as required.	EMR	AEMR

Table 10: Environmental monitoring parameters				
Monitoring parameter	Monitoring Frequency	Parameters to be measured and equipment required	Responsible Person	Reporting
Weed Management (ongoing)	Monthly	Visual inspection of weed infestations and control requirements	EMR / Ecologist	AEMR
	When herbicides are used.	The following is to be recorded in EMM 2. <ul style="list-style-type: none"> • Date of chemical control; • Herbicide applied; Time applied; and • Wind direction (if any). 	EMR/Ecologist	EMM2
Practical Completion	Date of practical completion for each stage	Compliance with the performance criteria in Table 7	EMR/Ecologist	Client, Camden Council and AEMR
Maintenance Phase (2 years following practical completion)	Annual	Compliance with the performance criteria in Table 7	EMR/Ecologist	Client, Camden Council and AEMR
Environmental Management Reporting				
Annual Environmental Management Report (AEMR)	Within 12 months of date of DPE approval (22/05/2009) and modification (Mod 3 25/10/2012) & (Mod 4) and annually thereafter. Submitted to DPE, EPA and Camden Council and website by 31 st March each year..	As per s4 of Schedule 5 of Appendix 4.	Environmental consultant	AEMR
Independent Environmental Audit	Before 30 th June 2019 and every three years thereafter.	As per s5 of Schedule 5 of Appendix 4. As per approved DPE correspondence letter dated 30 th September 2016 Appendix 15.	Environmental consultant	Audit Report
Report to DPI for annual production data.	Annually by 15 December.	Complete form.	Industry and Investment (DPI) form	AEMR
EPA License	Annually, by 26 October.	Complete form	EPL licence annual form.	EPA

6. POST EXTRACTION LAND-USE AND AGRICULTURAL CLASSIFICATION

6.1. Existing agricultural classification

Based on the NSW Agriculture (2002) Land Classification System, the flat open paddock area of the subject site Lot 32 is currently classified as 'Class 1' agricultural land. This land within Lot 32, is suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent. There is currently 6.8 hectares of agricultural land.

6.2. Post extraction land-use and agricultural classification

Post-extraction, there will be approximately 5.9 hectares of Class 1 agricultural land on Lot 32 (as per NSW Agricultural Land Suitability Classification system). The reduction in total production area was due to a portion of the site being replanted as either riparian vegetation associated with the Nepean River or the Dry River Anabran. This loss of land will only marginally reduce the total agricultural productivity of the site but will have significant environmental benefits.

It is noted that DGRs for the proposed modification were issued on 23 December 2010 and as part of the consultation process for the Environmental Assessment, the NSW Department of Trade & Investment, Regional Infrastructure & Services (DT&IRI&S, 2011) made the following comments in relation to the post extraction agricultural landform:

'Agriculture issues

'The Cultural Landscape & Visual Assessment report seems to lack the historical context of the agricultural landscape association between the land proposed for sand and soil extraction and the broader Camden agricultural heritage. The Aboriginal Archaeological Assessment notes that the land was most likely cleared for agriculture in the 1830s and able to be cultivated for crops, market gardens and growing grapes which demonstrate the versatility and robust nature of farming on class 1 agricultural soil.'

The Landscape Management Plan is adequate for the restoration for agricultural uses. Environmental Risk Assessment - There is a risk that the rehabilitation does not return the extracted area to class 1 agricultural land. Demonstration of successful rehabilitation and return to agricultural suitability on previously extracted areas may assist in determining the risk level.'

As a response to the above correspondence, Harvest Scientific Services Pty Ltd was engaged by MCS Pty Ltd to prepare an Agricultural Assessment for a portion of the M Collins and Sons (Contractors) Pty Ltd site that has been subject to similar land-forming and rehabilitation controls to those proposed as part of the current sand and soil extension proposal.

The agricultural assessment by Harvest Scientific Services Pty Ltd (2011) concluded that the re-instated rehabilitated landform was classified as 'Class 1' agricultural land.

A copy of this assessment is appended as Appendix 7.

6.3. Conclusion

Based on an assessment of the protocols for the re-instatement of areas for agricultural land on Lot 32 and an assessment of a comparable site whereby comparable protocols have been implemented, the controls will result in the re-establishment of 'Class 1' Agricultural land on 5.9ha of land within Lot 32. The balance of Lot 32 and Lot 22 will be retained as agricultural riparian lands as per Figure 3.

7. LIMITATIONS TO THIS REPORT

This report has been prepared subject to a number of limitations. These include:

- The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose;
- The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points;
- In preparing this report, Harvest Scientific Services Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific Services Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services Pty Ltd assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Harvest Scientific Services; and
- This report is not to be relied upon for any purpose other than that defined in this report

8. CONCLUSION

Providing the rehabilitation protocols outlined in this report are implemented, it concluded that:

- This LMP provides MCS, contractors, Council and relevant Government Authorities with a common document that clearly sets out the performance targets, restoration principles, monitoring and maintenance procedures required for the long term sustainable management of the ecological plantings and their surrounding environment; and
- Open paddock areas on Lot 32 will have the capacity for use as 'Class 1' Agricultural land up to 5.9ha.

Importantly, implementation of this LMP will produce a sustainable post-extraction landscape, including enhanced biodiversity outcomes beyond those directly occasioned by extraction activities. Such landscapes will ultimately be little different to distant observers in a visual sense to that prevailing. The LMP also provides guidance on the plant species, planting techniques, revegetation methods and maintenance requirements for the site. Implementation of the LMP will:

- Revegetate large areas of native vegetation associated with the riparian zones of both the Nepean River (Zone 1 – Figure 3), Dry River Anabranh (Zone 2 – Figure 3) and Riparian Linkage (Zone 4 – Figure 3);
- Allow for continued use of zone 3 (Figure 3) for an agricultural land-use;
- Improve the condition of areas of existing native vegetation, through bush regeneration;
- Improve vegetation cover and connectivity throughout the site and surrounds;
- Remove heavy weed infestations throughout Dry River Anabranh (Zone 2 – Figure 3) and the eastern 'bank' of the Nepean River (Zone 1 – Figure 3); and
- Improve water quality leaving the development site and entering Nepean Catchment.
- Outlines additional mitigation measures to enhance regeneration of areas following extraction and reduce the visual impact during extraction.

9. REFERENCES

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- Department of Environment and Climate Change (2005) *Recovering Bushland on the Cumberland Plain' Best Practice Guidelines for the Management and Restoration of Bushland*, June 2005. DECC, Sydney
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- Harvest Scientific Services 2010. Landscape Management Plan for Spring Farm Sand and Soil Extraction (continuation of existing operations). Lot 22 DP 833317 Spring Farm
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- Noxious Weeds Act 1993* (NSW)
- NSW Agriculture 1991. Agricultural Land Classification Atlas. Sydney Basin, including the Lower Nepean/Hawkesbury. NSW Agriculture.
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- Platt, S (1999) Nest boxes for wildlife - Department of Primary Industries Victoria
- Ryan, P 1999, 'The use of revegetated areas by vertebrate fauna in Australia'
- Threatened Species Conservation Act 1995* (NSW)

APPENDIX 1

MODIFICATION 4

Notice of Modification

Section 75W of the *Environmental Planning and Assessment Act 1979*

As delegate of the Minister for Planning, I modify the development consent referred to in Schedule 1, as set out in Schedule 2.



Oliver Holm
Executive Director
Resource Assessments and Compliance

Sydney

2 August 2018

SCHEDULE 1

Development consent granted by the Minister for Planning on 13 October 1988 for the Spring Farm Quarry at 186 Macarthur Road, Lot 22 DP 833317 (formerly Lot 2 DP 625278 Vol 14788 Folio 34).

SCHEDULE 2

1. In the list of definitions delete the terms "Department", "Director General", "DRE", "Minister" and "NOW", and their definitions, and insert the following in alphabetical order:

AEP	Annual Exceedance Probability
Department	Department of Planning and Environment
Dol	Department of Industry - Lands and Water
DRG	Division of Resources and Geoscience within the Department
EA (Mod 4)	Environmental Assessment titled <i>Modification of Spring Farm Quarry Consent (DA 75/256)</i> , Lot 22 (No. 186) DP 833317 and Part Lot 32 (No. 172) (DP 635271) Macarthur Road, Spring Farm, prepared by Pascoe Planning Solutions, dated February 2018, and the associated Response to Submissions titled Spring Farm Quarry (DA 75/256 MOD 4) Modification, and dated 3 June 2018
Minister	NSW Minister for Planning, or delegate
PMF	Probable Maximum Flood
Secretary	Planning Secretary under the EP&A Act, or nominee

2. Delete all references to "Director-General" and replace with "Secretary".
3. Delete all references to "shall" and replace with "must", except in condition 3 of Schedule 2.
4. Delete all references to "DRE" and replace with "DRG".
5. Delete all references to "NOW" and replace with "Dol".
6. Delete all references to "approval" and replace with "consent", except in:
 - a) condition 4 of Schedule 3;
 - b) the first reference in conditions 10, 17 and 22A of Schedule 3;
 - c) conditions 3 and 4 of Schedule 4;
 - d) condition 1 of Schedule 5; and
 - e) the first reference in condition 8 of Schedule 5.
7. Delete condition 2 of Schedule 2 and insert the following:
 2. The Applicant must carry out the development generally in accordance with the:

- (a) EIS, SEE (Mod 1), EA (Mod 3) and EA (Mod 4); and
 - (b) Statement of Commitments (see Appendix 1).
- 8. After condition 2 of Schedule 2, insert the following:
 - 2A. The Applicant must carry out the development in accordance with the conditions of this consent.
- 9. In condition 4 of Schedule 2, delete subparagraphs (a) and (b) and insert the following:
 - (a) any reports, strategies, plans, programs, reviews, audits or correspondence that are submitted in accordance with the conditions of this consent;
 - (b) any reviews, reports or audits undertaken or commissioned by the Department regarding compliance with the conditions of this consent; and
 - (c) the implementation of any actions or measures contained in these documents.
- 10. In condition 5 of Schedule 2, delete "2019" and replace with "2021".
- 11. In condition 10 of Schedule 3:
 - a) delete the words "and implement" after the word "prepare"; and
 - b) after subparagraph (c) insert the following:

The Applicant must implement the Air Quality Monitoring Program as approved by the Secretary.
- 12. In condition 12 of Schedule 3:
 - a) delete the words "and implement" after the word "prepare"; and
 - b) after subparagraph (c) insert the following:

The Applicant must implement the Water Management Plan as approved by the Secretary.
- 13. In condition 17 of Schedule 3:
 - a) delete the words "and implement" after the word "prepare"; and
 - b) after subparagraph (c) insert the following:

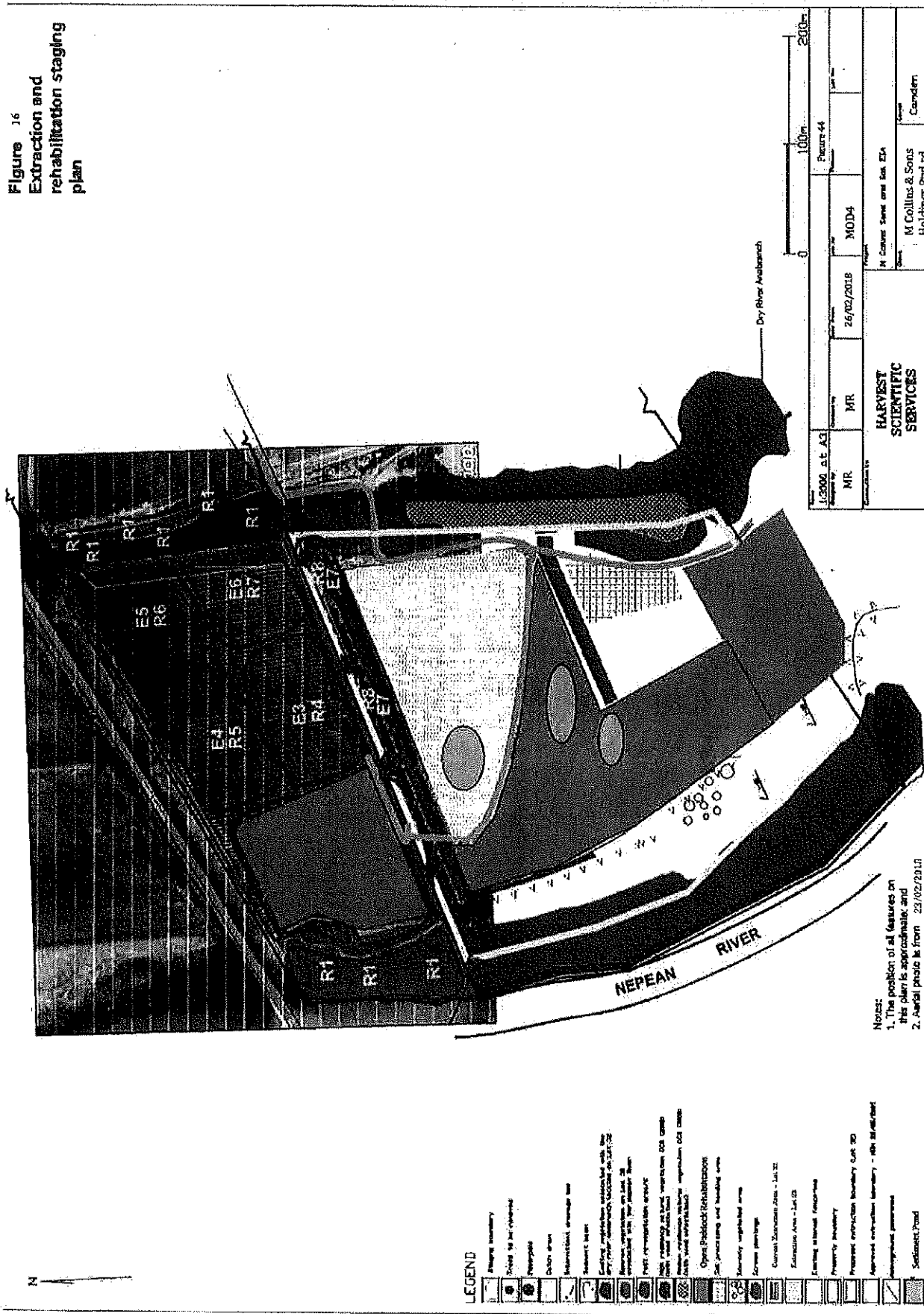
The Applicant must implement the Landscape Management Plan as approved by the Secretary.
- 14. In condition 18 of Schedule 3:
 - a) delete the words "and implement" after the word "prepare"; and
 - b) after subparagraph (g) insert the following:

The Applicant must implement the Rehabilitation Management Plan as approved by the Secretary.
- 15. In condition 16 of Schedule 3, following the words "Plan must", insert the words "be put in place for floods above the 1% AEP flood event up to the PMF and".
- 16. In condition 22A of Schedule 3:
 - a) relabel sub-paragraphs "(c)", "(d)" and "(e)", as "(a)", "(b)" and "(c)", respectively;
 - b) delete the words "and implement" after the word "prepare"; and
 - c) after subparagraph (c) insert the following:

The Applicant must implement the Waste Management Plan as approved by the Secretary.
- 17. In conditions 4 and 5 of Schedule 4, delete the words "If the matter cannot be resolved within 21 days, the Director-General shall refer the matter to an Independent Dispute Resolution Process (see Appendix 3)".
- 18. In condition 1 of Schedule 5:
 - a) delete the words "and implement" after the word "prepare"; and
 - b) after subparagraph (e) insert the following:

The Applicant must implement the Environmental Management Strategy as approved by the Secretary.
- 19. In condition 4(b) of Schedule 5 delete the words "EIS, SEE (Mod 2), EA (Mod 3)" and insert the words "documents listed in condition 2(a) of Schedule 2".
- 20. In the Statement of Commitment numbered 16 in Appendix 1, delete the words "Water Ministerial Corporation" and insert the words "Water Administration Ministerial Corporation".
- 21. In Appendix 2 delete both figures, and insert the following:

Figure 16
Extraction and
rehabilitation staging
plan



ZONE 2b. Dry River Anabranch
CRZ - additional plantings



22. Delete Appendix 3.
23. Update the Table of Contents to reflect the above changes.

APPENDIX 2

CONTROLLED ACTIVITY APPROVAL - 2018



Natural Resources Access Regulator

Contact: Mohammed Ismail
Phone: 02 8838 7535
Fax: 02 8838 7554
Email: mohammed.ismail@nrar.nsw.gov.au

Collins and Sons Holdings Pty Ltd
SPO Box 378,
NARELLAN NSW-2567

Our ref: **10CX122891** (old Ref: ERM2013/830)
DA 75/256

email: matt@mcollins.com.au

7 December 2018

Re: Controlled activity approval - EXTENSION

For activity described as	Building/construction (Non-Residential)
To be carried out at	Spring Farm and Nesbitt Site, 186 Macarthur
Road, SPRING FARM 2570	
Date of Issue: 27/12/2018 - Date of Expiry: 7 December 2018.	

I refer to your application for extension of controlled activity approval under the *Water Management Act 2000* which was received by this office. Receipt of your application fee of \$722 is also acknowledged.

1. Controlled activity approval

The Natural Resources Access Regulator (NRAR) has determined to grant you an extension to a controlled activity approval. Please find enclosed the **Notice of Determination** together with your **Statement of Approval**.

Please read carefully the conditions of the approval and seek clarification from NRAR for any condition not fully understood.

A **copy** of this approval and any annotated documentation should be **provided to the council**, your **certifier** and to **all contractors** engaged in the implementation of this controlled activity to ensure they are also aware of the conditions.

The controlled activity approval must be kept **current until** the controlled activity has been **completed**. Applications for **extending the approval** should be made to NRAR, in writing, prior to the expiry date on the approval.

2. Inspections and fees

As the approval holder, you are required to notify NRAR on completion of the controlled activity. A site inspection may be needed to confirm that all of your obligations under the controlled activity approval have been carried out.

Costs associated with a single inspection may be covered by the application fee. However, if extra inspections or significant reassessment is required, then additional fees will be incurred.

Fees will also apply to any amendments requested or any extension of this approval. The current fee schedule is available at <https://www.industry.nsw.gov.au/water/licensing-trade/approvals/controlled-activities>

3. Other approvals may be required

Subject to the conditions of the attached Statement of Approval, the approval holder is only authorised to carry out the controlled activity described in the location specified.

The attached Statement of Approval does not relieve the approval holder of any obligation which may exist to also obtain permission/approval/consent from any other agency who may have some form of control over the site or the proposed development.

Any questions regarding this correspondence should be directed to by email to mohammed.ismail@nrar.nsw.gov.au.

Yours sincerely



**Mohammed Ismail
Water Regulation Officer
Natural Resources Access Regulator
Dol Crown Lands & Water, NRAR**

Enc:
Notice of Decision
Statement of Approval



	Application details
Reference number	10CX122891
Application type	Controlled activity approval under section 92 of the <i>Water Management Act 2000</i>
Description of activity	Controlled Activities
Applicant/s	Collins and Sons Holdings Pty Ltd SPO Box 378, NARELLAN NSW-2567
	Decision
Decision	Granted, subject to conditions This decision was made under section 95 of the <i>Water Management Act 2000</i> .
Date of decision	7 December 2018
Determining officer	Mohammed Ismail by a delegation from the Minister administering the <i>Water Management Act 2000</i> under the <i>Instrument of Delegation (Water Management Act) 2011</i>
	Reason/s for decision
	<p>This controlled activity approval was granted on the basis DPI Water is satisfied adequate arrangements are in place to ensure that no more than minimal harm will be done to waterfront land as a consequence of the carrying out of the controlled activity.</p> <p>Conditions were applied for the purpose of protecting the environment from the impacts associated with the approval, to give effect to any agreement between the applicant and a person who objected to the application, or to require security for the cost of performing the approval holder's obligations under the approval in case the approval holder fails to fulfil those obligations.</p>

Right of appeal

Section 368 of the *Water Management Act 2000* provides a right of appeal to the Land and Environment Court in certain circumstances:

- The applicant/s may appeal against a decision **imposing certain conditions** on an approval or **fixing the term** of an approval. This right of appeal also applies to conditions which are amended or added after an approval is granted.
- A person who objected to the granting of the approval under section 93 of the *Water Management Act 2000* may appeal against a decision **granting** the approval.

If you wish to make an appeal you must do so **within 28 days** after the date of the decision.

END OF STATEMENT

Approval details

Approval number	10CX122891
Status	CURRENT*
Approval kind	Controlled Activity
Water sharing plan	Greater Metropolitan Region Unregulated River Water Sources 2011
Date of effect	27/11/2018 Should an appeal be made against the granting of this approval, this approval will not take effect until the appeal is finally disposed of.
Expiry date	21/11/2021
Approval holder(s)	Schedule 1
Activities	Schedule 2
Conditions	Schedule 3

Contact for service of documents

Name	Collins and Sons Holdings Pty Ltd
Address	PO Box 378 NARELLAN NSW-2567

* Note: An approval has effect for such period as is specified in the approval, or if the period is extended under section 105, that extended period. If an application for extension of an approval is lodged before the approval expires, the term of the expiring approval is extended until either the date of the final decision on the application, or a date fixed by the Minister for the approval, whichever is the later date. An approval which has expired can be the subject of an application to extend it but it needs to be accompanied by a statutory declaration of the reasons for the delay in making the application. If the Minister accepts these reasons the term of the approval is taken to have been extended, and the application may be dealt with, as if the application had been made before the approval expired.

It is an offence under the Water Management Act 2000 to breach a term or condition of the approval or to construct and use works to which the approval does not relate. It is also an offence to use works the subject of an approval if the approval has expired, been surrendered or cancelled.

Schedule 1 - Approval holders

The holders of this approval are:

Approval holder(s)	ACN (if applicable)
Collins and Sons Holdings Pty Ltd	000 521 871

Important notice - change of landholder or contact

Please advise the Office in the event of any of the following, as soon as practicable:

- If there is a change in the ownership or occupation of the land benefited by this approval (see Schedule 2). Under the Water Management Act 2000, an approval is typically held by the owner or lawful occupier of the benefited land. Consequently, a change in occupation may cause a change in your legal obligations as an approval holder.*
- If there is a change to the contact person. You will be required to lodge a written statement signed by all the holders.*
- If there is a change to the mailing address for the nominated contact person. This should be done by the contact person in writing.

* An updated Statement of Approval will be issued free of charge

Schedule 2 - Activities

Part A: Authorised activities

Subject to the conditions of this approval, in relation to each numbered activity in the table, the holders of this approval are authorised to undertake the activity of the type shown at the location specified:

Activity 1

Specified Activity

Extractive Industry

Specified location

1//587631	Whole Lot
32//635271	Whole Lot
22//833317	Whole Lot

Water source

Hawkesbury And Lower Nepean Rivers Water Source

Water sharing plan

Greater Metropolitan Region Unregulated River Water Sources 2011

Schedule 3 - Conditions

The approval is subject to the following conditions:

Conditions

Water management works

DK6301-00001

All excavated material associated with the carrying out of the controlled activity must be removed from waterfront land and disposed of or used in a way that prevents the material from re-entering the water source.

DS4875-00001

A. Before commencing the controlled activity authorised by this approval, the boundary of the area where the activity is to be carried out must be clearly marked on the ground.
B. The markings must remain in place until the controlled activity has been completed.

DS4860-00001

The approval holder must employ a suitably qualified person to directly supervise the controlled activity authorised by this approval to be carried out.

DS4862-00001

The controlled activity authorised by this approval must be maintained for a period of 2 years after completion of the controlled activity.

Activities

DS6039-00001

The bed of the watercourse must not be excavated..

DS5035-00284

The controlled activity authorised by this approval must be carried out in accordance with the following plan(s)/document(s) held by Natural Resources Access Regulator, Parramatta Office:
A. Plan No. 77310.01.P08, Original Surface Contours (1983) by SMEC Urban
B. Plan No. 77310.01.P09, Current Surface Contours (2008) by SMEC Urban
C. Plan no. 77310.01.P16, Design Final Surface Contours by SMEC Urban.
D. Plans Nos. 77310.01.P04, 77310.01.P05, 77310.01.P06, 77310.01.P11, 77310.01.P12 & 77310.01.P13, Sand Mining Cross Sections by SMEC Urban.
E. Plans No JET0328 drawing Nos 11 (issue 3) and 12 to 16 (inclusive all issue 2) by Johnstone Environmental Technology as indorsed by Department Land & Water (now office of Water) and department of Planning.
F. Plans No JET0989 drawing 2 to 4 inclusive and 7 to 10 inclusive.
.

DS5035-00285

The controlled activity authorised by this approval must be carried out in accordance with the following plan(s)/document(s) held by Natural Resources Access Regulator, Parramatta Office:

- A. Landscape Management Plan dated 24 April 2013 by Harvest Scientific Services Pty Ltd
- B. Figure 3 Final Landform and Rehabilitation Management Plan No 201279 dated 4 September 2012 by Harvest Scientific Services
- C. Attachment 1 to this CAA, Site drainage and erosion control measures.
- D. Attachment 2 to this CAA, Site Rehabilitation
- E. Vegetation Management Plan (VMP), The Knoll, Spring Farm, Elderslie NSW date February 2002

.

Environmental matters

DK4951-00001

A. Before commencing any work authorised by this approval, erosion and sediment control measures must be established and implemented in accordance with the requirements of the Managing Urban Stormwater Manual, Volume 1, Soils and Construction (2004) as amended or replaced from time to time.

B. These control measures must be maintained until work is completed.

DS4861-00001

All erosion and sediment control works must be decommissioned using a suitably qualified person on completion of the controlled activity once the site has stabilised.

DS4865-00001

A. All materials must be stored away from the water source so that materials do not:

- i. obstruct water flow, or
- ii. wash into the water source, or
- iii. cause damage to river banks.

B. When the controlled activity authorised by this approval has been completed, surplus materials must be removed from waterfront land.

DS4866-00001

Machinery used for the controlled activity authorised by this approval must not enter the water source at any time.

DS4945-00001

Vegetation may only be cleared to the minimum extent required for the carrying out of the controlled activity, which means that the minimum area is cleared to allow:

- A. carrying out of the controlled activity and
- B. access for appropriate equipment and personnel.

Monitoring and recording

DS4852-00001

A copy of this approval must be kept at the site where the controlled activity is taking place. A copy of the approval must be provided to all personnel working on the controlled activity.

DS6278-00001

The approval holder must provide a progress report detailing extraction operations, site conditions and materials replenishment to the Natural Resources Access Regulator every twelve (12) months from the date of the granted approval. This progress report must be submitted to Natural Resources Access Regulator, Parramatta Office, and the report is to include photos of the entire site and the photo points must be identified by survey or other methods.

Reporting

DS4864-00014

When the controlled activity authorised by this approval has been completed:

- A. a certificate of completion must be provided by a suitably qualified person, and
- B. the approval holder must send the certificate to Natural Resources Access Regulator, Parramatta Office within 60 days of the controlled activity being completed.

DS4863-00022

At completion of the maintenance period for the controlled activity authorised by this approval, the approval holder must report in writing to Natural Resources Access Regulator, Parramatta Office, that:

- A. the controlled activity has been completed, and
- B. the water source and waterfront land have been restored and rehabilitated in accordance with plans held by Natural Resources Access Regulator.

DS4857-00026

The approval holder must notify Natural Resources Access Regulator, Parramatta Office, in writing within 30 days of the controlled activity being completed.

DS4899-00003

The approval holder must notify Natural Resources Access Regulator, in writing to nrar.enquiries@nrar.nsw.gov.au , within 14 days of any change in site management, land ownership or land occupation.

DS4892-00031

- A. The approval holder must provide a report to Natural Resources Access Regulator, Parramatta Office, on the implementation of each of the following plan(s):
 - Vegetation Management plan; Works schedule every twelve (12) months up to the end of the maintenance period, and at the completion of the controlled activity authorised by this approval.
- B. Each report must:
 - i. address the requirements set out in each plan, and
 - ii. be prepared by a suitably qualified person.

Additional conditions

DK6311-00001

- The approval holder must not excavate:
- A. beyond the depth shown on plans No. 77310.01.P04, 77310.01.P05, 77310.01.P06, 77310.01.P11, 77310.01.P12 & 77310.01.P13, Sand Mining Cross Sections by SMEC Urban approved by the NSW Office of Water and stamped on 8 October 2013,
 - B. below the depth shown on plans JET0328 Drawing 12, 13, 14, & 15 (all issue 2) prepared by Johnstone Environmental Technology stamped on 30 April 1996,
 - C. below the depth shown on plans JET0.989 drawings 8 issues 1, drawing 9 issues 0 and drawing 10 issues 0.

DK6312-00001

The approval holder must not excavate beyond a depth of 3 metres above the normal flow water level (taken as R55.63).

DS4924-00049

A. Before commencing carrying out the controlled activity authorised by this approval, a security deposit of \$ 45,200 must be provided to Natural Resources Access Regulator, Parramatta Office, in the form of an SGI document or equivalent (e.g. bank guarantee) attached to this approval.

B. The security deposit will be held by Natural Resources Access Regulator until:

i. the controlled activity has been satisfactorily completed and the water source and waterfront land have been rehabilitated in accordance with plans held by Natural Resources Access Regulator, and

ii. a certificate of compliance/statement of completion has been completed by a suitably qualified person and provided to Natural Resources Access Regulator, Parramatta Office.

DS4924-00050

A. Before commencing carrying out the controlled activity authorised by this approval, a security deposit of \$ 43,850 must be provided to Natural Resources Access Regulator, Parramatta Office, in the form of an SGI document or equivalent (e.g. bank guarantee) attached to this approval.

B. The security deposit will be held by Natural Resources Access Regulator until:

i. the controlled activity has been satisfactorily completed and the water source and waterfront land have been rehabilitated in accordance with plans held by Natural Resources Access Regulator, and

ii. a certificate of compliance/statement of completion has been completed by a suitably qualified person and provided to Natural Resources Access Regulator, Parramatta Office.

Glossary

licensor - WaterNSW or DPI Water, depending on which organisation administers your licences and/or approvals

waterfront land - Land and material in or within 40 m of the top of the bank or shore of a river, lake, estuary or coastal waters.

General Notes

All conditions on an approval require compliance. An appeal to the Land and Environment Court against a decision to impose certain conditions on an approval can be made within 28 days after the date the decision is made. Conditions identified with the first letter "D" are those that can be appealed during the appeal period.

The words in this approval have the same meaning as in the *Water Management Act 2000*

Note: The words in this approval have the same meaning as in the WMA

END OF STATEMENT

APPENDIX 3

BOWANTZ REPORT



BUSH REGENERATION AND ECOLOGICAL RESTORATION REPORT

EXISTING SAND AND SOIL EXTRACTION OPERATIONS
Lot 32 DP 635271 & Lot 22 DP 833317
M Collins and Sons (Holdings Pty Ltd)



PREPARED BY
Bowantz Bushfire & Environmental Pty Ltd

Bowantz Bushfire & Environmental Pty Ltd

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Prepared for: M Collins and Sons (Holdings Pty Ltd)

Prepared by:

Daniel Anderson

Master EnvSc (Planning & Ecology), Grad Cert (Bushfire Protection), Grad Dip (Conservation Land Management)



Version Control:

Report Compilation and Review	Name and Position	Document Revision	Date
Author:	Daniel Anderson Grad Cert Bushfire Planning, Grad Dip CLM, Master EnvSc (Planning, Ecology) Scientific license survey & impact assessment PRSL_000019	Final Draft	23/07/2018
Author:	Jordan Pont BSc (Conservation Biology) Scientific license survey & impact assessment PRSL_000019	Review	25/07/2018
Client Review	Landholders Review	Final Version	

Referenced Documents:

Harvest Scientific Services 2016; Landscape Management Plan Lot 32 DP 635271, Lot 22 DP 833317 Macarthur Road Spring Farm.

NSW Office of Water Controlled Activity Approval; Statement of Approval Number 10ERM2013/0830

Actinotus 2012; Flora and Fauna Assessment for proposed Sand and Soil Extraction at Lot 32 DP 635271 Macarthus Road Spring Farm.

NSW Biosecurity Act 2015, Part 3 Priority Weeds NSW Department of Primary Industries, Greater Sydney Local Land Services.

NSW Water Management Act 2000; Guidelines for Riparian Corridors on Waterfront Land.

NSW Biodiversity Conservation Act 2016; Schedule 1 Threatened Species, Schedule 2 Threatened Ecological Communities & Schedule 4 Key Threatening Processes

TABLE OF Contents

1.0 INTRODUCTION	6
1.1 Background	6
1.2 Site Location	7
1.3 Site Description and Project Zones	7
1.4 Statutory Requirements	9
1.5 Aims and Objectives of the Restoration Program	9
2.0 RESTORATION PROGRAM	10
2.1 Landform Remediation Erosion / Sediment Management	10
2.1.2 Brush matting and use of harvested vegetation biomass	10
2.2 Vertebrate Pest Monitoring	11
2.3 Fencing Stock and Animal Exclusion	11
2.4 Installation of Nesting and Habitat Boxes	11
2.5 Weed Control Primary Eradication	11
2.6 Weed Control Secondary	12
2.7 Seed Collection and Provenance Plant Propagation	12
2.8 Revegetation	12
2.9 Watering - Installation of water tank supplies and drip irrigation lines	12
2.10 Maintenance Programs	13
3.0 SITE CONDITION MONITORING	13
3.1 Site Ecological Condition Assessments – Field Surveys	13
3.2 Restoration Zones – Condition Audits	13
4.0 IMPACTS AND IMPLICATIONS DELIVERY OF RESTORATION PROGRAM	14
4.1 Issues, Pressures and Failures in Implementation	14
4.1.1 Flooding	14
4.1.2 Drought	15
4.1.3 Animal Predation – Plant Damage	15
5.0 CONCLUSIONS AND RECOMMENDATIONS	15
6.0 PLANNED – PROGRAMMED WORKS 2018-2019	16
6.1 Vertebrate Pest Control	16
6.2 Weed Control	16
6.3 Revegetation	18
6.5 Fencing	19
6.6 Installation of Habitat / Nesting Boxes	19
6.7 Maintenance Repair & Watering	19
8.0 REFERENCES	21
9.0 APPENDICES	22

9.1 Tables	22
9.1.1 Work outputs and milestones completed 2017-18 program	20
9.1.2 Restoration zone progress reporting	23
9.1.3 Revegetation species list	31
Site Photos - Images 1 - 18	31
Site Maps - Maps 1 - 6	41
Site Vegetation Condition Surveys - Sites 1 - 5	47

1.0 INTRODUCTION

1.1 Background

Spring Farm Quarry is a sand and soil extraction and processing plant owned and operated by M Collins and Sons (Holdings) Pty Ltd (MCS). The Quarry and processing plant currently operates from two lots 22 DP 833317 and 32 DP 635271 located adjacent to the Nepean River in the Camden Local Government Area (LGA) *see figure 1 below*.

The site has been operational since 1988 and is a major source of products for the Sydney region, comprising a significant resource identified in the Sydney Regional Environmental Plan (No-9 Extractive Industry) (*Harvest Scientific Landscape Management Plan 2016*).

In May 2009 (MCS) was granted consent for the continuation of operations on the site by the Department of Planning for the continued extraction and processing of materials at the site. This approval was to allow operations to continue for a further 10 year period until 2019 (*Harvest Scientific Landscape Management Plan 2016*). Director General Requirements for the modification of continued operations were then issued on 23rd December 2010 and included requirements relating to future quarry closure and rehabilitation of the site (*Harvest Scientific Landscape Management Plan 2016*).

A Landscape Management Plan (LMP) was subsequently developed for the site by Harvest Scientific Services Pty Ltd in 2016 to address the Director General Requirements and to provide a clear practical framework for the restoration of the native vegetation impacted by the activity with accordance to relevant environmental and planning legislation and the operational consents for the site. As such the LMP has been used to provide MCS with clear performance targets, restoration principles, monitoring and maintenance procedures required for the sustainable management of the site and surrounding environments (*Harvest Scientific Landscape Management Plan 2016*).

Bowantz Bushfire & Environmental Pty Ltd (BBE) have been engaged by MCS since 2008 to manage and implement the environmental actions and recommendations described for the site within the LMP and other supporting planning documents for the site. Bowantz Bushfire & Environmental is an environmental restoration and environmental planning business, we have professional acumen and skills in ecological restoration works and an ability to integrate on ground practical project delivery with scientific monitoring and condition assessment practice.

This report constitutes a review of the applied restoration program predominantly targeting ecological restoration objectives and outcomes delivered over the most recent 2017-2018 work program. The report also incorporates specific condition assessment reviews of the key restoration zones in line with the original LMP objectives prescribed by Harvest Scientific within the LMP 2016.

The report focusses on specific auditing of outcomes delivered which relate to key restoration objectives stated for important ecological zones in the LMP and also responds to condition requirements 22 & 24 of the controlled activity approval number 10 ERM2013/0830 issued by the NSW Office of Water under the NSW Water Management Act 2000.

1.2 Site Location

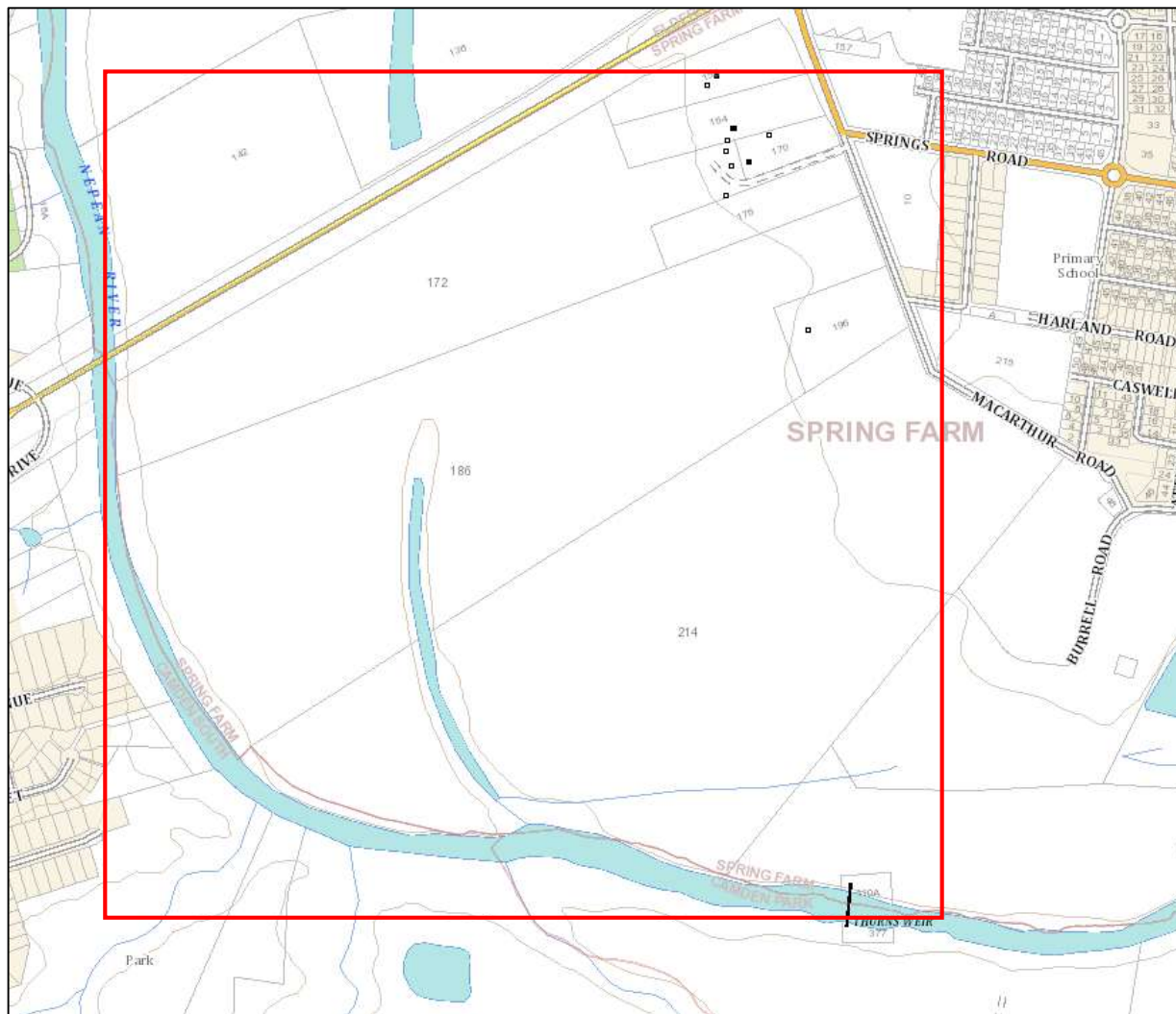


Figure 1; Site Location with subject site enclosed within red frame, (Image NSW Six Maps)

1.3 Site Description and Project Zones

The project site is displayed within the general area shown above in figure 1 (site location) and can also be referred as Map 1 within the appendices of this report. The project site is bound to the east by Macarthur Road, to the west by the Nepean River, the north by the Camden By-Pass Roadway and to the south again by the Nepean River.

Significant areas of environmental and ecological importance within the subject site have been to focus of the restoration works program. The LMP divided the restoration focus areas into four distinct zones accordingly:

- Zone 1 – The Nepean River Riparian Corridor
- Zone 2 – The Dry Past River Anabranch
- Zone 3 – Open Paddock Agricultural Production Areas
- Zone 4 – Riparian Linkage Zone

From this segregation our restoration program works have divided the work zones further into zone units which both reflect the vegetation and ecological landscapes intrinsic to each zone and portion the zones into management units incorporating the work activities prescribed.

The restoration work zones devised through the delivery of our program are provided as follows:

Zone 1a) Nepean River Corridor

This area contains remnant vegetation stands previously mapped by Actinotus (2011) as 'Riparian Forest on Coastal Floodplains'. This vegetation complex is now re-addressed as 'River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions' and is recorded as an endangered ecological community under the NSW Threatened Species Conservation Act.

Zone 1b) Core Riparian Zone – Nepean River

This zone is the land contained within and adjacent to important drainage channels.

This area has been scheduled for restoration program works over the coming program 2018-2019. The area has been prepared for a revegetation program with earthworks such as bank re-grading, battering and top dressing completed. Hydro mulch seeding and planting of native forestry tube stock has been planned for this zone *see section 6.3*.

Zone 2a) Dry River Anabran

This area contains limited remnant vegetation stands previously mapped by Actinotus (2011) as 'Alluvial Woodland on Coastal Plains'. This vegetation complex is now re-addressed as 'Alluvial Cumberland Plain Woodland' and is recorded as an endangered ecological community under the NSW Threatened Species Conservation Act and under the federal Environmental Protection and Biodiversity Conservation Act.

Zone 2b) Dry River Anabran

This area contains limited remnant vegetation stands previously mapped by Actinotus (2011) as 'Alluvial Woodland on Coastal Plains'. This vegetation complex is now re-addressed as 'Alluvial Cumberland Plain Woodland' and is recorded as an endangered ecological community under the NSW Threatened Species Conservation Act and under the federal Environmental Protection and Biodiversity Conservation Act.

Zone 3 Future Agricultural Area

This zone is located in the open paddock area between the Dry River Anabran and the Nepean River Riparian Zone. This area is determined to be used for future agricultural pursuits such as animal grazing.

Zone 4 Riparian Linkage

This zone links the Nepean River Riparian Corridor and the Dry River Anabran remnant vegetation corridors. This zone has been determined for ecological restoration whereby natural bushland areas are to be restored and re-created in the zone to link key retained remnant stands of vegetation on the subject site.

Zone 5 Nepean River Past Revegetation Zone

This area contains mostly recreated vegetation landscapes which reflect the vegetation assemblage of River-flat eucalypt forest on coastal floodplains. Previous revegetation programs in this zone date the vegetation stands to be approximately 15 years of age. Follow up weed management and secondary revegetation programs which aim to increase native species density and native species diversity have been initiated in the works program. This area is also functioning as an important habitat zone for native fauna populations.

Zone 6 Anabran Central

This area contains limited remnant vegetation stands previously mapped by Actinotus (2011) as 'Alluvial Woodland on Coastal Plains'. This vegetation complex is now re-addressed as 'Alluvial Cumberland Plain Woodland' and is recorded as an endangered ecological community under the NSW Threatened Species Conservation Act and under the federal Environmental Protection and Biodiversity Conservation Act.

This zone has received extensive weed control efforts and has progressed into a bushland zone which contains significant resilience and a great diversity of native plant species.

Zone 7 Anabranh South

This zone offers substantial ecological restoration opportunity due to connectivity to the Nepean River Riparian Corridor to the south of the zone. This zone hasn't received restoration works from our previous programs as alternative zones were prioritised. Our program has now progressed to identifying this zone as a key primary and secondary weed control objective for the coming 2018-2019 program. The area contains some valuable remnant trees and forms a vegetation transition between the Alluvial Cumberland Plain Woodland 'and the Riparian Forest on Coastal Floodplains.

1.4 Statutory Requirements

Commonwealth	Environmental Protection Biodiversity Conservation Act 1999 (EPBC Act)
State	Threatened Species Conservation Act 1995 (TSC Act) Biosecurity Act 2015 Environmental Planning and Assessment Act 1979 (EP&A Act) Native Vegetation Act 2003 (NV Act) Water Management Act 2000
Local	Camden City Council Development Control Plan 2011 Camden City Council Bushland Restoration Objectives

1.5 Aims and Objectives of the Restoration Program

The aims and objectives of the restoration program were originally developed as part of the broader site management considerations which include legislated and regulatory expectations along with reference to best practice advice. The overarching restoration goals and opportunities are presented within the LMP document which has been used as the key guiding reference for our on ground project work.

In broad context our project activities have been determined to work towards achieving the following goals:

- Improving the condition of remnant bushland areas through reducing the impacts of key threatening processes like invasive weeds, harbouring of feral animals, and loss of remnant species through senescence, flood and drought.
- Rehabilitating key remnant vegetation communities such as the Riparian Forest on Coastal Floodplains and Alluvial Cumberland Plain Woodland to support legislative responsibilities.
- Improving the connectivity between vegetation zones of the subject site by selectively designing and implementing revegetation programs to increase vegetation cover and vegetation diversity.
- Improving ecological function across the site through the utilisation of environmental processes and services to reduce degradation such as soil loss and erosion and improve elements like water quality.
- Improving the habitat condition of key vegetation zones, whereby restoration practice aims to incorporate habitat requirements into the selection of management activities for a zone.
- Improve the resilience of the natural landscapes by reducing threats such as weed invasion and increasing species diversity and plant maturity through revegetation programs.
- Undertaking on-going maintenance activities to monitor and

2.0 RESTORATION PROGRAM

2.1 Landform Remediation Erosion / Sediment Management

2.1.1 Zone 3 Future Agricultural Production Areas

This zone is located in the open paddock area surrounded on three sides by batters adjacent to the Camden By-Pass Bridge, the Nepean River Bank on the west side and the Dry anabranch on the eastern side. Following the extraction operations, as part of the first phase of rehabilitation the ground is trimmed and surface levels are graded to comply with the final landform design and a survey is completed to validate the on ground levels.

The ground surface is ripped along the contours in order to retain moisture in the subsoil. Once this is completed a 500mm thick layer of topsoil is spread over the area to provide growing medium for the establishment of agricultural pasture. Once the surface preparation is completed the area is sown down with pasture and grasses suitable for grazing of animals.

Sediment and Erosion controls are installed within the perimeter of the downslope areas to prevent any loss of topsoil or sediment during the establishment stage of the grasses. These sediment controls also direct runoff in the direction of the terminal sediment ponds to protect the waters of the Nepean River.

2.1.2 Grass Batters around the Endeavour Energy Power Poles

The mounds that contain the Endeavour Energy power poles are supported structurally by forming batters that connect to the post extraction ground levels. These batters serve to provide access to the power poles for necessary maintenance works.

The mounds and the batters are trimmed to the design profile and re topsoiled and sown down with grasses to stabilise the surface and complement the adjoining pasture within the open paddock areas.

As with the open paddock areas sediment and erosion controls are installed to control the loss of sediment and topsoil during the establishment of the grass surface.

2.1.3 Zone 4 Riparian Linkage Area

This elevated platform of land that links the Nepean River with the Dry Anabranch at the southern boundary between Lot 22 and Lot 1 has been completed and revegetated and stabilised with grasses ready for additional landscape plantings to occur. This has included formation of a batter down to the reduced level of the open grassland and a transition to the western side of the dry anabranch.

2.1.2 Brush matting and use of harvested vegetation biomass

The practice of brush-matting has been implemented throughout all restoration Zones, coupled with revegetation programs to improve native species germination. *Eucalyptus* and *Casuarina* species occur in relative abundance throughout the prescribed revegetation areas and are capable of producing a high seed yield lending to their suitability as a brush-matting species.

All woody material and debris resultant from the ongoing weed management program in Zones 1a, .2, .5 and .6 have been processed and piled in habitat mounds. This practice is expected to produce micro climates dispersed throughout the worked zones. These habitat mounds act as a significant ecological catalyst, their ability to retain moisture facilitates the decomposition of organic materials enriching the surrounding soil chemistry and assists in the germination of native seedlings. Micro-organisms and invertebrate species proliferate within these constructs increasing species richness across the project sites and aid in the pollination of native flora.

The project site occurs on a substantial alluvial deposit prone to erosion and sediment loss from natural weathering. Processed woody debris a product generated from woody weed control, has been applied as bank armouring along

susceptible areas of the Nepean River in *Zone.5 and .2*. Processed logs have been placed along slopes of steep contouring to assist in stabilize the sedimentary soils during the revegetation establishment periods in *Zone.1a, .2 and .5*.

2.2 Vertebrate Pest Monitoring

Vertebrate pest monitoring has been implemented as an ongoing process throughout the prescribed work zones. Initial monitoring aimed to identify the presence of high threat species which were able to impact our bushland restoration strategies. Dusk and dawn surveys collected and recorded the relative abundance and associated breeding sites of observed pest species across all zones. Data synthesized from the vertebrate pest monitoring program is expected to be used to facilitate an active baiting and culling program which aims to reduce pest species abundance and distribution across the project area.

Prescribed *Native and feral animal protection* actions as stated in *section 5.5.2* of the *LMP* have been enacted during revegetation programs applying tree guards and stakes to deter herbivores during the interim.

2.3 Fencing Stock and Animal Exclusion

An active fencing program has been implemented for the exclusion of heavy machinery, human influences and domestic stock for the protection of the rehabilitated riparian areas. Stock gates have been installed at vantage points in *Zone.1, .5 and .2* to maintain access to rehabilitated area and ensure the exclusion of domestic stock and human influences.

An approximate 750m of five (5) strand fencing has been installed to meet the objectives of the Fencing and Animal Exclusion works *refer Implemented Work Management Program Map 1*.

The project site is bordered by agricultural land and redeveloped residential allotments, upon completion of the fencing program it is expected to abate a number of key threats to the ecological community as listed in the NSW Department of Environment Climate Change and Water (DECCW) recovery plans for the 'River Flat Eucalypt Forest on Coastal Floodplains'.

2.4 Installation of Nesting and Habitat Boxes

The rehabilitation zones have been historically impacted from agricultural land use, historic land clearing and proceeding impacts such as weed proliferation. Much of the significant habitat features necessary to sustain native fauna populations have been impacted through the clearing and fragmentation of the native vegetation because of this surrogate habitat elements like man made boxes work to support the retention of native fauna within disturbed or impacted environments.

Habitat boxes have been installed in the rehabilitated vegetated areas of *Zone.1* and *Zone.2* to act as surrogate breeding and nesting boxes for aboral and avian species. This action is expected to increase species richness and diversity overtime, throughout the rehabilitated zones and act to improve the sites ecological resilience and future habitat value.

2.5 Weed Control Primary Eradication

Primary Weed Management strategies have been identified as a key support process in the restoration of the degraded Riparian Forest and Alluvial Woodlands. The proliferation of noxious woody and scrambling weeds has significantly inhibited native bushland natural regenerative processes and have reduced native species richness across the project site.

Primary weed control strategies have been enacted within *Zone.5* prior to implementation of a zone-specific revegetation program. The objectives of the primary weed management strategies aimed to increase light penetration through the weed dominant canopy and increase soil nutrients and microbial activity through the decomposition of weed biomass, to facilitate the succession of native seedlings and plant tube stock.

Several priority Primary Weed Management areas have been identified as a part of the conducted vegetation

assessment within *Zone.7*.

2.6 Weed Control Secondary

Weed management across the project site has been conducted as an active process, following primary weed control interventions, the succession of noxious annual and perennial weeds have established in the disturbed areas. Systematic treatment of the emergent noxious weeds has been enacted as a follow up to primary weed management in *Zone.1a* and the entirety of *Zone.2*.

Secondary Weed Management actions have aimed at reducing existing weed seed bank and targeting highly viable noxious weeds. Selective herbicide application and mechanical treatments have been applied to ensure native species establishment is advantaged during the ongoing rehabilitation of the native bushland areas.

2.7 Seed Collection and Provenance Plant Propagation

The practice of seed collection in accordance with *Flora Seed Collection Guidelines* as prescribed in the *LMP*, has been applied in the propagation of provenance species in collaboration with Wollondilly Council Nursery. This practice is viewed as an important process in obtaining local genetic material to ensure the natural resilience of revegetated stock against local environmental conditions and disease and restore natural species composition and assemblage.

Seed collection has been carried out across all zones to ensure a diversity of genetic material is collected prior to the enactment of revegetation programs. Where seed from species typical of the zones vegetative assemblage could not be collected due to seasonal variation, lack of local abundance or loss of species due to habitat clearing, collaboration with Wollondilly Council Nursery occurred to ensure species indicative of the local provenance and vegetation assemblage were sourced.

2.8 Revegetation

The revegetation programs were determined from a preliminary zone assessment, identifying the existing vegetation composition, species abundance and diversity. An adaptive management response was applied to ensure a wholistic representation of the natural vegetation assemblage was achieved through supplementary plantings. Special consideration was assigned to the planting of feed species, habitat trees and defined indicator species of the existing vegetation assemblage.

Revegetation programs have been carried out across *Zone.1a*, *.2* and *.5*. Plantings were carried out with the objectives of the *VMP* as guidelines, where the existing ecological composition required an adjustment to the plan, alterations were conducted to ensure the rehabilitation zones are restored to mirror their natural species composition and structure.

The implemented revegetation programs from the month of April 2017 to July 2018, facilitated the installation of 4,800 forestry tubes across *Zone.1a*, *.2* and *.5*. (refer to *table.1*). Planting allocations were conducted with the aims to improve the zones ecological habitat, stabilize alluvial soils and to provide food and nesting materials. Revegetation was conducted in *Zone.1a* and *.2* in accordance with the objectives of the *VMP*, *Zone.5* was identified as an additional area of significant ecological importance, for the improvement of vegetation connectiveness across the project site and enrichment of the sites ecosystem, actioning the implementation of weed management strategies and revegetation.

2.9 Watering - Installation of water tank supplies and drip irrigation lines

The project site's geological form is predominately composed of alluvial deposits, forming a freely draining substrate of low organic nutrient composition. These soil characteristics can be difficult for establishing plant growth and success of revegetation programs under less than optimal environmental conditions such as poor rainfall.

Water tanks and drip line irrigation were installed across *Zone.1a*, *.2* and *.5* to supplement revegetation programs during periods of low rainfall and extreme temperatures to assist in the succession of installed forestry tubes.

2.10 Maintenance Programs

A maintenance program has been enacted across the entirety of the project site to ensure a reduction of the noxious weed seed bank and limit the dispersal of noxious weeds from neighbouring land use across the rehabilitated zones.

A successive weed management strategy has been implemented across all work zones, transitioning from primary, secondary to maintenance phases to ensure the gradual eradication and suppression of noxious weeds during the establishment of revegetation to support the success of the restoration of the native ecology.

3.0 SITE CONDITION MONITORING

3.1 Site Ecological Condition Assessments – Field Surveys

A vegetation assessment was conducted over a two (2) day period from the 11th of July, with the objective of assessing the existing ecological condition within the defined zones across the project site and to audit the current and previous ecological management strategies.

The vegetation assessment was carried out in *Zones.1a, .5, .6 and .7*, observing the existing floral species richness within a delineated plot and recording species abundance and diversity within a randomly designated 10x10m quadrat. An integrated remote sensing and GIS analysis approach was employed to define the assigned vegetation classification in regards to *Tozer et al 2003*, occurring within each zone and produce a list of indicative species associated with the existing vegetation assemblage for baseline referencing.

The GIS desktop analysis mapped two (2) separate vegetative assemblage types encountered during the vegetation assessment. 'Riparian Forest' confined to the western end of the project site bordered by the Nepean River represented in *Zone.1a and .5* and 'Alluvial Woodland' encompassing the Dry River Anabranche represented by *Zone.6 and .7*. Both vegetation types fall within 'River Flat Eucalypt Forest on Coastal Floodplains' listed under Schedule 2 of the *BC Act (2016)*.

Spatial data delineating the surveyed plots and quadrat boundaries was obtained through the implementation of GPS systems and records regarding species richness and abundance were recorded by hand on field documents see appendix 9.3 Site vegetation condition assessment sheets.

3.2 Restoration Zones – Condition Audits

Nepean River Zone.1a (*refer plot 2 and respective quadrat*)

This plot represented the success of an ongoing weed management strategy and the implementation of a revegetation program. Current native species richness across the plot (*refer plot 2 & Quadrat 2; Map 2 page 42*), was assessed as low (discounting revegetation species) with the over-storey canopy comprised of remnant *Eucalyptus sp.* accounting for the greatest amount of native species richness, mid and shrub-strata were predominately absent with ground strata predominately comprised of exotic grasses.

Previous impact from significant woody and scrambling noxious weeds have significantly reduced native species richness and abundance across the assessed plot. The implementation of primary and secondary weed management strategy have eradicated all mature woody and scrambling noxious weed infestation across the plot, supporting an increase in native regeneration. The implementation of periodic weed maintenance and watering program is recommended to support growth and establishment of revegetation species.

Nepean River Zone.5 (*refer plot 1 and respective quadrat*)

This plot represented the success of an ongoing weed management strategy and the implementation of a revegetation program. Native species richness in this plot was significantly greater than the other representative 'Riparian Forest' plot in *Zone.1a*. The over-storey canopy accounted for the greatest native species diversity supporting a range of *Eucalyptus sp.* An important nectar species, *Banksia integrifolia* was observed dispersed throughout the predominately open mid-strata. With the shrub and ground-strata sparse in vegetation composition, though supporting a moderate degree of species richness.

Previous impact from significant woody and scrambling noxious weeds on native species richness and abundance were evident across the assessed plot. Ongoing weed management strategies have significantly reduced the abundance of noxious weeds occurring across plot and limited competitive stresses placed on regenerating native species. The implementation of periodic weed maintenance and watering program is recommended to support growth and establishment of revegetation species.

Dry River Anabranth Zone.6 (refer plot 3 and respective quadrat)

This plot was representative the successive implementation of weed management strategies leading to a maintenance phase. Native species richness and abundance throughout the delineated plot was assessed as moderate. A high degree of natural regeneration was observed, supported by a previous revegetation program (approx. 2 years growth).

A high proliferation of annual and perennial shrub and ground weeds was observed across the inner channel of the Anabranth, this was attributed to the deposition of highly fertile flood sediments trapped within the embankments. Continued periodic weed maintenance is recommended to reduce weed seed bank.

Dry River Anabranth Zone.7 (refer plot 4 & 5 and respective quadrats)

Plot 4 (Map 2 page 42) supported a moderate degree of species richness, with significant infestation of noxious weed impacting the mid, shrub and ground strata. Weed management strategies in this plot are not evident, with present native vegetation significantly stressed by competition with noxious weeds. A notable observation during the vegetative assessment was the presence of a marked and bordered *Pomaderris brunei* and *Commersonia fraseri* patch. Immediate resource allocation is recommended to eradicate noxious weeds impacting the endangered *Pomaderris brunei*.

The overall native vegetative composition was assessed as low with noxious weed accounting for over 50% of vegetative biomass. The implementation of primary weed management strategies is recommended to begin the rehabilitation of native vegetation occurring thorough this zone.

Plot 5 (Map 2 page 42) is representative of a significantly degraded native vegetation, supporting a dense proliferation of woody and scrambling noxious weeds. Existing native species occur at low abundance in the over-storey with only sporadic native individuals observed across the mid to ground strata. Implementation of primary weed management strategies is recommended to alleviate competitive stresses to native over-storey species and facilitate the enactment of native bushland restorative processes.

4.0 IMPACTS AND IMPLICATIONS DELIVERY OF RESTORATION PROGRAM

4.1 Issues, Pressures and Failures in Implementation

4.1.1 Flooding

Weather conditions prevalent across much of the 2017-2018 works period caused the greatest impact to the delivery of planned work activity. For example a large scale localised rainfall event which occurred in early 2017 created inundation to the entire Anabranth corridor of Zone 6. This rainfall was a positive influence of local ecological condition and no doubt provided a useful water source for local fauna species until mid- 2018 when infiltration and evaporation finally dispersed the water body. The retained water impacted our ability to work in this zone for the majority of the program period, although vast areas were suppressed from weeds due to inundation so we utilised our allocated work resources in different work zones. Flood waters from this same weather event also created a lot of damage to existing vegetation with zones 1a) and zone 5 along the Nepean River Corridor. Extensive bank scouring, the loss of trees and shrubs along the river banks and a substantial build-up of flood debris along sections this corridor were key impacts derived from this event. In response our restoration program was modified to undertake cleaning up of these zones and prepare for revegetation activities to help rehabilitate the river banks; the revegetation program along the flood damaged area was completed recently in July 2018 see *images 12 & 13*.

4.1.2 Drought

Outside of the flooding event of early 2017 the remainder of the program season was significantly hampered by limited rainfall and general drought conditions. Recurrent dry conditions limited our ability to undertake planned revegetation tasks due to limited confidence in follow rainfall which is generally relied upon to help establishing plants. Revegetation programs are an expensive component of restoration works, which require reasonable planning and good environmental conditions to ensure success. During dry periods our works plan was modified to focus on maintaining bushland through secondary and maintenance weed control whilst also preparing areas for revegetation programs for when weather became suitable.

Revegetation objectives that were held off for the majority of the 2017-2018 program were subsequently delivered recently in July 2018. We are currently hoping for winter rainfall patterns to help with the establishment of these areas.

To prepare for future droughts and dry conditions we spent some resources from the 2017-18 program to install poly water tanks and establish irrigation lines throughout key revegetation zones, zones 2a), 2b), 1a) & 5. The client (MCS) have supplied the water tanks and will supply water to the systems to aid in ongoing maintenance and watering activities.

4.1.3 Animal Predation – Plant Damage

The final reportable pressure impacting the success of our restoration program is sustained grazing pressure on our revegetation material from both native and pest animal species.

Newly installed plants and saplings are being heavily targeted by grazing animals. Tree stakes and guards have been installed around all of the planted tube stock, however grazing is still obvious damaging the top shoots and accessible branchlets.

There is evidence of predation from native animals wallabies and wombats and particular zones such as zones 2a), 2b) & 4 where rabbit activity is heightened. Bowantz has established a feral animal monitoring program in order to help with planning a future feral animal control program which aims to target reducing the current rabbit populations, control foxes and monitor for the presence of other introduced species such as deer.

The 2018-2019 restoration works program will see the implementation of this control program.

5.0 CONCLUSIONS AND RECOMMENDATIONS

This report provides an accurate account and evaluation of the delivery of key restoration work activities prescribed for the 2017-2018 reporting period. Bowantz Bushfire & Environmental were commissioned by (MCS) to undertake the site environmental restoration works program and produce a robust monitoring and evaluation report accounting for the progress of the program.

The report also includes a review of the current status and environmental condition of restoration project zones as of July 2018 whilst including planning objectives for the coming work seasons.

The site restoration works program has been guided by the objectives and outputs documented within the Landscape Management Plan (LMP) produced for the subject site by Harvest Scientific Services in 2016.

The restoration activity outputs delivered by (BBE) on behalf of (MCS) are described within sections 2 of the report and in table formatting in tables 1 & 2 of the appendices. These outputs have successfully contributed to the overall restoration goals for the site which collectively aim to mitigate environmental deterioration and improve ecological and environmental conditions within and across the subject site.

For licensing and reporting processes the report should also be consulted to respond to conditions 22 and 24 of the controlled activity approval provided by the NSW Office of Water under approval number 10ERM2013/0830.

The report has provided validated information to respond to the following items:

- i) A schedule and map showing the vegetation species, number and location of initial and replacement plantings and propagation materials.
- ii) The date of planting the vegetation
- iii) The percentage cover of groundcover, shrubs, tree and weeds
- iv) Notification of problems that impacted on the survival rates of plants including climatic, fire flood, vandalism etc
- v) A map of the location of any staged activities
- vi) Photographs showing the revegetation works during the reporting period.

The report should also be recognised for including a plan for implementation of restoration program works over the coming 2018-2019 season. The work actions presented in section 6, are effectively recommendations which when employed will continue to support the environmental restoration objectives for the site in line with the LMP and other operational and licensing responsibilities.

6.0 PLANNED – PROGRAMMED WORKS 2018-2019

6.1 Vertebrate Pest Control

The significant grazing of both native and pest vertebrate species has been causing damage to restoration plantings and contributing to reasonable losses of plants.

The development of a strategic and targeted pest control program for the site will aim to reduce grazing pressures on the restoration zones in order to allow for vegetation complexes to successfully develop to maturity.

Vertebrate pest control activities using a multi-faceted approach including baiting and shooting will be used to ensure the most effective methods are applied seasonally to reduce rabbit populations. Qualified and experienced Vertebrate Pest Controllers will design and implement the most effective control methods practical for a positive result for all stakeholders.

The rabbit control program will be undertaken across all proposed revegetation zones and surrounding bushland areas prior to, during and after the implementation of large scale revegetation works.

The planning and design phase for the vertebrate pest control program is currently active. Implementation of on-ground works are scheduled for September 2018 and will continue seasonally through to July 2019.

6.2 Weed Control

An annual weed control program will be enacted across the priority restoration areas to compliment progress made across many of the restoration zones and also to establish opportunities for restoration in new identified zones. Weed control actions will be segregated into descriptive activity groups which represent the condition and needs for each site. Many of the restoration areas across the project site are representative of different phases of the ecological restoration spectrum, the management of weeds generally reflects the condition of each site and maturity towards a naturalised condition.

Primary weed control is required to target the eradication of highly developed weed populations and thus is generally required on heavily degraded environments. Primary weed control activities will concentrate on the removal of mass volume of weed stands and / or the control of highly invasive weeds with proliferate within an area quickly.

Secondary weed control is employed as a secondary control measure, once the majority of infestation has been removed and when mobilised weed propagules germinate from an established weed seed bank. Secondary weed control actions are employed to counteract a re-emergence of weeds within a previously worked area.

Maintenance weed control generally refers to the management of weeds and problematic plants within an operational work area or within an area that is being rehabilitated, where positive progress has been made to recreate a natural landscape. Maintenance weed control is less invasive through application technique and generally requires less resources to implement.

Primary Weed Control

The project zones that have been identified for targeting of primary weed control works for the coming works program are:

Zone 4 – Described as Riparian Linkage zone by the Landscape Management Plan.

The restored landform levels for this previously extracted site have been instated and the site can now be prepared for a revegetation program. During the 2017 – 2018 restoration works program the disturbed areas within Zone 4 were managed by implementing hi-volume herbicide spray applications to control emerging weeds within the fallow areas.

Revegetation preparation were delay due to ongoing drought conditions. An improvement in rainfall conditions in the 2018-2019 program will allow for this area to be revegetated. To prepare for this primary weed control will be the focus of our early season works program.

Zone 7 – Described as Dry River Anabranh in the site LMP and in this report as Anabranh South.

This area has not been the focus of our previous restoration works plans as other areas which have now been restored had higher priority status. This area whilst still retaining a level of native plant canopy and shrub mid-storey is observed as being highly impacted by weeds. The 2018-2019 works program will see this area become the focus of the majority of our primary weed control efforts. This heavily weed infested vegetation corridor currently impacted by *Ligustrum* species, *Cestrum parqui*, *Cardiospermum grandiflorum* and *Anredra cordifolia* will play a key role for the linkage of the riparian zones for many native native species both flora and fauna.

A holistic approach to weed control involving heavy primary weed eradication work to encourage natural regeneration in this area will be implemented over the next 12 months.

Secondary Weed Control

Secondary weed control will be scheduled across three (3) of the project zones over the coming works program.

Once primary weed control actions have been completed within Zones 4 (Riparian Linkage) and Zone 7 (Anabranh South) as described above, then a secondary weed control objective will be deployed across these areas over the later parts of the 2018-2019 season. Secondary weed control here will aim to reduce re-emergence of weeds given a productive weed seed bank is assumed to present.

Zone 6 (Anabranh Central) will form part of our secondary weed control target area, as we envisage that weeds will continue to emerge within this area, requiring follow up eradication to ward off re-infestation of particularly highly mobile invasive grasses such as African Love Grass & Chilean Needle Grass.

Maintenance Weed Control

Key restoration areas that have been the focus of much of our work over the past few seasons will generally require monitoring for re-establishment of weeds and the need for maintenance type activities to ensure the successful establishment of revegetation areas. In general context all areas that have been recently revegetated such as the following zones:

Zone 1a) Nepean River Corridor

Zone 1b) Nepean River Core Riparian Zone (which to be revegetated in August 2018)

Zone 5 Nepean River past Revegetation Area

Zones 2a) & 2b) Dry River Anabranch

Will require some level of monitoring and maintenance weed control actions over the coming works program. Maintenance weed control will require less resources and works hours to complete than the other weed control tasks.

6.3 Revegetation

Revegetation of degraded environmental areas is a key restoration objective for the project site. The aims of revegetating areas within the project site offer a range of rehabilitation benefits from restoring highly modified environments to reduce risk of broader environmental problems such as erosion and landscape degradation to improving habitat values, increasing species diversity and embellishing vegetation resilience within remnant or recreated bushland.

The aim of revegetation for the site as prescribed within the LMP is to restore the natural species composition and structures combining this with other principals should achieve a self-sustaining eco-system that will require minimum human intervention to maintain over time.

The proposed revegetation plans for the 2018-2019 works period will involve two methods.

1. Hydro mulching - Hydroseeding and hydromulching are efficient and impressive alternatives to traditional planting processes, such as hand seeding, drill seeding and sod applications. Both methods produce thicker, healthier vegetation that binds with the ground surface soil to effectively protect against erosion.

Hydromulching is similar to hydroseeding, but it adds a fibre-mulch to the mixture of seed, fertiliser and water. The mulch acts as a cover for the seed, helping it retain moisture for faster germination and growth, while protecting the soil from erosion and the seeds from washing away in the rain.

Hydroseeding and hydromulching are efficient and sustainable methods of rehabilitating and revegetating cleared lands on construction or mine sites, especially when compared to traditional forms of seeding.

2. Direct planting of native plants as tube stock. The collection of native plant seed is undertaken within the native bushland areas onsite by our project staff. This seed along with other native plant seed collected within the Wollondilly along the Nepean River corridor is provide to a local nursery to propagate juvenile plants and saplings which are then planted back into the relevant project areas.

Native plant tube stock is directly planted into the project areas, with the inclusion of terracotem' native plant fertiliser, bamboo stakes and a cardboard tree guard to protect from animal predation.

Hydro-mulching

Native plant seed has been collected and stored to supply the revegetation mixes displayed by the hydro mulcher - seeder. A mixture of native grasses, sedges, herbs and groundcovers will be revegetated through direct seeding (Hydro-mulching).

Zone 1b) Core Riparian Zone has an area of approximately 1 hectare prepared for hydro-mulching to be undertaken this August 2018.

Zone 4 Riparian Linkage has an area of approximately 2 hectares that will be prepared for hydro-mulching to also be undertaken this August 2018.

Tubestock Plantings

The preparation of sites and planting of native tubestock (forestry tubes) for revegetation purposes will form a major component of this coming works program. Tubestock plantings will be used to establish new vegetated areas such as Zone 1 b) and Zone 4 to compliment hydro mulching seeding areas and also as replacement plantings in Zones 5 (Nepean Past Revegetation Zone) & Zones 2a) , 2b).

Zone 1b) supply & install 2,000 forestry tubes to be planted in designed rows complimentary to direct seeding program. All tubestock will receive fertiliser, stakes and guarding.

Zone 5 supply and install 500 forestry tubes as secondary plantings to fill areas of previous revegetation failure.

Zone 2a), 2b) Supply and install 1,500 forestry tubes as secondary plantings to fill areas of previous revegetation failure.

Zone 4 supply & install 2,000 forestry tubes to be planted in designed rows complimentary to direct seeding program. All tubestock will receive fertiliser, stakes and guarding.

6.4 Seed Collection for revegetation

Bowantz staff will continue to collect seed from native species across the project area during the 2018-2019 rehabilitation works program. Native plants endemic to the local environment and that are important colonising species will be collected from when the relevant fruiting seasons are occurring. All seed collected is taken to Wollondilly Shire Community Nursery where it is stored in refrigerated cabinets and germinated for propagation when requested.

By providing local plants to this project we are aiming to maintain genetic integrity within remnant and recreated landscapes to ensure that the plants provided back to the site retain characteristics of remnant plants which survive successfully under localised environmental condition.

6.5 Fencing

Fencing will be required around the restoration zone 1 b) to restrict stock access and access to the revegetation area by native grazing animals such as macropods.

It is proposed that 1 fence approximately 50m in length on the North West boundary of revegetation zone 1b adjacent to the Camden Bypass Bridge will be replaced to exclude stock from the rehabilitation areas.

6.6 Installation of Habitat / Nesting Boxes

The installation of nesting boxes for fauna habitat was identified as a key ecological activity within the site LMP objectives. The inclusion of nesting boxes in prioritised bushland areas is designed to compensate for a potential loss of habitat availability within the restoration and revegetation areas.

The size and design of the nesting boxes will target use from arboreal native animals such as possums to provide surrogate roosting and breeding habitats where hollow bearing remnant trees are lacking.

Boxes that have previously been installed within our program have already proved to be effective with monitoring showing regular use by local populations.

The 2018-2019 works program has provided for the supply and installation of 12 nesting and habitat boxes. We propose placements in the following zones.

Zone 4 – 2 boxes

Zone 5 – 4 boxes

Zone 6 – 2 boxes

Zone 7 – 4 boxes

6.7 Maintenance Repair & Watering

Maintenance is an important works requirement to ensure that the implementation of restoration work activities is monitored and progressing effectively. Revegetation zones are particularly reliant of maintenance activities during the early establishment period, for example tree stakes and guards are readily disturbed by animals such as wallabies and wombats and will require replacement or rectification. Young plants require watering during dry spells, whilst floods

create much disturbance which can lead to deposition of wood and debris and large losses of revegetation all requiring high level of maintenance to repair.

The 2018 – 2019 works program has allowed for the provision of 500 hours from our works crew to respond to tasks relevant to maintenance. Repair and watering.

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NSW Water Management Act 2000; Guidelines for Riparian Corridors on Waterfront Land.

NSW Biodiversity Conservation Act 2016; Schedule 1 Threatened Species, Schedule 2 Threatened Ecological Communities & Schedule 4 Key Threatening Processes

9.0 APPENDICES

9.1 Tables

Table 1: Work Outputs and Milestones Completed 2017 – 2018 Program

Output - Task	Units	Ecological Validation	Delivery Period
Vertebrate Pest – Vermin Monitoring Program	Monthly – observations and population estimate recordings	Refer section 5.5.2 of the LMP (pg.10) Prevention of excessive grazing and browsing of revegetation plantings. Prevent land degradation caused by rabbits.	June 2017 – July 2018 A pest eradication program for rabbits has been developed and will be implemented.
Dust Monitoring Program	August to September Daily on a three-week program. April to May Daily on a two-week program	Bowantz Bushfire & Environmental was engaged to help with undertaking of the dust monitoring program, to ensure sediment particulates are not excessively mobilised to become airborne.	August to September 2017 April to May 2018
Fencing – Stock and animal exclusion	Eastern boundary of zone 2b) 195m Stock & animal exclusion zone with access gate 1b) 60m Stock & animal exclusion zone 1b) 140m Southern boundary mine operation area – restricted access area 350m	Refer section 5.5.1 of the LMP (pg.9) Fencing was supplied and installed to ensure effective management of rehabilitated and revegetated areas through animal and stock exclusion	April 2017 May 2017 June 2017 August 2017
Installation of nesting / habitat boxes	Supply & installation of habitat nesting boxes zone 1b) Six (6) boxes Supply & installation of habitat nesting boxes zone 2a) Four (4) boxes	Refer section 5.10.1 of the LMP (pg.18) To support objectives of improving habitat value nesting / habitat boxes were installed in strategic bushland locations to provide surrogate habitat for local animal populations. Natural habitat provision through collection and retention of logs and ground	March 2017 August 2017 February 2018

	Inspections of boxes, cleanout maintenance	debris was also provide through our work methods.	
Weed Control -Primary Eradication	Core Riparian Zone (CRZ) Zone 1b) Zone 1b) Zone 1b) Zone 1b) Nepean Revegetation Area	Refer section 5.10 of the LMP (pg.18) Weed control for the purpose of regenerating bushland areas and recreation of bushland areas. Extensive primary weed control outcomes have been delivered over the past works program. Completed 1.4 hectares of primary weed control areas. Zones 1a) & Zone 5	July 2017 August 2017 September 2017 October 2017 November 2017 May 2018
Weed Control – Secondary	Zone 2a) Zones 2a) & 2b) Zone 2a) Zone 1b) Dry River Anabran Dry River Anabran Nepean River Revegetation Area Nepean River Revegetation Area Dry River Anabran	Refer section 5.10 of the LMP (pg.18) Weed control for the purpose of regenerating bushland areas and recreation of bushland areas. Extensive secondary weed control outcomes have been delivered over the past works program. Completed 1.5 hectares of secondary weeding Zone 6	July 2017 August 2017 September 2017 October 2017 January 2018 February 2018 March 2018 April 2018 June 2018
Weed Control – Maintenance	Zones 2a) & 2b) Zone 4	Refer section 5.10 of the LMP (pg.18) Weed control for the purpose of regenerating bushland areas and recreation of bushland areas. Extensive maintenance weed control outcomes have been delivered over the past works program. Completed 1.8 hectares of weed control maintenance Zones 2a), b). 1.6 hectares of weed control maintenance Zone 4.	July 2017 August 2017 September 2017 October 2017 January 2018 February 2018 March 2018 April 2018 June 2018
Seed Collection from established native plants	Seed collection along the Nepean	Refer section 5.7.1 & 5.7.2 of the LMP (pg.14)	July 2017

	river Zone 4 Riparian linkage Seed Collection Riparian zones	All plants produced and supplied to the project will be from local provenance seed. Propagation of 3,800 forestry tubes of variant species grown and replanted to the site from locally collected seed sources.	April 2018
Revegetation	Planting Zone 2a) 800 forestry tubes Planting Zone 1b) 500 forestry tubes Planting Zone 1a) 1,500 forestry tubes Nepean River – Previous revegetation zones 1,500 forestry tubes Zone 2a) 250 forestry tubes Zone 2b) 250 forestry tubes	Refer section 5.7.3 & of the LMP (pg.14) The revegetation program will consist of appropriate mixes of canopy, mid-storey and ground cover plant species from the suggested species list. The supply and installation of 3,800 forestry tubes with fertiliser, stakes and guards was completed during the past works program	April – May 2017 April 2018 July 2018 July 2018
Installation of water tank supplies and drip irrigation lines to support revegetation areas	Install water tanks and drip irrigation lines to support establishment of revegetation areas. Zones: 1a) 1b) 2a) 2b)	Refer section 5.9 & 5.9.2 of the LMP (pg.17) To support the practical completion of this revegetation program poly water tanks and irrigation lines were supplied and installed to support ongoing maintenance watering of the plants in Zones 1a), 2a) & 2b)	November & December 2017

Table 2: Restoration Zones Progress Reporting

Report Objective/ Section/ Statement	Progress (completed, not completed, in progress)	Comments (Alternatives, Additional Information required)
Zone 1: Nepean River Riparian Corridor		
Zone 1a (restore existing vegetation)	Completed	
<ul style="list-style-type: none"> • Stock & animal exclusion zone with access gate 1a) 60m • Stock & animal exclusion zone 1a) 140m • Primary Weed Control • Supply & installation of habitat nesting boxes zone 1a) Four (4) boxes • Secondary Weed Control • Site Preparation for Revegetation • Post extraction areas will commence upon completion of final landform levels. • Restore natural species composition and structures • Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 2m², Canopy 1 plant per 5 to 10m² 	<p>Stock and animal exclusion fencing was established with an access gate along the southern aspect of the restoration corridor May 2017.</p> <p>Additional fencing along the boundaries of zone 1a) southern extent (powerline easement) was erected June 2018.</p> <p>Primary weed control which aimed to eradicate key problem weeds (notably <i>Dolichandra unguis-cati</i>, <i>Eragrostis curvula</i> and <i>Ligustrum lucidum</i>) was undertaken between April 2016 & April 2017.</p> <p>Secondary weed control undertaken April 2017 – January 2018</p> <p>Supply install habitat nest boxes (4) March 2017</p> <p>Site preparation weed control and clearing of fallen vegetation undertaken May – June 2018 Species planted are provided in revegetation table.</p> <p>Revegetation planting programs were undertaken in both April – May 2017 & July 2018 within this zones.</p> <p>Collectively 2,300 forestry tubes and hiko cells have</p>	<p>Site management Issues</p> <p>Weed eradication tasks led to the eradication of well-established privet forests which were impacting vegetation diversity and native vegetation proliferation within this zone.</p> <p>A long established population of cat's claw creeper vine which had caused death to several native canopy trees was also eradicated.</p> <p>A reasonable flood event in mid-2017 caused extensive erosion to unconsolidated silts and sediment banks along the Nepean River.</p> <p>Long periods of drought and extensive dry conditions lead to delay of the proposed revegetation works for this zone.</p> <p>The revegetation program was recently initiated & completed in July 2018</p> <p>Plant predation on newly planted tubestock by wallabies, rabbits and wombats is impacting revegetation success and may need further monitoring / intervention.</p> <p>Works prioritised for July 2018-July 2019 works program.</p> <ul style="list-style-type: none"> • Watering & Maintenance • Vertebrate Pest Control • Maintenance Weeding

	<p>been planted with stakes and guards within this zone.</p> <p>Water tanks and irrigation lines have also been installed to support the watering of this revegetation zone.</p>	<ul style="list-style-type: none"> • Substitute Plantings due to revegetation failure • Installation of additional habitat / nesting boxes
Zone 1b (additional planting Lot 32) – To be implemented July – August 2018		
<ul style="list-style-type: none"> • Post extraction areas will commence restoration upon completion of final landform levels. • Restore natural species composition and structures • Revegetation to stabilise soil banks and batters • Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 2m², Canopy 1 plant per 5 to 10m² 	<p>The following work tasks will be completed August 2018</p> <p>Revegetation of the corner embankment of Zone 1 b) encompassing an area of approximately 1 hectare will be direct seeded using a hydro mulching process with locally sourced native plant seed material.</p> <p>Adding to the direct seeding revegetation of 2,000 plants as tube stock will be installed as dense pockets, plants in these areas will be no more than 2m apart.</p>	<p>The proposed revegetation area has been prepared with earthworks grading of the embankments and soil preparations as prescribed within the LMP, WM & ESCP planning documents.</p> <p>Cross ripping and soil cultivation will be undertaken shortly before the direct seeding by a hydro mulching system.</p> <p>The works plan for this revegetation program is included in this report as an appendices item.</p> <p>Installation of stock fencing to protect revegetation zone.</p>
Zone 5: Nepean River Past Revegetation Zone Completed		
<ul style="list-style-type: none"> • Primary Weed Control • Secondary Weed Control • Supply & installation of habitat nesting boxes zone 5) Two (2) boxes • Site Preparation for Revegetation • Post extraction areas will commence upon completion of final landform levels. • Restore natural species composition and structures • Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 	<p>Primary weed control which aimed to eradicate key problem weeds (notably <i>Cardiospermum grandiflorum</i>, <i>Eragrostis curvula</i> and <i>Ligustrum lucidum</i>) was undertaken between April 2017 & January 2018.</p> <p>Supply install habitat nest boxes (2) March 2017</p> <p>Secondary weed control undertaken January 2018 and May 2018</p>	<p>Site management Issues</p> <p>Weed eradication tasks led to the eradication of well-established privet forests which were impacting vegetation diversity and native vegetation proliferation within this zone.</p> <p>Dense thickets of privet were directly impacting the success of previously established canopy trees, both creating enormous competition for water and nutrients within the sub-soil and harbouring successful populations of Bell minor birds</p>

<p>2m², Canopy 1 plant per 5 to 10m²</p> <ul style="list-style-type: none"> • Watering & Maintenance 	<p>Site preparation weed control and clearing of fallen vegetation undertaken May – June 2018</p> <p>Revegetation planting programs were undertaken in both April – May 2017 & July 2018 within this zones. Species planted are provided in revegetation table.</p> <p>Collectively 1,000 forestry tubes and hiko cells have been planted with stakes and guards within this zone.</p> <p>Water tanks and irrigation lines have also been installed to support the watering of this revegetation zone.</p>	<p>which create biological imbalance within localised food chains which increase predation on eucalypt trees by insect populations. This pressure has been removed through weed eradication.</p> <p>A long established population of balloon vine which had caused death to several native canopy trees was also eradicated.</p> <p>A reasonable flood event in mid-2017 caused extensive erosion to unconsolidated silts and sediment banks along the Nepean River.</p> <p>Long periods of drought and extensive dry conditions lead to delay of the proposed revegetation works for this zone.</p> <p>The revegetation program was recently initiated & completed in July 2018</p> <p>Plant predation on newly planted tube stock by wallabies, rabbits and wombats is impacting revegetation success and may need further monitoring / intervention.</p> <p>Works prioritised for July 2018-July 2019 works program.</p> <ul style="list-style-type: none"> • Watering & Maintenance • Vertebrate Pest Control • Maintenance Weeding • Substitute Plantings due to revegetation failure • Installation of additional nesting / habitat boxes
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Zone 2: Dry River Anabran		
Zone 2a (regenerate existing vegetation) Completed		
<ul style="list-style-type: none"> • Application of bush regeneration techniques • Weed Management • A fence was installed along the Eastern edge of Zone 2a adjacent to the vineyard to exclude stock. • Supply & installation of habitat nesting boxes zone 2a) Four (4) boxes • Additional Revegetation as per native species list • Spread mulch • Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 2m², Canopy 1 plant per 5 to 10m² • Watering & Maintenance 	<p>Selective weed control, the structural management of vegetation (through under pruning of limbs, cutting / removal of dead material) and revegetation of native plants (tube stock) are activities which have contributed to bush regeneration within this zone. April 2017 – July 2018</p> <p>Primary weed control targeting the eradication <i>Olea europaea</i> ssp. <i>Africana</i>, <i>Eragrostis curvula</i> and <i>Acetosa sagittaria</i> was delivered January 2017.</p> <p>Secondary weed control was undertaken prior to implementation of revegetation work April 2017</p> <p>Fencing was erected along the eastern edge of the zone to exclude stock and animals from the restoration area. April 2017</p> <p>Supply install habitat nest boxes (4) March 2017</p> <p>Revegetation planting programs were undertaken in both April – May 2017 & July 2018 within this zones. Species planted are provided in revegetation table.</p> <p>Collectively 250 forestry tubes and hiko cells have been planted with stakes and guards within this zone.</p> <p>Water tanks and irrigation lines have also been installed</p>	<p>Site Management Issues</p> <p>The spread on invasive dry land exotic grass species became a prevalent issue for the management of this zone over the reporting period. Species such as <i>Eragrostis curvula</i> (Love Grass) and <i>Nassella neesiana</i> (Chilean needle grass) were targeted for our weed control activities with repetitive spraying of infested areas.</p> <p>The preparation of the site and installation of revegetation forestry tube stock was undertaken back in April 2017. The success of this planting program which included 250 plant units was hampered by prolonged drought periods after the planting and also heavy predation on the plants by local rabbits and wallabies. Significant plant losses led to less than 60% survival rates.</p> <p>Replacement plantings are programmed for the 2018 – 2019 works program, however this undertaking will be incorporated only when suitable rainfall is forecast or occurs to trigger the process.</p> <p>Works prioritised for July 2018-July 2019 works program.</p> <ul style="list-style-type: none"> • Watering & Maintenance • Vertebrate Pest Control • Maintenance Weeding • Substitute Plantings due to revegetation failure

	to support the watering of this revegetation zone.	
Zone 2b (additional planting)	Completed	
<ul style="list-style-type: none"> • Application of bush regeneration techniques • Weed Management • Table 1. Species list (5.7) • Post extraction areas will commence upon completion of final landform levels. • Restore natural species composition and structures • Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 2m², Canopy 1 plant per 5 to 10m² • Watering & Maintenance 	<p>Selective weed control, the structural management of vegetation (through under pruning of limbs, cutting / removal of dead material) and revegetation of native plants (tube stock) are activities which have contributed to bush regeneration within this zone. April 2017 – July 2018</p> <p>Primary weed control targeting the eradication <i>Olea europaea</i> ssp. <i>Africana</i>, <i>Eragrostis curvula</i> and <i>Acetosa sagittaria</i> was delivered January 2017.</p> <p>Secondary weed control was undertaken prior to implementation of revegetation work April 2017</p> <p>Revegetation planting programs were undertaken in both April – May 2017 & July 2018 within this zones. Species planted are provided in revegetation table.</p> <p>Collectively 250 forestry tubes and hiko cells have been planted with stakes and guards within this zone.</p> <p>Water tanks and irrigation lines have also been installed to support the watering of this revegetation zone.</p>	<p>Site Management Issues</p> <p>The spread on invasive dry land exotic grass species became a prevalent issue for the management of this zone over the reporting period. Species such as <i>Eragrostis curvula</i> (Love Grass) and <i>Nassella neesiana</i> (Chilean needle grass) were targeted for our weed control activities with repetitive spraying of infested areas.</p> <p>The preparation of the site and installation of revegetation forestry tube stock was undertaken back in April 2017. The success of this planting program which included 250 plant units was hampered by prolonged drought periods after the planting and also heavy predation on the plants by local rabbits and wallabies. Significant plant losses led to less than 60% survival rates.</p> <p>Replacement plantings are programmed for the 2018 – 2019 works program, however this undertaking will be incorporated only when suitable rainfall is forecast or occurs to trigger the process.</p> <p>Works prioritised for July 2018-July 2019 works program.</p> <ul style="list-style-type: none"> • Watering & Maintenance • Vertebrate Pest Control • Maintenance Weeding

		<ul style="list-style-type: none"> Substitute Plantings due to revegetation failure
Zone 3: Future Agricultural Area		
<ul style="list-style-type: none"> Construct Terminal sediment pond (fig 3./ p8) LMP report Revegetate with pasture grasses to Class 1 Agricultural land (section 5.7) LMP report 		
Zone 4: Riparian Linkage (non-agricultural production area) To be implemented August 2018 – July 2019		
<ul style="list-style-type: none"> Application of bush regeneration techniques Weed Management Secondary Revegetation program as per species list Spread mulch Groundcover <1.5m, 50% plant composition, 4 to 8 plants per m², Mid-canopy 4 plants per m² to 1 plant every 2m², Canopy 1 plant per 5 to 10m² 	<p>This project zone contains landscape areas with vastly differing natural vegetation conditions.</p> <p>Southern portions of the zone have been previously revegetated through past efforts and have established well as recreated natural vegetation habitats. These areas will be prioritised for ongoing bush regeneration style weed control efforts.</p> <p>Central and northern landscape areas within this zone will require ongoing maintenance weed control to manage emerging annual and perennial weeds which proliferate within the open stretches of reconfigured recreated areas.</p> <p>This weed control will be undertaken using hi-volume herbicide applications of selective herbicides. Once areas have been controlled revegetation programs will be engaged.</p> <p>Direct seeding of native endemic plants through hydro mulching processes may be implemented late within the next work period 2018- 2019.</p> <p>After hydro mulching as a preferred revegetation method site maintenance will be prioritised to engage in</p>	<p>Works prioritised for July 2018- July 2019 works program.</p> <ul style="list-style-type: none"> Hi- volume – broad area herbicide spraying weed control across fallow surfaces. Direct seeding of native plants via hydro mulching methods Watering & Maintenance Vertebrate Pest Control Maintenance Weeding Monitoring and reporting

	selective weed control, watering, and vertebrate pest control programs.	
Zone 6: Anabanch Central To be implemented August 2018 – July 2019		
<ul style="list-style-type: none"> • Secondary Weed Control • Selective Revegetation 	<p>The northern area of this works zone has received both primary and secondary weed control work from our project team – April 2017 – July 2018.</p> <p>The prevalence of weed species within the northern component of this zone is low, well below 20% cover with 80% native plant dominance.</p> <p>A flood event which occurred in mid-2017 was intense enough to render inundation to the remnant anabanch gullies with most of the gully depression inundated for many months. The permanency of the water supply provided great ecological benefit for local fauna species whilst also restricting weed growth in the lower elevations.</p> <p>Once the water subsided sometime between January and June 2018 a flourish of weed propagation occurred from existing seed banks of annual and perennial weed species. Our works team prioritised maintenance weed control here to remove weeds before maturity so that weed propagules were intercepted. March – April 2018</p>	<p>Works prioritised for July 2018- July 2019 works program.</p> <ul style="list-style-type: none"> • Vertebrate Pest Control • Maintenance Weeding • Infill revegetation planting • Installation of habitat nest boxes

Zone 7: Anabranh South To be implemented August 2018 – July 2019

- Application of bush regeneration techniques
- Extensive Weed Management (Primary Weed Control)
- Secondary Weed Control

Primary weed control will commence in the Dry River Anabranh extending to the south as mapped Zone 7 (Anabranh South).

No weed control has been undertaken in this area by Bowantz over the past 10 years. This heavily weed infested vegetation corridor currently impacted by Ligustrum species, Cestrum parqui, Cardiospermum grandiflorum and Anredra cordifolia will play a key role for the linkage of the riparian zones for many native native species both flora and fauna.

A holistic approach to weed control involving heavy primary weed eradication work to encourage natural regeneration in this area will be implemented over the next 12 months.

Primary weed control program to begin in September 2018 will utilize approximately 250 hours.

As Weed material is removed sequentially over the coming works program Habitat and nesting boxes will be installed to both replace lost habitats through weed removal and encourage habitation of the restoration area by new inhabitants drawn to the area through condition improvement.

Table 3: Revegetation Completed Species List 2017-2018

Botanical Name	Common Name	Revegetation Material	Program Date
Angophora subvelutina	Broad leafed apple	Forestry tubestock	July 2018
Angophora floribunda	Rough bark apple	Forestry tubestock	July 2018
Casuarina cunninghamiana	River She-oak	Forestry tubestock	April 2017
Casuarina glauca	Swamp She-oak	Forestry tubestock	July 2018
Eucalyptus amplifolia	Cabbage gum	Forestry tubestock	April – May 2017
Eucalyptus elata	River peppermint	Branch mulching – Direct seeding	July 2018
Eucalyptus tereticornis	Forest Red gum	Forestry tubestock	May 2017
Eucalyptus viminalis	Ribbon gum	Forestry tubestock	July 2018
Eucalyptus paramattensis	Drooping Red Gum	Forestry tubestock	July 2018
Eucalyptus piperita	Sydney Peppermint	Forestry tubestock	July 2018
Eucalyptus globoidea	White stringybark	Forestry tubestock	July 2018
Melia azedarach	White cedar	Forestry tubestock	April – May 2017
Acacia floribunda	Sally Wattle	Branch mulching – Direct seeding	April – May 2017
Acacia decurrens	Black wattle	Forestry tubestock	July 2018
Trema tomentosa	Native peach	Forestry tubestock	July 2018
Dodonea triquetra	Hop bush	Forestry tubestock	April – May 2017
Callistemon salignus	Willow bottlebrush	Forestry tubestock	July 2018
Callistemon linearifolius	Netted bottlebrush	Forestry tubestock	July 2018
Melicytus dentatus	Tree violet	Forestry tubestock	April – May 2017
Bursaria spinosa	Blackthorn	Forestry tubestock	May 2017
Kunzea ambigua	Tick bush	Forestry tubestock	May 2017
Leptospermum polygalifolium	Lemon scented Tea-tree	Forestry tubestock	May 2017
Olearia microphylla	Daisy bush	Forestry tubestock	July 2018
Dodonea viscosa	Sticky hop bush	Forestry tubestock	July 2018
Wahlenbergia gracillis	Blue bell	Forestry tubestock	July 2018
Lomandra longifolia	Matt Rush	Hiko tubestock	April – May 2017
Carex appressa	Tall sedge	Hiko tubestock	May 2017
Austrostipa ramosissima	Stout bamboo grass	Direct seeding	April – May 2017
Aristida ramosa	Purple Wire grass	Hiko tubestock	July 2018 July 2018
Commelina cyanea	Scurry weed	Hiko tubestock	May 2017
Glycine clandestina	Twining glycine	Hiko tubestock	April – May 2017
Dichelachne micrantha	Short hair plume grass	Hiko tubestock	July 2018
Microlaena stipoides	Weeping rice grass	Hiko tubestock	July 2018
Chenopodium nutans	Climbing salt bush	Hiko tubestock	July 2018
Juncus usitatus	Common rush	Hiko tubestock	July 2018
Tube stock and hiko cell Revegetation Numbers – Totals to July 2018 = 4,800 units			

9.2 Site Photos

Fencing



Image 1 Zone 2b) Implemented July 2017



Image 2 Zone 2b) Implemented July 2017

Seed Collection



Image 3 April 2017 – Collecting seed for propagation of revegetation material



Image 4 April 2017 – Collecting seed for propagation of revegetation material

Weed Control – Primary



Image 5 Zone 1b) Primary weed control privet eradication September 2017



Image 6 Zone 1b) Primary weed control privet eradication October 2017

Weed Control – Secondary



Image 7 Zone 2a) Core Riparian Zone, secondary eradication of annual weeds, November 2017



Image 8 Zone 2a) Core Riparian Zone, secondary eradication of annual weeds, February 2018



Image 9 Secondary weeding anabranh zone 2a), August 2017

Revegetation



Image 10 Dry River Anabranche Zone 2a) Revegetation July 2017



Image 11 Nepean River Zone 1a) Revegetation April & July 2018



Image 12 Dry River Anabranh Zone 2a) Revegetation August 2017



Image 13 Revegetation and erosion control using privet logs salvaged from woody weed control, Core Riparian Zone Nepean River, July 2018

Nest - Habitat Boxes



Image 14 Installation of nest boxes 1a) – Core Riparian Zone September 2017



Image 15 Installation of nest boxes Past Revegetation Area – Core Riparian Zone November 2017



Image 16 Installation of nest boxes Past Revegetation Area – Core Riparian Zone November 2017



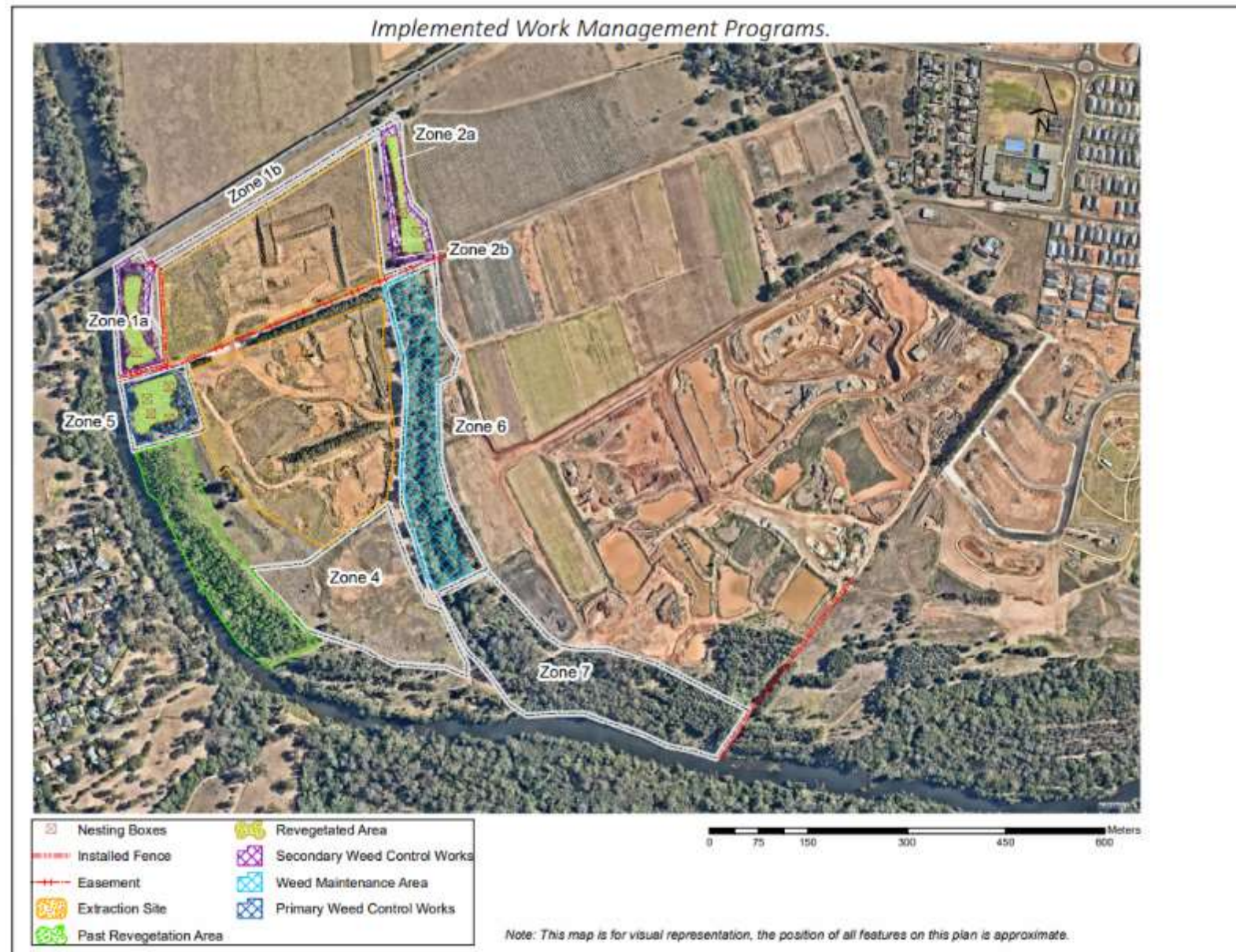
Image 17 Preparing areas for revegetation post weed control – Past Revegetation Zone, CRV Nepean River. March 2018

Revegetation infrastructure for irrigation of establishing plants

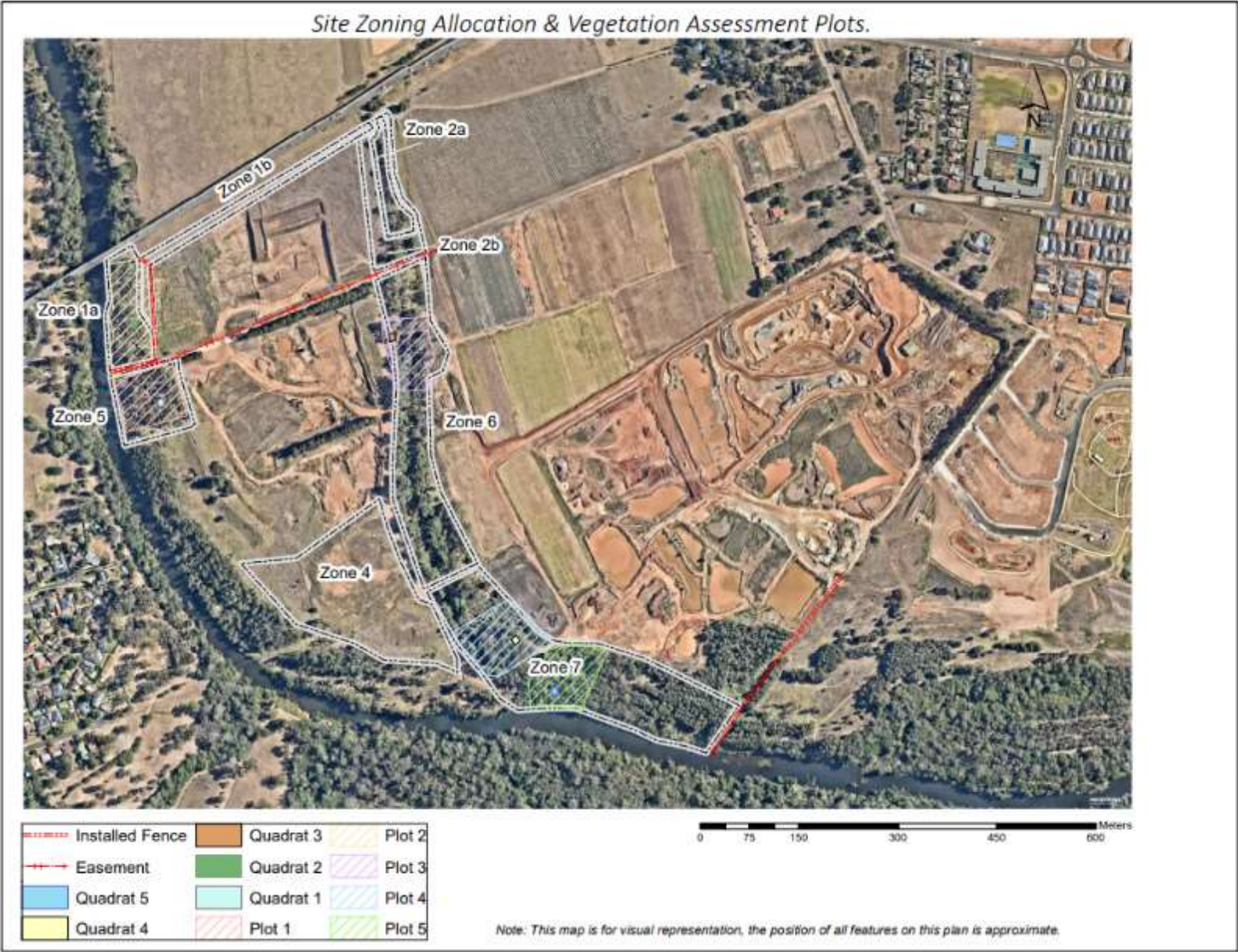


Image 18 Installation of water tanks and irrigation lines for watering of establishing plants Past Revegetation Zone, CRV Nepean River, January 2018

Map 1:



Map 2:



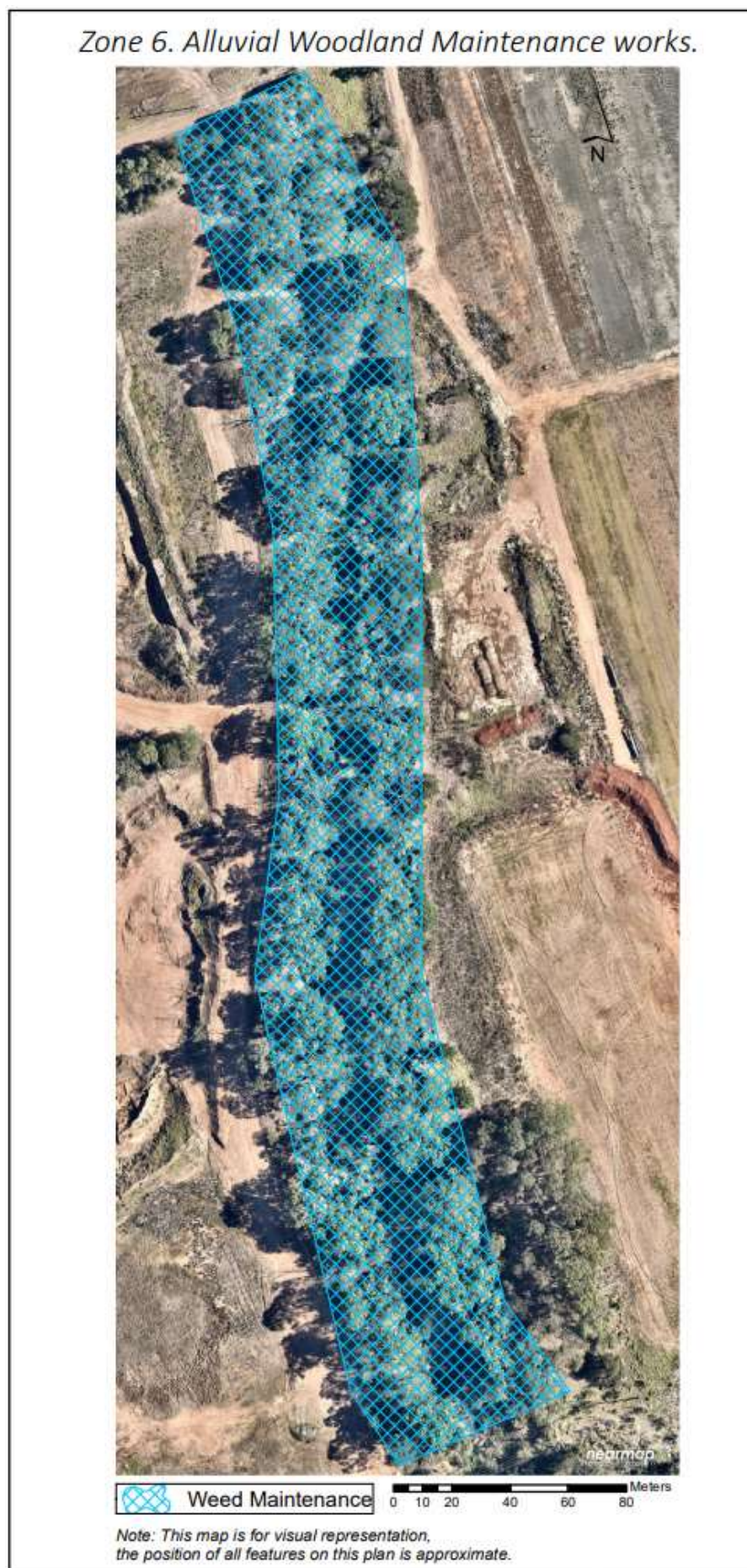
Map 3:



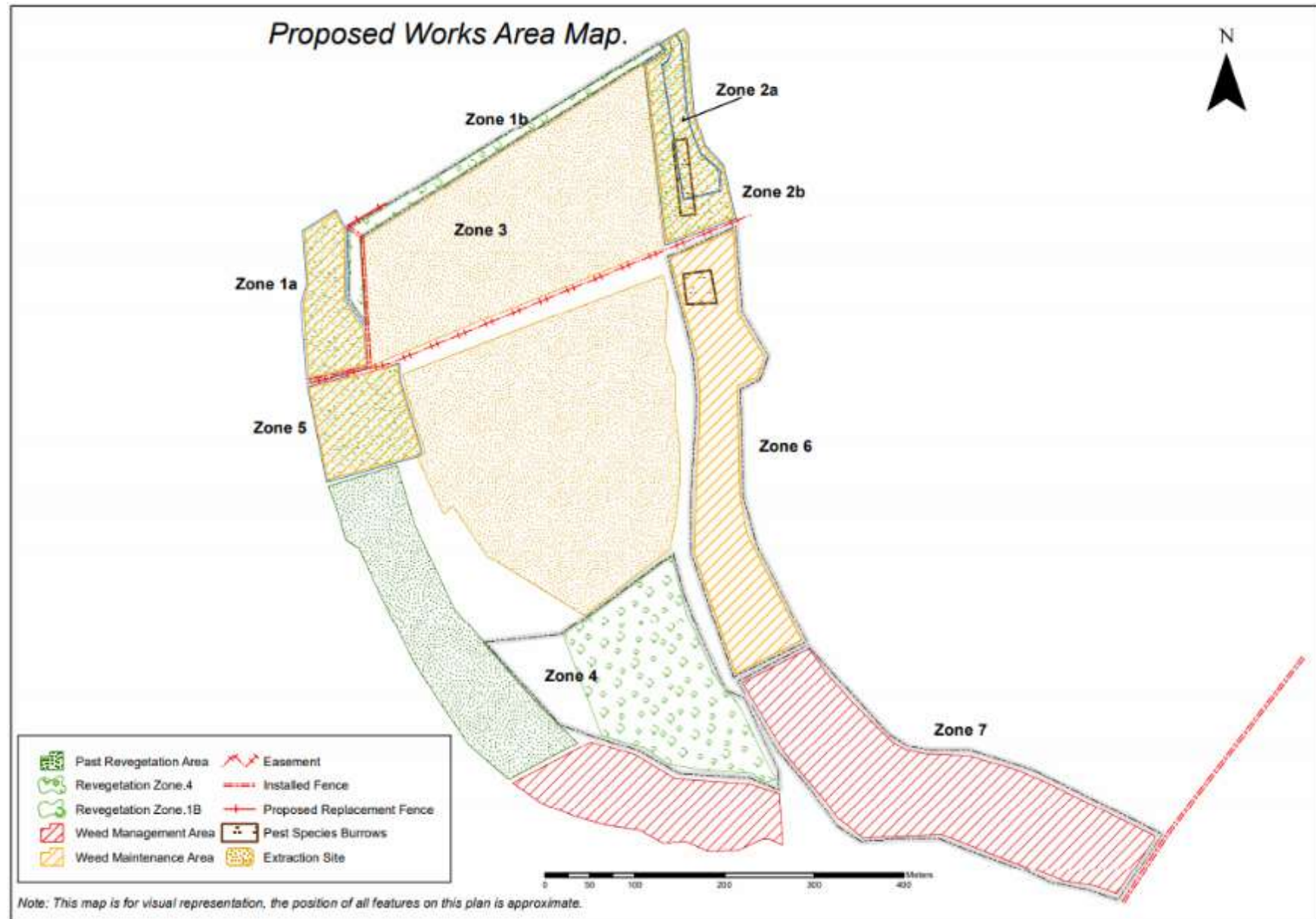
Map 4:



Map 5:



Map 6: Planned Site Works 2018-2019 Program



9.3 Site Vegetation Condition Assessment Surveys



Plot 1 – Zone 5 after weed control but prior to revegetation planting

DECCW VEGETATION FIELD SURVEY FORM

Module 1 (Minimum requirements)

Location - Prepared Re-veg Area. data point 022.
Collins - Nepean River

Date	11-7-13	Plot ID.	022	Plot no.	1.	Recorders	Daniel Anderson Jordan Pont.
AMG grid reference	zone 54 55 56	datum GDA	Easting		Northing		Position in quadrat
Base plot size	20x20	Orientation of 0.1ha plot		marked	yes (no)	photo # / orientation	5th West

Structure & composition (within 0.04 ha quadrat)

Keith class		Confidence: high mod low N.A
Regional veg class (BVT)	River flat Euc. Forest. coastal floodplain	Confidence: high (mod) low N.A
Biometric type (or NVCA)		Confidence: high mod low N.A
Other:		Confidence: high mod low N.A

NVIS level V (within 0.04 ha quadrat)

Stratum	Growth form	Species name	Cover	Abund.	For the entire	Field
Upper	Tree	Eucalyptus amplifolia	5%	re-current	Upper stratum	
Upper	Tree	Angophora costata subsp. costata	10%	50%	Height to crown (m)	
Upper	Tree	Corymbia gummiifera	20%	re-current	min mode max	25m
Mid	Shrub	Hymenathera - melichrytus dentata	10%	re-current	Mid stratum	
Mid					Height to crown (m)	
Mid					min mode max	2m
Ground	Grass	Microlaena stipoides	50%	40m	Ground stratum	
Ground	Herb	Dichondra Repens	30%		Height to crown (m)	
Ground	Herb	Opismenus amoenus	20%		min mode max	2cm 10cm

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern
Cover: 0-1,1,2,3,4,5,10,15,20,25,30,35, etc. Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000,>1000

DECCW VEGETATION FIELD SURVEY FORM

Site no. 1

Condition

(within 0.04 ha)	Upper stratum	Mid stratum	Ground stratum Grasses	Ground stratum Shrubs	Ground stratum Other	Cover %		(within 0.1 ha quadrat)	
Native richness	4-5 species	absent	Low	absent	minimal	Litter	50	No. trees with hollows	Nil
Native cover	100%	absent	60%	absent	50%	Bare ground	10	Woody debris linear metres	Heavy
Exotic cover	Nil	Nil	40%	Nil	50%	Cryptogam	5	Woody regeneration No. upper stratum sp. & abundance.	low

(within 0.1 ha quadrat)

Woody stem-sizes (DBH) (tally within category)	≥ 5- <10	≥ 10- <20	≥ 20- <30	20 → 30 cm	≥ 30 cm DBH measure all
(or, measure all ≥ 5cm DBH)					
Tree health	no evidence	branchlets dead yes	small branches dead yes	main branches dead yes	trees dead 30%

Landuse and landcover

Age structure	early regeneration	advanced regeneration	uneven age	mature	senescent	- Wood weeds recently removed
Landuse (dominant)	nature conservation	travelling stock route	forestry	grazing	cropping	other: - revegetation restoration
Landcover (upper stratum)	none	native	environmental planting	native plantation	exotic other:	
Landcover (ground stratum)	none	native	environmental planting	native plantation	exotic other:	

Site history

	Freq. code	Age code	Land manager survey: categories, quantities, comments			
Grazing management			not grazed	set stocked	rotational / cell grazing	
Farming			none	direct drill	disc plough tined implement	mouldboard rotary hoe
Erosion control			none	contour cultivation	mulching banks	other
Pasture improvement rates (fertiliser) kg/ha			none	<125	125-250	>250
Pasture improvement rates (lime/dolomite) t/ha			none	<2	2-4	4-7 >7
Timber extraction (incl. firewood)			- Revegetation area			

Site history, continued

	Freq. code	Age code	Land manager survey: categories, quantities, comments
Regrowth management			
Weed control		2yrs	- quarterly woody weed control efforts removal of descending vines
Pest animal control	3	R	
Burning			
Other			- bush regeneration & herbicide controls.

Frequency: 0=no record, 1=rare (>5yrs), 2=occasional (2-5yrs), 3=frequent (<2yrs) Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Plot disturbance

	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood collection			
Grazing			
Fire damage			
Storm damage			
Other	3	R	previously impacted by extensive weed infestation

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Focal taxa

(e.g. disturbance sensitive spp., ROTAPS, etc. within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
G	Shrub	Solanum pr inophyllum	Forest nightshade	Nil	L		
m	Shrub	Hymenstera dentata	Tree Violet - encourage natural regen	L	L		
m	T	Banksia	Banksia Integrifolia	L	L		

Physiography

Morphological Type - Riverine sediments	Landform Element - Riparian	Landform Pattern	Microrelief
Lithology - depositional	Soil surface Texture	Soil Colour - dark rich loam	Soil Depth - deep loam
Slope - negligent	Aspect - sth West	Site drainage - low	Distance to nearest water and type - 50m River

DECCW VEGETATION FIELD SURVEY FORM

Module 2 Full floristics

Site no.

Floristics

(within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
G	Grass	Microlaena	Microlaena stipoides				
G	H	Dichondra	Dichondra repens.				
G	Grass	Basket grass	Oplismenus aemulus.				
G	Weed	Rambling dock	Acetosa sagittata.				
G	Weed	Sida paddy's lucerne	Sida rhombifolia				
G	Weed	Purple Top	Verbena bonariensis				
G	Weed	blackberry nightshade	Solanum nigrum				
G	Weed	Scotch thistle	Onopordum acanthium.				
G	Weed	Japanese honeysuckle	Lonicera japonica				
G	Weed	Balloon vine	Cardiospermum grandiflorum.				
G	Weed	Solanum	Solanum syssiphyllum				
M	shrub	Tree Violet	Melichrytus dentata.				
C	T	smooth apple.	Angophora costata.				
C	T	Bloodwood	Corymbia gumifera				
C	T	Eucalypt swamp gum	Eucalyptus amplifolia				
C	T	Forest red gum	Eucalyptus tereticornis				
C	S	maclura	Maclura pomifera				
M	T	Banksia	Banksia integrifolia				
M	T	Pittosporum	Pittosporum undulatum.				
G	Weed	Cape Ivy	Delairea odorata.				
m	T	River she-oak	Casuarina cunninghamiana				
G	Grass	Lomandra	Lomandra longifolia				
G	Weed	Pitchforks	Bidens pilosa				
m	T	Water gum	Tristanopsis laurina				
G	Grass	African Love grass	Eriogonum curvula				
m	Shrub	Acacia fimbriata	fringed wattle.				
		floribunda	white sally - Ac. floribunda				
G	Weed	Wild turnip	Brassica tourefortii				
m	Shrub	Acacia deuyrens	Black wattle.				
T	Herb	Kurrajong	Brachychiton populneus				

Growth form: T=tree, M=males tree, S=shrub, Y=malice shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern, F=forb, L=vine, A=acacia, P=palm, X=xanthorrhoea, U=samphire shrub.

Cover: (<1% see explanatory notes) 1,2,3,4,5,10,15,20,25,30,35, etc. crown cover %

Abund: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 (>1000 see explanatory notes)



Plot 2 – Zone 1a) after weed control and currently revegetated with forestry tubes.

DECCW VEGETATION FIELD SURVEY FORM

Module 1 (Minimum requirements)

Location

Plot 027-029. Quadrat 030-033

Survey code		Plot no.		Recorders	
Date	11-7-18	Plot ID.	030	2	Jordan Post
AMG grid reference	zone 54 55 56	datum QDA	Easting 1029	Northing 102	Position in quadrat
Base plot size	10m x 10m	Orientation of 0.1ha plot	marked	yes <input checked="" type="checkbox"/> no <input type="checkbox"/>	photo # / orientation SW

Structure & composition (within 0.04 ha quadrat)

Keith class	Dry Sclerophyll forest (Syd Sandflats)	Confidence: high mod low N.A.
Regional veg class (BVT)		Confidence: high mod low N.A.
BioMetric type (or NVCA)		Confidence: high mod low N.A.
Other: <u>tozer</u>	Shale Plains Woodland. Riparian forest	Confidence: high mod low N.A.

NVIS level V (within 0.04 ha quadrat)

Stratum	Growth form	Species name	Cover	Abund.	For the entire	Field
Upper	T	E. viminalis ssp. viminalis	30%	1	Upper stratum	
Upper	T	Hebe elata			Height to crown (m)	
Upper					min mode max	
						35
Mid	S	Hymenoclea dentata	5%	2	Mid stratum	
Mid					Height to crown (m)	
Mid					min mode max	
						2m
Ground	G	Austrostipa racemosa	30%	220	Ground stratum	
Ground		Commelina cyanea	15%		Height to crown (m)	
Ground					min mode max	
						2m

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern
Cover: 0-1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, etc. Abundance: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000, >1000

DECCW VEGETATION FIELD SURVEY FORM

Site no.

Condition

(within 0.04 ha)	Upper stratum	Mid stratum	Ground stratum Grasses	Ground stratum Shrubs	Ground stratum Other	Cover %	Plot (within 0.1 ha quadrat) ↓	
Native richness	3-5 species	Absent	weed dominant	Native grass	Minimal	Litter	No. trees with hollows	Y
Native cover	70%	-	80%	60%	-	Bare ground	Woody debris linear metres	Heavy
Exotic cover	-	-	80% -90%	-	-	Cryptogam	Woody regeneration No. upper stratum sp. & abundance.	Le

(within 0.1 ha quadrat)

Woody stem-sizes (DBH) (tally within category) (or, measure all ≥5cm DBH)	≥5- <10	≥10- <20	≥20- <30	≥30 cm DBH measure all
Tree health	no evidence	branchlets dead	small branches dead	main branches dead trees dead

Landuse and landcover

Age structure	early regeneration	advanced regeneration	uneven age	mature	senescent	- woody weed removal
Landuse (dominant)	nature conservation	travelling stock route	forestry	grazing	cropping	- Regeneration
Landcover (upper stratum)	none	native	environmental planting	native plantation	exotic other:	
Landcover (ground stratum)	none	native	environmental planting	native plantation	exotic other:	weed treatment

Site history

	Freq. code	Age code	Land manager survey: categories, quantities, comments			
Grazing management			not grazed	set stocked	rotational / cell grazing	
Farming			none	direct drill	disc plough tined implement	mouldboard rotary hoe
Erosion control			none	contour cultivation	mulching banks	other
Pasture improvement rates (fertiliser) kg/ha			none	<125	126-250	>250
Pasture improvement rates (lime/dolomite) t/ha			none	<2	2-4	4-7 >7
Timber extraction (incl. firewood)			- Regeneration			

Site history, continued

	Freq. code	Age code	Land manager survey: categories, quantities, comments
Regrowth management	-	-	
Weed control	3	2yrs	woody weed, ascending vines & grandcreeper
Pest animal control	-	-	
Burning			
Other			Bush regeneration, herbicide control

Frequency: 0=no record, 1=rare (>5yrs), 2=occasional (2-5yrs), 3=frequent (<2yrs) Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Plot disturbance

	Severity code	Age code	Observational evidence:
Clearing (inc. logging)	3	R	Woody weed removal
Cultivation (inc. pasture)	-	-	
Soil erosion	3	R	Flooding, High erosion on banks
Firewood collection	-	-	
Grazing	-	-	
Fire damage	-	-	
Storm damage	2	R	High winds, snapped limbs
Other	3	R	Extensive weed infestation

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Focal taxa

(e.g. disturbance sensitive spp., ROTAPS, etc. within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
	*	lack of nectar/flower producing spp.					

* note no flowering species/nectar. species
Physiography

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil surface Texture	Soil Colour Dark rich Silt	Soil Depth
Slope	Aspect	Site drainage	Distance to nearest water and type

Holocene alluvium (100%)

Native Vegetation Interim Type Standard

Module 2 Full floristics

Floristics

(within 0.04 ha quadrat)

[illegible]

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern, F=forb, L=vine, A=cycad, P=palm, X=xanthorrhoea, U=samphire shrub.

Cover: (<1% see explanatory notes) 1,2,3,4,5,10,15,20,25,30,35, etc. crown cover %

Abund: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 (>1000 see explanatory notes)



Plot 3 – Zone 6

DECCW VEGETATION FIELD SURVEY FORM

Module 1 (Minimum requirements)

Location

		Survey code	Plot no.	Recorders
Date	12/7/18	Plot ID.	03	Jordan & Aaron
AMG grid reference	Zone 54 55 56	datum	Easting	Northing
Base plot size	10x10m	Orientation of 0.1ha plot	SW	marked
		yes	no	photo # / orientation
				SW

Structure & composition (within 0.04 ha quadrat)

Keith class	Dry Sclerophyll forest (Sgd Srd) flats	Confidence: high mod low N.A
Regional veg class (BVT)		Confidence: high mod low N.A
BioMetric type (or NVCA)		Confidence: high mod low N.A
Other: TOZER	Alluvial Woodland	Confidence: high mod low N.A

NVIS level V (within 0.04 ha quadrat)

Stratum	Growth form	Species name	Cover	Abund.	For the entire	Field
Upper	T	E. baueriana	15%		Upper stratum	
Upper	T	Casuarina cunninghamiana	5%	2	Height to crown (m)	
Upper	T	Unknown ribbon gum	40%	4	min mode max	
Mid		Amelia azedarach	-	1	Mid stratum	
Mid		Melaleuca maritima		2	Height to crown (m)	
Mid		Gallipetrum citreum (S. kill)		1	min mode max	
Ground		Hymenandra dentata			5m	
Ground		Einadiola Hostata	40%		Ground stratum	
Ground		Austrostipa racemosa		Sind	Height to crown (m)	
Ground		leaf litter + exotic grass			min mode max	
					>2m	

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern
Cover: 0-1,1,2,3,4,5,10,15,20,25,30,35, etc. Abundance: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000,>1000

* = uncertain

DECCW VEGETATION FIELD SURVEY FORM

Site no.

Condition

(within 0.04 ha)	Upper stratum	Mid stratum	Ground stratum Grasses	Ground stratum Shrubs	Ground stratum Other	Cover %	(within 0.1 ha quadrat)
Native richness	low High	low	1-2 sp low	low	-	Litter	No. trees with hollows y/low
Native cover	100%	100%	40%	40%	-	Bare ground	Woody debris lineal metres low
Exotic cover	-	-	30%	-	-	Cryptogam	Woody regeneration No. upper stratum sp. & abundance. moderate

(within 0.1 ha quadrat)

Woody stem-sizes (DBH) (tally within category)	≥ 5– <10	≥10– <20	≥20– <30	≥30 cm DBH measure all	
(or, measure all ≥5cm DBH)					
Tree health	no evidence	branchlets dead	small branches dead	main branches dead	trees dead

Landuse and landcover

Age structure	early regeneration	advanced regeneration	uneven age	mature	senescent	
Landuse (dominant)	nature conservation	travelling stock route	forestry	grazing	cropping	other: mining re-vegetation weed control
Landcover (upper stratum)	none	native	environmental planting	native plantation	exotic other:	
Landcover (ground stratum)	none	native	environmental planting	native plantation	exotic other: Annual & perennial sporeadic weeds	

Site history

	Freq. code	Age code	Land manager survey: categories, quantities, comments			
Grazing management			not grazed	set stocked	rotational / cell grazing	
Farming			none	direct drill	disc plough tined implement	mouldboard rotary hoe
Erosion control			none	contour cultivation	mulching banks	other
Pasture improvement rates (fertiliser) kg/ha			none	<125	125-250	>250
Pasture improvement rates (lime/dolomite) t/ha			none	<2	2-4	4-7 >7
Timber extraction (incl. firewood)			-Revegetation area/low brush debris			

Site history, continued

	Freq. code	Age code	Land manager survey: categories, quantities, comments
Regrowth management			n/a
Weed control		5yrs	Removal of woody's, suppression of groundworks
Pest animal control			n/a
Burning			n/a
Other			Revegetation program in past

Frequency: 0=no record, 1=rare (>5yrs), 2=occasional (2-5yrs), 3=frequent (<2yrs) Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Plot disturbance

	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood collection			
Grazing			
Fire damage			
Storm damage			
Other			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Focal taxa

(e.g. disturbance sensitive spp., ROTAPS, etc. within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
Mid	T		Melaleuca spp. Callistemon	30%	low		
			x sparse/lack diversity of ground h shrub strata.				

Physiography Holocene alluvium (59%) Wianamatta Shale (22%) Mittagong form (8%)

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil surface Texture	Soil Colour	Soil Depth
Slope mod	Aspect Sth west	Site drainage	Distance to nearest water and type >200m.

Hawkesbury Sandstone (81%) Tertiary alluvium (31%)

Native Vegetation Interim Type Standard

DECCW VEGETATION FIELD SURVEY FORM

Module 2 Full floristics

Site no.

Floristics

(within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
Upper	T		E. Elata.				
Mid	S		Bursaria spinosa.				
Mid	T		Acacia floribunda				
Vine	Vine		Passiflora cinerariaea				
Mid	S		leptasperrum (polyanthura)				
Mid	T		Melia azedarach				
Ground	G		austrastipa racemosa				
Ground	G		lamandra longifolia				
Mid	T		Acacia decumens				
Upper	T		Casuarina cunninghamiana				
Upper	T		E. baueriana				
Shrub	S		Hymenthra dentata				
Ground	H		Einadiola spp.				
Upper	T		Unknown ribbon gum				
			Mistletoe spp.				
✓	✓	Moth vine	Moth-v				
	✓	Trad					
	✓	Sida					
	✓	Mustard seed					
	✓	Purple top					
	✓	turkey rubarb					
	✓	Erhanta.					
	✓	Blackberry nightshock	Solanum nigrum				
	✓	Inkweed					
	✓	thistle.					
	✓	Alea bone.					
	✓	African love grass					
	Vine		Clematis aristata.				

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern, F=forb, L=vine, A=cycad, P=palm, X=xanthorrhoea, U=samphire shrub.

Cover: (<1% see explanatory notes) 1,2,3,4,5,10,15,20,25,30,35, etc. crown cover %

Abund: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 (>1000 see explanatory notes)



Plot 4 – Zone 4 Scheduled for restoration works 2018-2019 program

DECCW VEGETATION FIELD SURVEY FORM

Module 1 (Minimum requirements)

Location

		Survey code	Plot no.	Recorders
Date	12/7/18	Plot ID.	4	JP, AR
AMG grid reference	zone 54 55 56	datum	Easting	Northing
Base plot size	10x10	Orientation of 0.1ha plot	marked	yes no photo # / orientation
				Sw

Structure & composition (within 0.04 ha quadrat)

Keith class	Dry Sclerophyll forest (Scl)	Confidence: high mod low N.A.
Regional veg class (BVT)	Sand flats	Confidence: high mod low N.A.
BioMetric type (or NVCA)		Confidence: high mod low N.A.
Other: Tozer	Alluvial Woodland	Confidence: high mod low N.A.

NVIS level V (within 0.04 ha quadrat)

Stratum	Growth form	Species name	Cover	Abund.	For the entire	Field
Upper		E Elata	70-80%	67	Upper stratum	
Upper					Height to crown (m)	
Upper					min mode max	
Upper		Acacia decurrens		1		
Mid		Acacia floribunda		4	Mid stratum	
Mid		Trema tormentosa		3	Height to crown (m)	
Mid		Clematis		1	min mode max	
Ground		Dicandra repens	10-20%		Ground stratum	
Ground		Pteridium	45%		Height to crown (m)	
Ground		Protia purpurea	45%		min mode max	

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fern

Cover: 0-1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, etc. Abundance: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000, >1000

phyllanthus spp. <5 seedlings
 austrostipa racemosa <10%
 hymenandra stenoloba <10%

DECCW VEGETATION FIELD SURVEY FORM

Site no.

Condition

(within 0.04 ha)	Upper stratum	Mid stratum	Ground stratum Grasses	Ground stratum Shrubs	Ground stratum Other	Cover %	(within 0.1 ha quadrat)
Native richness	low	low	low	low	mod	Litter	No. trees with hollows
Native cover	100%	80%	20-30%	10-15%	-	Bare ground	Woody debris linear metres
Exotic cover	-	10%	5%	5%	5%	Cryptogam	Woody regeneration No. upper stratum sp. & abundance.

(within 0.1 ha quadrat)

Woody stem-sizes (DBH) (tally within category)	≥ 5– <10	≥10– <20	≥20– <30	≥30 cm DBH measure all	
(or, measure all ≥5cm DBH)					
Tree health	no evidence	branchlets dead	small branches dead	main branches dead	trees dead

Landuse and landcover

Age structure	early regeneration	advanced regeneration	uneven age	mature	senescent	
Landuse (dominant)	nature conservation	travelling stock route	forestry	grazing	cropping	other: <i>mining</i>
Landcover (upper stratum)	none	native	environmental planting	native plantation	exotic other:	
Landcover (ground stratum)	none	native	environmental planting	native plantation	exotic other:	

Site history

	Freq. code	Age code	Land manager survey: categories, quantities, comments			
Grazing management			not grazed	set stocked	rotational / cell grazing	
Farming			none	direct drill	disc plough tined implement	mouldboard rotary hoe
Erosion control			none	contour cultivation	mulching banks	other
Pasture improvement rates (fertiliser) kg/ha			none	<125	125-250	>250
Pasture improvement rates (lime/dolomite) t/ha			none	<2	2-4	4-7 >7
Timber extraction (incl. firewood)			n/a.			

Site history, continued

	Freq. code	Age code	Land manager survey: categories, quantities, comments
Regrowth management			n/a
Weed control			n/a
Pest animal control			n/a
Burning			n/a
Other			n/a

Frequency: 0=no record, 1=rare (>5yrs), 2=occasional (2-5yrs), 3=frequent (<2yrs) Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Plot disturbance

	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			n/a
Cultivation (inc. pasture)			n/a
Soil erosion			n/a
Firewood collection			n/a
Grazing			n/a
Fire damage			n/a
Storm damage			n/a
Other			Heavily weed infestation

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Focal taxa

(e.g. disturbance sensitive spp., ROTAPS, etc. within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
		Endangered pbr pomaderis					
		* Lack of flowering/nectar shrub spp.					

Physiography

Morphological Type	Landform Element	Landform Pattern	Microrrelief
Lithology	Soil surface Texture	Soil Colour	Soil Depth
Slope	Aspect	Site drainage	Distance to nearest water and type

→ Holocene alluvium (59.1%), Wianamatta Shale (22.1%), Mithagang formation (8.1%),
Native Vegetation Interim Type Standard
Hawks Sandstone (8.1%), Fertile alluvium (3.7%)

DECCW VEGETATION FIELD SURVEY FORM

Module 2 Full floristics

Site no.

Floristics

(within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.
			E. Blata				
			Clematis				
			Bursaria spinosa				
		Brush Kerpajong	Commersonia fraseri				
		Broken fern	Pteridium esculentum				
			Commelina cyanea				
			Passiflora cinnabarina.				
			trema tomentosa.				
			austroskipa racemosa.				
			Dicondra repens				
			Acacia floribunda.				
		Black Wattle.	Acacia decurrens				
			Hymenandra dentata				
		Snake vine					
			Pomadouris (Endangered)				
			Aralia purpurens				
			Breynia oblongifolia.				
			Glycine clandestina.				
	weed	Maple					
	"	Int weed					
	"	Crack Willow					
	"	Olive					
	"	Ballon vine					
	"	Trach					
	"	African love grass					
	"	S	Sida rhombifolia.				
	"		ligustrum spp.				
	"	Man vine					
	"		Solanum sisbrifilum				
	"	Bridal Creeper					

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fem, F=forb, L=vine, A=cycad, P=palm, X=xanthorrhoea, U=samphire shrub.

Cover: (<1% see explanatory notes) 1,2,3,4,5,10,15,20,25,30,35, etc. crown cover %

Abund: 1,2,3,4,5,6,7,8,9,10,20,50,100,500,1000 (>1000 see explanatory notes)



Plot 5 – Zone 7 scheduled for restoration works 2018-2019 program

DECCW VEGETATION FIELD SURVEY FORM

Module 1 (Minimum requirements)

Location

		Survey code	Plot no.	Recorders	
Date	12-7-18	Plot ID	5		
AMG grid reference	zone 54 55 56	datum	Easting	Northing	Position in quadrat
Base plot size	10x10m	Orientation of 0.1ha plot	marked	yes no	photo # / orientation 048 / East

Structure & composition (within 0.04 ha quadrat)

Keith class	Dry River Sclerophyll forest (by Sand) flat	Confidence: high mod low N.A.
Regional veg class (BVT)		Confidence: high mod low N.A.
BioMetric type (or NVCA)		Confidence: high mod low N.A.
Other:	Alluvial Woodland	Confidence: high mod low N.A.

NVIS level V (within 0.04 ha quadrat)

Stratum	Growth form	Species name	Cover	Abund.	For the entire	Field
Upper	T	E. Gladiolus		4	Upper stratum	
Upper					Height to crown (m)	
Upper					min mode max	
Mid	S	Hymenocallis densata		4	Mid stratum	
Mid		phylanthus spp.			Height to crown (m)	
Mid	S	phyllanthus spp.			min mode max	
Ground	S	Lomandra longifolia		2	Ground stratum	
Ground					Height to crown (m)	
Ground	V	Clematis aristata	27%		min mode max	

Growth form: T=tree, M=mallee tree, S=shrub, Y=mallee shrub, Z=heath shrub, C=chenopod shrub, G=tussock grass, H=hummock grass, D=sod grass, V=sedge, R=rush, E=fem
 Cover: 0-1, 1, 2, 3, 4, 5, 10, 15, 20, 25, 30, 35, etc. Abundance: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 50, 100, 500, 1000, >1000

DECCW VEGETATION FIELD SURVEY FORM

Site no.

Condition

(within 0.04 ha)	Upper stratum	Mid stratum	Ground stratum Grasses	Ground stratum Shrubs	Ground stratum Other	Cover %	(within 0.1 ha quadrat)
Native richness	low 100%	absent	low	low	low	Litter	No. trees with hollows No
Native cover	100%	—	10-15%	5%	—	Bare ground	Woody debris linear metres low
Exotic cover	—	90% 100%	10-15%	15%	15%	Cryptogam	Woody regeneration No. upper stratum sp. & abundance.

(within 0.1 ha quadrat)

Woody stem-sizes (DBH) (tally within category)	≥ 5– <10	≥10– <20	≥20– <30	≥30 cm DBH measure all	
(or, measure all ≥5cm DBH)					
Tree health	no evidence	branchlets dead	small branches dead	main branches dead	trees dead

Landuse and landcover

Age structure	early regeneration	advanced regeneration	uneven age	mature	senescent	
Landuse (dominant)	nature conservation	travelling stock route	forestry	grazing	cropping	other: old mining
Landcover (upper stratum)	none	native	environmental planting	native plantation	exotic other	
Landcover (ground stratum)	none	native	environmental planting	native plantation	exotic other	

Site history

	Freq. code	Age code	Land manager survey: categories, quantities, comments			
Grazing management			not grazed	set stocked	rotational / cell grazing	
Farming			none	direct drill	disc plough tined implement	mouldboard rotary hoe
Erosion control			none	contour cultivation	mulching banks	other
Pasture improvement rates (fertiliser) kg/ha			none	<125	125-250	>250
Pasture improvement rates (lime/dolomite) t/ha			none	<2	2-4	4-7 >7
Timber extraction (incl. firewood)						

Site history, continued

	Freq. code	Age code	Land manager survey: categories, quantities, comments
Regrowth management			n/a
Weed control			Not in the last 5 yrs
Pest animal control			n/a
Burning			n/a
Other			n/a

Frequency: 0=no record, 1=rare (>5yrs), 2=occasional (2-5yrs), 3=frequent (<2yrs) Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Plot disturbance

	Severity code	Age code	Observational evidence:
Clearing (inc. logging)			
Cultivation (inc. pasture)			
Soil erosion			
Firewood collection			
Grazing			
Fire damage			
Storm damage			
Other			

Severity: 0=no evidence, 1=light, 2=moderate, 3=severe Age: R=recent (<3yrs), NR=not recent (3-10yrs), O=old (>10yrs)

Focal taxa

(e.g. disturbance sensitive spp., ROTAPS, etc. within 0.04 ha quadrat)

Stratum	Growth form	Field name	Species name	Cover	Abund.	Field no.	RBG no.

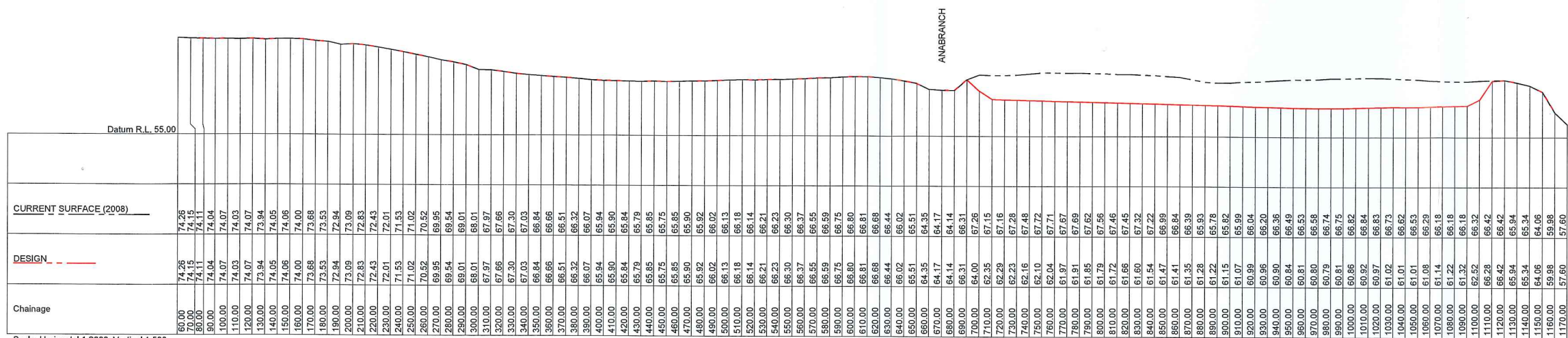
Physiography

Morphological Type	Landform Element	Landform Pattern	Microrelief
Lithology	Soil surface Texture	Soil Colour <i>Dark rich silt</i>	Soil Depth
Slope	Aspect <i>Sth West</i>	Site drainage	Distance to nearest water and type

* Holocene alluvium (59%), Manamatta Shale (22%), Mittagong form (8%),
Native Vegetation Interim Type Standard
Huskerry Sandstone (8%), Tertiary alluvium (37%)

APPENDIX 4

FINAL LANDFORM DESIGN



NOTES

1. ORIGINAL SURFACE DATA EXTRACTED FROM ORTHOPHOTO MAPPING(1983), FIELD SURVEY(2005) & LIDAR(2008)
2. CURRENT SURFACE DATA EXTRACTED FROM LIDAR (2008)
3. DESIGN SURFACE DATA EXTRACTED FROM JOHNSTONE ENVIRONMENTAL TECHNOLOGY Pty. Ltd., Plan No. JET0328 Drawings 1-16 Issue 4 Dated 11/04/2001 & SMEC URBAN Plan No. 77310.01.P04-P07 Dated 13/10/2011

REVISION	DATE	DES/DT	APPD
A REVISE SHEET LAYOUT	2/12	MS	

Principal
M.COLLINS & SONS Pty. Ltd
17 Patrick St.
REVEBY, NSW. 2212

Designed
D.Morison
Drawn
D.Morison
Checked
D.Morison
Authorised
P.McNamara
Date
Feb. 2012

Scale @ A1
Hor. 1:2000 Ver. 1:500

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Brisbane	+61 7 3831 9988	Melbourne	+61 3 9659 0800
Canberra	+61 2 6126 1900	Perth	+61 8 9323 5900
Geelong	+61 3 5228 3100	Traralgon	+61 3 5173 0100



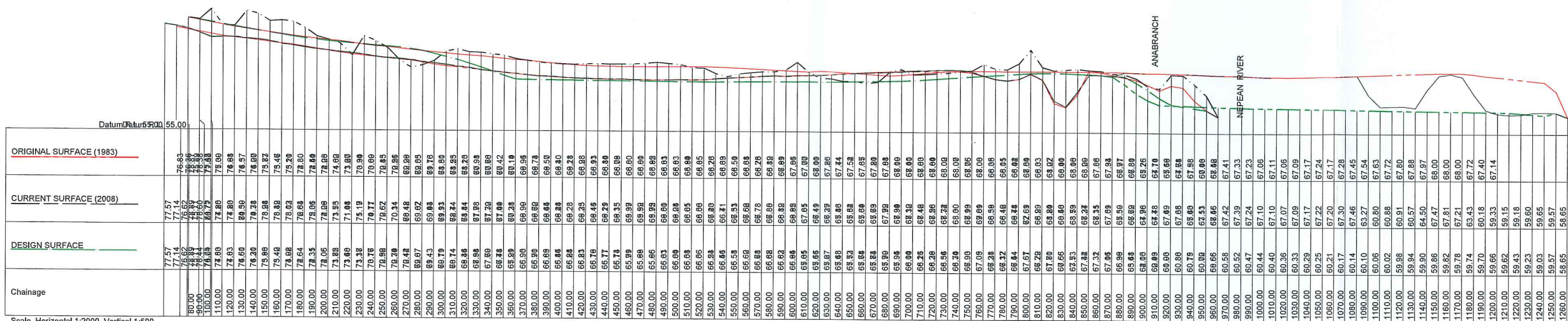
LEAN & HAYWARD PTY LTD

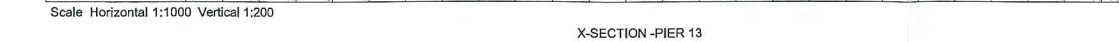
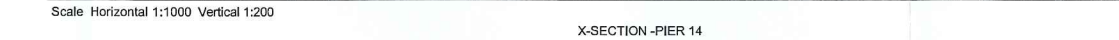
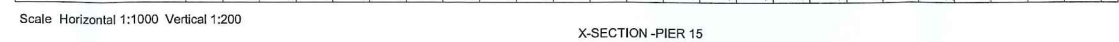
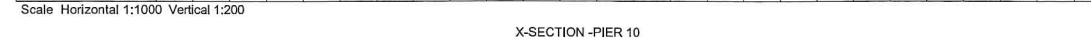
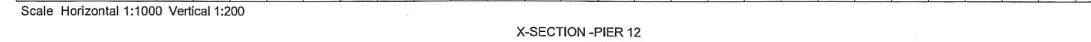
SPRING FARM
MACARTHUR ROAD
Department of Planning and Infrastructure
Sand Mining Cross Sections

Drawing No. 77310.01.P11
Sheet No. 4 of 6

Rev A

Subject to Approval
Not to be used for construction





	No.	AMENDMENT	DATE	DRAWN	CHECK'D	AUTH'D
R						
E						
S						
O						
N						
G						
I						
T						
H						
L						
F						
J						
M						
B						
X						
P						
K						
V						
W						
Z						

	AUTHORITY	SCALE
	CAMDEN COUNCIL	AS SHOWN
	PROPERTY DESCRIPTION	ORIGIN OF LEVELS
	LOT 32 DP 635271	FROM GPS & LIDAR SURVEY
	LOCALITY	DATUM
5	ELDERSLIE	APPROX. A.H.D.

FILE NAME: 77310.01.F04FF08

APPENDIX 5

SUMMARY OF WEED CONTROL TECHNIQUES

Common Name	Botanical Name	Status	Removal Techniques
African love grass	<i>Eragrostis curvula</i>	Environmental Weed	Slash or mow before it sets seed along roads and in highly disturbed areas. Spot spray with diluted 1:100 Roundup. Hand remove isolated plants.
Dodder	<i>Cuscuta sp.</i>	Environmental Weed	Hand remove.
Blackberry	<i>Rubus fruticosus agg. Spp.</i>	Noxious Weed W2	Cut and paint crown/lignotuber with undiluted Roundup or Garlon and diesel immediately for isolated plants. Slash large populations and spray re-growth with selective herbicide Garlon, Grazon or Brushoff at flowering/fruitlet stage.
Bridal Creeper	<i>Myrsiphyllum asparagoides</i>	Environmental Weed	Hand remove (i.e. by crowning with a knife) isolated plants after removing and bagging fruit. Spray large populations with Brushoff at flowering stage.
Cobblers peg	<i>Bidens pilosa</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Crofton weed	<i>Ageratina adenophora</i>	Environmental Weed	Hand remove or spray with 1:100 Roundup.
Fireweed	<i>Senecio madagascariensis</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Fleabane	<i>Conyza spp.</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Green cestrum	<i>Cestrum parqui</i>	Noxious Weed W2	Stem scrape and paint with Garlon and diesel (i.e. both sides of stem) immediately at flowering stage. Remove and bag fruit.
Inkweed	<i>Phytolacca octandra</i>	Environmental Weed	Hand remove or cut and paint base with undiluted Roundup after removing and bagging fruit.
Kikuyu	<i>Pennisetum clandestinum</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup.
Lantana	<i>Lantana camara</i>	Noxious Weed W2	Cut and paint base of trunks with undiluted Roundup immediately. Slash Lantana stems into 2x2 metre piles. Treatment of re-growth may be necessary as layering stems may re-shoot. Hand remove seedlings.
Large leaf privet	<i>Ligustrum lucidum</i>	Environmental Weed	Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup immediately before fruiting stage. Hand remove or spot spray seedlings with 1:100 Roundup.
Madiera winter cherry	<i>Solanum pseudocapsicum</i>	Environmental Weed	Stem scrape and paint with Garlon and diesel (i.e. both sides of stem) immediately at flowering stage. Remove and bag fruit.
Moth plant	<i>Arauja sericifolia</i>	Environmental Weed	Hand remove or cut and paint base of stems with undiluted Roundup after removing and bagging fruit.
Paddy's lucerne	<i>Sida rhombifolia</i>	Environmental Weed	Hand remove or cut and paint base with undiluted Roundup. Slash large populations and spray re-growth with 1:100 Roundup.
Pampas grass	<i>Cortaderia spp.</i>	Noxious Weed W2	Spot spray with diluted 1:70 Roundup after removing and bagging fruit/flowering stems.
Paspalum	<i>Paspalum dilatatum</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup.
Prickly pear	<i>Opuntia spp.</i>	Noxious Weed W4f	Mattock/hand remove all parts of plant.
Boneseed	<i>Chrysanthemoides monilifera</i>	Environmental Weed	Spray actively growing plants, spray to wet all foliage. Spray Roundup at a ratio of 1:100.
Scotch thistle	<i>Onopordum acanthium</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Broom	<i>Spp.</i>	Environmental Weed	Spray with Garlon 600 Herbicide.
Silky oak	<i>Grevillea robusta</i>	Environmental	Cut and paint base of trunk or drill/chisel trunk

Common Name	Botanical Name	Status	Removal Techniques
		Weed	(>10cm diameter) and inject with undiluted Roundup immediately. Hand remove seedlings.
Small leaf privet	<i>Ligustrum sinense</i>	Environmental Weed	Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup immediately before fruiting stage. Hand remove or spot spray seedlings with 1:100 Roundup. Treatment of re-growth may be necessary as the plant has the ability to sucker from roots.
Sowthistle	<i>Sonchus oleraceus</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed. Hand remove isolated plants.
Verbena	<i>Verbena spp.</i>	Environmental Weed	Spot spray with diluted 1:100 Roundup. Best done before it sets seed.
Wandering jew	<i>Tradescantia fluminensis</i>	Environmental Weed	Spot spray with 1:50 Roundup or Starane. It is photo-inhibited so must be treated on overcast days after rain. Rake and hand remove all stem fragments in small populations amongst native species.
Mother of millions	<i>Kalanchoe tubiflora</i>	Environmental Weed	Remove by hand, bag all plant material and dispose of in appropriate manner.

Note: Not all weeds listed in the above table are currently found on-site. Weeds in the above table are found in the locality and the information regarding their treatment will assist those involved in future management of the site should infestation occur.

APPENDIX 6

EXAMPLE FIELD MONITORING SHEET

Landscape Management Plan Monitoring Field Sheet

Project: _____

Date: _____

Quadrat: _____

Recorder: _____

Measure	Observation				Comments/Actions Required	Responsibility	Completion Date
Plant Growth (cm):							
Trees	0-5	5-20	20-50	50+			
Understorey	0-5	5-10	10-30	30+			
Ground cover	0-5	5-10	10-20	20+			
Percentage Cover (%):							
Trees	0-10	10-50	50-85	85+			
Understorey	0-10	10-50	50-85	85+			
Ground cover	0-10	10-50	50-85	85+			
Survival Rates (%):							
Trees (Minimum 85%)	0-10	10-50	50-85	85+			
Understorey (Minimum 85%)	0-10	10-50	50-85	85+			
Ground cover (below 85%)	0-10	10-50	50-85	85+			
Plant replacement required/Ha							
Trees	0-5	5-20	20-50	50+			
Understorey	0-5	5-20	20-50	50+			
Ground cover	0-5	5-50	50-100	100+			
Weed regrowth (% cover below 15%)	0-10	10-50	50-85	85+			
Condition of Tree Guards	Poor	Ok	Good				
Watering required	Yes	Some	No				
Stream bank erosion	Stable	Slight	Mod.	Severe			

Photographs:

Number

Location

Direction

Comments:

APPENDIX 7

AGRICULTURAL ASSESSMENT – RECONSTRUCTED AGRICULTURAL LANDFORM



Harvest Scientific Services Pty Ltd
Geotechnical Environmental & Resource Consultants
ABN 43 132 363 289

AGRICULTURAL ASSESSMENT

RECONSTRUCTED AGRICULTURAL LANDFORM

Macarthur Road, Spring Farm

Prepared for:

M Collins and Sons (Contractors) Pty Ltd

**Job reference: 201279
14 December 2011**

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Revisions register

Version	Date	Details
1	30/11/2011	Draft report for comment
2	14/12/2011	Report finalised. Minor typographical changes.

Executive summary

Introduction and background

M Collins and Sons (Contractors) Pty Ltd (MCS Pty Ltd) owns and operates the Spring Farm Quarry located at Lot 22 DP833317 at Spring Farm, in the Camden Local Government Area (LGA). Development consent (DA 75/256) for the extraction and processing of sand and soil was originally granted by the Minister for Planning in 1988 and the consent was modified in 1998 to extend the quarry's life. The site is a major source of products for the Sydney region and comprises part of the regionally significant resource identified in the Sydney Regional Environmental Plan No 9 (Extractive Industry).

On the 22 May 2009 MCS Pty Ltd was granted a further Section 96(2) Modification for the Continuation of Operations by the Department of Planning for extraction within an 8 hectare portion of the subject site and for the continued processing of extracted materials onsite. That approval was to allow operations to continue for a further 10 year period until 2019.

MCS Pty Ltd is currently seeking a further modification under Section 75W of the Environmental Planning and Assessment Act (1979) (NSW) to extend sand and soil extraction activities onto an adjacent portion of land within Lot 32 DP 635271. The extension of extraction activities are proposed to consist of the following features:

- Extraction of sand and soil within a 6.8 hectare (approximate) portion of land within Lot 32 DP 635271.
- Dry screening of sand and soil within the quarry floor;
- Active extraction within a 1 hectare portion of land at a time and concurrent rehabilitation works within an additional 1 hectare portion of land;
- Extraction and rehabilitation works are proposed to occur in concert over an 8 year period (completion in 2019); and
- Rehabilitation maintenance activities are proposed to occur over an additional 2 year period.

Agricultural production areas are proposed to be rehabilitated subject to the following controls:

- At the completion of extraction within any given extraction cell that is to be utilised for future agricultural production (Zone 3 - Figure 3), the ground is to be prepared by ripping to a depth of 300 to 400 mm, no further than 300 mm apart. First stages of ripping should run down any batters or contours followed by a cross ripping along the contours. The cross rip will reduce the chance of incisions after periods of rain, help retain moisture on sloping surfaces, fracture soil between rip lines, eliminate glazing of the undisturbed soil interface and reduce air pockets and trench effects.
- The entire area is then to be covered to a minimum depth of 500 mm with stock-piled top-soil (stored in the bunded mound around the extraction pit). Pasture grasses are then to be re-established by either natural re-generation from grass seed stored in the topsoil stock-pile or seeding with pasture species.

Director General Requirements for the proposed modification were issued on 23 December 2010. As part of the consultation process for the Environmental Assessment, the NSW Department of Trade & Investment, Regional Infrastructure & Services (DT&IRIS, 2011) made the following comments in relation to the post extraction agricultural landform:

'Agriculture issues

'The Cultural Landscape & Visual Assessment report seems to lack the historical context of the agricultural landscape association between the land proposed for sand and soil extraction and the broader Camden agricultural heritage. The Aboriginal Archaeological Assessment notes that the land was most likely cleared for agriculture in the 1830s and able to be cultivated for crops 1 market gardens and growing grapes which demonstrate the versatility and robust nature of farming on class 1 agricultural soil.

The Landscape Management Plan is adequate for the restoration for agricultural uses. Environmental Risk Assessment - There is a risk that the rehabilitation does not return the extracted area to class 1 agricultural

land. Demonstration of successful rehabilitation and return to agricultural suitability on previously extracted areas may assist in determining the risk level.'

In response to the above correspondence, Harvest Scientific Services Pty Ltd has been engaged by MSC Pty Ltd to prepare an Agricultural Assessment for a portion of the M Collins and Sons (Contractors) Pty Ltd site that has been subject to similar land-forming and rehabilitation controls to those proposed as part of the current sand and soil extension proposal.

Aims and objectives

This Agricultural Assessment aims to:

- Describe the soil and agricultural conditions of a portion of the subject site that has previously been subject to land-forming activities and subsequent profile re-construction; and
- Classify the agricultural capacity of the re-habilitated landform.

Methodology

This assessment was subject to the following methodology:

- A visual site inspection;
- Excavation of a soil test-pit; and
- Classification of the agricultural capacity of the subject land with reference to the classification system outlined in the Agricultural Classification Atlas (**NSW Agriculture, 1991**).

Results

At the time of the site inspection, the investigation area was intensively cropped with turf farming (**Plate 1**) and had been continuously intensively cropped since the land was re-habilitated. No surficial constraints to agricultural production were evident.

The soil profile (**Plate 2**) consisted of approximately 450mm of brown sandy loam with a weak to massive structure. Some soil compaction was noted in the zone of approximately 100 to 300mm below ground level. Located immediately below the topsoil horizon was a loose friable moderately structured red sandy clay sub-soil.

Whilst some compaction was noted in the zone of approximately 100 to 300mm below ground level, this constraint is minor and consistent with adjacent areas of alluvial 'Class 1' agricultural lands. Soil compaction in the turf farming environments result from a combination of intensive management (and associated vehicle movements), organic matter depletion (due harvesting of the organic rich layer with the product) and sodicity.

Soil compaction on Class 1 Agricultural lands is routinely managed by ripping to the depth of compaction, addition of gypsum and organic matter as required.

Conclusion

Based on the findings of this assessment it was found that the re-constructed soil profile and associated soil landscape was consistent with the 'Class 1' Agricultural land. The proposed method of profile re-construction is therefore considered appropriate to return the subject land to 'Class 1' agricultural land.

Table of contents

1. INTRODUCTION	1
2. AIMS AND OBJECTIVES	2
3. METHODOLOGY	2
4. AGRICULTURAL CLASSIFICATION SYSTEM	2
5. SITE DESCRIPTION	3
5.1. Site location	3
5.2. Land-forming history	3
5.3. Land-use	3
6. RESULTS.....	4
6.1. Visual assessment	4
6.2. Soils	4
6.3. Agricultural classification	4
7. LIMITATIONS OF THIS REPORT.....	4
8. CONCLUSION.....	5
REFERENCES.....	6

FIGURES

Figure 1 Site location

TABLES

Table 1 Summary of the five agricultural classes as described by NSW Agriculture (2002)

PLATES

Plate 1 View of the re-constructed agricultural landform – currently utilised for turf farming
 Plate 2 View of the re-constructed soil profile

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- Classify the agricultural capacity of the re-habilitated landform.

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This assessment was subject to the following methodology:

- A visual site inspection;
- Excavated a soil test-pit; and
- Classification of the agricultural capacity of the subject land with reference to the classification system outlined in the Agricultural Classification Atlas (**NSW Agriculture, 1991**).

4. AGRICULTURAL CLASSIFICATION SYSTEM

Knowledge of the relative suitability of land for agriculture is required to enable the development of strategic plans which protect land highly suited to agriculture and allow identification of land more suited to non-agricultural activities. This process requires that land be evaluated based upon generally accepted practices.

The Agricultural Land Classification method, as presented by **NSW Agriculture, (2002)** considers the various factors that influence land use in a different manner (NSW Agriculture, 2002). A brief summary of agricultural classification definitions relied upon by this method are outlined in **Table 1**.

Table 1. Summary of the five agricultural classes as described by NSW Agriculture, (2002)

Class	Definition
1	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.
2	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation. It has moderate to high suitability for agriculture, but edaphic (soil factors) or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.
3	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate because of edaphic or environmental constraints. Erosion hazard, soil structural breakdown and other factors including climate may limit the capacity for cultivation; and soil conservation or drainage works may be required.
4	Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.
5	Land suitable for agriculture or at best suited to only light grazing. Agricultural production is very low to zero as a result of severe constraints, including economic factors, which preclude land improvement.

5. SITE DESCRIPTION

5.1. Site location

The site of the former land-forming area is located immediately to the south of Lot 22 and is delineated as the investigation area (in red) on **Figure 1**.

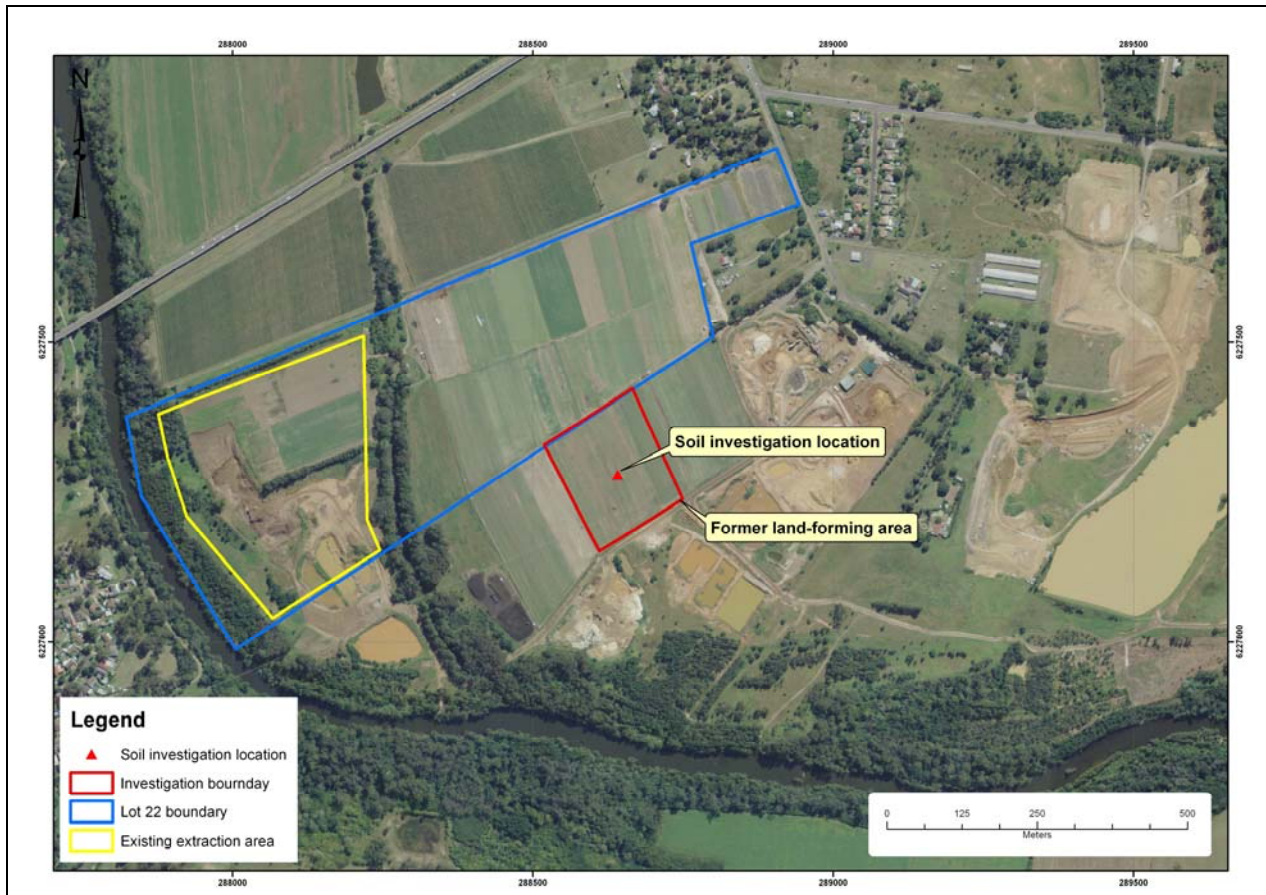


Figure 1. Site location (Lot 22 DP833317). Source: Department of Lands circa 2008.

5.2. Land-forming history

The investigation area was subject to land-forming and profile re-constructive activities approximately 8 years ago. At that time, the profile was reconstructed by the following protocols:

- Forming of the desired subsoil landform with onsite derived sandy clay and clayey sand sub-soil;
- Preparing the reconstructed sub-soil horizon by ripping to approximately 300mm; and
- Importing of approximately 300-500mm of onsite derived sandy loam top-soil onto the finished re-constructed profile.

5.3. Land-use

The investigation area has been used for turf farming continuously since the profile was re-constructed.

6. RESULTS

6.1. Visual assessment

At the time of the site inspection, the investigation area was intensively cropped with turf farming (**Plate 1**) and had been continuously intensively cropped since the land was re-habilitated.

No surficial constraints to agricultural production were evident.

6.2. Soils

The soil profile (**Plate 2**) consisted of approximately 450mm of brown sandy loam with a weak to massive structure. Some soil compaction was noted in the zone of approximately 100 to 300mm below ground level.

Located immediately below the topsoil horizon was a loose friable moderately structured red sandy clay sub-soil.

Whilst some compaction was noted in the zone of approximately 100 to 300mm below ground level, this constraint is minor and consistent with adjacent areas of alluvial 'Class 1' agricultural lands. Soil compaction in the turf farming environments result from a combination of intensive management (and associated vehicle movements), organic matter depletion (due harvesting of the organic rich layer with the product) and sodicity.

Soil compaction on Class 1 Agricultural lands is routinely managed by ripping to the depth of compaction, addition of gypsum and organic matter as required.

6.3. Agricultural classification

Based on the **NSW Agriculture (2002)** Land Classification System, the re-constructed profile and surrounding landscape is considered to be '**Class 1**' agricultural land. This land is suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.

This finding is supported by the continued use of the subject land for intensive turf-farming operations since the profile was reconstructed.

7. LIMITATIONS OF THIS REPORT

This report has been prepared subject to a number of limitations. These include:

- The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose;
- The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points;
- In preparing this report, Harvest Scientific Services Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific Services Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services Pty Ltd assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Harvest Scientific Services Pty Ltd; and

- This report is not to be relied upon for any purpose other than that defined in this report.

8. CONCLUSION

Based on the findings of this assessment it was found that the re-constructed soil profile and associated soil landscape was consistent with the 'Class 1' Agricultural land. The proposed method of profile re-construction is therefore considered appropriate to return the subject land to 'Class 1' agricultural land.

Prepared by

A handwritten signature in black ink, appearing to read 'Jim Cupitt', written in a cursive style.

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PLATES



Plate 1 View of the re-constructed agricultural landform – currently utilised for turf farming



Plate 2 View of the re-constructed soil profile. Note: Scale is 1 metre in length.