

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

LANDSCAPE MANAGEMENT PLAN (Including Quarry Closure, Rehabilitation and Post Extraction Land-use)

PROPOSED EXTENSION OF EXISTING SAND AND SOIL EXTRACTION OPERATIONS

Lot 32 DP 635271 Macarthur Road, Spring Farm

Prepared for:

M Collins and Sons (Contractors) Pty Ltd

**Job reference: 201279
17 February 2012**

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Revisions register

Version	Date	Details
1	22/06/2011	Draft document for comment
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
6	30/11/2011	Minor revisions to address comments by NSW Department of Planning and Infrastructure dated 06 October 2011.
7	14/12/2011	Minor typographical revisions.
8	17/02/2012	Various typographical changes. Inclusion section for post-extraction land-use.

Executive summary

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);
- 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.

Director General Requirements (DGRs)

Director General Requirements for the proposed modification were issued on 23 December 2010 and included the following requirements relating to quarry closure and rehabilitation:

'Quarry closure and rehabilitation – including:

- *a detailed description of the proposed measures that would be undertaken during the closure of the Quarry;*
- *a detailed revision of the quarry rehabilitation strategy, including justification for the proposed final land form and consideration of the objectives of the relevant strategic land use objectives'*

Harvest Scientific Services Pty Ltd has been engaged by MCS Pty Ltd to prepare a Landscape Management Plan (LMP) to address the above DGRs.

Aims and objectives

The LMP aims to provide a clear, concise and practical framework for the restoration of the vegetation impacted by the proposed 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 proposed rehabilitation works on the adjacent Lot 20 DP 833317, as outlined in the Landscape Management Plan prepared by **Harvest Scientific Services Pty Ltd (2010)**.
- 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;
- Create specialised habitat attributes for arboreal marsupials by 2 years post extraction;
- To assess the capacity of the proposed restoration program to return agricultural production areas to 'Class 1' agricultural land; and
- Provide an outline of the proposed post-extraction land-use.

Site description and existing vegetation

The area proposed to be extracted 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 that are under-going rehabilitation works and active extraction works, respectively.

(a) *Lucerne paddock*

Vegetation within the area proposed to be extracted has been extensively modified through historic clearing and ongoing agricultural activities. The proposed extraction area is currently utilised for the growing of Lucerne.

(b) *Bank of the Nepean River*

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

This vegetation comprises of 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.

(c) *Dry River Anabranch*

Vegetation immediately to the east of the proposed 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.

Landscape Management

(a) *Water Management Act (WM Act) 2000 and 'Controlled Activity Approval'*

The proposed soil extraction activities and associated re-vegetation works involve works within 40 meters 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 (WM Act) 2000*.

MCS Pty Ltd have a current Controlled Activity Approval (CAA), which is administered by the NSW Office of Water (NOW). The expiry date of the CAA is the 08 April 2013. The existing CAA will be required to be amended to reflect the proposed works.

(b) *Erosion and sediment controls*

The erosion and sediment controls that are to be implemented as part of the sand and soil extraction and rehabilitation works are outlined in a separate document entitled 'Water Management and Erosion and Sediment Control Plan' (WM & ESCP), as prepared by **Harvest Scientific Services (2012)**. This LMP assumes that all erosion and sediment controls outlined in the ESCP will be implemented.

(c) *Restoration program*

This LMP has been prepared giving consideration to the NSW Office of Environment and Heritage (DECCW – formally Department of Environment and Climate Change DECC) guidelines and addresses the following issues: legislative requirements and LMP methodology, existing site conditions, riparian zone protection, initial weed control, site preparation, supply of plant material, plant installation, program of works, costing, and monitoring and evaluation.

For re-vegetation works, the site has been divided into three distinct zones (**Figure 3**), which are summarised as follows:

- Zone 1.** The Nepean River; and
- Zone 2.** Dry River Anabranche;
- Zone 3.** Open paddock agricultural production areas

Zones 1 and 2 are then further broken down into sub-zones depending on the specific rehabilitation actions required for each zone. Sub-zones denoted by the letter 'a' will be subject to progressive weed removal and limited plantings (where necessary), whilst zones denoted by the letter 'b' will be subject to complete re-planting and ongoing maintenance.

All plants to be used in the restoration works in zones 1 and 2 will be sourced from local provenance material collected in the local area and grown by local nurseries. All vegetation will be planted as forestry tubes, hikos or enviro cells. All plant species will be suitably guarded to prevent herbivore and weed competition and to encourage optimum growing conditions.

The restoration project also includes a two year maintenance bush regeneration component, targeting remnant vegetation (zones 1a and 2a). Areas subject to complete replanting (zones 1b and 2b) will be subject to a 2 year maintenance period. The restoration program will include the preparation of yearly monitoring and evaluation reports, as required by the guidelines, to assess the success of the restoration program and the achievement (or otherwise) of clear performance targets.

Conclusion

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

- This LMP provides MCS Pty Ltd, 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 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 prevailing.

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Abbreviations

CAA Controlled Activity Approval
 CC Camden Council
 CMA Catchment Management Authority
 CRZ Core riparian zone
 DECCW Department of Environment Climate Change and Water (formally Department of Environment Climate Change DECC)
 DEHWA Department of Environment, Heritage, Water and the Arts
 DOP Department of Planning
 EECs Endangered Ecological Communities
 EP&BC Act Environment Protection and Biodiversity Act 1999
 EP&A Act Environmental Planning and Assessment Act 1979
 ESCP Erosion and Sediment Control Plan
 LGA Local government area
 LMP Landscape Management Plan
 NES National environmental significance
 NOW NSW Office of Water

TSC Act Threatened Species Conservation Act 1995
VB Vegetated buffer
WM Act Water Management Act 2000
WM & ESCP Water Management and Erosion and Sediment Control Plan

1. INTRODUCTION

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- Create specialised habitat attributes for arboreal marsupials by 2 years post extraction;
- To assess the capacity of the proposed restoration program to return agricultural production areas to 'Class 1' agricultural land; and
- Provide an outline of the proposed post-extraction land-use.

1.2. 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.

1.2.1. 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 (WM Act) 2000.

A controlled activity approval under the WM Act 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 DECCW 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 proposed soil extraction activities and associated re-vegetation works involve works within 40 meters 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* (WM Act) 2000.

MCS Pty Ltd have a current Controlled Activity Approval (CAA), which is administered by the NSW Office of Water (NOW). The expiry date of the CAA is the 08 April 2013. The existing CAA will be required to be amended to reflect the proposed works. A copy of the existing CAA for Lot 22 is appended as **Appendix 3**.

1.2.2. 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 Proposal 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.

1.2.3. 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 Proposal 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.

1.2.4. 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 should be implemented upon initiation of clearing works to decrease the chances of site infestation by invasive noxious weed species.

1.3. Project team

1.3.1. Names and qualifications

Name	Position	Qualifications	Relevant experience
Mart Rampe	Principal	Bachelor of Science in Applied Geology	37 + years in Earth Sciences, including 22+ years in quarry and mine site rehabilitation.

Name	Position	Qualifications	Relevant experience
Jim Cupitt	Senior Environmental Scientist	Bachelor of Science in Agriculture (Hons).	12+ years in the Environmental and Earth Sciences, including 8 years in the environmental consulting industry. 10 + years part-time in the plant nursery industry.

1.3.2. Related projects

Landscape Management Plan for Spring Farm Sand and Soil Extraction (continuation of existing operations), Lot 22 DP 833317 dated 10 February 2010 (**Harvest Scientific Services Pty Ltd, 2010**).

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;
- 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 DECCW 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 proposed 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 site of the sand and soil extraction area is approximately 6.8 hectares in size and is bound by the Camden Bypass to the north, a dry river anabranch on the East, the adjoining Collins property Lot 1 DP 5877631 on the South and the Nepean River on the West (**Figure 1**).

The area proposed to be extracted 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 area proposed to be extracted has been extensively modified through historic clearing and ongoing agricultural activities. The proposed extraction area currently consists of Lucerne paddocks.

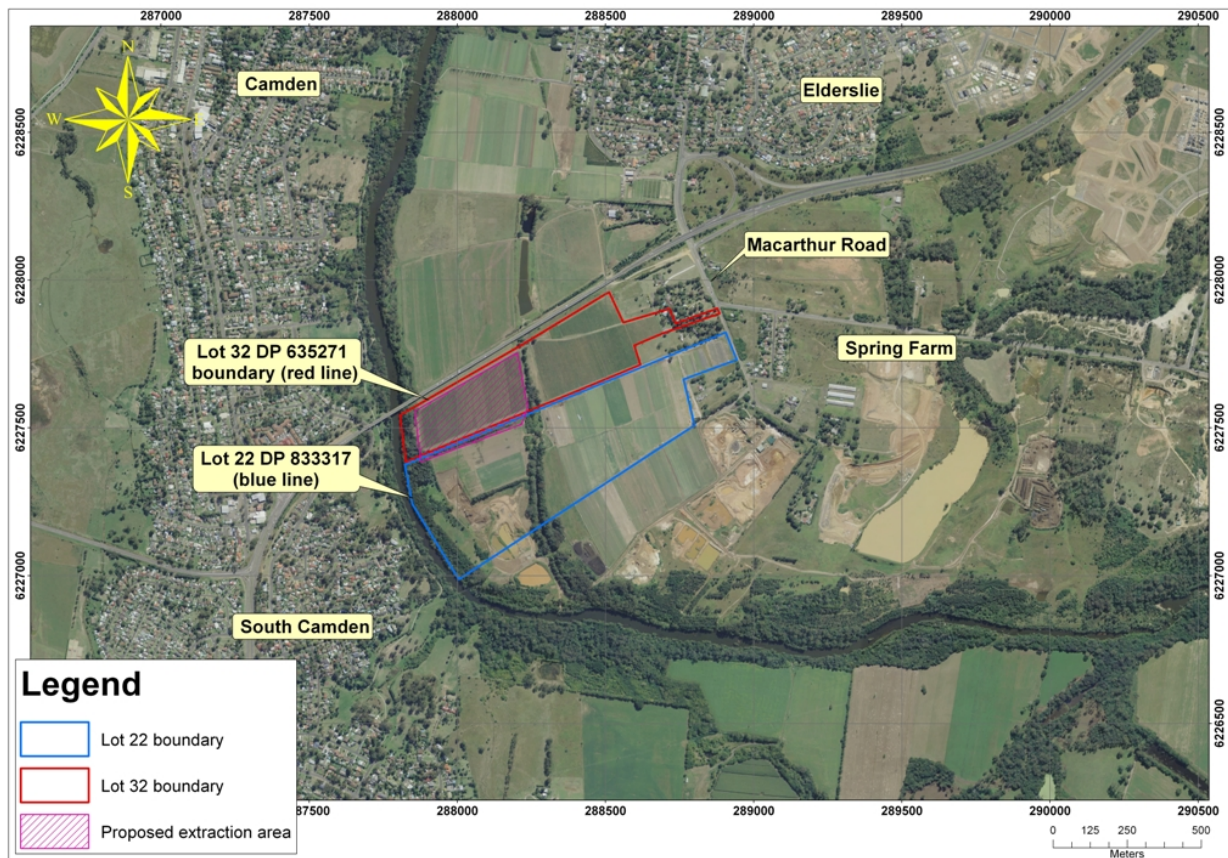
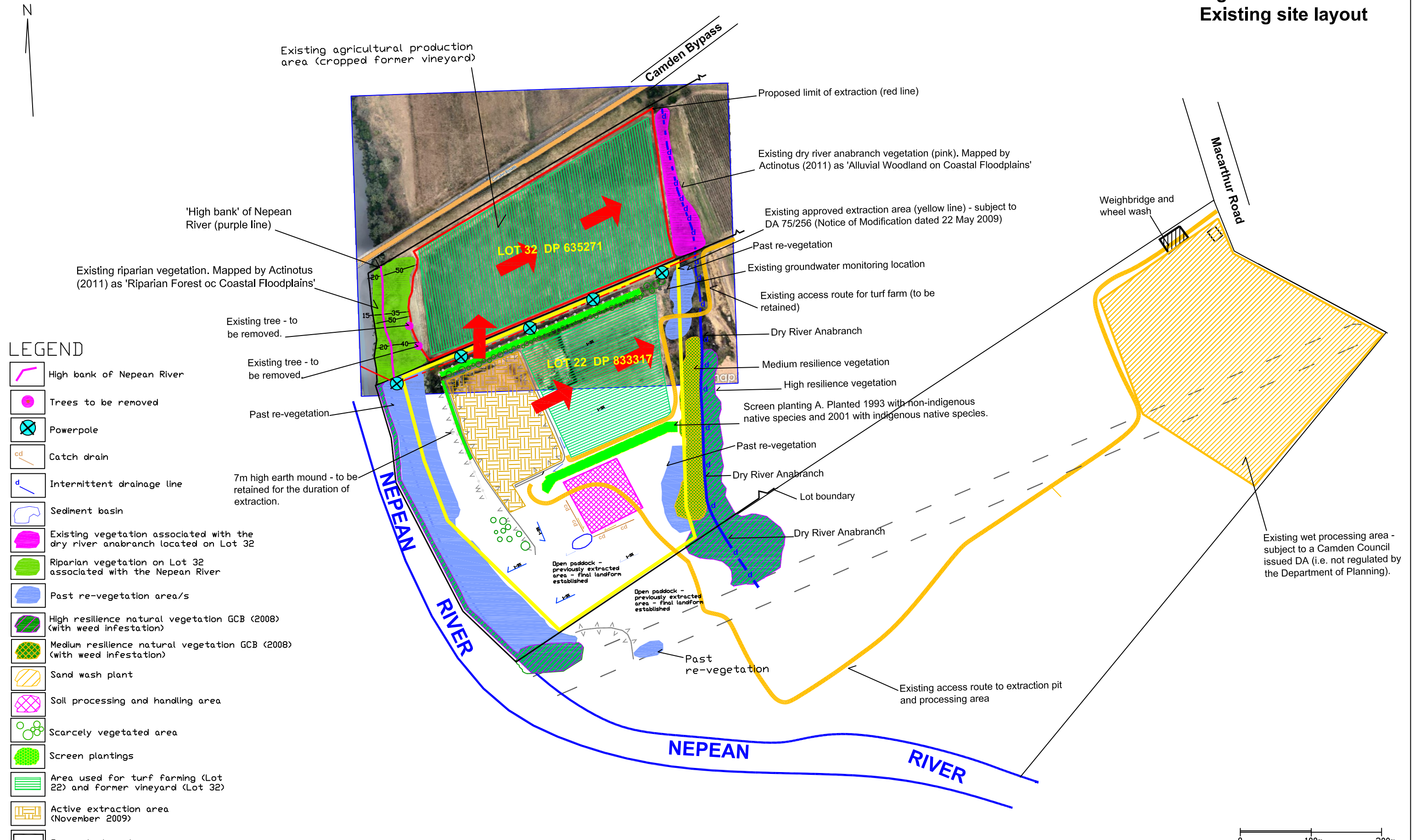


Figure 1. Site location (Lot 22 DP833317). Source: Department of Lands circa 2008.

3.2. Climate

The Commonwealth Bureau of Meteorology website provides climatic information for the study area taken from Camden Airport AWS weather station (closest station to site). A review of this data indicated that the mean rainfall peaks in summer and ranges from 104.3 mm in February down to 39.4 mm in July. Mean daily maximum temperatures range from 29.4°C in summer to 17.2°C in winter with mean minimum temperatures ranging from 16.7°C in summer down to 2.9°C in winter (**BoM 2009**).

Figure 2
Existing site layout



LEGEND

- High bank of Nepean River
- 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 weed infestation)
- Medium resilience natural vegetation GCB (2008) (with weed infestation)
- Sand wash plant
- Soil processing and handling area
- Scarcely vegetated area
- Screen plantings
- Area used for turf farming (Lot 22) and former vineyard (Lot 32)
- Active extraction area (November 2009)
- Property boundary
- Proposed extraction boundary (Lot 32)
- Approved extraction boundary - NDM 22/05/2009
- Aboveground powerlines
- Proposed progressive direction of extraction

Notes:
1. The position of all features on this plan is approximate; and
2. Aerial photo is dated 16/02/2011.

Scale 1:5000 at A3		FIGURE 2		
Designed by JC	Checked by JC	Date Drawn 06/07/2011	Job No 201279	Filename
Consultants HARVEST SCIENTIFIC SERVICES			Project Spring farm and Woodgrand Quarries	
Client M Collins and Sons Pty Ltd (Contractors)			Council Camden	

Figure 3
Final landform and
rehabilitation
management plan

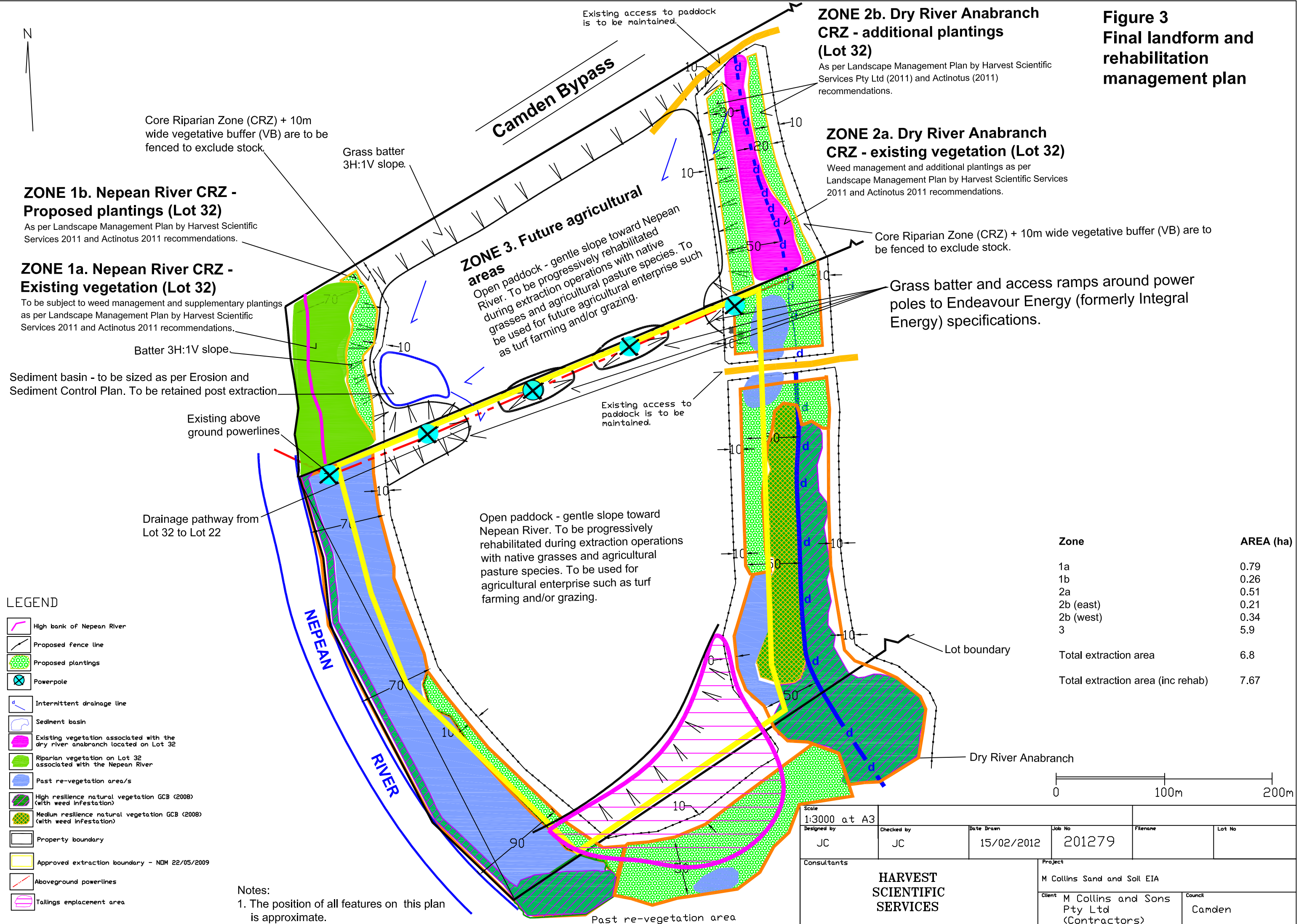
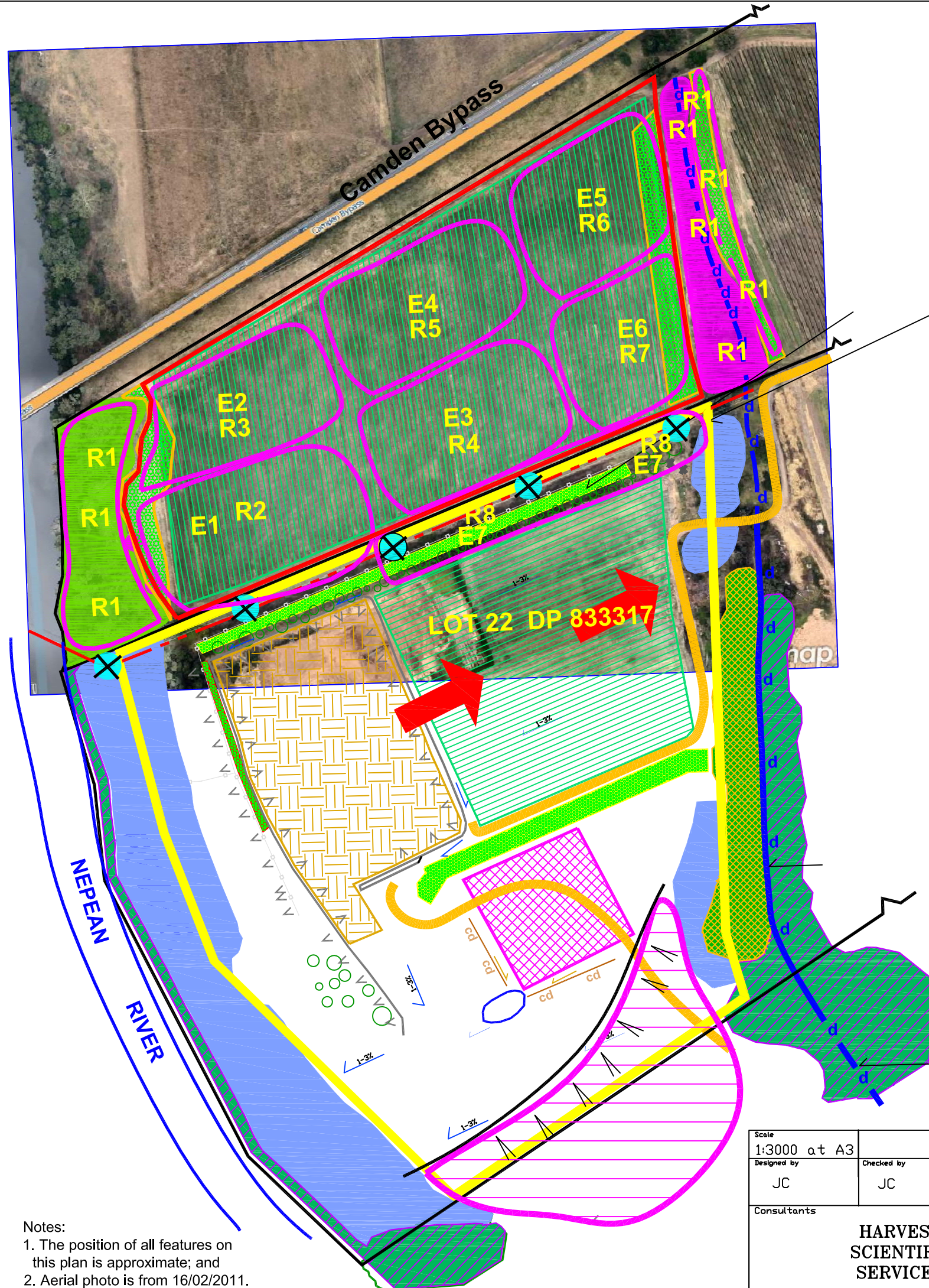


Figure 4
Extraction and
rehabilitation staging plan

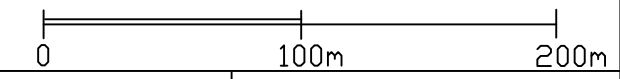


LEGEND

- Staging boundary
- To be removed
- 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 weed infestation)
- Medium resilience natural vegetation GCB (2008) (with weed infestation)
- Sand wash plant
- Soil processing and handling area
- Scarcely vegetated area
- Screen plantings
- Area used for turf farming (Lot 22) and former vineyard (Lot 32)
- Active extraction area (November 2009)
- Existing internal fence-line
- Property boundary
- Proposed extraction boundary (Lot 32)
- Approved extraction boundary - NDM 22/05/2009
- Aboveground powerlines
- Proposed progressive direction of extraction
- Tailings emplacement area

Notes:
1. The position of all features on this plan is approximate; and
2. Aerial photo is from 16/02/2011.

YEAR	REHABILITATION CELLS	EXTRACTION CELLS
2012	R1	E1
2013	R2	E2
2014	R3	E3
2015	R4	E4
2016	R5	E5
2017	R6	E6
2018	R7	E7 (extraction complete)
2019	R8 (rehabilitation complete)	
2020	Maintenance R6 and R7	
2021	Maintenance R7	



Scale 1:3000 at A3		FIGURE 4	
Designed by JC	Checked by JC	Date Drawn 15/02/2011	Job No 201279
Consultants HARVEST SCIENTIFIC SERVICES		Project M Collins Sand and Soil EIA	
Client M Collins and Sons Pty Ltd (Contractors)		Council Camden	

3.3. Vegetation

The proposed 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 area proposed to be extracted has been extensively modified through historic clearing and ongoing agricultural activities. The proposed extraction area is currently utilised for the growing of Lucerne.

Bank of the Nepean River

Vegetation immediately to the west of the proposed 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 Anabranh

Vegetation immediately to the east of the proposed extraction area along the dry banks of the anabranh 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.

3.4. Proposed impacts to native vegetation

The Proposal 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 proposed 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 proposed 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 Anabranh 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.

3.5. 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.

3.6. Hydrology

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

3.7. Adjacent land use

The site is primarily set in a rural area with surrounding land uses and features including the Camden Bypass to the north, the Nepean River to the west, a vineyard to the east and the existing extraction operations to the south.

4. QUARRY CLOSURE

At quarry closure, the site is proposed to consist of the following features:

- **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.** 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; and
- **Terminal sedimentation pond.** The proposed terminal sedimentation pond is proposed 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 proposed agricultural land beyond the life of the extraction project.

The locations of the above features are depicted on **Figure 3**.

5. RESTORATION PROGRAM

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.

5.1. Restoration zones

The site can be divided into three distinct zones (**Figure 3**) that will require different vegetation management, these are:

Zone 1a-b (Nepean River) – This zone incorporates a block of remnant Riparian Forest alongside the Nepean River. This area will require 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 will involve 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 proposed to be continued to be used for agricultural production land-uses.

5.2. Staging of extraction and rehabilitation

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

- A Active extraction 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 an 8 year period (completion in 2019).

The staging proposal is illustrated on **Figure 4**.

5.3. Noise generating re-vegetation activities

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

5.4. Riparian corridor zones of the Water Management Act

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

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

Permanent fencing will provide for 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 DECCW and the DEWHA recovery plans for the 'River Flat Eucalypt Forest on Coastal Floodplains'.

Signage will be 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 will allow 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 follow 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 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 should 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 need to 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 will be removed by hand systematically as part of the management of natural areas. Litter created in the process of revegetation will be removed as an ongoing process and at completion of planting.

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 (2012)**.

5.6.1. Soil preparation

Zones 1b (Nepean River – proposed plantings) and 2b (Dry Anabranh – proposed plantings) (Figure 3)

All battered re-vegetation areas are to be covered to a minimum depth of 500 mm with a clean weed free top soil. Preferably the tailing soils, which remain after the top soil has been processed will be used for this purpose. 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 should 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.

Zones 3 (Figure 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 - 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-pilled 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.

5.7. Re-vegetation program

Zones 1 (Nepean River – proposed plantings) and 2 (Dry Anabranh – proposed plantings) (Figure 3)

To implement the LMP and achieve OEH targets it is recommended that a combination of revegetation techniques be employed throughout Restoration Zones 1 and 2 (**Figure 3**). Each of the techniques proposed 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 should be 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.

Zones 3 (Figure 3) Agricultural production areas

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

5.7.1. Seed collection

To allow for enough lead-in time for the propagation of local provenance species, seed collection should 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 should 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 should 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.

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 need to 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 DECCW 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 should be utilised throughout the development of the vegetation in bushland areas and in revegetation. Stems and branches should 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 need to predominantly be maintained by hand weeding. When placing the materials out the maintenance capacity of the program should be considered.

5.8. Species for use in re-vegetation activities

The species outlined in **Table 1** are recommended 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 1: Plant schedule for revegetation program

Botanical Name	Common Name	Density	Revegetation Activity
Canopy:			
<i>Angophora subvelutina</i>	Broad-leaved apple	1 per 5m ²	Planting/ brush matting/ broadcasting
<i>Casuarina cunninghamiana</i>	River-oak	1 per 5m ²	Planting/ brush matting/ broadcasting
<i>Eucalyptus amplifolia</i>	Cabbage gum	1 per 10m ²	Planting/ brush matting/ broadcasting
<i>Eucalyptus elata</i>	River peppermint	1 per 10m ²	Planting/ brush matting/ broadcasting
<i>Eucalyptus tereticornis</i>	Forest red gum	1 per 10m ²	Planting/ brush matting/ broadcasting
<i>Melia azedarach</i>	White Ceder	1 per 10m ²	Planting/ brush matting/ broadcasting
Middle Storey:			
<i>Acacia parramattensis</i>	Parramatta green wattle	1 per 2m ²	Planting/ brush matting/ broadcasting
<i>Acacia floribunda</i>	Sally Wattle	1 per 2m ²	Planting/ brush matting/ broadcasting
<i>Acacia decurrens</i>	Sydney Green Wattle	1 per 2m ²	Planting/ brush matting/ broadcasting
<i>Backhousia myrtifolia</i>	Grey Myrtle	1 per m ²	Planting
<i>Baeckea linifolia</i>		1 per m ²	Planting/ brush matting /clumps
<i>Bursaria spinosa</i>	Black thorn	1 per m ²	Planting/ brush matting /clumps
<i>Callistemon salignus</i>	Willow bottlebrush	1 per m ²	Planting/ brush matting /clumps/ broadcasting
<i>Commersonia fraseri</i>	Native Hemp	1 per 10m ²	
<i>Dodonaea triquetra</i>	Hop Bush	1 per m ²	Planting
<i>Ficus coronata</i>	Creek Sandpaper Fig	1 per 10m ²	Planting close to river bank
<i>Hymenanthera dentata</i>	Tree violet	1 per 2m ²	Planting/ clumps
<i>Kunzea ambigua</i>	Tickbush	1 per 2m ²	Planting/ brush matting /clumps/ broadcasting
<i>Leptospermum morrisonii</i>	Tea-tree	1 per m ²	Planting/ brush matting /clumps/ broadcasting

Botanical Name	Common Name	Density	Revegetation Activity
<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>	Course 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

Botanical Name	Common Name	Density	Revegetation Activity
<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>Stypandra 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 should be replaced and any remaining plants should 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 should be continually maintained to a weed free state through a weed spraying program which is guided by the weather conditions, season and site monitoring. Generally the site should 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 DECCW and the DEWHA 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.

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 are 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 should be contacted and stock piles of large trees, branches or trunks should 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 inturn 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 may need to be trialled. The entrance should face away from prevailing winds and rain. Boxes should 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).

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.

Table 2: Inside dimensions of nest boxes for some species that will use the general nest box design (all measurements are in millimetres. all depths are minimum).

	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

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 A provides a summary of the most appropriate weed treatments. Control of these plants usually requires several treatments and is most effective during summer.

Table 3 lists the noxious weeds identified on site while Appendix A provides a summary of recommended treatments.

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 3, below.

Table 3: Noxious weeds recorded in the Camden LGA area

Common name	Scientific name	Control category
Green Cestrum	<i>Cestrum parqui</i>	3
Alligator Weed	<i>Alternanthera philoxeroides</i>	3
African Box Thorn	<i>Lycium ferocissimum</i>	4
Small-leaved Privet	<i>Ligustrum sinense</i>	4
Large-leaved Privet	<i>Ligustrum lucidum</i>	4
Blackberry complex	<i>Rubus fruticosus sp. agg.</i>	4
Bridal Creeper	<i>Asparagus asparagoides</i>	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**) will be subjected to a comprehensive bush regeneration program. All bush regeneration should start as soon as practical. The site has scattered specimens of woody weeds which will be 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 will first work to recover resilient areas which are supporting a diversity of native plant species which demonstrate structural complexities characteristic of riparian forest. Work will then graduate from these areas to assist limits of riparian forest which are in a state of decline. Working in this manner will allow the program to utilise the local ecosystem functions as a fundamental tool to stimulate natural resilience, eventually providing the necessary recovery mechanisms required for the colonisation of adjacent revegetation areas with remnant flora and fauna.

The bush regeneration program will run the entire length of the overall restoration program. It is recommended that 41 primary bush regeneration sessions occur in the 24 months covering all areas. This will allow for an average 7 visits in each site over the first 24 months. Following the 24 month establishment period there will be 14 visits scheduled per year for all areas. It is anticipated that beyond the 2 year restoration program the number of visits will eventually reduce to 6 maintenance visits per year for the whole site.

A 2 year maintenance program will run concurrently with the bush regeneration program. **Table 4** below indicates the specific restoration actions to be incorporated into zones 1 and 2. All work sessions are based on a two person team.

Table 4: Specific Restoration Actions for Zone 1 Nepean River (Figure 3)

Item	Description of Rehabilitation Actions - Zone 1(a) – 0.79 ha	No. Required
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 - Zone 1(b) – 0.26 ha	No. required
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 days
6.	Report at practical completion	1 report
7.	Commence maintenance program	14 visits (all tasks)
8.	Broadcast seeding	1 days

Table 5: Specific Restoration Actions for Zone 2 Dry River Anabranh (Figure 3)

Item	Description of Rehabilitation Actions – Zone 2(a) – 0.51 ha	No. required
1.	Target Weed control	1 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 - Zone 2(b) – 0.55 ha	No. required
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 days
6.	Report at practical completion	1 report
7.	Commence maintenance program	20 visits (all tasks)

5.12. Monitoring and reporting

In order to accurately evaluate the success of the restoration works, Harvest Scientific Services recommends an initial report be prepared at ‘Practical Completion’ and then summary reports be prepared every twelve months throughout the two year maintenance period. These reports should be brief, approximately one page, and include a copy of the field monitoring sheet (or similar) in Appendix B. These reports will be provided to the client and Camden Council.

The monitoring and evaluation program should address the following issues:

- 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;
- Guard repair and weeding inside guards; and
- Maintenance watering regime.

Harvest Scientific Services Pty Ltd recommends that the above issues be monitored and evaluated through the establishment of one representative quadrat in each of the major vegetation communities at the practical completion stage. It is also essential to keep an accurate photo-record of the progress of the restoration works by setting up an appropriate number of representative fixed photo-points across all restoration zones. Photos should be taken by digital camera and recorded in the project file by date and discrete photo-point number. Photo-point locations should be clearly marked on site and mapped by GPS.

The six monthly monitoring reports should also contain recommendations by the restoration contractor to the client in regard to issues affecting the ongoing success, or otherwise, of the restoration works, and the possible need for additional activities that may be required outside the normal maintenance program.

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 is currently classified as '**Class 1**' agricultural land. This land 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 agricultural land. 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 Anabranh. 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 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.'

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 4**.

6.3. Conclusion

Based on an assessment of the protocols proposed for the re-instatement of areas proposed for agricultural land and an assessment of a comparable site whereby comparable protocols have been implemented, it is considered that implementation of the controls will result in the re-establishment of 'Class 1' Agricultural land.

The risk that the subject land will not be returned to Class 1 Agricultural land is therefore considered to be low.

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 Pty Ltd, 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 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 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**) and Dry River Anabranch (Zone 2 – **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 Anabranch (**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.

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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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- Environmental Planning and Assessment Act 1979* (NSW)
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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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- Greening Australia NSW Inc (1999) *Management Principles to Guide the Restoration and Rehabilitation of Indigenous Vegetation*, August 1999. Greening Australia.
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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 A

Summary of Weed Control Techniques

Table 1: Recommended 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>Cuscata sp.</i>	Environmental Weed	Hand remove.
Blackberry	<i>Rubus fruticosus</i> agg. Spp.	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/fruited 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	<i>Ligustrum lucidum</i>	Environmental	Cut and paint base of trunk or drill/chisel

Common Name	Botanical Name	Status	Removal Techniques
privet		Weed	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 Weed	Cut and paint base of trunk or drill/chisel trunk (>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.

Common Name	Botanical Name	Status	Removal Techniques
Wandering jew	<i>Tradescantia fluminensis</i>	Environmental Weed	Spot spray with 1:50 Roundup or Starane. It is photo-inhibited so should 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 B

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	0-10	10-50	50-85	85+			
Understorey	0-10	10-50	50-85	85+			
Ground cover	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)	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:

HARVEST SCIENTIFIC SERVICES PTY LTD

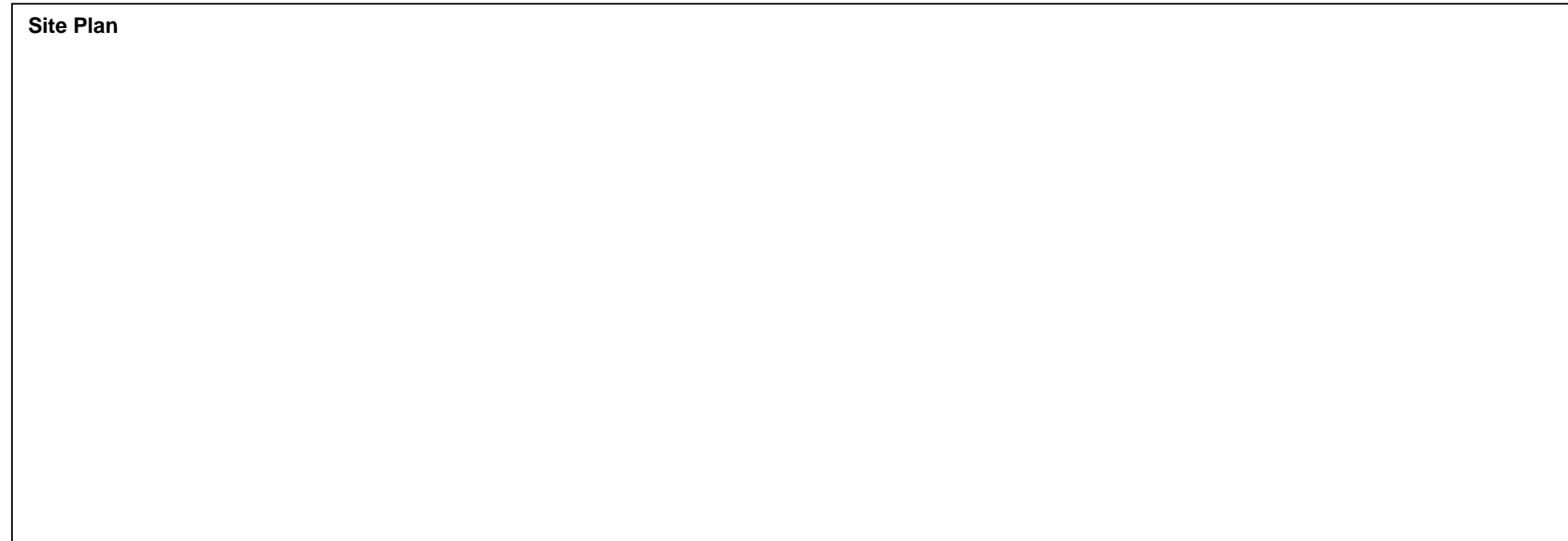
Number

Location

Direction

Comments:

Site Plan



APPENDIX C

DWE - Controlled Activity Approval for Lot 22 DP 833317



Office
of Water

Controlled Activity Approval

Water Management Act 2000

DA5075.960-2

File: PAR0151208

ERM04/4722

To: M. Collins & Sons (Contractors) Pty Limited
PO Box 55
MILPERRA NSW 2214

To Excavate or Remove:

A Maximum of 901,200m³ of Sand and Soil

From Protected Land in or near the Rivers known as:

Nepean River and the Anabranh

At the Site Described as:

The "Nesbitt Property", Lot 22 DP 833317, Parish of Narellan, County of Camden (the Site).

Permit Expires: 8 April 2013

This Controlled Activities Approval (CAA) is granted under the Water Management Act 2000 as amended and is subject to the following conditions:

Area and Extent of Operation

1. The location and nature of the operation as shown on the endorsed plan number JET0328 drawing numbers 11 (issue 3) and 12 to 16 (inclusive and all issue 2) shall not be altered. One copy of the plans has been issued to you, and to Council, and a copy is retained in the NSW office of Water (NOW) (formerly know as the Department of Natural Resources DNR).
2. No operations shall be undertaken outside the area shown in red on the endorsed plans.
3. Operations shall be undertaken in such a manner that no excavation takes place below the limit lines shown in red on the endorsed plans, with the exception of the construction of temporary runoff traps as defined in Schedule 1.

4. Operations shall not take place on the river bank at a level of less than 3 metres above normal low flow water level. Low flow water level shall be defined as the broad crest height of Camden Weir, being **RL 55.63 m AHD**.
5. The surface of the excavated area shall be progressively graded to a smooth and even slope free from holes or ridges. The slope shall drain towards the river at grades consistent with those shown on the endorsed plans. No slopes shall be flatter than a grade of **1V:50H** within 50 m of the top of the river bank, or steeper than a grade of **1V:3H**.
6. This CAA is only valid for operations on freehold land. The CAA is null and void for any operation on Crown Land.

Survey Information

7. A permanent bench mark is to be established on the Site and outside the area of operations.
8. The cross sections shown on the endorsed plans shall be marked permanently on Site and outside the area of operations. Markers shall consist of steel star pickets painted white and set firmly in the ground in concrete.
9. Work as executed survey plans of a satisfactory standard shall be provided to NOW on request.

Site Water & Sediment Runoff Management

10. Site drainage and erosion control measures in accordance with **Schedule 1** of this CAA shall be implemented prior to commencement of, and during the course of, operations, and shall be maintained in good working order.

Method of Operation

11. Operations shall commence at the downstream end of the Site and progress in an upstream direction for Areas 1 and 2, and thereafter follow the sequence of extraction as indicated by Areas, on drawing number 11. Separate and concurrent extraction from elsewhere on the Site is not permitted without written approval from NOW.
12. Operations shall be undertaken in successive stages, with no more than 100 metres of the river bank or Anabranche being excavated at any one time.
13. Operations shall not damage or interfere in any way with:
 - vegetation and habitat on the river bank up to a level of 3 metres above low flow water level
 - vegetation and habitat outside the area of operation
 - the stability of adjacent or nearby river banks or bed
 - the flow of water in the river
 - the quality of water in the river
 - any pumps or structures in the vicinity
14. Excavated material shall be transported from the area of operation or shall be stored on the adjacent floodplain. Where material is stored, the stockpile shall be no larger than 14 days supply. All stockpiled material shall be removed if the operation ceases.

15. All scrub, undergrowth and timber removed from the area of operation shall be mulched and stored above flood height, or otherwise disposed of, so that the debris cannot be swept back into the stream during a flood. Burning shall not be carried out unless a permit is obtained from the relevant authority.
16. If any work is detrimentally affecting the river, the Anabranche or their environment, NOW may direct all operations to cease immediately.

Site Rehabilitation

17. Rehabilitation of the Site shall be undertaken progressively in accordance with **Schedule 2** of this CAA. Rehabilitation is to be completed prior to the operation ceasing. Maintenance of the rehabilitation works shall continue until a standard that is satisfactory to NOW has been achieved.
18. Rehabilitation of the area is the responsibility of the CAA holder and the owner or occupier of the land.

Monitoring and Maintenance Report

19. A brief and concise monitoring and maintenance report shall be forwarded to NOW every twelve months for the length of the maintenance period. The report shall include the results of monitoring of the implementation of **Schedule 2** of this CAA as required by these conditions. The report shall also describe any problems implementing **Schedule 2** of this CAA and means to overcome these.

Bonds

20. The bond provided, for the amount of \$43,850.00, equal to the cost of decommissioning any temporary sediment and erosion controls, completing earthworks in accordance with the endorsed plans, and the rehabilitation and maintenance of the Site as required by these conditions, will be held until such time as the rehabilitation works and any specified maintenance period are completed to the satisfaction of NOW.
21. The sum held may be reduced on application to NOW, subject to the satisfactory completion of "stages" of the extraction and rehabilitation works.
22. A sum of money, being not less than 25% of the total amount of the bond, will be held by NOW for a minimum period of 24 months after completion of all works. The money will be released upon satisfactory performance of the works and completion of vegetation establishment and maintenance over the area affected by the works.
23. NOW may at any time, and more than once and without notice to the Part 3A CAA holder, draw on all or part of the moneys available under the bond, if in its opinion, the CAA holder has failed at any time to satisfactorily complete the extraction, decommission any temporary sediment and erosion controls or to rehabilitate and maintain the Site in accordance with these conditions, as determined by NOW.

Controlled Activity Approval Breaches

24. If any CAA condition is breached, the CAA holder shall follow NOW directions to address the breach and shall rehabilitate the Site as directed by, and to the satisfaction of, NOW. If any breach of the CAA conditions requires a special site inspection by NOW, then the CAA holder shall pay a supplementary CAAfee for this inspection and for each and every subsequent inspection until the breach has been rectified.

Other Approvals

25. This CAA does not allow an extractive industry at the Site unless a current development consent or an existing use determination has been obtained from Council.
26. This CAA does not relieve you of any obligation which may exist to also obtain permission from other authorities who may have some form of control over the Site and or the operation that you propose to undertake.
27. A licence is required from this Department if you intend to:
- install a pump
 - construct a dam
 - construct a levee
 - divert the river

Resolution of Inconsistencies


28. In the event that there is an inconsistency between the drawings, other documentation and the conditions herein, the interpretation that will result in the best outcome for the stabilisation of the Site and the subsequent rehabilitation and maintenance of the Site and protected land and any river, is to prevail. Such interpretation is to be applied in consultation with, and with the approval of, NOW.

CAA to be kept Current

29. This CAA is to be kept current by payment of the appropriate fee until such time as the Site has been fully stabilised and rehabilitated, and any required maintenance satisfactorily completed and reported on, in accordance with these conditions.
30. Any application for renewal of the CAA is to be lodged at least **one month** prior to the expiry date of the CAA.

Miscellaneous

31. The CAA holder and the owner or occupier of the land is responsible for any excavation or removal of material undertaken by any other person or company at the Site.
32. The CAA holder shall notify NOW in writing within 7 days of any change in:
 - site management
 - land ownership
 - land occupation
33. NOW is to be notified in writing three months in advance if the operation is to cease.
34. A copy of this CAA must be displayed at the Site office at all times or alternatively made available on Site to Department officers on request.



Mohammed Ismail
Natural Resource Project Officer
Licensing South

Address all correspondence to:
Mohammed Ismail
Natural Resource Project Officer
NSW Office of Water
PO Box 3720
PARRAMATTA NSW 2124

SCHEDULE 1

Site Water and Sediment Runoff Management

Preamble

The aim of Site water and sediment runoff management is to minimise the amount of sediment and dirty water that can enter the river system and thereby detrimentally affect the downstream environment. The requirements below are basic only and all designs are to follow current engineering standards and be in accordance with the Landcom publication "*Managing Urban Stormwater: Soils and Construction – Volume 1, 4th Edition (2004)*". All erosion and sediment controls are to meet the requirements of the Environmental Protection Authority.

Site Runoff

- A.** All runoff from the Site, or other streams or drains passing through disturbed areas, shall be conveyed by pipe or lined channel to the base of the river bank.
- B.** The outlet of any drainage line shall not induce scour of the river bed or banks.

Sediment Control

- A.** Runoff from the Site of operations shall be intercepted by a catch drain or diversion bank and shall be directed to an appropriately designed and located sediment control structure.
- B.** There shall be no more than one sediment control structure within the area being worked. Any such structure shall:
- be no closer than 20 metres to the top of the river bank
 - have a maximum depth of 2 metres and shall not intercept the water table
 - have a maximum volume not exceeding that designed for the disturbed area
 - have a filter fencing baffle intercepting flow through the outlet
 - be regularly de-silted so as to maintain at least 60 percent capacity at all times
 - be filled in and the Site rehabilitated as the operation progresses
- C.** A filter fence of an appropriate geofabric shall be installed on the Site downslope of all disturbed areas prior to the commencement of earthworks. Any such structure shall:
- have its base buried upslope to a minimum depth of 20 centimetres.
 - be replaced as required.
 - be regularly cleaned of accumulated sediment.
- D.** All sediment and erosion control structures shall be inspected following any local storm event and any necessary maintenance shall be undertaken to ensure the continued proper operation of the structures.

SCHEDULE 2

Site Rehabilitation

Preamble

The aim of rehabilitation of the area of operations is to produce a healthy area of local native vegetation and habitat along the river. Revegetation is to aim at structural diversity using a mix of native tree, shrub, groundcover and grass species local to the area.

Rehabilitation of the Site is to be undertaken progressively in accordance with this schedule and is to be completed prior to the operation ceasing. Follow-up maintenance will be required.

Rehabilitation of that part of the Site located on Lot 1 DP 587631 "Spring Farm" shall be in accordance with the requirements of the consent for the Site made on 1 May 1995, as amended, and the Landscape Plan of Management, but shall not be of a lesser standard than that described below.

Topsoil

- A. A quantity of the original excavated topsoil sufficient to cover all areas of operation to a depth of 100 mm must be retained on Site. The topsoil is to be stored in low heaps to allow survival of soil organisms.
- B. The topsoil shall be progressively spread over the area where operations have been completed.
- C. Prior to spreading the topsoil, the subsoil shall be prepared by roughening.
- D. The area covered in topsoil shall be contour ploughed, re-grassed and maintained to prevent erosion.

Grass Cover

- E. Grassing is to comprise of a cover crop of the following species:

<i>Type</i>	<i>Spring/Summer Sowing</i>	<i>Autumn/Winter Sowing</i>
Japanese Millet	20 kg/ha	---
Ryecorn/Barley	---	30 kg/ha
Red Clover	4 kg/ha	4 kg/ha
White Clover	4 kg/ha	4 kg/ha

Wimmera Rye	10 kg/ha	---	
Perennial Rye	---	10 kg/ha	
Couch (hulled/unhulled)	8/8 kg/ha (hulled/unhulled)	8/8	kg/ha

Note: Kikuyu is not to be used as it is a vigorous choking perennial that will out-compete native species.

F. Supplementary planting of local *native* grass and groundcover species shall be undertaken using locally collected seed consisting of species selected from the list below:

<i>Aristida</i> spp.	Three-awned Spear Grass
<i>Cymbopogon refractus</i>	Barbed-wire Grass
<i>Danthonia pilosa</i> var. <i>pilosa</i>	Wallaby Grass
<i>Dichelachne micrantha</i>	Plume Grass
<i>Echinopogon</i> spp.	Hedgehog Grass
<i>Ghania</i> spp.	Saw Sedge
<i>Imperata cylindrica</i>	Blady Grass
<i>Kennedia rubicunda</i>	Dusky Coral Pea
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
<i>Microlaena stipoides</i>	Weeping Meadow Grass
<i>Oplismenus aemulus</i>	Basket Grass
<i>Pteridium esculentum</i>	Bracken Fern
<i>Stipa ramosissima</i>	Stout Bamboo Grass
<i>Themeda australis</i>	Kangaroo Grass

Appropriate for planting on the bank and along the toe of the bank:

<i>Baumea</i> spp.	Twig-rushes
<i>Carex</i> spp.	Sedges
<i>Eleocharis</i> spp.	Spike rushes
<i>Juncus</i> spp.	Rushes
<i>Lepidosperma</i> spp.	Sword-sedges
<i>Restio</i> spp.	Cord-rushes
<i>Schoenoplectus</i> spp.	Club-rushes
<i>Schoenus</i> spp.	Bog-rushes

Trees and Shrubs

G. The following species shall be propagated from locally collected seed:

Trees

<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Casuarina cunninghamiana</i>	River Oak

<i>Eucalyptus amplifolia</i>	Cabbage Gum
<i>Eucalyptus bauerana</i>	Blue Box
<i>Eucalyptus elata</i>	River Pepperment
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus viminalis</i>	Ribbon Gum, Manna
Gum	

Shrubs

<i>Acacia binervia</i> (prev. <i>A. glaucescens</i>)	Coast Myall
<i>Acacia decurrens</i>	Green Wattle
<i>Acacia floribunda</i>	Sally Wattle
<i>Acacia parramattensis</i>	Sydney Green Wattle
<i>Commersonia fraseri</i>	Black-fellow's Hemp
<i>Hymenathera dentata</i>	Tree Violet, Scrub Box
<i>Callistemon viminalis</i>	Bottle Brush
<i>Leptospermum polygalyfolium</i> (prev. <i>L. flavescens</i>)	Yellow Tea-tree
<i>Tristaniopsis laurina</i>	Water Gum

H. Native tree and shrub species are to be established on the banks of the Nepean River as follows:

- no more than 2 m apart
- in at least 16 staggered rows no more than 2 m apart
- to cover a strip 30 m wide from the top the river bank
- plant only *Casuarina*, *Leptospermum* and *Tristaniopsis* species in the three rows closest to the river
- with an even mix of all other shrub and tree species in remaining rows
- existing small native plants and seedlings growing on the area to be excavated are to be transplanted to the area being restored
- existing native trees and shrubs, when felled, are to have seeding branches collected and spread over the area under restoration

I. Native tree and shrub species are to be established on the western bank of the Anabranck, and across it near the access track at the northern boundary, to supplement existing native vegetation, as follows:

- no more than 2 m apart
- in staggered rows no more than 2 m apart
- to form a strip on the "Nesbitt" property at least 20 m wide, and on the "Spring Farm" property at least 50 m wide, from the top of the bank
- plant tree and shrub species listed except for the last three shrub species
- plant grass species as listed

General

J. The use of fertilizers shall be minimised in order to reduce the influx of nutrients to the river system. If used at all, fertilizers are to be low P types, and slow release, such as Agriform Tablets, Kokei Pellets, Osmocote, etc.. Pellets, if used, are to be placed at least 100 mm beneath the root tip of seedlings being planted.

K. The vegetation shall be regularly watered and protected against predators such as hares and rabbits).

L. The rehabilitated area shall be regularly weeded of exotic plant species.

M. A stock proof fence shall be constructed and maintained around the replanted site.

APPENDIX D

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&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 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.

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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

1. INTRODUCTION

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2. AIMS AND OBJECTIVES

The 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.

3. METHODOLOGY

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**.

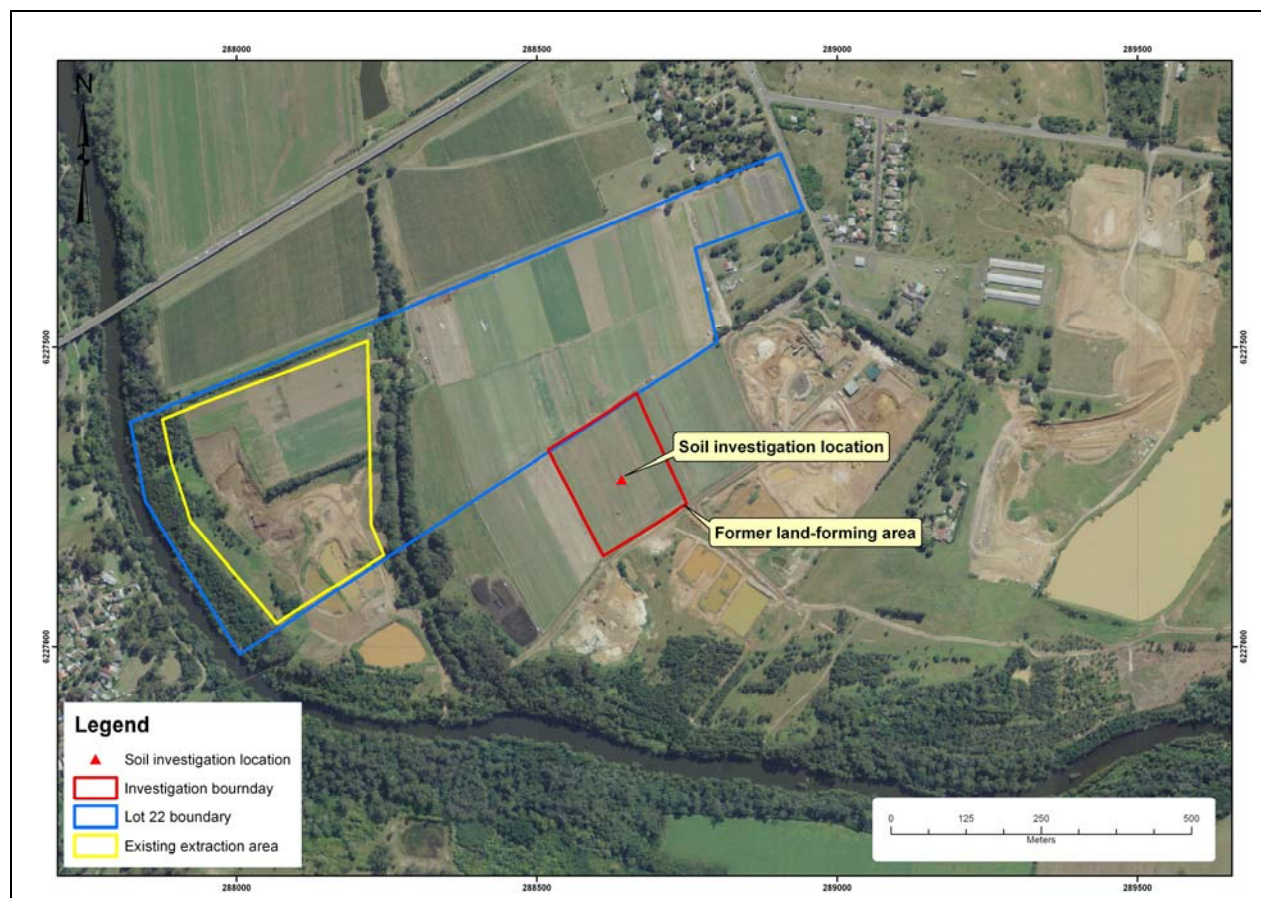


Figure 1. Site location (Lot 22 DP833317). Source: Department of Lands circa 2008.

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". The signature is written in a cursive, flowing 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.