Hornsby Quarry Rehabilitation
DA Deferral Submissions Report

(Response to Sydney North Planning Panel Record of Deferral - 8 May 2020)

Prepare by Hornsby Shire Council
July 2020

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1. Introduction

Hornsby Shire Council submitted the following Development Application No. DA/101/2019 – Rehabilitation of the existing Hornsby Quarry involving bulk earthworks (and associated civil works including construction of access tracks, drainage and retaining walls), site remediation, tree removal, revegetation work and site rehabilitation - Lot A DP 318676, Lot B DP 318676, Lot C DP 318676, Lot D DP 318676, Lot E DP 318676, Lot 1 DP 926103, Lot 1 DP 926449, Lot 1 DP 114323, Lot 1 DP 169188, Lot 2 DP 169188, Lot 7306 DP 1157797, Lot 1 DP 859646, Lot 11 DP 258657, Lot 9 DP 264621, Lot 3 DP 575390, Lot 13 DP 734459, Lot 404 DP 788628, Lot 114 DP 749606, Lot 213 DP 713249, Hornsby Quarry, HORNSBY to the Sydney North Panning Panel for consent conditions in early 2020.

The Sydney North Planning Panel at its meeting on 6 May 2020, determined to defer its decision on DA101/2019 pending the Applicant carrying out additional works. The Hornsby Shire Council project team have now completed these additional investigations and have prepared this Hornsby Quarry Rehabilitation DA Deferral Submissions Report for public exhibition and finalisation before submitting a final report to the Sydney North Planning Panel later this year.

2. Record of Deferral Sydney North Planning Panel

NSW GOVERNMENT Planning Panels

RECORD OF DEFERRAL
SYDNEY NORTH PLANNING PANEL

DATE OF DEFERRAL	8 May 2020
PANEL MEMBERS	Peter Debnam (Chair), Julie Savet Ward, Sue Francis, David White, Ross Walker
APOLOGIES	Brian Kirk
DECLARATIONS OF INTEREST	None

Public meeting held via teleconference on 6 May 2020, opened at 1.05pm and closed at 4.08pm.

MATTER DEFERRED
2019SNH025 – Hornsby – DA101/2019 for rehabilitation of existing Hornsby Quarry (as described in Schedule 1)

REASONS FOR DEFERRAL
The Panel acknowledged the application provided substantial information on the proposed rehabilitation of the Hornsby Quarry and has considerable merit in laying the groundwork for a unique and major recreational area in the Hornsby Shire.

However, the Panel noted that several key issues of significant public interest are sufficiently unresolved and the Deferred Commencement Conditions set out in the Assessment Report do not provide the Panel or the public with the necessary certainty in the outcomes. Consequently, the Panel deferred the Application so the Applicant can:

1. Complete the Biodiversity Offset Package, Vegetation Management Plan, Habitat Creation and Enhancement Plan, to the level of detail described in the Deferred Commencement Conditions in the Assessment Report, and submit those documents for public exhibition and finalisation;

2. Provide a definitive plan outlining protection measures, including the extent and scheduling of works, for the maximum possible buffer zone around the Powerful Owl breeding pair's roosting tree in the Northern Spoil Mound, and submit this plan for public exhibition and finalisation;

3. Provide additional information regarding staging of the project. The Staging Plan should address works, stabilisation, rehabilitation and revegetation required in each stage as well as how each stage relates to other stages across the site; and

4. Provide further information on the Volcanic Diatreme located on the eastern face of the quarry void. The Diatreme must be clearly identified on relevant plans and cross sections and the Panel needs advice from the Applicant regarding how the Diatreme is incorporated in the proposal in terms of the level of fill, treatment, rehabilitation and protection whilst appropriately reflecting it's geological significance. The Panel recommends this work be undertaken in consultation with geological societies who have the appropriate expertise in this field.

5. Make any subsequent changes to the proposed rehabilitation of the Hornsby Quarry as a result of the above.

The Panel believes the above information could be finalised in the next few months and once the information has been provided to Council, a Supplementary Assessment Report prepared by the independent planner should be provided to the Panel as soon as possible. The Panel Chair will then convene a further public meeting to determine the application.

The decision to defer the matter was unanimous.

PANEL MEMBERS	
 Peter Debnam (Chair)	 Julie Savet Ward
 Sue Francis	 David White
 Ross Walker (OAM)	

3. Biodiversity Offset Package, Final Draft Vegetation Management Plan and Habitat Creation and Enhancement Plan

Condition from Record of Deferral:

> *"Complete the Biodiversity Offset Package, Vegetation Management Plan, Habitat Creation and Enhancement Plan, to the level of detail described in the Deferred Commencement Conditions in the Assessment Report, and submit those documents for public exhibition and finalisation.*

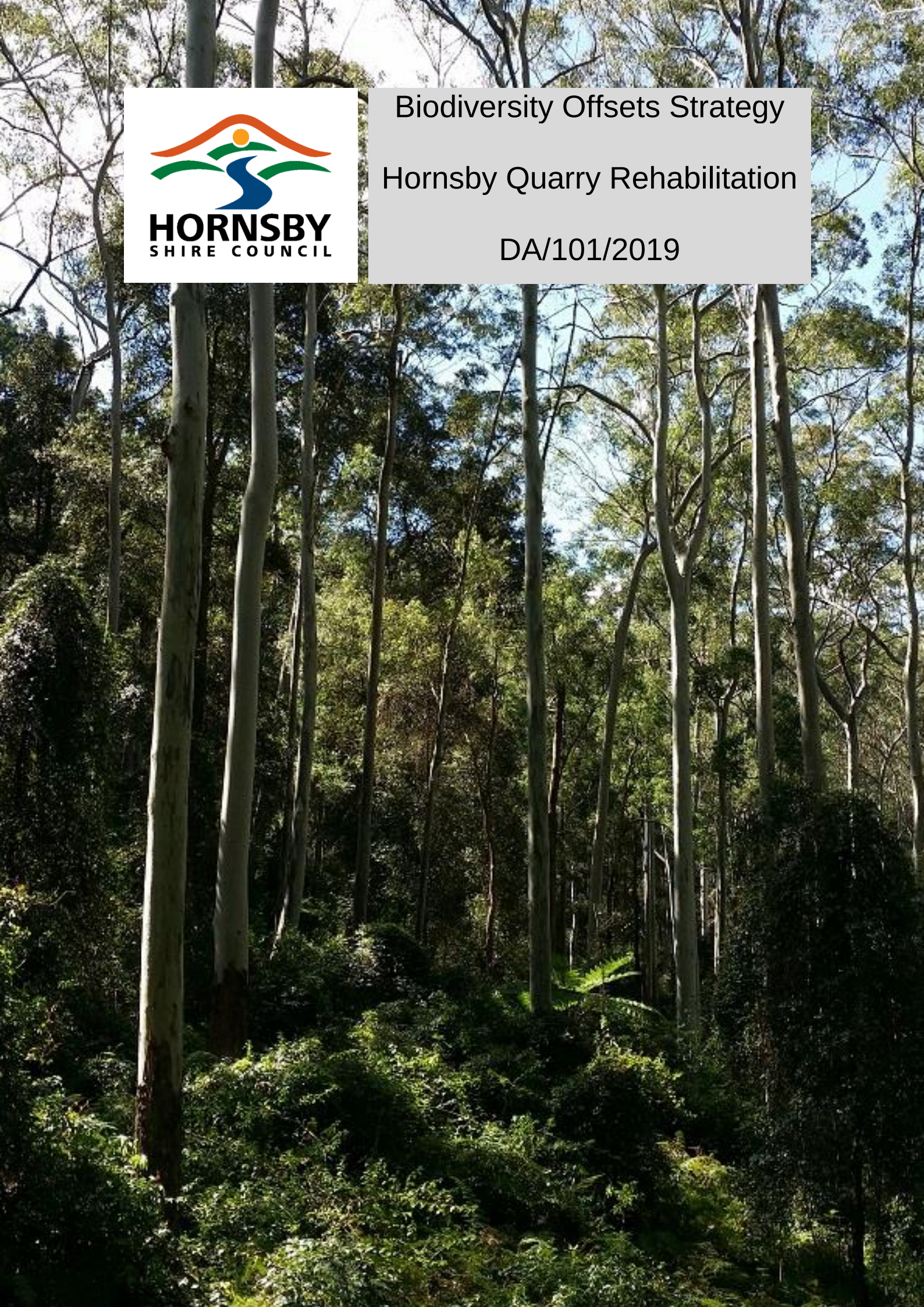
Biodiversity Offset Strategy
During the preparation of the Biodiversity Offset Strategy, Council has liaised and consulted with the NSW Biodiversity Conservation Trust (BCT). The BCT has indicated in principle support for the use of a Voluntary Conservation Agreement on the site, including a Vegetation Management Plan/Habitat Creation and Enhancement Plan. Furthermore, Council engaged an independent third party, an expert ecological consultancy, to peer review the Biodiversity Offset Strategy to ensure compliance with NSW OEH's SEARs.

Vegetation Management Plan (VMP) and Habitat Creation and Enhancement Plan (HCEP)
The preparation of Vegetation Management Plan (VMP) and Habitat Creation and Enhancement Plan (HCEP) included extensive consultation and review with Dr. Beth Mott from Birdlife Australia (a recognised expert on Powerful Owls). Council also engaged an environmental consultancy, Gecko Environment Management, to assist in the preparation of the plan, with a specific focus on fauna assessment and mitigation measures.

Condition from Record of Deferral:

> *Provide a definitive plan outlining protection measures, including the extent and scheduling of works, for the maximum possible buffer zone around the Powerful Owl breeding pair's roosting tree in the Northern Spoil Mound, and submit this plan for public exhibition and finalisation.*

Council consulted with Dr. Beth Mott from Birdlife Australia to provide input into the development of the VMP and HCEP. The document incorporates measures for the protection and habitat creation for the Powerful Owls, during the earthworks and operational phase of the development. Recommendations relate to the staging of earthworks and exclusion zones, with consideration to the Owl's breeding cycle. Post works habitat creation and appropriate vegetation management practises are also stipulated. The protection measures are contained in the VMP and HCEP.



Biodiversity Offsets Strategy

Hornsby Quarry Rehabilitation

DA/101/2019

Revision	Date	Details
A	17/07/2020	Final draft issued for exhibition

Executive Summary

The purpose of this Biodiversity Offset Strategy for the Hornsby Quarry Rehabilitation project (DA/101/2019) is to identify the most suitable offset mechanism to provide the best environmental outcomes for the Hornsby Quarry site in perpetuity; outline the offsetting actions to be implemented to adequately offset for impacts on biodiversity values, including vegetation and habitat; and demonstrate compliance with the NSW Office of Environment and Heritage requirements.

Hornsby Quarry is located on an old volcanic diatreme consisting of a hard breccia rock that was sought for road base and aggregate materials. The quarrying activities continued throughout the 1900s ceasing in the 1990s. The Site was later acquired by Council in 2002 in an un-remediated state. The cessation of mining activities left some areas of the quarry benches, embankments and infrastructure in an unsafe condition and the remediation of these high-risk areas is a principal predominant objective of the current development proposal.

The presence of a diatreme and its volcanic soils are a unique environmental characteristic of the site. Vegetation mapping of Hornsby Shire has previously noted the presence of several native vegetation communities within the quarry and surrounding lands being Blue Gum High Forest on the diatreme soils and Blackbutt Gully Forest located on the enriched sandstone soils. Blackbutt Gully Forest has been identified of local significance while Blue Gum High Forest is listed as a Critically Endangered Ecological Community under the NSW Biodiversity Conservation Act 2016. The Blue Gum High Forest on this site is of particularly high conservation significance due to its occurrence on diatreme soils, the singular occurrence of this ecological community in the Sydney basin bioregion.

The Hornsby Quarry Rehabilitation project (DA/101/2019) required an Environmental Impact Statement (EIS) to be prepared. This EIS included a Biodiversity Impact Assessment in accordance with the requirements of the Secretary's Environmental Assessment Requirements (EAR) issued by the NSW Office of Environment and Heritage (OEH) (EAR 1167, dated 31/8/17). The assessment concluded that there will be a residual impact on biodiversity values. With consideration of the EAR, this Biodiversity Offsets Strategy has been developed in accordance with Council's Green Offsets Code and estimates that approximately 24 ha is required to be offset (refer to Table. 5, Appendix.1).

This Biodiversity Offsets Strategy gives direction for the preparation of several supporting plans (identified below) that deliver an appropriate offset. Priority has been given to the delivery of an offset strategy that ensures offsets occur locally and are managed and protected in-perpetuity. To ensure that offsets occur locally the quarry and surrounding lands have been identified as a suitable offset recipient site. The ongoing management of the offset areas will be directed through a Vegetation Management Plan (VMP) which will extend beyond the offset area into adjacent bushland within the Hornsby Quarry site. The VMP incorporates a Habitat Creation and Enhancement Plan (HCEP). In-perpetuity protection of the offset areas will be provided by a Voluntary Conservation Agreement (VCA) which will comprise the offset area and additional lands managed under the VMP. The VCA will be co-signed by Hornsby Council and the NSW Biodiversity Conservation Trust and will include the VMP and HCEP.

This Biodiversity Offset Strategy details the offsetting actions to be implemented to adequately offset for impacts on biodiversity values, including vegetation and habitat. In doing so, consideration has been given to

any conditions of approval, consultation with government agencies and the EAR 1167. Section 3 of this strategy discusses the assessment undertaken using the BioBanking Assessment Methodology (BBAM) and extent of impacts to address 1.b of the EAR, Section 4 discusses the offset options and conservation mechanisms to address 1.c of the EAR, Section 5 identifies the preferred offset strategy within which Table 6 addresses the 13 OEH offsetting principles to address 1.a of the EAR and Section 6 provides a statement of commitment to address 1.d of the EAR.

Contents

Abbreviations and acronyms

BBAM	BioBanking Assessment Methodology
BBGF	Blackbutt Gully Forest
BCT	Biodiversity Conservation Trust
BGHF	Blue Gum High Forest
BOS	Biodiversity Offsets Scheme
BSA	Biodiversity Stewardship Agreement
CEEC	Critically Endangered Ecological Community
CSA	Conservation Significance Assessment map
EAR	Secretary's Environmental Assessment Requirements (also SEAR)
EIS	Environmental Impact Statement
GOC	Green Offsets Code (HSC 2015)
HDCP	Hornsby Development Control Plan 2013
OEH	NSW Office of Environment and Heritage
TFD	Total Fund Deposit (for Biodiversity Stewardship Site management fund)
VCA	Voluntary Conservation Agreement
VMP	Vegetation Management Plan

1 Project Background

The main objective of DA/101/2019 is for the rehabilitation and reshaping of land within Hornsby Quarry. The rehabilitation actions have taken into consideration a desired future landform for the site that enables development of a regional parkland supporting active and passive recreational activities within a natural setting. Initial rehabilitation actions have included the partial filling of the quarry void with spoil generated from the NorthConnex project. Further rehabilitation works and landform modification under this development application includes excavation of the north spoil mound to resolve geotechnical instability and public safety issues and general earthworks to provide a platform suitable for parkland embellishment.

While the site has been impacted by historical quarrying activities the Hornsby Quarry, Old Mans Valley and Hornsby Park precinct still contains over 42 hectares of vegetation (both native and exotic) and habitat of varying condition. The Hornsby Quarry project site pertaining to this development application occupies approximately 10 hectares including the quarry void, hardstand area, roads and vegetation. Project design has given consideration to avoiding and minimising impacts on vegetation and habitat (Refer to Table.1). However, the filling and geotechnical works required to make the site safe will have a residual impact on this native vegetation and habitat.

The vegetation to be impacted by the Hornsby Quarry Rehabilitation project comprises 1.54 hectares of native vegetation (of varying condition) and 2.31 hectares of exotic vegetation and habitat. The 1.54 hectares of native vegetation to be impacted comprises 0.68 hectares of Blue Gum High Forest on diatreme soils which is listed as a Critically Endangered Ecological Community under the NSW *Biodiversity Conservation Act 2016*. Vegetation on the site was also noted as providing habitat for several threatened fauna species.

2 Conditions of approval

In preparing the Environmental Impact Statement (EIS) for the Hornsby Quarry Rehabilitation project, a request for EAR's was made to the NSW Office of Environment and Heritage (OEH). EAR 1167 was issued by OEH on 31/8/17, specifically outlining the requirements regarding biodiversity and offsetting. Under the heading Biodiversity, the EAR's state:

OEH further recommends that the proposal be designed to avoid and minimise impacts on biodiversity and offset remaining direct and indirect biodiversity impacts. In determining an appropriate offset package, it is recommended that the EIS:

a. Accord with the 13 OEH offsetting principles (see Section 5.2 for detail) available at http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.thm

b. Use the BioBanking Assessment Method (OEH, 2014) to determine the quantum of offsets required to compensate for those remaining biodiversity impacts, including credit report.

c. Identify the conservation mechanisms to be used to ensure the in-perpetuity protection and management of proposed offset sites

d. Include a specific Statement of Commitments for the proposed offsets package which is informed by a., b., and c. above and by any consultation with OEH.

3 Offsetting Requirements and Options

3.1 Extent of impacts

The Biodiversity Impact Assessment (EIS, Attachment F) report prepared by GHD for DA/101/2019 (dated December 2018) has noted that the extent of vegetation clearing associated with the project comprises 2.5 ha of native vegetation, including 0.74 ha Blue Gum High Forest (BGHF), and 3.39 ha of exotic vegetation for a total loss of 5.89 ha of vegetation and habitat. The report also demonstrates how the project design has sought to avoid and minimise impacts on biodiversity values. Subsequent refinement between December 2018 and 2019 has reduced the extent of impact on vegetation to 3.85 ha (Refer to Table 1). This outcome of avoiding and minimising impacts is consistent with OEH's offsetting principles (a requirement of the EAR's) and Hornsby Council's Development Control Plan 2013 (HDCP).

Table 1: Extent of impacts on vegetation communities.

		Clearing area (ha)			
Plant Community Type (PCT) and Zone ID	**Vegetation Community and Condition**	**Feb 2018 (Early concept)**	**Sept 2018**	**Dec 2018 (DA/EIS)**	**Dec 2019 (RtS)**
1841 & HN648	Blackbutt Gully Forest (BBGF) Moderate/good - high	0.94	0.26	0.26	0.06
1841 & HN648	Blackbutt Gully Forest (BBGF) Moderate/good - poor	3.71	1.53	1.5	0.8
1237 & HN596	Sydney Blue Gum - Blackbutt - Smooth-Barked Apple Moist Shrubby Open Forest (BGHF) (CEEC TSC/BC Act) Moderate/good-poor	4.65	0.90	0.74	0.68
	Exotic vegetation (Blackbutt Gully Forest (HN648, Low)[1].	2.98	3.41	3.39	2.31
	Total area of vegetation impacted	**12.3**	**6.10**	**5.89**	**3.85**[2]

1. Classified under BBAM
2. Refer to Table. 6 for detail on compliance with OEH's offsetting principles, specifically avoidance and mitigation of impacts

To identify the most appropriate offset strategy to maintain consistency with the EAR's, any other conditions of approval and community expectations, three offsetting options have been discussed below.

3.2 Option 1: BioBanking credits

This option involves the purchasing and retiring of BioBanking credits to offset for impacts on biodiversity.

A BioBanking/Biodiversity Stewardship Agreement (BSA) is a conservation agreement between a landholder and the Biodiversity Conservation Trust (BCT) to permanently protect and manage that land to improve biodiversity values. The creation of the agreement generates biodiversity credits for that land which can then be sold to credit buyers, with the proceeds from sales funding the ongoing management of that site. This is a recognised offsetting method under the Biodiversity Offsets Scheme (BOS) and the *Biodiversity Conservation Regulation 2017*.

The BioBanking Assessment Methodology (BBAM) undertaken as part of the EIS assessed impacts on biodiversity values and concluded that the Hornsby Quarry project would need to provide offsets for two vegetation communities (HN648, HN596) and one species (Gang-gang Cockatoo population). The ability to trade these credits is reliant upon their availability on the market. The market also influences credit prices and therefore there is some unpredictability in estimating the cost to Council in purchasing credits. Current availability for HN596 (Blue Gum High Forest) ecosystem credits is limited to one site located in the Hills Shire. Currently, there are no Gang-gang population credits available.

3.3 Option 2: Create a new stewardship site and sale of credits

This option involves the creation of a new stewardship site within the Hornsby Quarry, Old Mans Valley and Hornsby Park precinct and the sale of credits generated to fund future management actions.

This is similar to option 1 but utilises the Hornsby Quarry, Old Mans Valley and Hornsby Park lands as a new stewardship site. This would require an accredited assessor to undertake an assessment of the site in accordance with the Biodiversity Assessment Method to produce a Biodiversity Stewardship Site Assessment Report (BSSAR). The BSSAR sets out the credits generated from the site and ongoing management actions that form part of the Biodiversity Stewardship Agreement (BSA). The credits generated from the BSA would then be sold, with those funds being managed by the Biodiversity Conservation Trust (BCT), generating annual payments for the implementation of management actions contained in the BSA.

The Hornsby Quarry, Old Mans Valley and Hornsby Park lands occupy approximately 60 hectares including approximately 42 hectares of vegetation and habitat. The precinct is proposed to be developed as a regional park supporting passive and active recreational activities while retaining some and creating additional natural areas. The creation of a stewardship site needs to consider current and future land uses and their consistency with biodiversity conservation objectives of a BSA. Certain land uses may not be consistent with the conservation purposes of a BSA and as such would be excluded from the stewardship site. The BSA would exclude lands affected by easements, mountain bikes, walking tracks, roads, services and structures. As a result of the incompatibility of these uses it is likely that the extent of any stewardship site on these lands would be much less than the 42 hectares of vegetation on site. Final design of park facilities and associated infrastructure needs to consider consolidating impacted areas to maximise the potential area available for a stewardship site.

Once the BSA is signed off, credits are then generated for various vegetation communities and/or species as identified in the Biodiversity Stewardship Site Assessment Report. The credits generated at the Hornsby Quarry site could then be purchased and retired by Council contributing to any offsetting requirements. Detailed analysis would be required to determine if the number of credits generated at the site would be enough to meet offsetting requirements.

3.4 Option 3: Local offsets

This option would involve the development and implementation of a Biodiversity Offset Strategy in accordance with Council's Green Offsets Code 2015.

The main purpose of the Green Offsets Code (GOC) is to facilitate the provision of offsets locally. The GOC lists a variety of offsetting actions which seek to enhance and protect biodiversity values on the receiving site. Priority is given to the provision of offsets on the impact site, with minor variations and the packaging of multiple actions that enable this to occur are considered on a case by case basis. Typically, the offset area would be enhanced through the implementation of management actions including weed control, bush regeneration and planting. Protection would involve a legal mechanism that conserves the biodiversity values on the site.

Mechanisms for protection discussed in the GOC includes the use of Voluntary Conservation Agreements (VCA) while enhancement is typically achieved through a Vegetation Management Plan (VMP). The VCA is an unfunded agreement between Council and the BCT within which is a VMP. Funding to implement the VMP would require a guarantee from Council through ongoing budget processes. The requirement for a VCA could be imposed as a condition of consent.

4 Summary of offsetting options

4.1 Offsetting options

Table 2 provides a comparison of three offsetting options considered for the Hornsby Quarry rehabilitation project.

Table 2: Offsetting option comparison

	1. BioBanking Credits	2. Stewardship Site	3. Local Offsets
Location of offsets	Off-site	On-site	On-site
Ongoing Management	N/A	Implementation of VMP as part of the BSA	Implementation of VMP as part of the VCA
Site suitability	N/A	Site contains some high biodiversity conservation values. Incorporate conservation works with park development.	Site contains some high biodiversity conservation values. Incorporate conservation works with park development. Connectivity with National Park

		Connectivity with National Park	
Time	Availability of credits – may not be available for some time	Time required to set up the BSA. Credit purchase could occur immediately.	VCA set up
Cost	Credit purchase costs	BSA set up costs. Credit purchase costs.	VCA set up costs, VMP development and implementation
Ongoing funding	N/A Once credits are purchased there are no further offset costs	Reliant on the sale of credits achieving the Total Fund Deposit (TFD) which would guarantee annual payments from BCT	Requires recurrent expenditure from Council
OEH offsetting principles	BSA is a recognised offsetting strategy	BSA is a recognised offsetting strategy	GOC is consistent with principles of OEH
BBAM	Used to determine credit requirements	Used to determine credit requirements	Used to determine extent of impacts
In-perpetuity protection	Credits purchased generated from a BSA	BSA provides in-perpetuity protection of the offset site	VCA provides in-perpetuity protection of the offset site
Statement of commitment	Condition of consent would outline credit requirements.	Condition of consent would outline credit requirements including creation of stewardship site and BSA	Condition of consent would outline requirements in accordance with the GOC including VCA, VMP and recurrent funding
Benefits	Potential ease of compliance with EAR's through BOS. Recognised offsetting method.	Offset occurs locally on-site. Conservation of BGHF on diatreme soils. Total Fund Deposit would fund ongoing management costs. There is potential that the sale of any surplus credits generated on the site could produce a profit. Council would dictate credit prices for required offsets.	Offset occurs locally on-site Conservation of BGHF on diatreme soils Not reliant on external parties for credit sales Greater flexibility in the VCA for passive recreational and commercial activities, infrastructure, tracks and trails within the conservation site
Limitations	Availability of credits required is limited and could take time to source. Large upfront costs when purchasing credits, price dictated by an open market. Council would still require ongoing funding for implementation of a VMP as part of the park development.	BSA set up time. If credits are purchased by Council, there are large upfront costs. Limited recreational and commercial activities permitted within the conservation site. Limited ability to vary uses within the site and to undertake adaptive management.	VCA set up time. Reliant on recurrent funding from Council.

4.2 Discussion

Option 1 most closely aligns with the Biodiversity Offsets Scheme which has been developed as a simple offsetting mechanism for major projects. Hornsby Council has previously utilised this scheme through the creation of stewardship sites and the purchasing of credits for Waitara Creek associated with the NorthConnex project and Upper Pyes Creek and New Farm Road associated with North West Rail Link. The sale of credits as an offset for these projects provided funding for the ongoing management of these Council reserves. What is proposed in this option is the purchasing of credits from an existing stewardship site to offset for the biodiversity impacts occurring in Hornsby Quarry. The limited availability of required credits means that the offsetting of impacts in Hornsby Quarry will likely be provided by a site located outside of Hornsby Shire. The current availability of BGHF credits is limited to one site located in the Hills Shire, which if purchased to meet the offsetting requirements, would achieve compliance with the EAR's but have no local benefit. Due to the limited availability of required credits there may also be a lengthy time in sourcing suitable credits. The limited availability of these credits will also influence their price, with previous sales for BGHF credits suggesting the likelihood of large upfront costs in meeting offsetting requirements.

Option 2 follows a similar path to the NorthConnex and North West Rail Link projects with the creation of a new stewardship site and the sale of credits generated to meet offsetting requirements. The main difference being that the stewardship site and impact site would both be situated locally. The intention would be to utilise the Hornsby Quarry, Old Mans Valley and Hornsby Park lands to create a new stewardship site which would generate credits to be sold on the market. There are several limitations with this option, the first being the extent of land available for the stewardship site. With proposed future development of the site as a regional park, the extent of land suitable for conservation purposes will be limited. This will likely result in creating a smaller stewardship site which will generate fewer credits for offsetting. The sale of generated credits is essential in funding ongoing management of the site. The sale of credits on the open market provides the seller with an opportunity to produce a profit, charging high credit prices above what is required to achieve the Total Fund Deposit (TFD). As Council would be both seller and purchaser of credits, sale prices would likely be minimal to achieve TFD alone. The creation of a new stewardship site and the purchasing of credits to meet offsetting requirements has large upfront costs for Council.

Option 3 places the focus of offsetting at the local level, ensuring the offset occurs locally within Hornsby Local Government Area and provides offsets at the impact site. The in-perpetuity protection of the offset site is achieved through a Voluntary Conservation Agreement (VCA) in partnership between Council and the Biodiversity Conservation Trust (BCT). Ongoing management of land in the VCA is directed by a Vegetation Management Plan (VMP) which forms part of the VCA. The area of land protected by the VCA would include the offset area and additional land that is to be used for a mix of passive and active recreational purposes. These additional lands would be managed in accordance with the VMP providing support for the offset area. This means that the extent of land to be conserved under a VCA can include land managed for conservation and recreational purposes, ensuring appropriate and sensitive management of biodiversity values across the entire site. The extent of land conserved under the VCA can be larger than that conserved by a BSA. There is also greater flexibility within a VCA to incorporate adaptive management strategies and/or modify use of the land outside of the offset area. There is also a difference in the funding of the management actions between the VCA and BSA. The VCA will source funding for implementing the VMP through recurrent budgeting by Council accounted for in its long-term financial planning. As the VCA and VMP form part of a legally binding agreement between Council and the BCT there will be surety that appropriate funding will be

provided and allocated. The VMP provides a breakdown of annual management costs which would be enable long-term financial planning and the provision of management payments on an annual basis over the life of the plan. This would reduce upfront costs for Council.

4.3 Recommendation

The conservation outcomes for Option 1 will result in the offset actions being located offsite and potentially outside of Hornsby Local Government Area with no observable benefit to the local site or community. The purchasing of credits has large upfront costs for Council and with no guarantee on credit availability provides uncertainty for compliance with offsetting requirements.

Option 2 retains the offsets locally but again has large upfront costs for Council. The number of credits generated from the creation of a new stewardship site is uncertain and may achieve the quantity and type of offsetting required. This would require the purchasing of additional credits to meet with offsetting obligations.

Option 3 ensures that all offsets occur locally, directly benefit the impact area and has a feasible financial approach to fund ongoing management of the site. Offsetting can be incorporated into the future development of the site.

It is considered that the three offsetting options outlined above would all meet the requirements of the EAR's but Option 3 provides greater certainty that offsets occur locally and will directly benefit the impact area. It is recommended that the proposed offsetting measures developed under Option 3 – offsetting using Council's Green Offsets Code 2015, be implemented.

5 Biodiversity Offsets using Council's Green Offsets Code 2015

5.1 Details – Actions, Area of Impact and Offset requirement

The GOC uses a Conservation Significance Assessment (CSA) map to delineate different land categories to contiguous patches of vegetation communities, corridors and habitat. Tables 2 & 3 of the GOC list each land category and a range of offsetting actions and offset area ratios. Using the CSA map, we can determine the land categories affected by the development, determine the area of impact within each land category and calculate an offset area using the offset ratio.

Approximately 0.68 ha of vegetation to be removed is mapped as Core Regional in the CSA map. The remainder of native and exotic vegetation to be removed is 3.17 ha and will be assessed as Core Local mapping.

The GOC requires that the receiving offset site must be ecologically suitable and appropriate. Wherever possible, the offset action must involve the same vegetation community. The land category of the receiving site must also be determined using the land category map. Table 3 below outlines where offsetting actions

can be applied based on the proposed action and the land category of the receiving site. The table ensures that an appropriate management treatment is given to the particular land category receiving the offset action.

The offset site proposed within this strategy comprises the same geology and vegetation communities as the impact site and is considered as a suitable offset site. The two land categories on the site are Regional Core and Local Core which can support the Enhance and Protect offset actions as proposed in this strategy and are consistent with the requirements of the EAR's (Table 3 and 4).

Table 3 – Offset actions for each land category (from Table 2 GOC 2015)

Vegetation Offset Action on receiving land			
Land Categories of receiving site	**Protect**	**Enhance & Protect**	**Create & Protect**
Regional Core	Yes	Yes	No
Local Core	Yes	Yes	No
Support for Core	No	Yes	Yes
Remnant EEC Trees	No	Yes	Yes
Other Native Vegetation and remnant trees	No	Yes	Yes

Specifically, the two relevant offset actions include:

Protection actions involve a legal mechanism that binds future owners of that land to manage the land for conservation and for its habitat values. Protection can take place on the proponent's land or on someone else's land. Types of protection actions available include creating covenants (Sections 88b and 88e of the *Conveyancing Act 1919*), rezoning to environmental protection with conservation registration, voluntary conservation agreements, reservation in Council or NPWS reserve and certain secure community schemes.

Enhance and protect means that the receiving sites are enhanced and managed to improve their ecological integrity and viability over time. Protection and ongoing management are an integral part of this action.

This offsets strategy proposes a combination of enhance and protect management actions. The protection mechanism for this site will be through a Voluntary Conservation Agreement (VCA) in partnership between Council and the Biodiversity Conservation Trust. The enhance mechanism for this site will be through the implementation of the Vegetation Management Plan attached to the VCA. Consultation with the BCT has indicated that the project would be suitable for a VCA.

The minimum required offset area is calculated using relevant offset ratios from the GOC as shown in Tables 4 & 5. The area of vegetation/habitat impacted shown in Table 5 is based on the amended development footprint submitted in the Response to Submission documentation (December 2019) as indicated in Table 1.

Table 4 – Offset multipliers for each land category and offset action (from Table 3 GOC 2015)

Land categories being impacted on by the activity	Offset multiplier		
	Offset action on receiving land		
	Protect	Enhance & Protect	Create & Protect
Regional Core	2	8	-
Local Core	1.5	6	-
Support for Core	-	4	8
Remnant EEC Trees	-	5	5
Other native vegetation and remnant trees	-	2	4

Table 5 – Area of impact and offset requirement

Conservation significance categories	**Offset ratio**	**Area of vegetation/habitat impacted (ha)**	**Offset requirement**
Core Regional	8	0.68	5.44
Core Local	6	3.17	19.02
Total offset requirement			24.46 ha

5.2 Proposed offset details

The Vegetation Management Plan (VMP) comprises a large portion of the Hornsby Quarry, Old Mans Valley and Hornsby Park lands. The total area to be managed under the VMP is approximately 42 hectares.

The offset area is a subset of land to be managed under the VMP. The use of land within the offset area is clearly defined within the VMP and supports the main objectives of the offset area being for conservation purposes. The Habitat Creation and Enhancement Plan is integrated within the VMP and offset works. A limited number of tracks have been permitted within the offset area primarily for service access and enabling natural area experiences in line with the recreational objectives of the site. Any tracks and trails within the offset area have been carefully located to ensure retention of the ecological integrity and value of the offset area. These tracks, trails and services have been excised from the total offset area with the net offset area being approximately 27 hectares. Refer to Appendix. 1 for a map of the offset area. It should be noted that the current extent of impact area (which the offset areas have been calculated on) may be reduced if possible during the construction phase.

5.3 Consistency with EAR's

1. Accord with the 13 OEH offsetting principles available at http://www.environment.nsw.gov.au/biodivoffsets/oehoffsetprincip.thm

See Table. 6 below

2. Use the BioBanking Assessment Method (OEH, 2014) to determine the quantum of offsets required to compensate for those remaining biodiversity impacts

The Biodiversity Assessment Report submitted with DA/101/2019 used BBAM 2014 to determine the extent of impacts

3. Identify the conservation mechanisms to be used to ensure the in-perpetuity protection and management of proposed offset sites

This Biodiversity Offsets Strategy proposes a Voluntary Conservation Agreement between Council and the Biodiversity Conservation Agreement to provide in-perpetuity protection of the Hornsby Quarry, Old Mans Valley and Hornsby Park lands subject to the associated Vegetation Management Plan.

4. Include a specific Statement of Commitments for the proposed offsets package which is informed by a., b., and c. in Section 2 above and by any consultation with OEH.

See Section. 6 below

6 Statement of Commitments

The Biodiversity Assessment Report submitted for DA/101/2019 for the rehabilitation of Hornsby Quarry has concluded that there will be residual impacts on biodiversity. To ensure that offsets are provided locally it is proposed that an offsets strategy be prepared in accordance with Council's Green Offsets Code. This Biodiversity Offset Strategy has proposed the ongoing conservation of vegetation within the Hornsby Quarry, Old Mans Valley and Hornsby Park lands and the implementation of a Vegetation Management Plan for those lands. Funding for the VMP is to be provided by Council through recurrent funding.

In accordance with the EAR's and with the contents of this document, Hornsby Council commits to the following:

1. To create a Voluntary Conservation Agreement for the land managed under the Vegetation Management Plan, including the offset area, in partnership with the Biodiversity Conservation Trust. The minimum offset area must be calculated in accordance with Council's Green Offsets Code and in accordance with Tables 4 and 5 in this document.
2. To develop and implement a detailed Vegetation Management Plan and Habitat Creation and Enhancement Plan for land within the Hornsby Quarry, Old Mans Valley and Hornsby Park lands including land identified as the offset area. The VMP is to be consistent with the Preliminary VMP submitted with DA/101/2019 and form part of the VCA.
3. To provide a guarantee of funding for the VMP through Council's ongoing budget process.

Table 6. The 13 OEH offsetting principles and options response

These principles have been developed by the Department of Planning, Industry and Environment to provide a useful framework when considering biodiversity impacts and appropriate offset requirements.

They are intended to be used for proposals other than those for state significant development (SSD) or state significant infrastructure (SSI).

Principle	Detail	Option response
1. Impacts must be avoided first by using prevention and mitigation measures.	Offsets are then used to address the remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.	*Table 1 shows the project design iterations over time indicating a reduction in the footprint of impact, specifically a reduction in the footprint impacting on BGHF. Sections 6.1 and 6.3 of the EIS demonstrate how the project has sought to avoid and minimise impacts on vegetation and habitat. Residual impacts are to be mitigated on-site through the in-perpetuity implementation of a Vegetation Management Plan and enforced through a Voluntary Conservation Agreement.*
2. All regulatory requirements must be met.	Offsets cannot be used to satisfy approvals or assessments under other legislation, such as assessment requirements for Aboriginal heritage sites and for pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).	*The EIS prepared by GHD for the Hornsby Quarry rehabilitation project provides information on the project to enable a merit assessment assessed against relevant planning controls. The offset strategy is to provide mitigation measures for any residual biodiversity impacts if the project is approved. These mitigation measures will be a requirement of any conditions of approval. All mitigation measures proposed in this strategy are solely to address the offsetting requirements of this development application and are not being used to satisfy any other offsetting requirements under different legislation.*
3. Offsets must never reward ongoing poor performance.	Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.	*The proposed offset areas have not been mismanaged or deliberately degraded. The proposed offset strategy utilises Council's Green Offsets Code and will be funded by recurrent Council funding. The EIS prepared by GHD has provided an independent assessment of biodiversity values on the site and*

		enabled the preparation of a detailed Vegetation Management Plan to improve local biodiversity values. The proposed offset strategy is using Council's Green Offsets Code to determine appropriate offset area which is not influenced by vegetation condition.
4. Offsets will complement other government programs.	A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks, and incentives for private landholders	*The offset area is to be legally bound through a Voluntary Conservation Agreement between Council and the Biodiversity Conservation Trust (BCT). The BCT being appointed under the BC Act with an objective of maximising biodiversity outcomes on public and private lands including overseeing the NSW Biodiversity Offsets Scheme. The land party to the Voluntary Conservation Agreement bounds Berowra Valley Regional Park and is adjacent to Council's reserve network and BioBanking sites. The conservation of this land contributes to the ongoing protection and connectivity of the reserve network*
5. Offsets must be underpinned by sound ecological principles.	They must: • include the conservation of structure, function and compositional elements of biodiversity, including threatened species • enhance biodiversity at a range of scales • consider the conservation status of ecological communities • ensure the long-term viability and functionality of biodiversity. Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.	*The offsets strategy includes the implementation of a detailed Vegetation Management Plan seeking to improve the quality and extent of vegetation communities and associated fauna habitat on the site. This includes the CEEC BGHF on diatreme soils, Blackbutt Gully Forest and riparian corridors.*

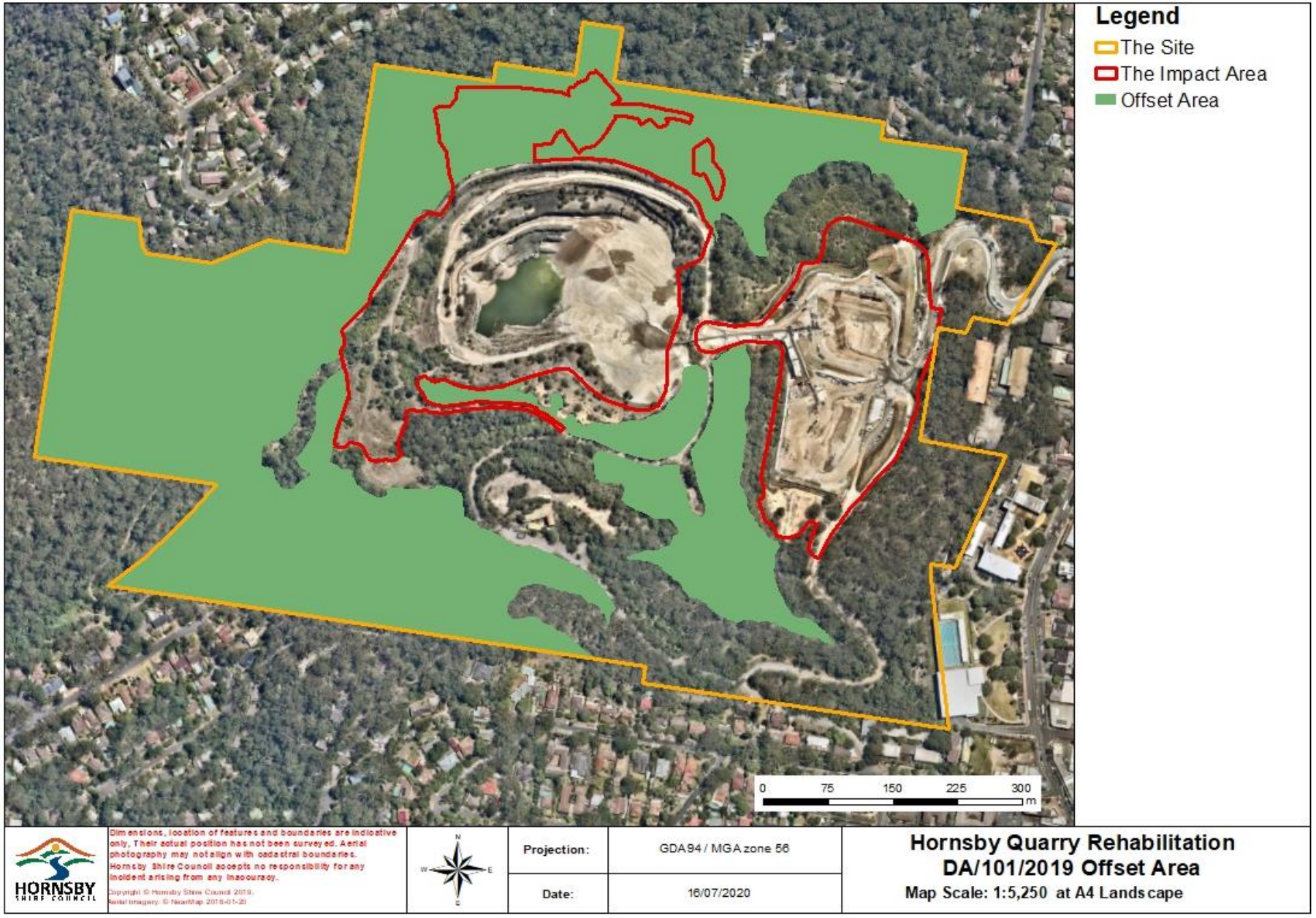
6. Offsets should aim to result in a net improvement in biodiversity over time.	Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site. Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation. Offsets may include: • enhancing habitat • reconstructing habitat in strategic areas to link areas of conservation value • increasing buffer zones around areas of conservation value • removing threats by conservation agreements or reservation	*Council's Green Offsets Code applies multipliers that ensure the area proposed for conservation is larger than the area of impact. By identifying the offset action of 'Enhance and Protect' for the vegetation pertaining to the VMP the offset ratios are the highest that can be assigned to the respective land categories. The implementation of a VMP will ensure that the condition of vegetation on the site will be improved. It is also proposed that the extent of vegetation will be increased with the creation of soils and additional planting to improve connectivity and reduce edge effects.*
7. Offsets must be enduring – they must offset the impact of the development for the period that the impact occurs.	As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.	*This offsets strategy comprises a VMP and a VCA. The VMP will form part of the VCA which is an in-perpetuity legally binding conservation agreement between Council and the Biodiversity Conservation Trust.*
8. Offsets should be agreed prior to the impact occurring.	Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval. .	*The offsets strategy will be a requirement of any conditions of approval for the project. The timeframe for implementation of the VCA and the VMP will be determined by the conditions of approval*

9. Offsets must be quantifiable – the impacts and benefits must be reliably estimated.	Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include: • the area of impact • the types of ecological communities and habitat or species affected • connectivity with other areas of habitat or corridors • the condition of habitat • the conservation status and/or scarcity or rarity of ecological communities • management actions • level of security afforded to the offset site. The best available information or data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where: • they protect land with high conservation significance • management actions have greater benefits for biodiversity • the offset areas are not isolated or fragmented • the management for biodiversity is in perpetuity, such as secured through a conservation agreement. Management actions must be deliverable and enforceable.	*Early design identified impacts on 12.28 ha of BGHF and BBGF (refer to Table 1) and calculated an offset requirement of 361 ecosystem(biobanking) credits (refer to Section 3.2) which was estimated to require approximately 25-35 hectares of vegetation to be conserved. For the same extent of impact implementing Council's Green Offsets Code requires the conservation of approximately 36 hectares of vegetation.* *BioBanking Assessment Methodology (BBAM) was used as the assessment methodology in determining the extent of impacts due to the proposed development.* *Subsequent reductions in the extent of impact reflected in the EIS and Response to Submissions Report results in the BBAM calculation requiring 13 ha of vegetation to be conserved in perpetuity. Under Council's Green Offsets Code, the offset requirement is 24 ha (refer to Table 5) and the proposed offset area is approximately 27 ha.* *A VMP forms part of the agreement ensuring that the condition of vegetation on the site is improved, resulting in an offset, not only providing an increased offset area when compared to BBAM requirements, but also providing for an improved vegetation condition.* *The offsets proposed preserves vegetation comprising two local vegetation communities. Blackbutt Gully Forest which is noted as locally significant, and Blue Gum Diatreme Forest which is a subset of the Critically Endangered Blue Gum High Forest in the Sydney Basin, at this site specifically occurring on diatreme soils. The offset area is directly connected to Berowra Valley National Park and the remainder of the Blue Gum Diatreme Forest corridor which links with the Dog Pound Creek and Waitara Creek stewardship sites.*

		The condition of vegetation within the offset area varies from good to poor and long-term management actions have been developed to improve the condition of this vegetation. The management actions for the offset area are directed by a Vegetation Management Plan and Habitat Enhancement and Creation Plan which will be coupled with a legally binding Voluntary Conservation Agreement between Council and the Biodiversity Conservation Trust. The VCA will ensure that the management actions are implemented, and the offset area is protected in-perpetuity. The BCT will also act in an auditory role as a signatory to the VCA.
10. Offsets must be targeted.	They must offset impacts on the basis of like-for-like or better conservation outcomes. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity, but these benefits do not reduce the biodiversity offset requirements.	*The Biodiversity Assessment Report has identified the project is impacting on BGHF and BBGF on the site. The offsets strategy will target conservation and management of these two local vegetation communities. To mitigate for the loss of fauna habitat, including habitat for any locally occurring threatened species, a Vegetation Management Plan and Habitat Enhancement and Creation Plan has been prepared and will form part of the VCA.*
11. Offsets must be located appropriately.	Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.	*The offsets strategy has sought to ensure that offsets occur locally. Use of a Biodiversity Stewardship Agreement (refer to Section 3.2) to provide offsets would likely result in offsets being located outside of Hornsby Shire. Implementing Council's Green Offsets Code ensures that offsets are not only retained within Hornsby Shire but will directly benefit the site of impact.*

12. Offsets must be supplementary.	They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space, cannot be used as offsets.	*The offsets strategy will significantly increase the area of conserved land and the management actions being undertaken within the Hornsby Quarry, Old Mans Valley and Hornsby Park lands.* *The offset area comprises currently unmanaged lands and does not have any management obligations or funding under any conservation agreements or management plans. The proposed offset works are solely associated with the subject development application and offsetting requirements.*
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or contracts.	Offsets must be audited to ensure that the actions have been carried out and monitored to determine that the actions are leading to positive biodiversity outcomes.	*The offsets strategy will be a requirement of any conditions of approval for DA/101/2019. The VCA will be a legally binding conservation agreement between Council and the BCT. The VMP will form part of the VCA ensuring that conservation management actions are implemented in accordance with an agreed plan. Funding for the VMP will be through recurrent Council funding.*

Appendix. 1 Offset Area



Hornsby Shire Council
Hornsby Quarry Rehabilitation

Vegetation Management Plan
and
Habitat Creation and Enhancement Plan

Report prepared by Hornsby Shire Council
and
Gecko Environment Management

2020

Revision	Date	Details
A	17/07/2020	Final draft issued for exhibition

Title Page Photo: Powerful Owl Breeding Pair © Birdlife Australia

Executive Summary

The former Hornsby Quarry is located entirely in the Hornsby diatreme. A diatreme is a relatively rare volcanic intrusion which is believed to be formed during the Jurassic period. The material sort after from the diatreme was used primarily for road base. Quarrying activities continued from 1902 and throughout the 1990's under a range of ownerships. Hornsby Shire Council (Council) acquired the Quarry in 2002. Since acquisition, the area has been closed to the public for safety reasons as the Quarry and surrounds were deemed unstable. During that time, Council has undertaken extensive investigations, planning and design to rehabilitate and make the site safe so the highly modified but unique surrounding landscape can be protected and used by the community for a mixture of open space and recreational uses within a bushland setting.

Being of volcanic origin, soils derived from the weathering of the Diatreme are generally deep, clayey soils with high nutrient levels and as such, support a Blue Gum Diatreme Forest (BGDF), a forest listed as a Critically Endangered Ecological Community under both the *Environment Protection and Biodiversity Conservation Act 1999* and the *NSW Biodiversity Conservation Act 2016*. Previous studies and Council investigations have mapped the extent and condition of the remaining BGDF. Additional geotechnical studies have been undertaken to determine the best way to stabilise the site for future use while preserving the BGDF. It is necessary however, to remove a part of the regrowth BGDF on the degraded and unstable north spoil mound to make the area safe. As part of the geotechnical studies the area to be removed has been limited as much as possible and will be compensated as 'offset' areas on the site through the Biodiversity Offset Strategy prepared for the Hornsby Quarry Rehabilitation project.

The rehabilitation project relates primarily to earthworks necessary to stabilise and reshape the Quarry site to ensure the area is safe and usable for future community recreational use. The Development Application required an Environmental Impact Statement (EIS) be prepared. This EIS included a Biodiversity Impact Assessment in accordance with the requirements of the Secretary's Environmental Assessment Requirements (EAR) issued by the NSW Office of Environment and Heritage (OEH) (EAR 1167, dated 31/8/17).

This Vegetation Management Plan (VMP) and Habitat Creation and Enhancement Plan (HCEP) has been prepared to provide direction for ongoing native vegetation and habitat management in accordance with the EAR's and any conditions of approval. The VMP also supports Council's Biodiversity Offset Strategy and associated Voluntary Conservation Agreement (VCA) for the Hornsby Quarry Rehabilitation. The Biodiversity Offset Strategy identifies the steps taken to avoid and mitigate the impacts from earthworks pertaining to the DA and recommends that the residual offsetting requirements resulting from the works are undertaken locally, on the Site.

Council plans to open the Quarry for the public, hence the highly modified area within the extent of works (hereafter 'the Impact Area') will be made available for recreation, balanced with conserving, re-establishing and enhancing the surrounding bushland (hereafter 'the Site') in-perpetuity. Through the implementation of this VMP and HCEP, Council will be able to ensure the following:

- protection of the native vegetation onsite with specific reference to the unique Blue Gum Diatreme Forest and connection with the Berowra Valley National Park
- protection of existing fauna known and predicted to occupy the area prior, during and post the proposed earthworks
- restoration and conservation of the connectivity of native vegetation and habitat corridors in-perpetuity

- sustainably establish native vegetation and associated ecological processes to a condition representative of the surrounding plant communities, with particular emphasis in areas where there has been major disturbance or areas that require stabilisation works
- establishment of an adaptive management program for the natural areas of the Site to ensure ecological condition is maintained and improved
- improved integration of ecological management and habitat protection with the objectives of appropriate recreation pursuits such as walking and riding

The northern spoil mound is a critical area requiring stabilisation to ensure public safety and prevent the potential loss of existing high value vegetation through localised landslip. Much of this area is steep, unstable and covered with weeds that are currently the source of weed seed threatening the surrounding bushland areas. Of significance is *Cortaderia selloana* Pampas Grass, a weed listed as a Priority Weed under the NSW *Biosecurity Act 2016*. Following stabilisation earthworks, the north spoil mound will be restored with specifically engineered soils, re-used natural elements and revegetation using densely planted native endemic species. The intention is to revegetate with species representative of the surrounding bushland plant community types, specifically the BGDF. Any vegetation clearing and habitat protection required as part of the stabilisation process will be undertaken in accordance with the VMP and associated Construction and Environmental Management Plan.

Important in the restoration of the Quarry is the development of and implementation of actions which aim to protect, enhance and conserve a high level of ecological function within the Site now and in-perpetuity. To achieve the aim, the current site description and condition have been provided. It is evident that the bushland areas have been highly modified through the impacts of historic mining activities. Yet, despite the modifications, a high level of habitat value exists. The Impact Area, the Site and adjacent bushland provides roosting, nesting, sheltering and foraging sites for arboreal, herpetofauna, mammals, microbats and birds who can move freely between these areas. Of significance is the inclusion of a breeding pair of *Ninox strenua* Powerful Owl successfully breeding in recent years within the Site.

Mitigating potential direct, indirect and cumulative impacts from the earthworks associated with the DA have been identified and mitigation management actions have been provided that are reflective of the planning and design done to date. Mitigation relies heavily upon ongoing vegetation management because of its importance in supporting the existing fauna on-site. A strong emphasis has also been placed on the importance of riparian areas as wildlife corridors and the weed species, *Ligustrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet, as roosting areas. The staging and location of weed treatment has been itemised in management action tables and the performance criteria specified relates to baseline data collated. All works will be assessed and incorporated in ongoing adaptive management through a detailed and prescribed annual monitoring program.

Recommendations are provided regarding the staging of earthworks with consideration to the breeding cycle of the *Ninox strenua* Powerful Owl and consultation with Birdlife Australia. Works will not be undertaken within the recommended exclusion zones if a breeding pair are occupying a nest on Site. Through the implementation of this plan site management activities will facilitate the return of the Powerful Owls at the completion of the north spoil mound stabilisation and restoration works.

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Abbreviations

Abbreviation	Description
AS	Australian Standard
BBAM	BioBanking Assessment Methodology
BBGF	Blackbutt Gully Forest
BC Act	*Biodiversity Conservation Act* 2016
BGDF	Blue Gum Diatreme Forest
BVNP	Berowra Valley National Park
CBD	Central Business District
CEEC	Critically Endangered Ecological Community
DA	Development Application
DBH	Diametre at Breast Height
EAR	Environmental Assessment Requirements
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act* 1999
FM Act	*Fisheries Management Act*
GBD	General Biosecurity Duty
HCEP	Habitat Creation and Enhancement Plan
KTP	Key Threatening Process
LGA	Local Government Area
MZ	Management Zone
PPE	Personal Protective Equipment
PCT	Plant Community Type
SDT	Standing Dead Trees
SEAR	Secretary's Environmental Assessment Requirements
SWM	South West Mound
VCA	Voluntary Conservation Agreement
VMP	Vegetation Management Plan

1. Introduction

1.1 Purpose

The rehabilitation and development of the former Hornsby Quarry as a new recreational parkland, Hornsby Park, has been proposed under DA/101/2019. The Secretary's Environmental Assessment Requirements (EAR No 1167) dated 6 September 2017 notes that the EIS, in determining a Biodiversity offsets package, should *identify the conservation mechanisms to be used to ensure the in-perpetuity protection and management of proposed offset sites.*

A Preliminary Vegetation Management Plan (VMP) was submitted as part of the Application that provided a general description of the ongoing conservation mechanisms for an offsets package in accordance with the EAR's and any conditions of approval. Following the Sydney North Planning Panel public meeting held via teleconference on 6 May 2020, the Panel deferred the Application to enable several key issues of significant public interest be resolved with certainty for both the Panel and the Public.

Key relevant issues to be resolved are the completion of the Biodiversity Offset Package following the finalisation of a VMP and an associated Habitat Creation and Enhancement Plan (HCEP). The purpose of this document is to cover the VMP and HECP. It will provide the mechanisms for ongoing ecosystem management within the extent of works (hereafter 'the Impact Area') as part of the DA and within the surrounding area (hereafter 'the Site') (Figure 1.1) as per the Biodiversity Offset Package and Voluntary Conservation Agreement (VCA). Additional focus will to be on a staged plan of works with reference to natural rehabilitation, habitat protection and the breeding pair of Powerful Owls, as keystone species, for 'the Site's' ecosystem processes.

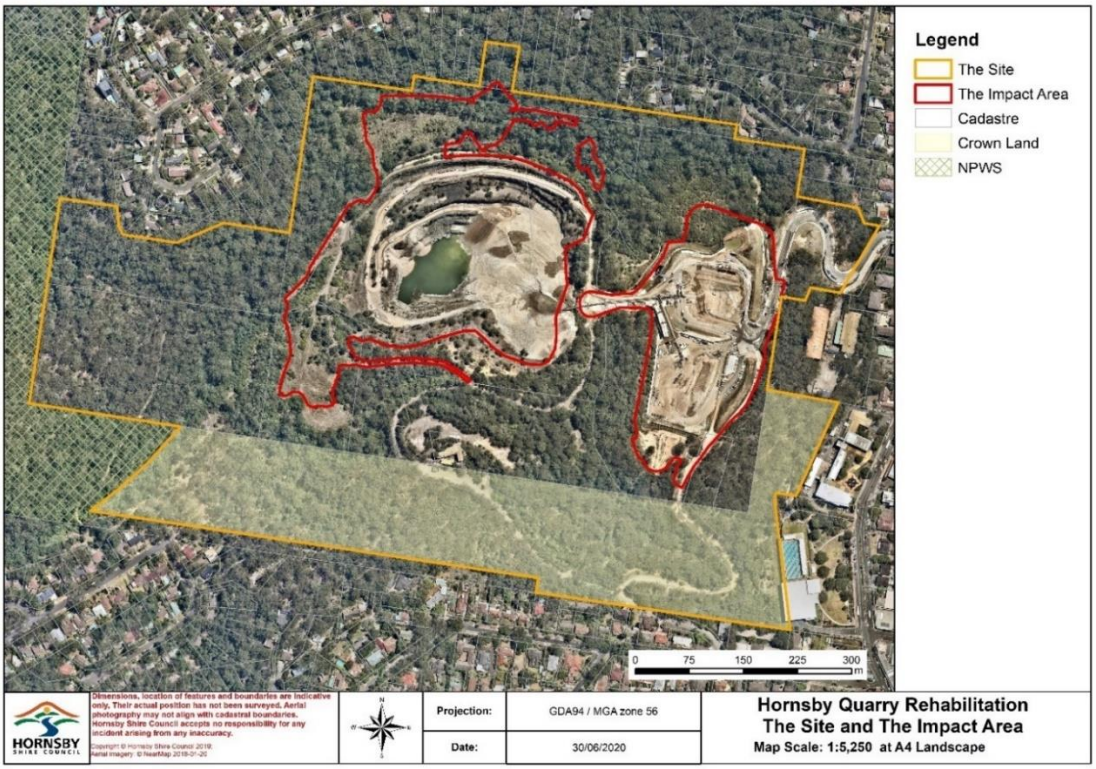

Figure 1. 1 The Site and Impact Area

1.2 Background

The northern portion of the Hornsby Diatreme was mined for blue metal aggregate since the early 1900's in an area that is now known as the Hornsby Quarry. The Quarry was decommissioned and then acquired by Hornsby Council in 2002. Since acquisition, the Quarry and surrounds have been closed to the public for safety reasons and Council has undertaken extensive studies with the aim to rehabilitate the area. Plans have now been prepared to stabilise the Quarry and provide a landform for future embellishment as a place to be enjoyed as a public recreational parkland surrounded by a landscape of high ecological integrity. Initial stabilisation works involved partial filling of the void. Roads and Maritime Services were given approval to undertake the filling operations with material extracted from the NorthConnex tunnel works.

The rehabilitation details pertaining to DA/101/2019 relate primarily to earthworks necessary to complete stabilisation requirements and reshape the Quarry precinct to ensure the area is safe and usable for the public. Landscaping and embellishment will be determined through a future approval process. This VMP, the HCEP and the Biodiversity Offsets Strategy discuss the works proposed under DA/101/2019 and together, will act as a directive to ongoing ecological management in-perpetuity.

Stabilisation works of relevance to this Development Application are needed to stabilise the north spoil mound, an area on the northern slope above the void used as an overburden site. Since the rehabilitation project's inception, many reiterations of how the north spoil mound should be stabilised, with the least possible disturbance, have been explored by a team of Engineers, Landscape Architects and Natural Resource Managers. Water entering the site along the drainage line from Manor Road Hornsby is of high importance and its management is critical to the structural integrity of the north spoil mound. There is an existing trapped low point behind the overburden. Water is no longer able to drain due to the failure of a drainage pipe that was installed during the mining operations. The proposed design will remove steep and unconsolidated fill profiles that are at risk of landslide resulting in additional significant tree loss, promote improved management of overland flows and reinstate collection of low flows, managed by a stormwater drainage system. The design will also provide for managed overflow in high rainfall and flood events. In the process, the north spoil mound can be reshaped to incorporate a topography more conducive to safe access, the weeds can be treated, the soil improved, and the area can be revegetated with plants of local provenance representative of the surrounding native vegetation. Vegetation removal is necessary as part of the required works to ensure the area is stabilised as such, a small part of the Blue Gum Diatreme Forest of poor quality requires removal. The area to be removed has been limited to the fullest extent possible and will be offset as per Council's Biodiversity Offset Strategy.

The landscape within the Impact Area of the DA and the Site, is currently complex and physically difficult to manage because of the steep and unstable topography that occupies most of the area. The soils are varied and disturbed. Opportunistic woody weeds have established as the dominant midstorey under a canopy of native canopy regrowth on these disturbed areas.

The Site currently supports a diverse range of native fauna. Of note has been the recent confirmation of a breeding pair of *Ninox strenua* Powerful Owl. It is inevitable that the proposed project will be disruptive in the short term, but it is Council's plan to aim for best practice ecologically sustainable development to ensure the natural longevity of the remnant forest including the areas subject to rehabilitation. The stringent and accountable processes accepted through this document, will enable a much more sustainable long-term outcome for the Site's biodiversity, the connectivity to adjacent natural areas and as an education platform for

the broader community. Confidence should be gained from the resilience currently observed of native vegetation regrowth over the Site despite historic disturbances (Figures 2.3 to 2.9).

1.3 Aims and Objectives

This VMP and HCEP describes the ecological processes currently within the Impact Area and the Site (Figure 1.1), with reference to fauna and flora present, the Site condition, the proposed impact and proposed mitigation mechanisms. The aim of this report is to formulate mechanisms and management actions to protect, enhance and conserve a high level of ecological function within the Site now and in-perpetuity through building ecosystem resilience (Gleeson 2012).

The objectives are to:

- protect the native vegetation onsite including the Blue Gum Diatreme Forest and surrounding natural areas
- protect existing fauna known and predicted to occupy the Impact Area and the Site prior, during and post the proposed earthworks
- restore and conserve connectivity of native vegetation and habitat corridors in-perpetuity
- sustainably establish native vegetation and associated ecological functions and processes to a condition representative of the surrounding Plant Community Types (PCTs) in areas of major disturbance including areas requiring stabilisation works
- establish mechanism to provide succinct flora and fauna baseline data for future reference
- set up a monitoring and evaluation program for adaptive management of flora and fauna
- improve integration of habitat with appropriate recreation provision

1.4 Methodology

The following has been undertaken in the process of preparing this report:

- Review of previous reports: Soils - SESL Australia (2018), Tree Survey - Arterra (2019), EIS - GHD (2019), Vegetation Survey and Mapping - Kleinfelder (2017), EcoLogical (2015), Dragonfly MBT REF (2011), Preliminary Construction Environmental Management Plan – GHD (2019), Preliminary VMP (2019)
- On-ground field investigations
- Discussions with relevant stakeholders
- Consideration to the final earthwork requirements for stabilisation, vegetation condition and future surrounding land use design

1.5 Plan Tenure

The VMP and HCEP is to cover a period of twenty years and then in-perpetuity under the guise of adaptive management. Levels and types of input and resources required to ensure processes endure will need to be reviewed annually to assess if any alterations to ecological functionality are apparent due to disturbance: unforeseen, naturally occurring or through deviations from the original plan by others. It is advised that this document is reviewed in 5 years.

1.6 Legislation and Planning Controls

Table 1. 1 Relevant Legislation

Government Level	Relevant Policy/Legislation	Relevance to the Site
Local	• Hornsby Local Environmental Plan 2013	• RE1 Public Recreation (public open space or recreation; protect and enhance the natural environment for recreation; protect and maintain areas of bushland with ecological value) Note: A small section of R2 Low Density Residential Land is also incorporated into the Site.
State	• *Biodiversity Conservation Act 2016* • *NSW Biosecurity Act 2015*	• CEEC present. • Secretary's Environment Assessment Requirements (SEARs) published 28.08.17 (assess significance of impact including residual impacts to determine if Offsets are required.
Commonwealth	• *Environment Protection and Biodiversity Conservation Act 1999*	• CEEC present.

2. Existing Environment

2.1 Location

Hornsby is a suburb of Sydney located approximately 21 kilometres north west from the CBD. The Hornsby Quarry is located within Old Mans Valley and adjacent to Hornsby Park. Old Mans Valley and Hornsby Park are located on the west side of the Hornsby CBD. The Hornsby Railway Station is a major transport link to the city. Both the Railway Station and the CBD are within walking distance to Old Mans Valley and Hornsby Park (Figure 2.1 and Table 2.1).

Native vegetation surrounds the Quarry. The native vegetation on the northern, southern and eastern boundaries of the Quarry in Old Mans Valley creates a buffer to the Quarry from the built environment of the Hornsby CBD and the Hornsby residential zones. The native vegetation on the western boundary borders the Berowra Valley National Park and as such, the Impact Area and the Site have linkages to protected natural areas along Dog Pound Creek to the Blue Gum Creek Reserve and the Dog Pound Creek BioBanking site. This BioBanking site is also a Blue Gum Diatreme Forest and protected in-perpetuity under the State's BioBanking Agreement Number 142**.**

Table 2. 1 The Site Definition

Land Title	Lot A, B, C, D and E in DP 318676, Lot 1 DP 926103, Lot 1 DP 926449, Lot 1 DP 114323, Lots 1 and 2 in DP 169188, Lot 7306 DP 1157797, Lot 1 DP 859646, Lot 13 DP 734459, Lot 114 DP 749606, Lot 213 DP 713249
Location	Old Mans Valley and Hornsby Park, HORNSBY
Grid Reference	151.090704 E, -33.69740 S
Ownership	Hornsby Shire Council, Crown
Zoning	RE1 Public Recreation
Current Land Use	Decommissioned Quarry, Mountain Bike Track, Walking Tracks, Native Bushland

2.2 Topography

The original topography of the Site would have been representative of a river system imbedded in gently undulating low hills within a steep valley. The Site now forms an amphitheatre sloping away from the higher elevation of the built environment of Quarry, Old Peats Ferry, Manor and Summers Roads to the south, east and north respectively. Joe's Mountain, within the Berowra Valley National Park, is to the west (Figure 2.2). The void is at the centre of the amphitheatre, a large hole surrounded by exposed rockfaces. The eastern rockface exposes an impressive geological representation of the diatreme formation. The northern, southern and western rockfaces of the Quarry rim are a combination of steep exposed slopes comprising of a mixture of spoil from quarrying activities, bedrock and eroded soil (Figure 2.8).

The most recent LiDAR image provides a detailed representation of the current topography including the modified landforms due to mining activities and the complexity of the challenges these present (Figure 2.9).

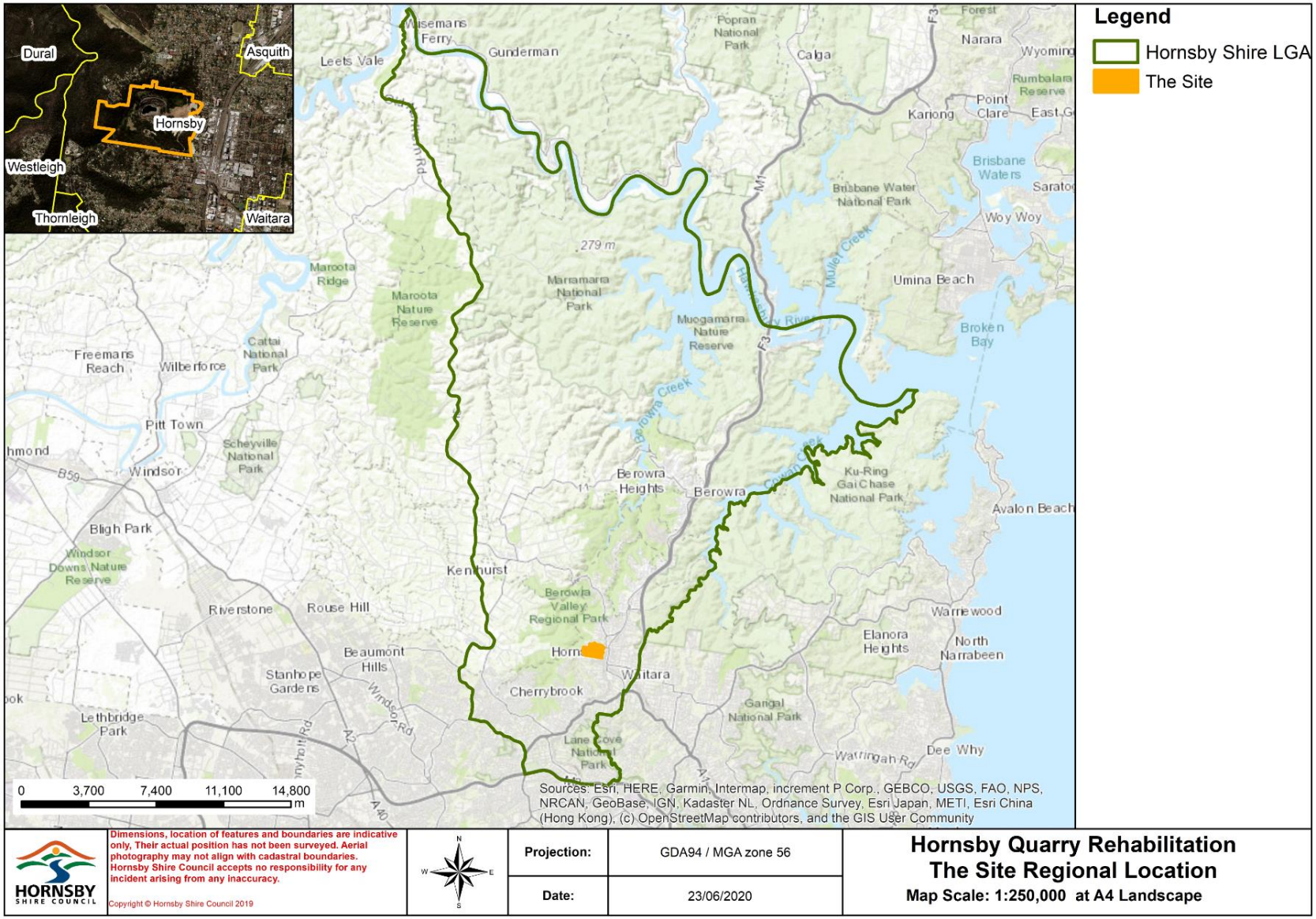

Figure 2. 1 The Site Regional Location

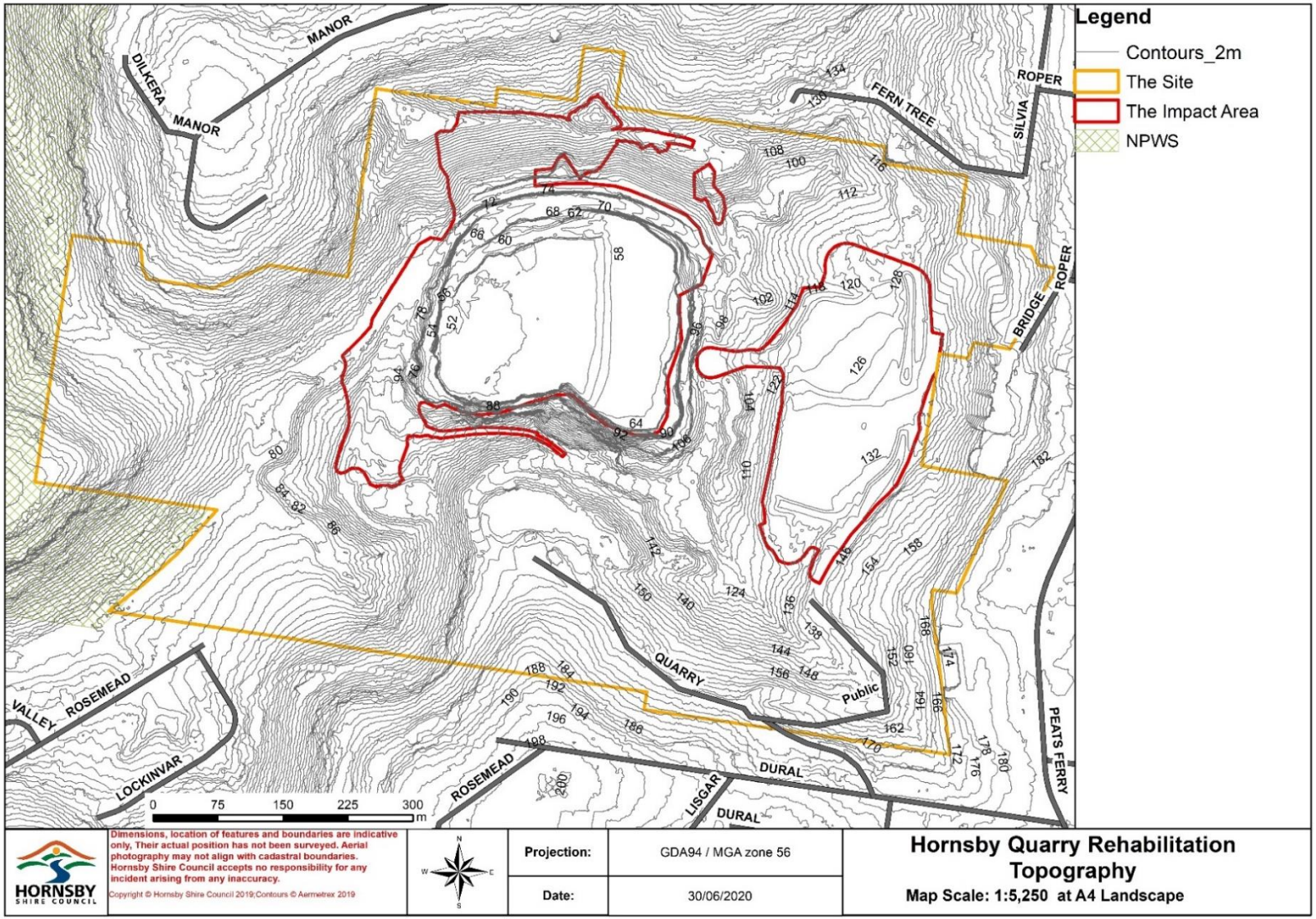

Figure 2. 2 Topography

2.3 Geology and Soil

The Quarry is at the northern end of the Hornsby diatreme, a rare volcanic structure formed within the joint system and horizontal layers of sedimentary rocks. Formed millions of years ago, the soil was a mixture of basaltic breccia, sedimentary breccia and metamorphosed Hawkesbury sandstone. The surrounding areas are Hawkesbury Sandstone (PSM 2007). The intrinsic qualities of the Hornsby Diatreme's soil have resulted in its value to development and the mining of its properties. Based on Chapman and Murphy (1989) soil type descriptions, Hornsby (ho), Hawkesbury (ha) and Lucas Heights (lh) soils have been mapped on site in the *Soil Landscapes of the Sydney 1:100,00 Sheet.*

Previous studies of the Site soils have been undertaken by Coffeys and Partners Investigations (1990), Parsons Brickenhoff Investigations (2004), PSM Investigations (2007) and SESL (2019). These studies indicate that little, if any, of the remaining A horizon exists in the Impact Area and B horizons have been heavily modified. Excavated material associated with mining activities, have been deposited around the Impact Area and the Site. These deposits are a mixture of varying development stages of breccia and sandstone overburden. The Quarry void has been half filled with crushed sandstone excavated during the construction of the North Connex tunnel.

Historic aerial photos provide a good temporal and spatial story reflecting the historic land clearing and soil disturbance that has occurred prior to this project (Figures 2.3 to 2.8).

Figure 2. 3 View from Old Mans Valley looking West South-West Pre-mining

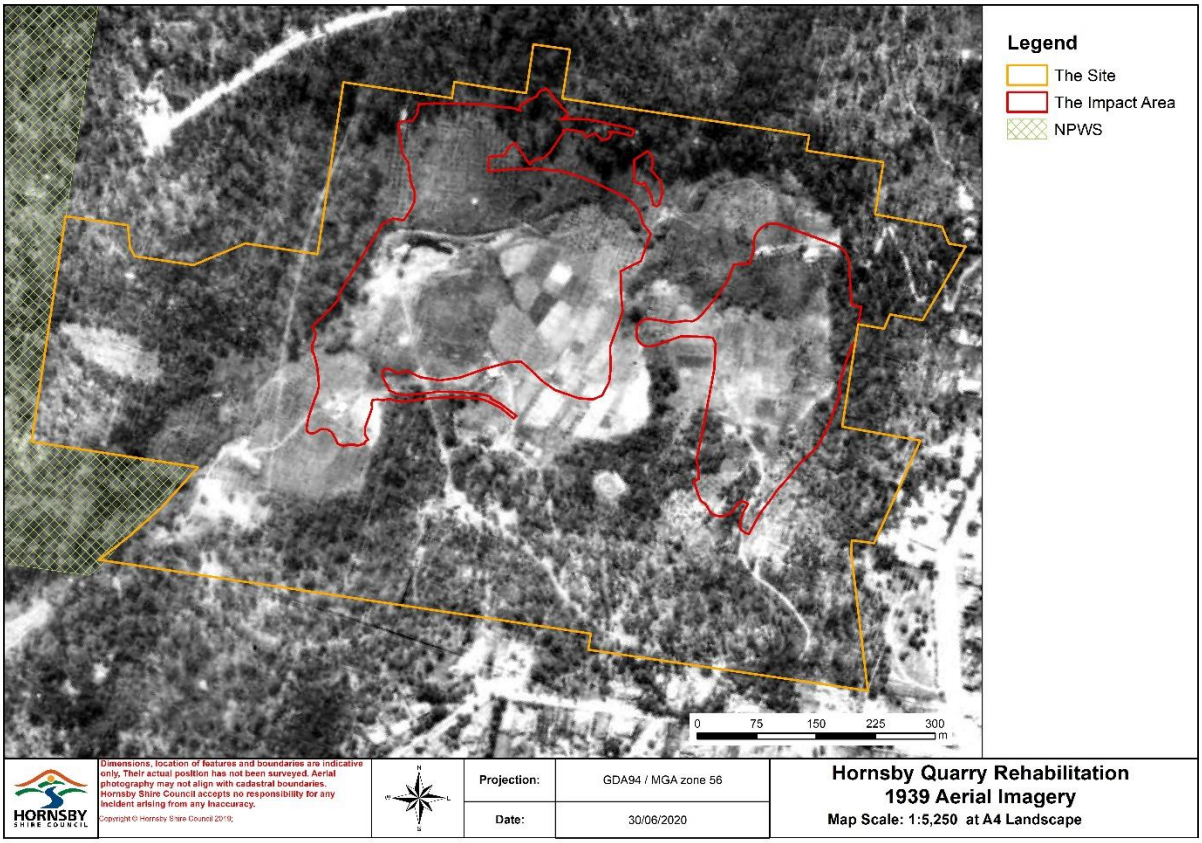

Figure 2. 4 Quarry Aerial Imagery 1939

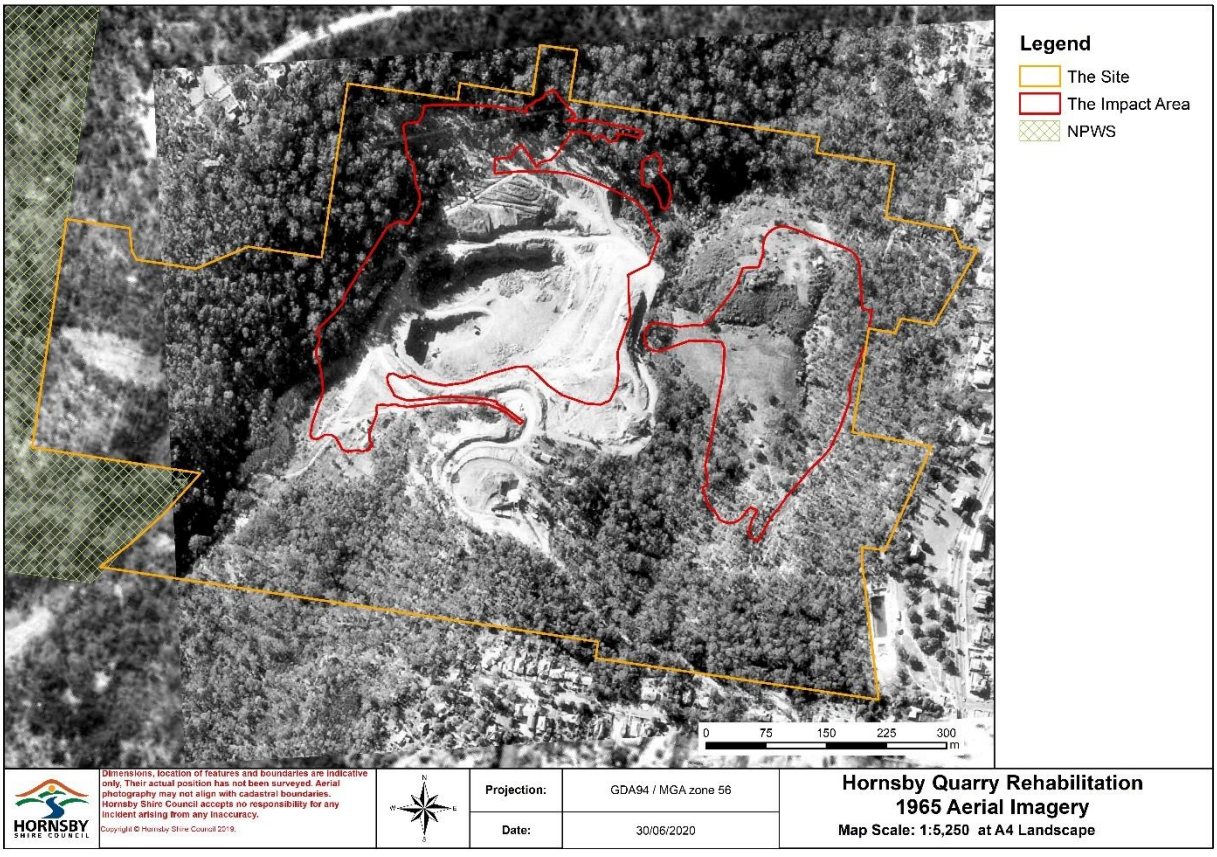

Figure 2. 5 Quarry Aerial Imagery 1965

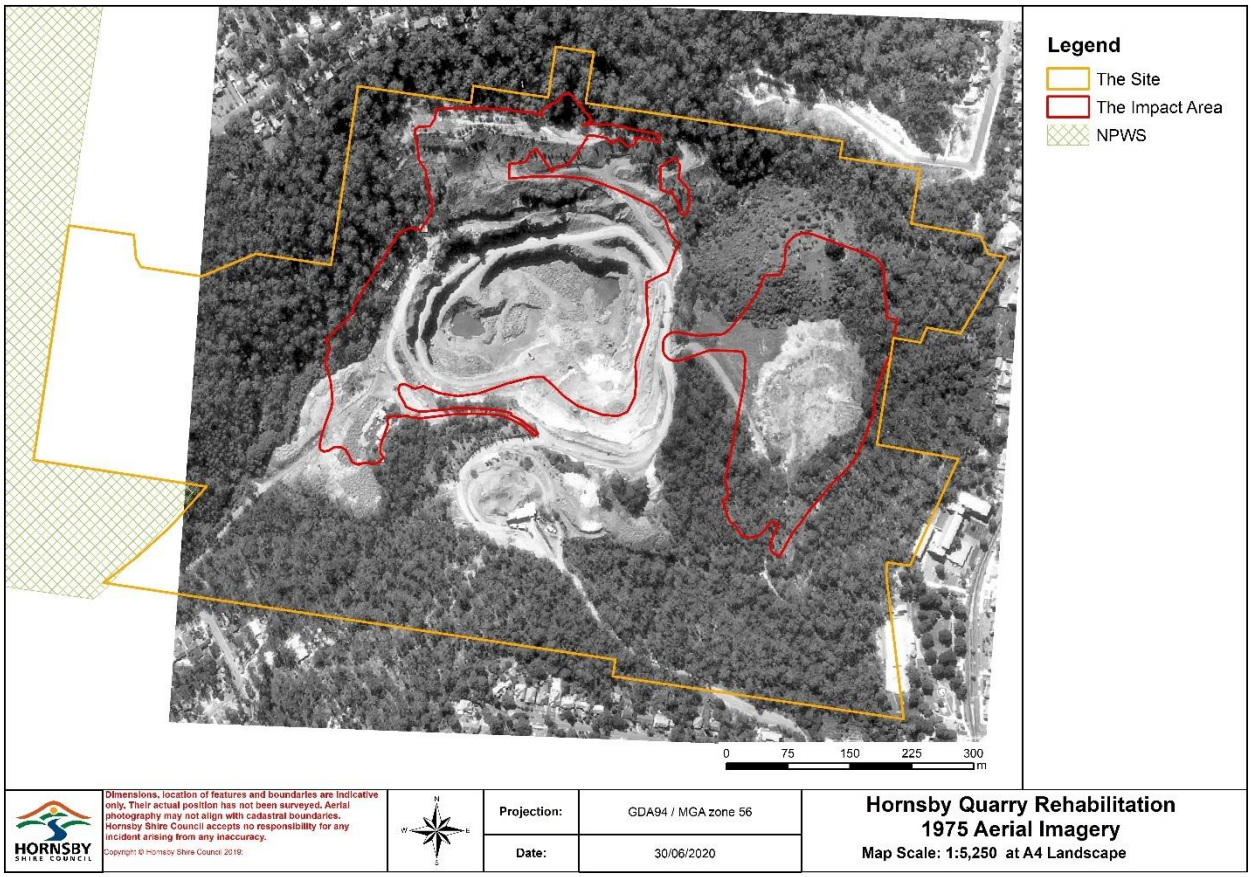

Figure 2. 6 Quarry Aerial Imagery 1975

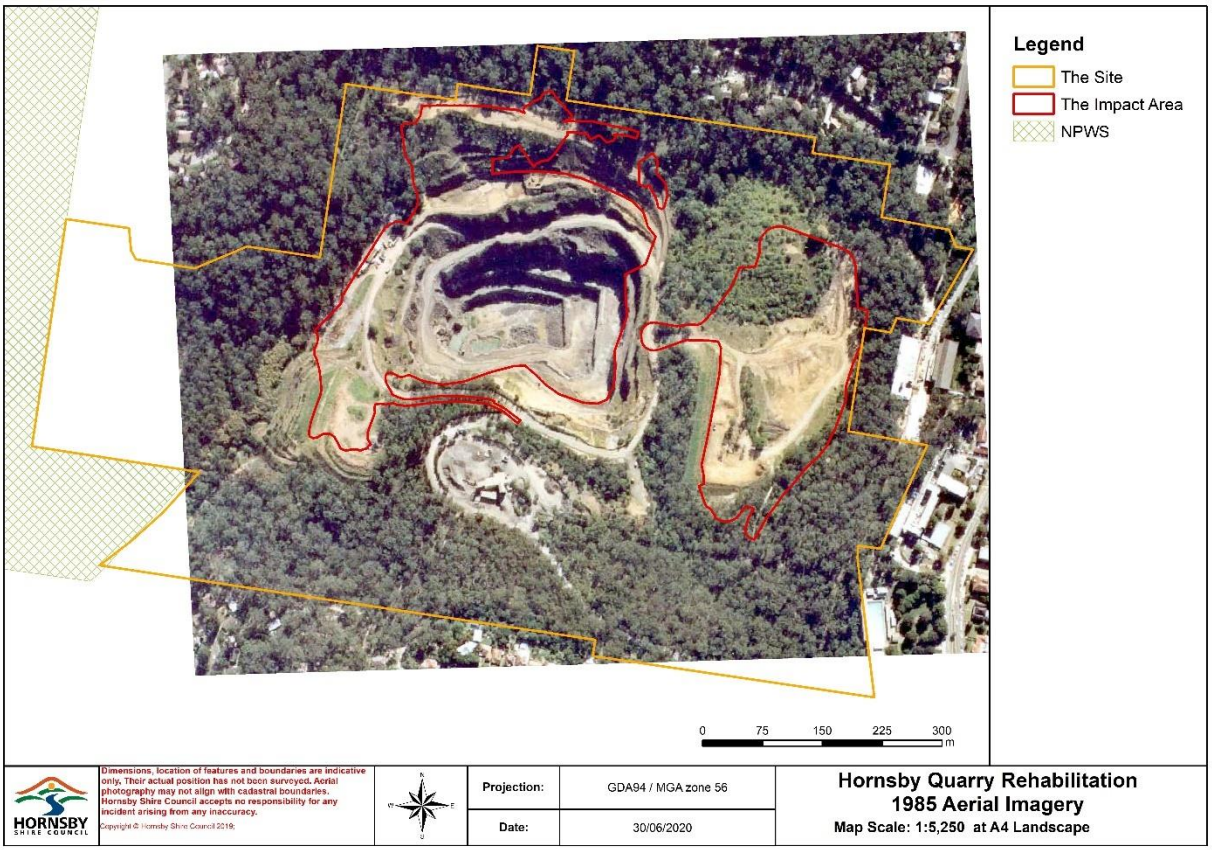

Figure 2. 7 Quarry Aerial Imagery 1985

Figure 2. 8 Aerial view looking South towards Crusher Plant early 1960s

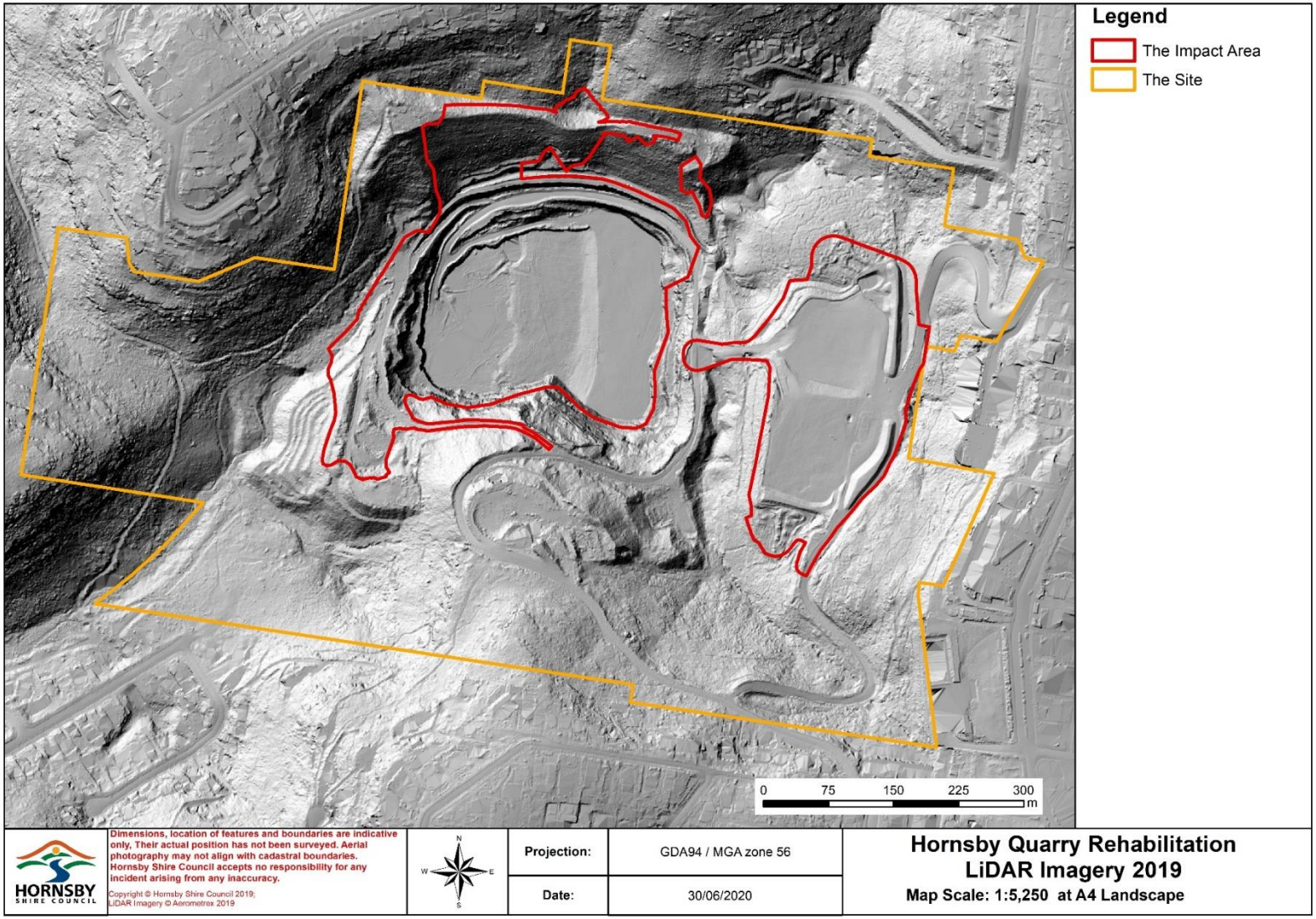

Figure 2. 9 LiDAR Imagery

2.4 Hydrology

Old Mans Valley is within the Hawkesbury Nepean River Catchment, the largest river/estuary system in the Sydney Region and one of the most important river systems in NSW. The land use of Old Mans Valley has changed over time, and as such, so has the integrity of the natural water flows. Following thousands of years of Aboriginal occupation and use, the natural landforms were subjected to land clearing, then orcharding and finally mining activities. Water now flows into the valley from neighbouring urban and natural areas via ephemeral drainage lines. All surface water flows have been diverted around the quarry void via a series of pipes, constructed channels and culverts to Old Mans Creek, a tributary of Berowra Creek within the Hawkesbury River Catchment (Figure 2.10). Groundwater inflow has historically filled the base of the void with water requiring pumping out by Council under a *Water Management Act 2000,* dewatering licence with an allocation of 370 ML/year.

2.5 Conservation Significance

The Blue Gum Diatreme Forest (BGDF) as described by Smith and Smith (2008) is part of the complex vegetation community that is Blue Gum High Forest (BGHF) in the Sydney basin and is listed as critically endangered under both the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the NSW *Biodiversity Conservation Act 2016.* A critically endangered ecological community classification, as per the Scientific Committee, is one facing an extremely high risk of extinction in New South Wales in the immediate future.

The BGHF and BGDF ecological communities are defined by the geology and soils that support them. The BGHF grows on soils derived from Wianamatta Shale and the BGDF grows on soils derived from volcanic diatremes. The original distribution of the BGHF complex occupied an area of 2000 hectares in northern Sydney. Less than 4.5% of the original distribution remains and these are in small remnants. The Hornsby Local Government Area (LGA) contains approximately 25% or the remaining remnants and possibly all of the remaining BGDF (Smith & Smith 2008). The existing condition of the BGDF within the Impact Area and the Site is variable and is highly modified due to past mining activities.

The Hornsby Diatreme in Hornsby's LGA is one of six priority Blue Gum High Forest management sites identified in NSW to be included in the Saving our Species program, a targeted strategy for managing threatened species. The conservation strategy of the program aims to secure the ecological community in the long term. The status of the Hornsby Diatreme in the program is 'Proposed'. Ten conservation management actions are proposed for this site and these have been addressed as part of the DA, the Biodiversity Offset Strategy as well as through mechanisms provided by this VMP and HCEP. The following objectives of the proposed management actions that have been addressed are:

- Minimise spread of disease within the site
- Minimise impacts of commercial activities
- Minimise impacts of recreational activities
- Maintain appropriate fire regime for the species/community
- Reduce and maintain weed densities at low levels
- Minimise impacts of development

Two threatened plant species have been recorded near the Site boundary but not within the Impact Area, *Galium australe* Tangled Bedstraw and *Darwinia peduncularis.*

Four threatened fauna species have been positively recorded within the Site boundary:

- Eastern Bentwing Bat *Miniopterus schreibersii oceanensis,* listed as vulnerable under the BC Act
- Grey-headed Flying-Fox *Pteropus poliocephalus,* listed as vulnerable under the BC Act and the EPBC Act
- Powerful Owl *Ninox strenua,* listed as vulnerable under the BC Act
- Varied Sittela *Daphoenositta chrysoptera,* listed as vulnerable under the BC Act and the EPBC Act

The Site and the Impact Area provide significant roosting, nesting, sheltering and foraging sites for arboreal herpetofauna, mammals, microbats and birds who can move freely between the native vegetation within these areas and the neighbouring bushland.

The core area of bushland in the Site has a significant connection to largely undisturbed bushland. On the western boundary is the Berowra Valley National Park (BVNP). Connected to the BVNP are Council Bushland Reserves including the Rosemead Road Bushland as well as both the Dog Pound Creek and Galston Park BioBanking sites to the south and west respectively, and the Pyes Creek/NewFarm Road BioBanking site to the South. To the north, Council's reserves Turner Road Bushland, Woolwash Bay and Furber Park connects the BVNP to Muogamarra Nature Reserve and the Marramarra National Park, all on the banks of Berowra Creek flowing into the Hawkesbury River (Figure 2.11). In developing the recreational parkland, opportunities exist here for sensitively and passively connecting the urban interface with significant bushland experiences.

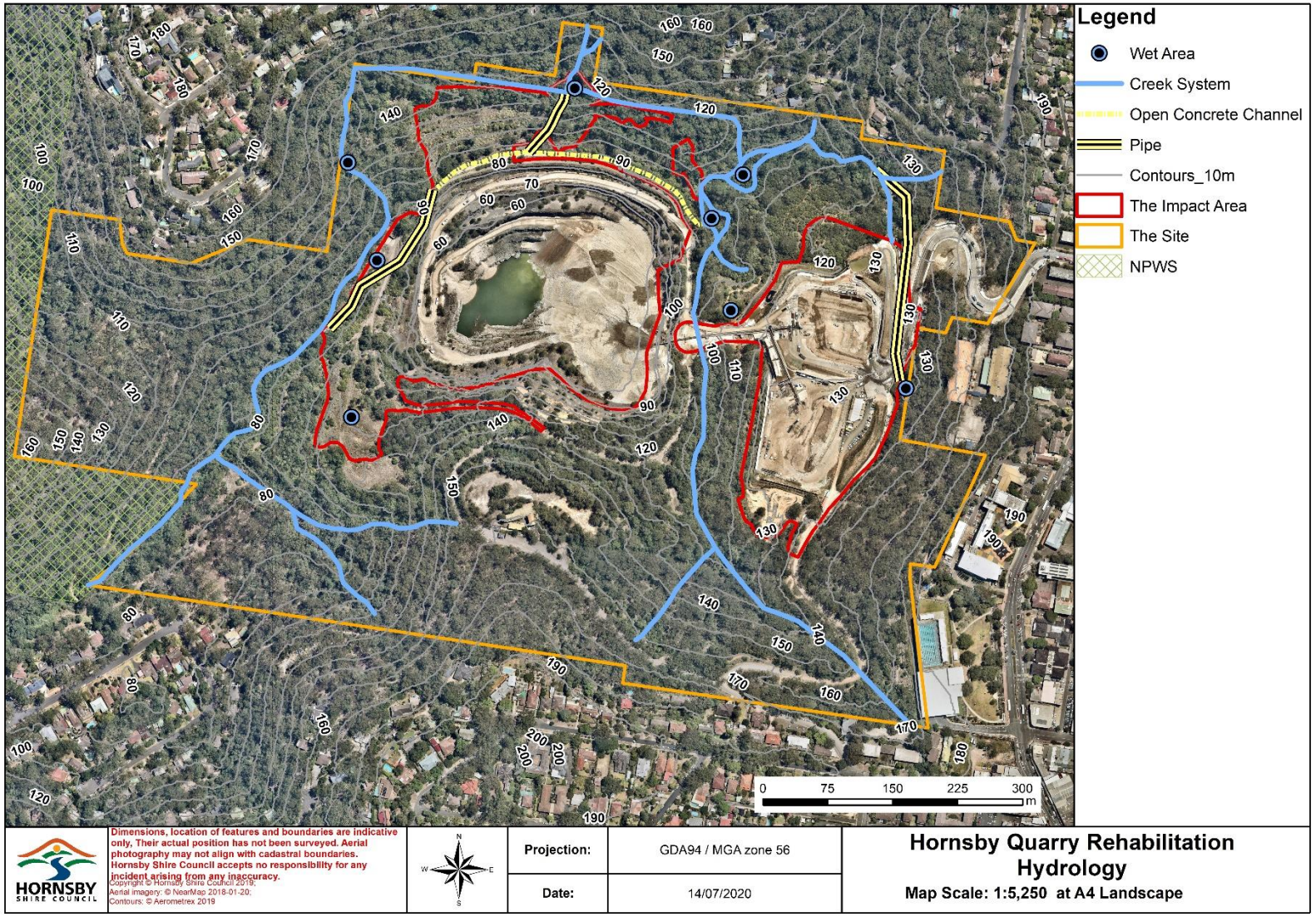

Figure 2. 10: Hydrology

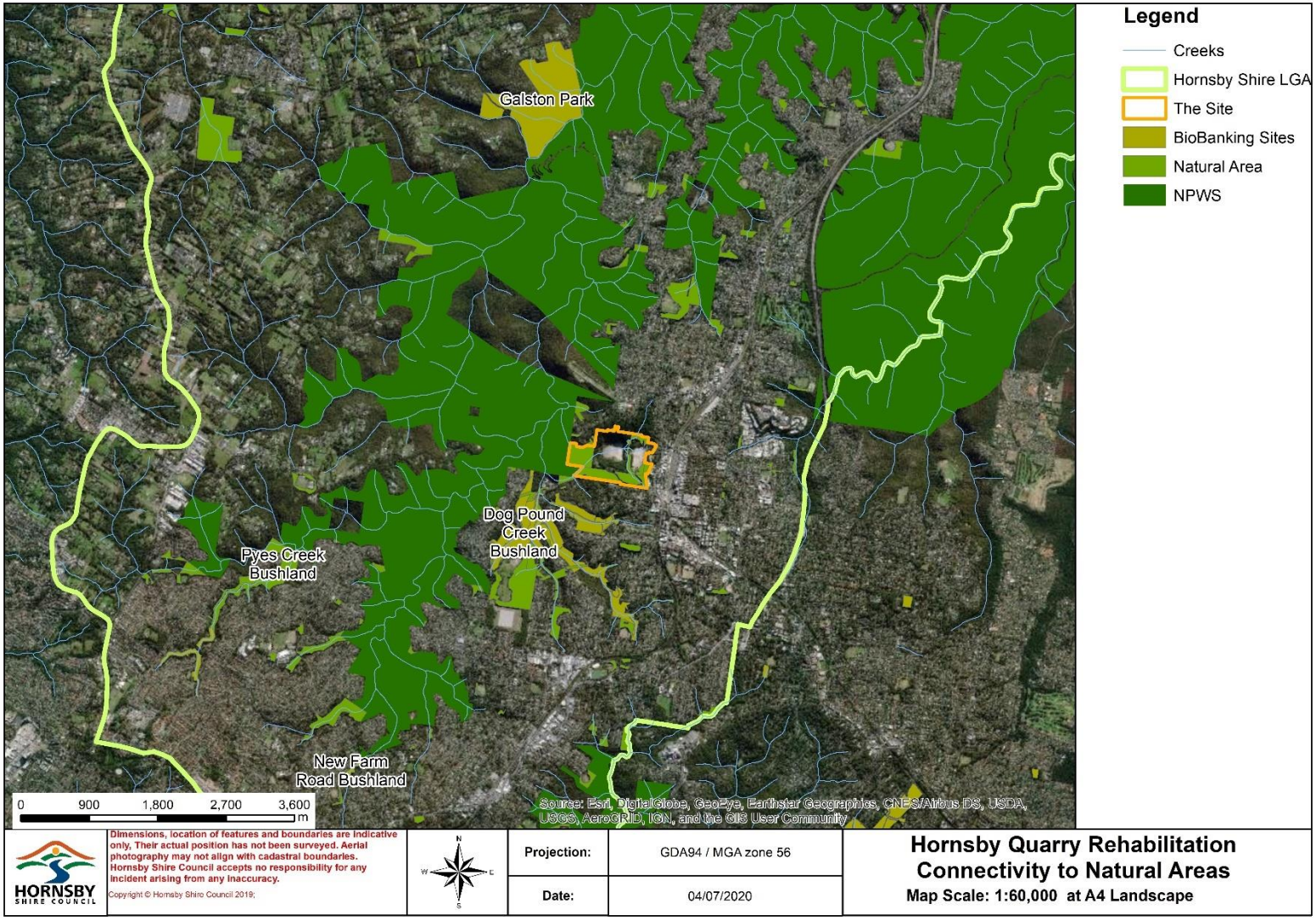

Figure 2. 11 Conservation Significance

2.6 Native Vegetation

2.6.1 Vegetation Communities – Plant Community Types

Both Kleinfelder (2017) and GHD (2019) used the BioBanking Assessment Methodology (BBAM) to assess the vegetation on Site. BBAM was the methodology used by the BioBanking Scheme established under Part 7A of the NSW *Threatened Species Conservation Act 1995* (TSC Act). While both reports used the same methodology, the presentation of their results were for different purposes. Kleinfelder used the BBAM to describe plant community type and condition (Figure 2.12). Whereas, GHD used the BBAM for the purposes of calculating the number and type of credits that could be generated for retirement as part of an offset package for development (Figure 2.13). The presentations differ because credit calculation requires vegetation mapping to represent a Plant Community Type (PCT) irrespective of the extent of exotic presence.

Both Kleinfelder and GHD's assessments concluded the same PCTs exist on Site from their results. The BioBanking Scheme has since been replaced by the Biodiversity Offsets Scheme and the Biodiversity Assessment Methodology (BAM) under the *Biodiversity Conservation Act 2016*. The replacement does not alter the PCT classification by Kleinfelder or GHD and its relevance to the VMP and HCEP.

For the purposes of this VMP and HCEP, GDH's mapping data has been used to display the vegetation communities (Figure 2.13). In addition, Kleinfelder's mapping data has been used to map vegetation condition (Figure 2.12) and to determine appropriate Management Zones (Figure 6.1). The Smith and Smith (2008) naming classification has been used to describe both plant communities Blue Gum Diatreme Forest (BGDF) and Blackbutt Gully Forest (BBGF) in this document (Table 2.2, Table 2.3). The Blue Gum Diatreme Forest is listed as a critically endangered ecological community (CEEC) under the *NSW Biodiversity Conservation Act 2016* and critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Blue Gum Shale Forest. The community is very restricted and may now be confined to the Hornsby Local Government Area (Smith & Smith 2008).

Table 2. 2 Hornsby Shire Vegetation Communities and other Vegetation Classifications

Hornsby vegetation community (Smith & Smith 2008)	Australian endangered ecological community (EPBC Act)	NSW endangered ecological community (BCT Act)	BioMetric Vegetation Type (NSW BioBanking Scheme)	NSW Plant community Type (VIS Classification 2.1) PCTID
Blue Gum Diatreme Forest (BGDF)	Blue Gum High Forest in the Sydney Basin Bioregion (CE)	Blue Gum High Forest in the Sydney Basin Bioregion (CE)	HN596/ME001. Sydney Blue Gum – Blackbutt – Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin	1237. Sydney Blue Gum – Blackbutt – Smooth-barked Apple moist shrubby open forest on shale ridges of the Hornsby Plateau, Sydney Basin Bioregion
Blackbutt Gully Forest (BBGF)	Not Listed	Not Listed	HN648 Smooth-barked Apple – Turpentine – Blackbutt tall open forest on enriched sandstone slopes and gullies of the Sydney region.	1841. Smooth-barked Apple – Turpentine – Blackbutt tall open forest on enriched sandstone slopes and gullies of Sydney region.

The area of each plant community within the Site and the Impact Area is as follows:

Table 2. 3 Plant Community Areas

Plant Community Type (PCT) (GHD 2019)	Area of PCT within the Site (Ha)	Area of PCT within the Impact Area (Ha)	Condition of PCT within Impact Area (Kleinfelder 2017)
Blue Gum Diatreme Forest	15.75	0.68	Moderate-good_poor
Blackbutt Gully Forest	20.46	0.86	Native Rehabilitation/Regen
Blackbutt Gully Forest Regrowth	6.95	2.31	Exotic
Total	**43.16**	**3.85**	

Of note is the mapped location of BBGF located on the south west mound (SWM). With reference to the site geology, this location is likely to have been BGDF. This can be a consideration when planning a planting schedule for revegetation of the SWM (Appendix B).

2.6.2 Vegetation Condition

The soil structure and composition within the Site and the Impact Area have been highly modified due to mining activities and as a result the native vegetation has been compromised. The current bushland condition directly reflects the amount and type of soil disturbance that has occurred. Kleinfelder (2017) and GHD (2019) mapped and described the PCTs and condition in line with BBAM methodology (OEH 20014) (2.6.1 Vegetation Communities – Plant Community Types). This document has incorporated the bushland condition mapping method from The National Trust of Australia (NSW) Bush Regenerator's Handbook 3rd Edition (2010) with the previous condition mapping results for both PCTs. The National Trust method classifies the native vegetation condition by assessing the description (structure, species composition, diversity, response to disturbance i.e. native resilience and density of weeds present). It provides a guideline for appropriate management actions and the ability to establish baseline data that can quickly and easily be assessed in a monitoring regime. (Tables 2.4, Appendices A and F).

The results of the National Trust bushland assessment methodology have been overlain with the Kleinfelder condition mapping polygons for consistency and comparison (Figure 2.13).

2.6.1 Native Species List

A list of native species recorded on the Site can be found in Appendix C.

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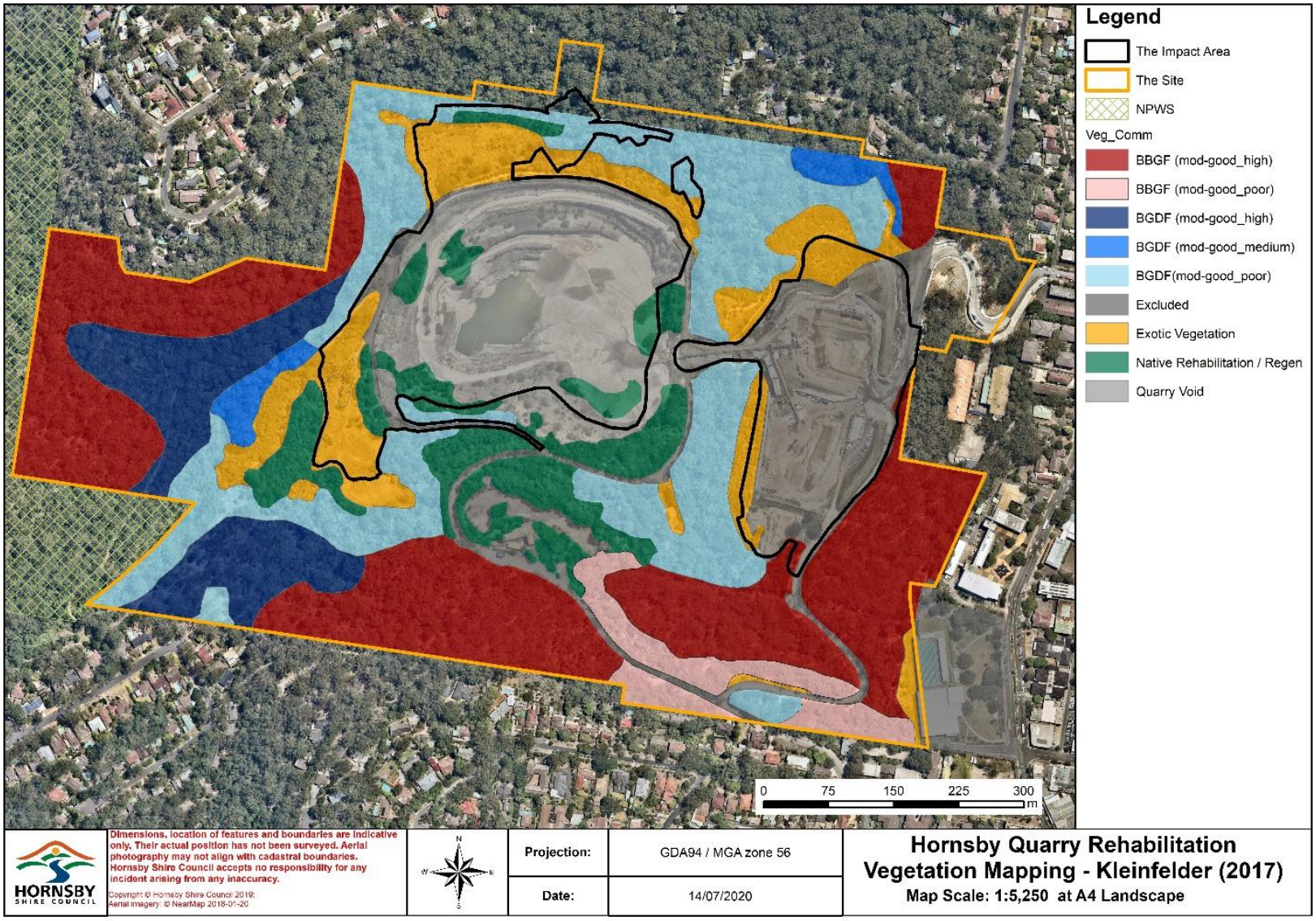

Figure 2. 12: Vegetation Condition – Kleinfelder 2017

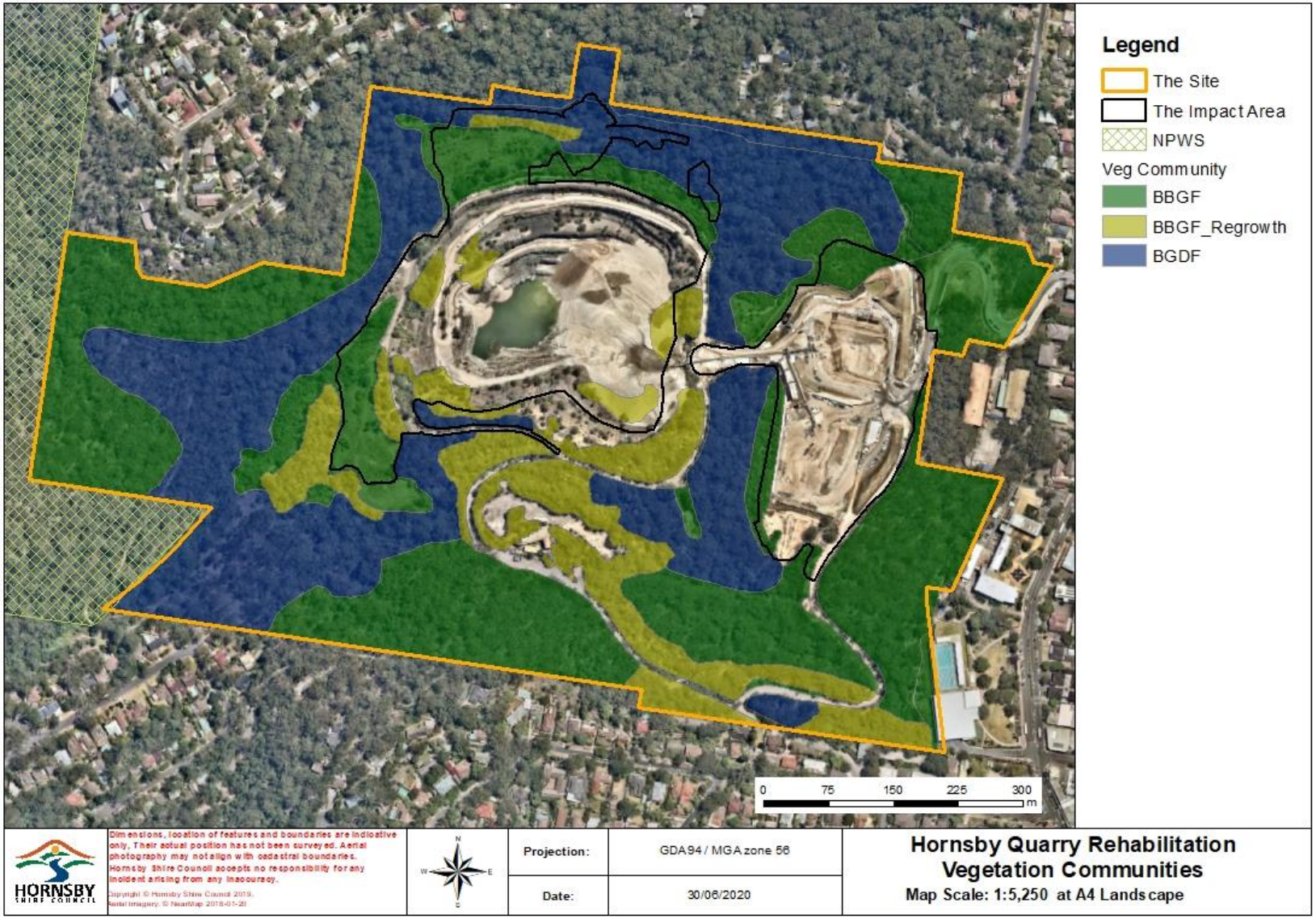

Figure 2. 13 Vegetation Communities – GHD 2019

Table 2. 4 Bushland condition mapping adapted from The National Trust of Australia (NSW)

Colour Code	Condition of Bushland	Weed Density	Description	Management Actions
Green	**Good**	<5%	High level of native vegetation structure, species composition and diversity. Virtually weed/exotic plant free. Soil intact. High Level of resilience.	**Low (Regeneration)** Maintain connectivity to bushland of similar condition. Prevent impacts from bushland of lesser condition. Monitor for possible wind or bird dispersed weed/exotic plants.
Blue	**Fair**	6-20%	Plant community slightly compromised but native species dominate the site. Minor infestations of weed/exotic plants. Soil relatively intact. Good level of resilience.	**Medium (Regeneration)** Assess cause of infestation and address where possible (e.g. neighbouring property source, over clearing, overuse). Remove weed/exotic plants with best practice bush regeneration techniques.
Orange	**Poor**	21-60%	Dominant native species highly suppressed, one or more strata layers missing. Severe infestations of weed/exotic plants. Soil integrity low. Poor level of resilence.	**High (Regeneration and Revegetation)** Assess cause of infestation and address where possible (e.g. modified soils, neighbouring property source, over clearing, overuse). Remove weed/exotic plants with best practice bush regeneration techniques. 'Assisted regeneration' e.g. revegetation, physical disturbance, fire.
Red	**Very Poor**	>61%	Only mature specimens of the dominant highest stratum of the PCT remain. Recruitment absent due to modified soils and heavy infestation of weeds/exotic plants. Bushland has been completely replaced by exotics.	**Extremely High (Revegetation)** Ability of the PCT to recover is extremely low, at times non-existent. 'Assisted regeneration' will require soil reconstruction, revegetation and ongoing weed/exotic plant treatment.

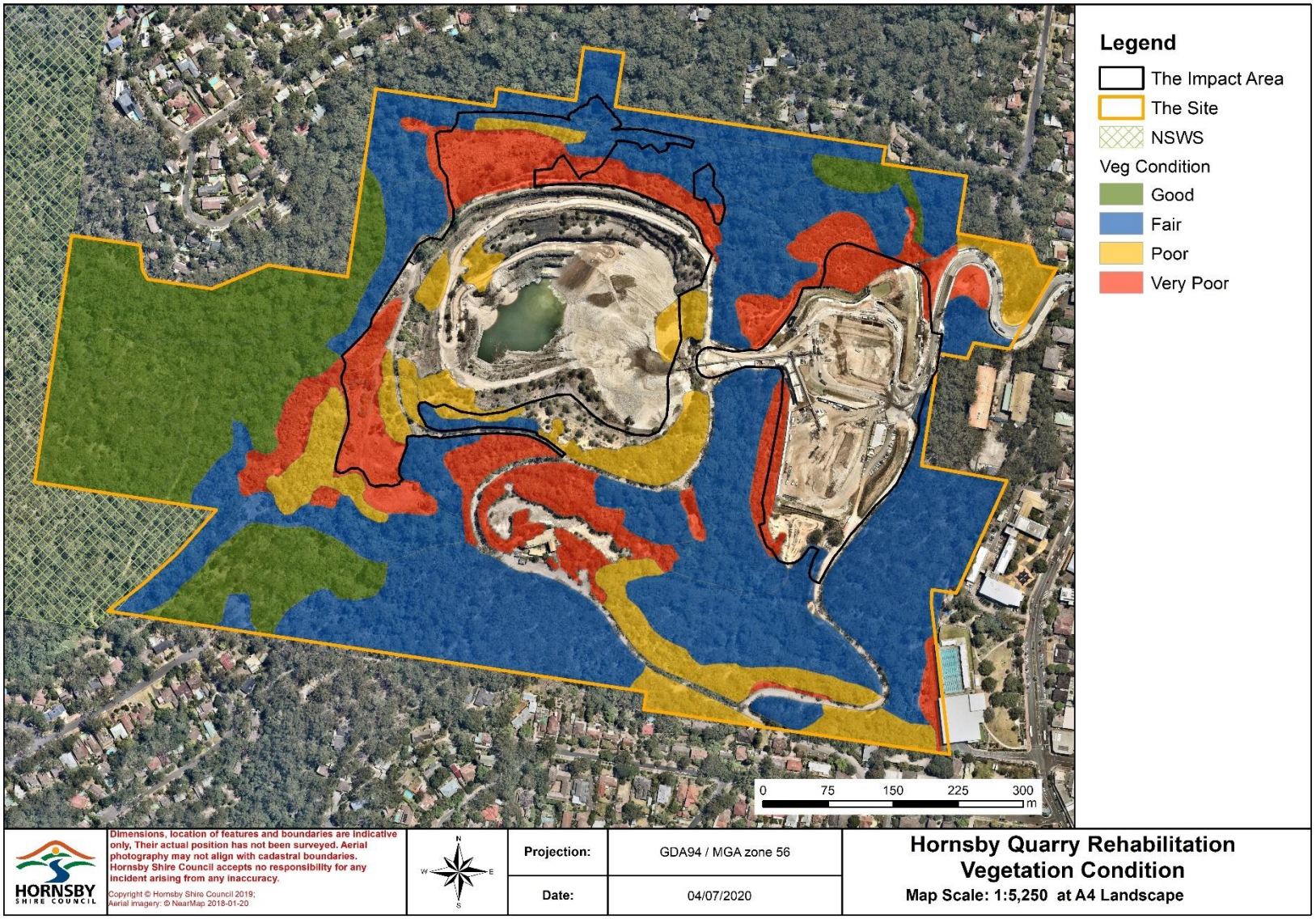

Figure 2. 14 Vegetation Condition – The National Trust of Australia (NSW)

2.7 Weed Species

A weed is a plant growing in the wrong location, dominating the landscape and suppressing plants which would normally exist. With reference to bushland, weeds are plants which do not grow within the classified Plant Community Type (PCT). Weeds are known to be opportunistic in a disturbed area with adaptations of rapid growth and effective dispersal mechanisms. They have the capacity to dominate an environment to the extent that they alter microclimates and ecosystems. This in turn improves conditions for their survival and the level of ongoing disturbance. Whilst undesirable, the value of weeds as habitat for fauna should be considered in a treatment plan.

2.7.1 Priority Weeds

The *Biosecurity Act 2016* and regulations provide a list of priority weeds and high-risk activities at a State level. The Biosecurity Act prioritises weeds based upon management objectives. Prevention is the highest followed by Eradication, Containment and Asset Protection. Table 2.5 lists priority weeds recorded on the Site, their status at State and Greater Sydney Local Land Services Regional scale, and the outcomes to demonstrate compliance with the General Biosecurity Duty (GBD).

Table 2. 5 Priority Weeds

Botanical Name	Common Name	State level Category	Regional Level Category	*Biosecurity Act 2015* requirements and Strategic response in region for GBD
Anredera cordifolia	Madeira vine	Asset Protection		No movement import or sale
Asparagus aethiopicus	Asparagus weed	Asset Protection		No movement import or sale
Cortaderia selloana	Pampas grass		Asset Protection	Fully and continuously suppressed and destroyed
Genista monspessulana	Cape/Montpellier broom	Asset Protection		No movement import or sale
Lantana camara	Lantana	Asset Protection		No movement import or sale
Ligustrum lucidum	Privet – broad-leaf	Asset Protection		No movement import or sale
Ligustrum sinense	Privet – narrow leaf	Asset Protection		No movement import or sale
Olea europaea subsp. *cuspidata*	African olive		Containment	Prevent spread, reduce impact on assets, identify assets for targeted mgmt
Rubus fruticosus	Blackberry	Asset Protection		No movement import or sale
Senecio madagascariensis	Fire Weed	Asset Protection		No movement import or sale

Biosecurity duty definitions

General Biosecurity Duty: *All plants are regulated with a **general biosecurity duty** to prevent, eliminate or minimise any biosecurity risk they may pose. Any person who deals with any plant, who knows (or ought to know) of any biosecurity risk, has a duty to ensure the risk is prevented, eliminated or minimised, so far as is reasonably practicable.*

Asset Protection: *These weeds are widely distributed in some areas of the State. As Weeds of National Significance, their spread must be minimised to protect priority assets.*

Containment: *These weeds are widely distributed in the region. While broad scale elimination is not practicable, minimisation of the biosecurity risk posed by these weeds is reasonably practicable.*

2.7.2 Weeds of Regional Concern

Weeds recorded on the Site that are of regional concern because, by definition, they present a risk to biodiversity due to the likelihood of them spreading throughout the Site and into the surrounding areas. Despite appearing in separate lists within the *Biosecurity Act 2016,* they will also be treated as a priority due to the impact they will have on the success of rehabilitation (Table 2.6).

Table 2. 6 Weeds of Regional Concern

Botanical Name	Common Name	Asset/value at risk
Agapanthus praecox subsp orientalis	Agapanthus	Environment
Ageratina adenophora	Crofton weed	Environment
Ageratina riparia	Mistflower	Environment, Agriculture
Andropogon virginicus	Whiskey Grass	Environment
Araujia sericifera	Moth vine	Environment
Bidens pilosa	Farmers Friend	Environment, Agriculture
Cardiospermum grandiflorum	Balloon vine	Environment
Chlorophytum comosum	Spider Plant	Environment
Cinnamumum campphora	Camphor laurel	Environment, Agriculture, Human health
Cotoneaster spp	Cotoneaster	Environment
Cyperus eragrostis	Umbrella Sedge	Environment, Agriculture
Delairea odorata	Cape Ivy	Environment
Eragrostis curvula	African lovegrass	Environment
Hedychium gardnerianum	Ginger Lily	Environment
Ilex aqifolium	English Holly	Environment
Lonicera japonica	Japanese Honeysuckle	Environment
Nephrolepis cordifolia	Fishbone Fern	Environment
Ochna serrulata	Ochna	Environment
Pennisetum clandestinum	Kikuyu	Environment
Senna pendula	Cassia, Senna	Environment
Solanum mauritianum	Wild tobacco bush	Environment, Agriculture
Tradescantia fluminensis	Trad	Environment

2.8 Fauna

A total of four surveys have been undertaken at the project site and adjacent areas by GHD (2019), Kleinfelder (2017), Ecological Australia (2015) and PB (2004) with some surveys building on previous data sets. A total number of sixty-seven (67) fauna species were recorded including fifty-three (53) bird species, four terrestrial or arboreal mammal species, five bat species, three reptile species, and two frog species. Additionally, the introduced species *Vulpes vulpes* European Red Fox and *Pycnonotus jocosus* Red-whiskered Bulbul were also recorded.

2.8.1 Survey Effort

Fauna surveys included call recordings, call playback and a targeted *Daphoenositta chrysoptera* Varied Sitella survey. A significant portion of the survey effort primarily utilised incidental or opportunistic fauna sightings. General habitat assessments were conducted to ascertain suitable habitat from condition and structural parameters.

Across all four surveys, temporal effort was focussed over a summer period. An ongoing fauna monitoring program incorporating increased spatial and temporal sampling is recommended to enhance the current fauna baseline data and representation across the site and adjacent areas. Gecko Environment Management undertook two observational surveys in June 2020. All survey results to date have been collated in Appendix D.

2.9 Existing Habitat and Value

The key terrestrial habitats identified here recently by GHD (2019), Kleinfelder (2017), Ecological Australia (2015) and PB (2004) include BBGF, BGDF and disturbed landscapes. Habitat attributes afforded by structural vegetation layers have been positively associated with major fauna groups in temperate eucalypt forests (Table 2.7).

The significance of fauna habitat attributes extant within a site are relevant in their:

- resource type and quality
- specific breeding, nesting, feeding and roosting resources to existing species
- functional redundancy within the landscape
- temporal sustainability
- role in sustaining trophic interactions/food webs

Some of the resources recently surveyed include:

- hollow-bearing trees
- specific feed trees
- rock outcrops (potential den sites for the *Dasyurus maculatus* Spotted-tailed Quoll)
- water bodies
- rocks, logs, peeling bark and leaf litter for small reptiles
- winter-flowering eucalypts (important for the *Lathamus discolor* Swift Parrot and *Pteropus poliocephalus* Greyheaded Flying-fox)
- food trees of the *Phascolarctos cinereus* Koala and *Calyptorhynchus lathami* Glossy Black-cockatoo
- hollow-bearing trees and logs which provide refuge, nest and den sites for a range of threatened fauna species
- stags and other roost sites for raptors and owls
- termite mounds comprising potential habitat for *Varanus rosenbergi* Rosenberg's Goanna
- wetlands, moist grassland and other foraging habitat for waterbirds (including migratory birds) and frogs

Within the VMP some finer scale structural vegetation / habitat zones have been identified as important in taking a precautionary approach to avoiding critical localised impacts for several protected and threatened species. Key habitat zones within the VMP are:

- Blue Gum Diatreme forest
- Blackbutt Gully Forest
- Open Rocky Faces
- Riparian Corridors

- Disturbed Areas
- Privet
- Grasslands
- Wet Areas

Table 2. 7 Habitat Attributes Associated with Major Fauna Groups in Temperate Eucalypt Forests

Stratum	Attribute	Birds	Arboreal Mammals	Ground Mammals	Bats	Reptiles	Amphibians	Invertrates
Overstorey	Number of overstorey stems	■						■
	Number/basal area of large trees		■					
	Increased larger DBH distribution				■			
	Basal area of overstorey stems	■	■	■				
	Species richness and diversity	■	■					
	Floral resources	■	■					
	Decorticating bark	■	■					■
	% canopy cover	■	■	■				■
	Canopy height/volume	■	■		■			
	Number of hollow bearing trees	■	■					
	Distribution of hollow bearing trees		■					
	Number and DBH of large dead trees					■		
Mid-storey	Mid storey height				■			
	Canopy-mid storey gaps				■			
	% cover	■		■	■			■
Ground layer	Shrub diversity	■		■		■		
	% cover shrubs and herbs	■	■	■	■	■	■	■
	% cover debris (litter, rocks, logs)	■		■	■	■	■	■
	% cover bare ground					■	■	■
	Permanent water and proximity				■		■	

McElhinny et al. (2006) conducted a literature review that identified fifty-five studies from south-east and south-west Australian temperate forests. These studies demonstrated the presence and abundance of different fauna were significantly ($p<0.05$ associated with structural vegetation attributes. The habitat requirements for different fauna types included birds, arboreal mammals, ground mammals, reptiles, bats, amphibians and invertebrates were reviewed, and thirty-four key structural attributes were identified. These attributes function as a comprehensive set with a demonstrated associations with biodiversity values.

2.9.1 Blue Gum Diatreme Forest

Blue Gum Diatreme Forest (BGDF) consists of tall open forest to over 30 metres height over a sparse to dense mid-storey of mesophyllous species and a ground layer of ferns, grasses vines and herbs. Structurally this community contains attributes consistent with supporting a diverse variety of fauna demonstrated in Table 2.7. The canopy provides a range of foraging floral resources accessed throughout the year at different flowering times by a range of birds, bats, arboreal mammals and invertebrates. Important habitat corridors exist within this community to the north, east and west surrounding the quarry site, supporting mesic vegetation of varying condition. These corridors form vital habitat for arboreal mammal possum species and in turn hunting flyways for the *Ninox strenua* Powerful Owl. The northern corridor provides essential structural and functional vegetation for extant Powerful Owls. Significant nesting and roosting trees are present. It is estimated that Eucalypts forming suitable hollows for Powerful Owl in this community may be >150 years old, older trees and ongoing recruitment specimens in this community should be regarded as an irreplaceable resource. The northern BGDF links directly into the western and eastern corridors extending available habitat for this

keystone species. These corridors are important to a host of species. Swamp Wallaby *Wallabia bicolor* are commonly observed within this community on site (Figures 2.13 and 2.14).

2.9.2 Blackbutt Gully Forest

Blackbutt Gully Forest (BBGF) is a tall open forest occurring on enriched sandstone slopes and gullies. Typical species that occur within the community include *Eucalyptus pilularis* Blackbutt, *Angophora costata* Sydney Red Gum and *Syncarpia glomulifera* Turpentine. The structural attributes afforded from this community are in line with eucalypt forest fauna habitat requirements of in Table 2.7.

Eucalyptus pilularis Blackbutt are known to begin forming hollows beyond the DBH of 85cm (Todarello and Chalmers 2007). Over twenty trees exhibiting a DBH greater than 85cm were identified by GHD's survey, the vast majority occurring in the southern extent of the site. Senescent or standing dead trees (SDT) are also scattered throughout this community providing significant nesting hollows to many species. Additionally, *Eucalyptus pilularis* Blackbutt provide important browse trees for the threatened *Daphoenositta chrysoptera* Varied Sittella that exploits the often-overlooked bark resources of eucalypt trees which can support rich invertebrate communities of up to 300 species for a single tree (Recher et al 1996). Several bat species utilise bark resources and tree hollows for roosting, hibernation and maternity sites (Brown et al 1997). Bats prefer a diverse range of tree hollows often occupying small hollows when roosting individually or large hollows when roosting communally (Tideman and Flavel 1987) whilst some bat species preferred trees with a DBH greater than 120cm (Taylor and Savva 1988). Attributes associated with increased bark resources are a function of increased bark surface area and therefore, tree basal area and DBH.

Ground layer fauna values such as litter, logs and rocky areas provide important habitat values for several fauna species. Logs, woody debris and litter are a critical resource for small ground mammals such as the *Tachyglossus aculeatus* Short-beaked Echidna and *Antechinus stuartii* Brown Antechinus (Smith et al 1989). Several studies (Bauer et al 2000; Smith et al 1994; Andrews et al 1994) have correlated the richness of small ground mammals with the abundance of large logs. The *Wallabia bicolor* Swamp Wallaby are commonly observed within this community on site.

2.9.3 Open Rocky Faces

Open rocky areas to the north and south of the quarry have been difficult to access for survey for fauna and this will need to be addressed by future management recommendations. These open rocky faces and rock screes can provide important shelter and refuge sites for ground mammals such as the Short-beaked Echidna, wallabies and *Dasyurus maculatus* Spotted Tailed Quoll (Paull and Date 1999). Reptiles utilise rocky faces for refuge, nesting and basking sites and Fanning (1995) found that reptile species richness was significantly higher when these features were present.

2.9.4 Riparian Corridors

The riparian corridors onsite predominantly have their origins in minimally disturbed upper catchments and transect several vegetation communities creating significant ecotones along their extent (Figure 2.15). Within the riparian corridors, canopy eucalypt species such as *Eucalyptus saligna* Sydney Blue Gum include a large tree 30-50 metres high with DBH up to 2 meters. Hollows range from small branch stubs to large hollows suitable for forest owls in both mature and senescent trees. Approximately eighteen trees of potential small hollow forming DBH (greater than 85cm DBH) are distributed within the western riparian corridor. This

increased structural complexity allows for greater diversity of fauna. Amphibians such as the *Crinia signifera* Common Eastern Froglet utilise boggy seepages and water sources for reproduction and development for their young (Smith et al 1994). Retention of canopy and understorey vegetation cover here is important in maintaining a moist microclimate (Parris 2002) with the additional benefits of ground debris for refuge and shelter from predation (Ferraro and Burgin 1993).

Many bat species require easy access to permanent water sources to satisfy their feeding and roosting requirements McElhinny et al. (2006). Proximity to water allows bats to expend minimal energy to access feeding grounds and Riparian areas are important for many insectivorous bat species as insects congregate the open spaces above water sources.

2.9.5 Disturbed Areas

The Site exhibits significant disturbed areas of vegetation around the perimeter of the quarry. Connective vegetation plays a functional role as habitat regardless of whether it is exotic or native. Exotic vegetation dominates these disturbed areas consisting of dense Privet forests within mesic riparian corridors. Similar levels of dominant exotic vegetation is found in open grasslands of perennial grass species, on more exposed and drier aspects (2.9.7) or in wet areas containing collected water.

2.9.6 Large and Small-leaved Privet

Ligustrum lucidum and *Ligustrum sinense* Large and Small-leaved Privet is a highly invasive weed capable of transforming native vegetation communities by dominating the mid and lower strata. Although damaging to native floral diversity, these stands induce a mesic microclimate and provide structural and functional resources conducive to favourable habitat for frugivorous birds, bats and arboreal mammals including *Pseudocheirus peregrinus* Common Ringtail Possum, the *Trichosurus vulpecula* Common Brushtail Possum and, as in this Site, the *Ninox strenua* Powerful Owl. Because of its attributes and important value as habitat, the control of *Ligustrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet will require careful observation prior to any works. Strong consideration will need to be given to seasonal timing and sequencing of mosaic removal and replacement via regeneration or revegetation with native species to maintain canopy connectivity, the current moist and cool microclimate and the riparian wildlife corridor (Figure 2.15).

2.9.7 Grasslands

Perennial grass species dominate the ground layer on exposed aspects. The structure and function afforded by this exotic vegetation provides foraging opportunities for many reptiles, ground mammal and some bat species. The dense understorey allows refuge and shelter opportunities for reptiles, small mammals and invertebrates. This in turn provides predatory species with food sources and hunting advantages with large canopy gaps present.

2.9.8 Wet Areas

Low areas of contained impeded clean drainage on Site currently form wet areas which retain an environment suitable for the highly sensitive Vulnerable species *Pseudophryne australis* Red Crowned Toadlet, which has been located just outside the site previously. These do not appear however, to be within the Impact Area. Wet areas are typically biodiverse zones providing good habitat for a range species. Invertebrate populations are typically high in these areas, as are generalist and insectivorous bird species. Common reptiles to this habitat

in the local area include *Eulamprus quoyii* Eastern Water Skink *Pseudechis porphyriacus* Red Belly Black Snake and *Physignathus lesueurii* Eastern Water Dragon. Within the largely exotic grassland area to the very south west of the Impact Area, a wet area on disturbed ground currently support the *Crinia signifera* Common Eastern Froglet. The preservation or creation of wet areas on the Site with revegetation or inclusion in landscape design will provide great opportunities for improving habitat and allowing for passive activity such as bird watching (Figure 2.10).

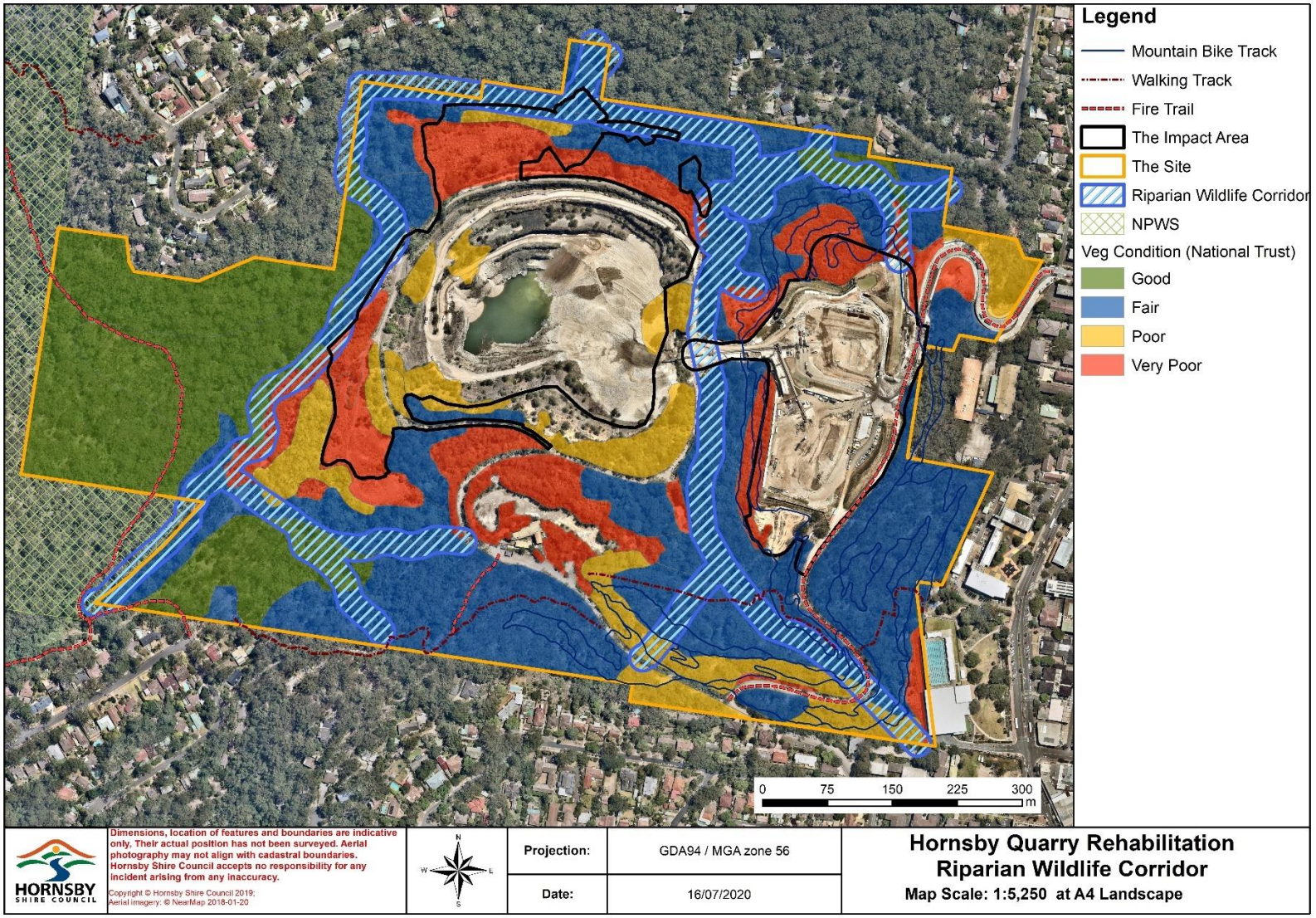

Figure 2. 15 Riparian Corridors as Wildlife Habitat

3. Impacts

The impacts of DA/101/2019 on the ecological functional relationship between vegetation as habitat and fauna are of relevance to this VMP and HCEP. The potential direct, indirect and cumulative impacts of the Site and their relevance to the key threatening processes have been identified. The mitigation of these will be discussed to support the proposed Biodiversity Offset Strategy and necessary actions to achieve the aims (1.3 Aims and Objectives). Mitigation measures to limit the impacts are discussed in Chapter 6 Habitat Management.

Whilst the Site has been historically impacted by mining activities and the areas of high condition have been avoided wherever possible, the proposed development will have an impact on the current environment. It should be noted here that the impacted vegetation has predominately been mapped as exotic (Kleinfelder 2017) and in poor condition (The National Trust of Australia NSW) (Figures 2.12 and 2.14) due to vegetation consisting mainly of weed growth. The value of the weed growth as habitat has been considered in this plan because of its use by existing fauna for shelter, foraging and breeding. It is also important to note here the inclusion of a breeding pair of *Ninox strenua* Powerful Owl nesting within the Site, and its role as a 'keystone species', when identifying and discussing the impacts.

3.1 Key Threatening Processes and Keystone Species

The roles fauna and flora have on maintaining 'ecosystem function' relates to the processes and interactions (or roles) they both have within their environment. Some of these functions include nutrient cycling, water filtration and cycling, energy flow (production, consumption and decomposition), soil formation, pollination, carbon cycling and gene flow. Table 3.1 below groups the species that together perform an ecosystem function (Department Natural Resources 2011). A 'keystone species' is described as a one that has a '*disproportionately important role in maintaining ecosystem function*' (Department Natural Resources 2011) and in this report, it is considered as a 'restoration target'. Species specific mitigation measures to avoid disturbance to the *Ninox strenua* Powerful Owl's life cycle habitat requirements are identified Chapter 6 Habitat Management.

A key threatening process (KTP) is defined under the NSW *Biodiversity Conservation Act 2016* Act (Table 3.2) as an action, activity or proposal that:

- adversely affects two or more threatened species, populations or ecological communities
- could cause species, populations or ecological communities that are not currently threatened to become threatened

Discussion of the KTP serves to inform prioritised prevention, containment, modification or mitigation actions of processes and associated impacts on the Impact Area and the Site, in all activities including future planning and design.

Table 3. 1 Interactive roles of fauna groups in ecosystem function

Functional group	Key processes	Example of functional group members
Primary producers	Energy flow, carbon cycling, nutrient cycling, water filtration and cycling	Plants
Pollinators	Pollination	Birds, insects and small mammals
Seed dispersers	Gene flow	Bird, ants
Decomposers	Nutrient cycling, energy flow carbon cycling	Fungi, bacteria, insects
Nitrogen fixers	Nutrient cycling	Plants hosting rhizobial bacteria
Consumers	Nutrient cycling, energy flow, gene flow	Herbivores, (many mammals such as kangaroos, wallabies and wombats
		Carnivores (birds of prey, snakes, spiders)
		Insectivores (some birds, bats)
		Frugivores (some birds)
		Nectarivores (some birds, small mammals, insects)
		Omnivores (some generalist birds)

Table 3. 2 Key threatening process listed on the EIS from the Schedules of the *BC Act 2016*

EIS Key Threatening Process List
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands
Anthropogenic climate change climate change
Loss of hollow-bearing trees
Clearing of native vegetation
Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis
Infection of native plants by *Phytophthora cinnamomic*
Introduction and establishment of Exotic Rust Fungi of the order *Pucciniales* pathogenci on plants of the Myrtaceae family
Invasion of plant communities by perennial exotic grasses
Removal of dead wood and dead trees
Additional KTPs identified through this VMP and HCEP
Bush rock removal
Invasion and establishment of exotic vines and scrambles
Invasion of native plant communities by African olive, *Olea europaea* supsp. *Cuspidata*
Invasion, establishment and spread of Lantana, *Lantana camara*
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Predation by the European red fox, *Vulpes vulpes*
Predation by the feral cat, *Felis catus*

3.2 Direct and Indirect Impacts from the Earthworks within the Impact Area

As detailed within the EIS and previously in this document, most of the project area comprises highly modified landforms, soil profiles and vegetation types. The extent of earthworks and vegetation being cleared as part of this DA, is within modified land containing exotic species with some native regrowth. Engineering and landscaping plans have considered potential impacts with numerous design modifications being made to protect native vegetation, fauna habitat and the BGDF with the least possible impact on flora and fauna. All revegetation following the earthworks is aimed at mitigating impacts to provide improved long-term outcomes for the Site including the degraded north spoil mound. Revegetation is to occur immediately after earthwork stabilisation (Appendices A and F)

3.2.1 North Spoil Mound Stabilisation and Vegetation Clearing

To ensure public safety and remove the risk of embankment failure resulting in additional significant tree loss, geotechnical recommendations require stabilisation work be undertaken on the north spoil mound. The stabilisation work plans to lower ground levels and remove established exotic vegetation on the mound itself including the area directly adjoining the north slope of the riparian corridor. Until the planned revegetation has established, the act of vegetation clearing will:

- remove existing weeds present on the north mound which are currently providing habitat to all functional groups (Table 3.1)
- fragment the riparian corridor and isolate critical habitat resources
- increase risk of predation
- provide an environment conducive to opportunistic weed establishment as has happened in the past (pampas, privet)
- expose and alter the microclimate of the north riparian wildlife corridor through the removal of vegetation
- alter growing conditions in the corridor with increased evaporation, temperature and light hence decreased levels of available moisture and humidity

3.2.2 Earthworks Disturbance and the *Ninox strenua* Powerful Owl

Since the preparation of the EIS, it has been confirmed that a breeding pair of *Ninox strenua* Powerful Owl has, and continues to, roost, forage, nest in tree hollows and successfully raise young on site. The north, east and western area of the Site currently constitutes key habitat for this threatened species. The *Ninox strenua* Powerful Owl is known to be highly sensitive to disturbance and vegetation clearing. It has been known to be affected by the removal of vegetation, vibration, dust and loud noise associated with earthworks. Any clearing or earthworks between April and October within 100m of known nesting trees will increase the risk of the owls abandoning the nest site and potential their chicks. Clearing the vegetation adjacent to the riparian wildlife corridor behind the mound will remove a key roosting area in the mesic corridor (See 4.2 Protection of the *Ninox strenua* Powerful Owl).

3.2.3 Wildlife Buffers

The term ‘wildlife buffer’ is used to describe the interface between a natural area (Gleeson 2012) and a ‘hostile matrix’ of land uses unsuitable for sustaining Biodiversity (Franklin and Lindenmayer 2009). Wildlife buffers

exist on the Site and despite weed species dominating, they are performing key interactive roles in the Site's ecosystem functions (Table 3.1 and Figure 4.1).

The role and effectiveness of a wildlife buffer varies in relation to the level and type of disturbance as well as the impact the disturbance will have on the ecology of the natural area. A buffer structure and width depend on its position along a hostile matrix, the distance to core good bushland and it's intended use. For example, Lemckert and Brassil (2000) recommended a 30m buffer from a stream to protect breeding habitat of the endangered *Mixophyes iteratus* giant barred frog from logging where Rogers and Smith (1995) recommended a buffer greater than 100m to protect bird species along a coastal temperate forest also from logging in Vancouver Island, Canada. The main buffer that this DA will impact is due to the clearing on the north mound and the north riparian wildlife corridor (Figure 4.1).

3.2.4 North Spoil Mound Stabilisation and Tree Loss

The ground levels along a portion of the top of the north mound are going to be dropped to improve water management, facilitate a suitable gradient over the extent of the north mound and improve safety. The vegetation at the top of the mound predominately consists of Eucalypt canopy cover with an exotic mesic midstorey. The survey of Eucalypts present indicates a mixture of endemic and native species not endemic to the existing Plant Community Types (PCT)s. It has also been consistently recorded that there are mature trees, trees approaching maturity and younger samplings present. Loss of these trees and their role as 'primary producers' (Table 3.1) is inevitable. In addition, the loss of the trees will expose the north mound riparian corridor (3.2.1) and remove emerging trees with the potential to form nesting hollows.

3.2.5 Clearing of Vegetation and Habitat Resources

The works associated with the DA will result in 3.85 hectares of vegetation being cleared. This vegetation currently provides foraging, breeding and roosting resources for a range of fauna species including threatened species. Where possible the focus on clearing works identified in the earthworks DA has been upon the recently and historically modified areas of the site.

Both individually and in concert, structural layers of vegetation within vegetation communities on site provide key habitat attributes for a range of fauna (Tables 2.7 and 3.1). Threatened species on site use the mesic corridors for protection, hunting of prey and roosting. Vegetation plays a functional role regardless of whether it is exotic or native. Whilst reduction of the impacts from invasive species needs to be addressed within this Site, it is important to note that in some circumstances the presence of exotic species may not detract from their ecosystem function in providing habitat.

The clearing of connective native vegetation would result in the loss of connectivity within that strata, critically within the riparian zone on site having direct impacts on arboreal mammals, removing safe movement corridors, nesting resources and protection from foxes and cats, indirectly creating potential reduction in food resources for the Powerful Owl.

Vegetation clearing within the site could directly impact:

- nectar resources
- foraging substrate for birds, reptiles (varanids),
- foraging and protection of arboreal species, such as birds, mammals and bats.

- fallen logs and rock outcrops,
- termite mounds
- low condition grassland habitat
- steep rocky face not currently surveyed, though likely habitat for frogs and reptiles

Within the Impact Area the EIS identifies five known hollow bearing trees for removal. The fact that the Powerful Owls nesting hollows had not been detected in previous hollow tree surveys highlights the difficulties in accurately surveying for hollow bearing trees. Hollow entrance sizes effectively select for species suitability. *Eucalyptus pilularis* Blackbutt are known to begin forming small hollows beyond the DBH of 85 cm (Todarella and Chalmers 2007), common within the BGDF and BBGF PCT's on site. Small hollows here, including branch stubs, are likely to be utilised by species such as Sugar Glider, Brush Tail and Ringtail Possums, Sulphur Crested Cockatoos, Lorikeets and microbats. Large hollows suitable for Forest Owls commonly form in Eucalypts >150 years old (Giibons and Lindenmeyer 2002). Birdlife Australia has documented *Ninox strenua* Powerful Owls commonly using tree hollows with entrances greater than 35cm in both living and dead trees. A number of dead standing trees on site likely provide important hollows to several species, additionally they provide important browse trees for the threatened Varied Sitella located on site. A precautionary approach must be taken in all vegetation clearing to not directly harm Fauna and to avoid the removal of hollow bearing trees (Chapter 6 Habitat Management).

Whilst there is currently no proposed removal of natural creek lines, the landscape works and installation of artificial drains and culverts provide opportunities in design for works and associated revegetation/landscape installation to enhance some riparian zones on site. The EIS identified that:

"*Culverts represent potential roosting habitat for microbat species such as the Eastern Bentwing Bat .... extension of these culverts could provide additional roots habitat …*".

Figure 3. 1 Low Point behind North Spoil Mound

3.3 Cumulative Impacts

The Site brings a confluence of what are essentially a conflicting range of land uses in that the quarry sits within a bushland matrix connected to large tracts of regional National Park and bounded to the North by established residential and commercial areas. The current use of the natural area has identified inevitable conflicts between human activities and maintaining habitat attributes (Table 2.7). The VMP and HCEP aims to mitigate these and assist in maximising opportunities to enhance such attributes where practicable with the recommended management actions.

The Site currently has a 6-kilometre mountain bike track in the north, east and southern bushland parcels. It also has existing fire trails and a series of sandstone steps built in the 1930's, half of which degraded, the other half has been restored and now experiences high levels of visitation. The mountain bike and pedestrian tracks have been shown to have significant impacts within bushland areas, effectively increasing the critical distances of edge effects into bushland. The impacts include:

- increased soil erosion and sedimentation
- vegetation clearing and reduced ground layer biomass
- unforeseen extent of impact due to creation of informal tracks
- increased risk of introduction of domestic pets and/or predators to site
- increased noise levels
- increased introduction and spread of pathogens e.g. *Phytophthora cinnamomi*

Mountain bike tracks have also been shown to introduce more severe impacts including:

- damage from the construction of unauthorised tracks and jumps
- increased erosion from rutting, skidding and wheel spin
- increased native fauna flight initiation distances and escape behaviour

Night access into sensitive areas by both pedestrians and bikes using head torches is known to impact successful breeding and raising of young by *Ninox strenua* Powerful Owl.

The cumulative impact of regular switchbacks on steep terrain and exclusive separate pedestrian, vehicle and bike tracks can physically cover a substantial area of vegetation clearing multiplying the effect significantly. Careful consideration is required during any potential design to ensure these elements are designed to reduce any impact.

4. Impact Mitigation

The mitigation methods proposed are presented in this chapter and listed as management actions (Appendix A). They aim to reduce the extent of impacts caused by the DA and to restore sustainable ecological functions on the Site. Consideration has been given to the functional requirements of the natural area and role the group members or groups in establishing the desired outcomes (Table 3.1). For example, following earthworks on the north spoil mound, revegetation will incorporate nitrogen fixing plant species as primary succession species, revegetation with fast growing flowering species will provide habitat for pollinators, retained timber will be provide habitat for decomposes and the overall protection, conservation and restoration of vegetation over the Site will constitute the ultimate primary produces.

4.1 Areas of Habitat to be Retained, Enhanced or Created

All management actions have been prescribed with the intention of maintaining a high level of habitat on site (Chapter 6 Habitat Management, Appendix A).

4.1.1 Impact Area Wildlife Habitat Buffer

To mitigate edge effect impacts, wildlife buffers (buffers) will need to be retained, enhanced or created along interface areas of management zones. The buffers around the perimeter of the Impact Area will protect the ecological functions of the vegetation on Site (Figure 4.1). Management actions include buffer creation with dense planting of quick growing shrub species, buffer enhancement with supplementary planting to improve the vegetation structural properties, or buffer retention, regardless of species. If a buffer is an existing weed plume, revegetation will need to be scheduled to complement the timing of staged weed treatment and/or any naturally occurring regeneration. The restoration of the north spoil mound with stabilisation, soil improvement and revegetation with plant species representative of BGDF will replace the current buffer due to be cleared and in time, mitigate fragmentation, enhance connectivity and assist with ongoing maintenance of the mound and adjacent natural areas.

4.1.2 Riparian Wildlife Corridor Enhancement and Revegetation

Riparian wildlife corridors are to be a high priority in habitat protection (Figures 2.15 and 4.1) along with the Powerful Owl breeding temporary authorised access area (Figure 4.2). This document recommends a 30m buffer around the Impact Area edge and a 30m buffer along the riparian wildlife corridors outside the Impact area. These areas have been mapped and referred to in the management actions per zone. Figure 4.1 maps the extent of the 30 metre buffer to the Impact Area and the 30 metre buffer along the riparian wildlife corridor. The respective management actions have been listed beside ‘Management Issue’ in Appendix A and Performance Criteria in Appendix F. The mitigation summary of riparian wildlife corridor impacts is as follows:

- retain and enhance the remnant vegetation along the riparian corridor
- install a mosaic canopy and midstrata structure with supplementary rainforest plantings in conjunction with a conservative staged mosaic removal of weed species

- retain overhanging vegetation particularly horizontal branches over natural clearings or tracks and incorporate elements to mimic overhangs as a valuable structure within a movement corridor to assist with the natural 'hop-scotch' movement behaviour of the *Ninox strenua* Powerful Owl (Table 3.1 and Figure 4.1)
- avoid canopy or midstorey disturbance in densely vegetation areas within buffers to preserve roosting microclimates for *Ninox strenua* Powerful Owls

4.1.3 Protection and Creation of Permanent Water or Wet Areas

Permanent water including existing wet areas should be retained and protected where possible. Additional water features may be incorporated into the landscape design process to facilitate an increase in habitat complexity. These features could also become an attraction for visitors to the park. As valuable habitat, water features will support wildlife that could be observed from the security of a wildlife hide or the like. Examples of additional water features which could be utilised in the landscape are:

- permanent water features to act as a significant habitat requirement for all fauna, particularly bats and amphibians.
- the creation of vegetated wetlands to extend and supplement habitat for amphibians, reptiles, invertebrate and birds
- constructed drainage with design elements to facilitate shelter, food and breeding opportunities e.g. example, reed beds, rock stacks and overhanging vegetation

4.1.4 Retention of Natural Elements

Good opportunities exist within the construction phase to collect, retain and stockpile suitable habitat replenishment materials. Rocks, live and dead timber (including intact hollows) are to be harvested and incorporated into an extension of remnant vegetation edges. This will enhance and supplement suitable habitat for many ground mammals, reptiles, invertebrates and birds, particularly the complexity of ground layer of suitable habitat extensions and the creation of islands and refugia (Table 3.1) through installation of:

- felled or fallen timber
- rock piles or stacks

4.1.5 Retention of Standing Dead Trees Where Possible

Every consideration should be given to retaining dead standing trees as habitat where possible. They provide valuable hollows and browsing sites. Any alignment design of mountain bike tracks, walking tracks, recreational areas and thoroughfares should avoid proximity to any standing dead trees or senescing trees containing important nesting, refuge and habitat. Firstly, to maintain a significant barrier to ongoing anthropogenic disturbances such as traffic, noise and light pollution by keeping these activities separate. Secondly, to avoid having to remove the trees later because they may pose a threat to any human activity below from falling branches and stags.

4.1.6 Nesting Boxes to Offset Tree Losses

Nesting boxes are a useful habitat supplementation tool suitable for a diverse range of hollow using fauna including arboreal mammals, birds and bats. A well-designed nesting box program can help mitigate the transitional hiatus of hollow development in nearby remnants and offset some losses caused by tree removal. Additionally, valuable research and field survey opportunities exist through the ongoing monitoring of nesting boxes onsite to evaluate existing fauna populations. Recommended next box locations and type have been listed in Table 4.1.

Nest box material, design and installation considerations should consider the following:

- utilise failed branches and trunks where possible (Figures 4.3 to 4.6)
- hollow entrance sizes effectively selected for species suitability and therefore a diverse range of designs
- entrance sizes and internal dimensions need to be installed to accommodate the various bat, arboreal mammal and bird species present onsite
- nest boxes are often occupied by pest species which compete successfully with native species particularly near urbanisation (Pell and Tideman 1997)
- exclusion of pest species such as the Common Myna should utilise designs published by Birds Australia successfully tested by Homan 2000 or similar
- thermoregulation in nesting boxes is lacking compared to natural tree hollows and are strongly influenced by ambient temperatures and solar radiation (Rowland et al 2017)
- installation locations should consider, aspect, levels of solar exposure, temperature extremes and predominant wind direction
- material of nesting boxes should have thermal mass or insulating properties or the ability to install insulating material.
- monitoring for Fauna populations, species diversity and densities, invasive pest species such as European honeybee, ants or some bird species, damage and dislodgement and occupancy
- nest boxes require regular maintenance to remain suitable for occupancy and can sustain nest box projects for several decades
- maintenance schedules are to include: eradication of unwanted pest species, re-installation/fitment of damaged or compromised nest boxes, removal of excessive nesting material, replacement of decayed boxes and maintenance of connection to structure

4.2 Protection of the *Ninox strenua* Powerful Owl

Data provided by Birdlife Australia confirming the presence of the keystone species *Ninox strenua* Powerful Owl has lead the restoration focus to strongly consider its behavioural characteristics as well as its habitat composition and structural requirements as crucial to maintaining the functional ecosystem processes (Department Natural Resources 2011). Of major importance are:

- any clearing or Earthworks disturbance within 100m of an active breeding tree during April to October period should be avoided on site
- chain sawing or mulching must not be carried out an hour before sunset, an hour after sunrise or within 50m of identified roost sites

- chain sawing or mulching must not be carried out an hour before sunset, an hour after sunrise or within 100m of identified nest trees during April to October
- canopy connection and horizontal perching branches 4-10 cm diameter should be retained above tracks to accommodate 'hop-scotching' movement along flight ways
- midstorey vegetation should be retained or weeds species strategically treated based on roosting and fledging requirements with riparian wildlife corridors and adjacent woodland within 50m of riparian corridors to be a priority
- creek and wildlife buffer distances to be maintained, particularly in sensitive areas
- creek crossings for public use should be limited, maintained and fixed where possible

A strong emphasis should be given to staging earthworks in relation to the breeding cycle of *the Ninox strenua* Powerful Owl. In consultation with Birdlife Australia, every attempt is to be made to ensure works are not undertaken when a breeding pair are occupying a nest on Site. Through the implementation of this plan, it is hoped the management actions will encourage the Owls to return and continue breeding at the completion of the north spoil mound stabilisation and restoration works. Management actions to encourage the protection and return of the breeding pair includes:

- no works are undertaken within 100m of a breeding tree before the end of the current breeding season to allow any Owls that may currently be nesting on the Site, to safely move their fledglings prior to Earthworks commencing
- the cleared area is revegetated with a combination of fast-growing primary succession and long-lived canopy species representative of BGDF and BBGF Plant Community Types (Appendix B)
- restricted access to core habitat following construction by authorised personnel only for up to three years or until the area has stabilised (Figure 4.2). Ongoing consultation with Birdlife Australia on these matters is recommended

Table 4. 1 Nesting box recommendations for targeted fauna and management objectives

Management Zones	Targeted Fauna requirements			Total per MZ
	Arboreal Mammals	Birds	Bats	
MZ1	5	3	3	11
MZ2	7	3	3	13
MZ3	10	10	5	25
MZ4	30	5	5	40
MZ5	3			3
MZ6				
MZ7 South West	4	4	2	10
MZ8	10	5	5	20
MZ9	4	2	2	8
Total	**73**	**32**	**25**	**130**

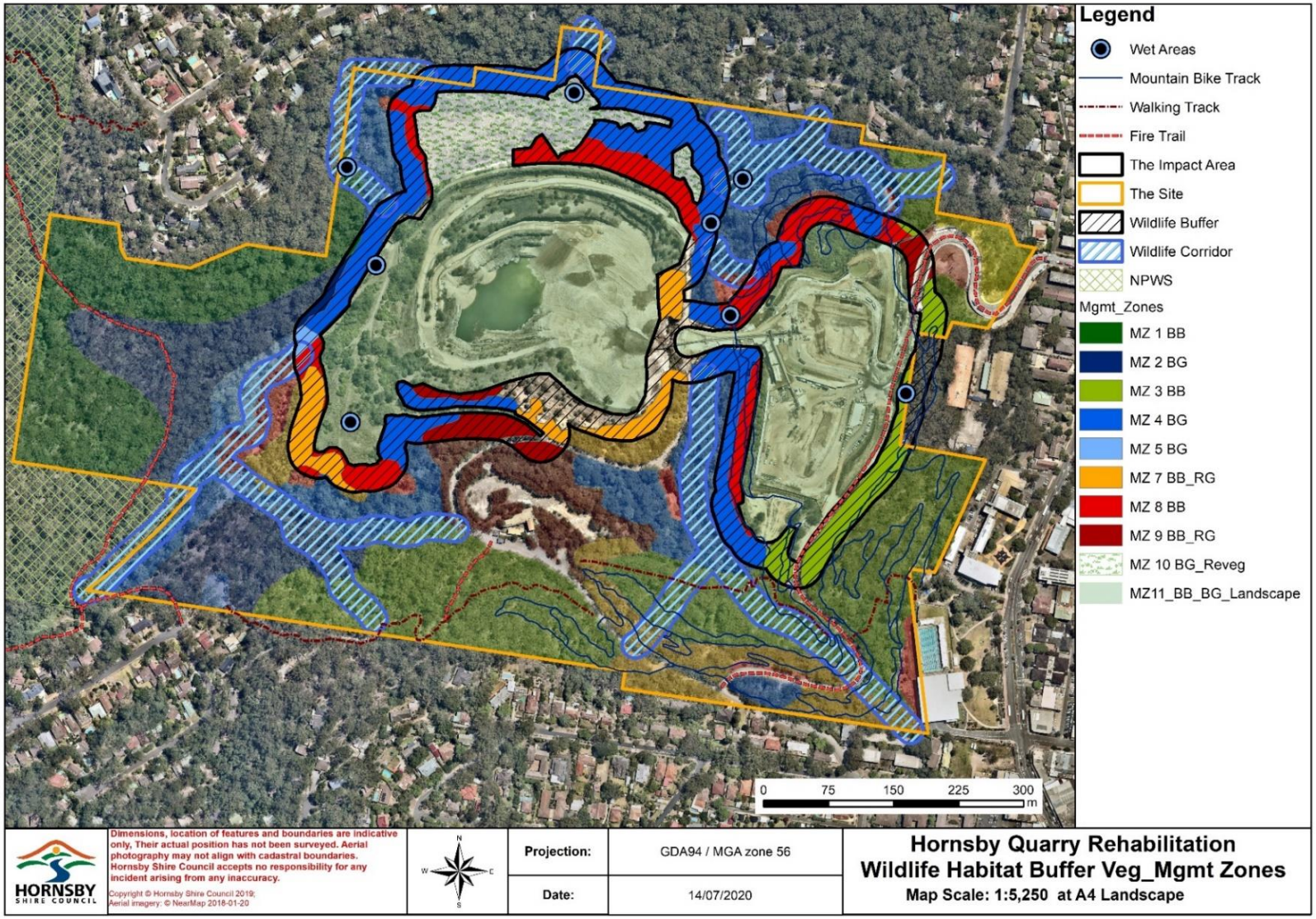

Figure 4. 1 Wildlife Buffer and Vegetation Management Zones

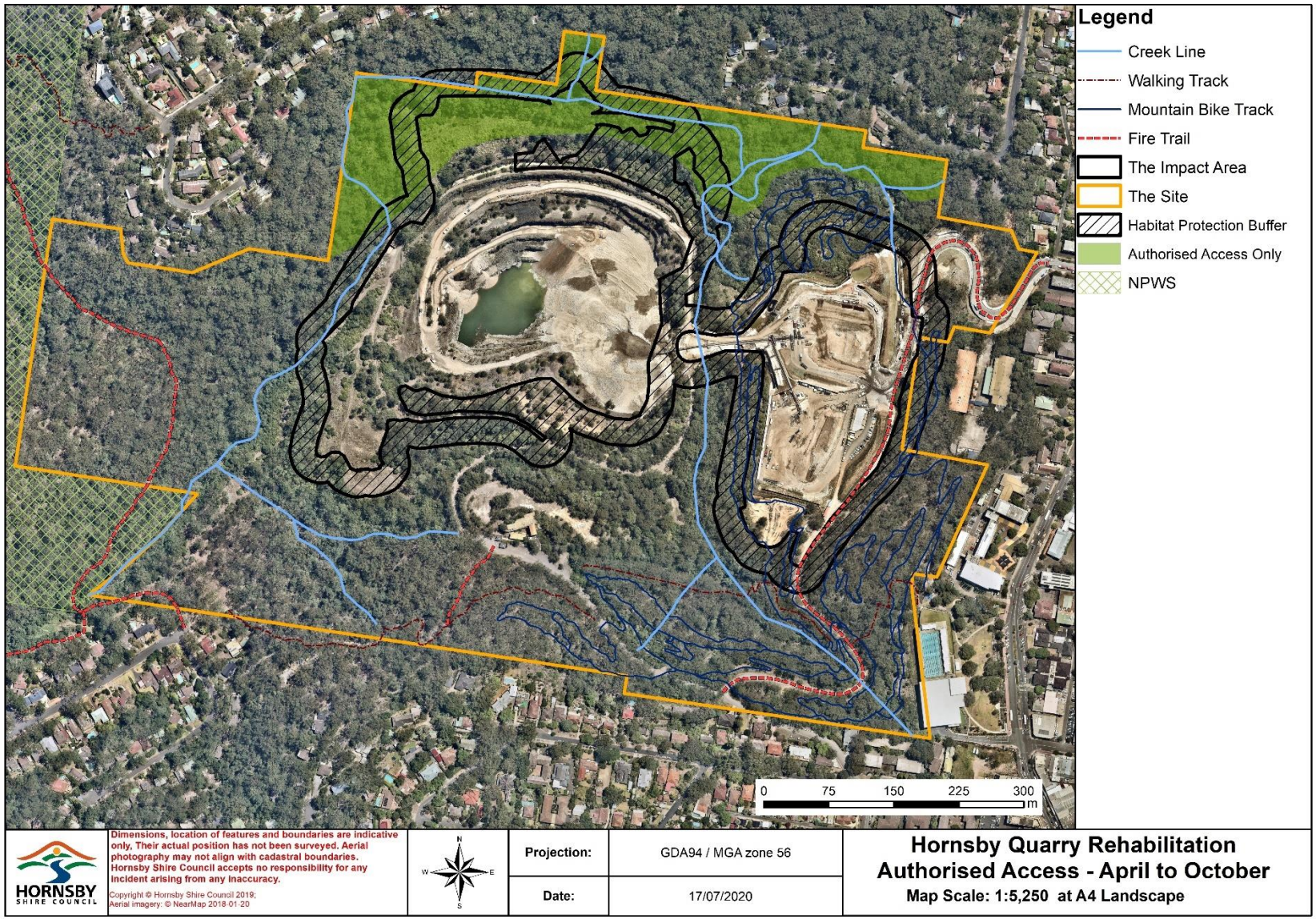

Figure 4. 2 Temporary Authorised Access only during Owl Breeding Season

Figure 4. 3 Example of Branch Hollows to be Retained

Figure 4. 4 Example of Trunk Hollows to be Retained

Figure 4. 5 Example of Branch Hollows to be Retained

Figure 4. 6 Recycling Timber for Nest Boxes

5. Protection of Bushland during Construction

The following bushland and habitat protection measures are to be implemented prior to construction earthworks by Council engaged constructors and/or the principal earthworks contractor and documented within the approved Construction and Environment Management Plan (CEMP).

5.1.1 Bushland Fencing

Access to the bushland is to be restricted to authorised personnel only during construction. No machines or equipment are to go beyond the Impact Area. Signage is to be installed at regular intervals along the interface to signify no entry. Monitoring of the bushland is to be undertaken to identify if fencing is necessary. If so, fauna friendly and fit for purpose fencing is to be installed to enforce no access. No barbed wire or electric fencing is to be used.

5.1.2 Tree Protection

Tree protection measures to be installed around all trees to be retained. Tree protection measures are to reflect best practice in accordance with Australian Standard (AS) 4970-2009 *Protection of Trees on Development Sites.* Wherever possible, habitat trees should be identified, retained and protected.

5.1.3 Fauna Management during Clearing of Vegetation

Fauna injury and mortality are a real risk in any clearing works. Mitigation of impacts of clearing and earthworks disturbance within the Impact Area is a major focus of mitigation recommendations. Hanger & Nottidge (2009) outline extensive best practice in fauna harm mitigation surrounding vegetation clearing and disturbance. The removal of wildlife as soon as possible prior to the commencement of vegetation clearing and earthworks to minimise the risk of injury to animals is imperative. Wildlife load reduction measures must be implemented or conducted by the wildlife spotter/catcher for an appropriate period immediately prior to the onset of operational works. Measures may include, but are not be limited to:

- fauna trapping using an appropriate range of trapping methods
- fauna exclusion fencing
- use of fauna aversion techniques
- manual removal of fauna

Any technique, method or machine that may cause unmitigated risk to native fauna must not be used as the primary method of vegetation removal until native fauna has been thoroughly removed. Unacceptable methods include, but are not limited to:

- mobile mulching machines or those attached to plant equipment as the primary vegetation removal techniques
- the felling of hollow bearing trees prior to native fauna removal
- mulching or burning of vegetation or other potential refugia without spotter/catcher supervision
- the burning of habitat, standing vegetation or other fauna refugia

Licensed wildlife spotter/catchers must be engaged for any vegetation clearing and development activities or process undertaken onsite. They must:

- be present during the clearing of vegetation or damage or disturbance to any structural habitat or refugia
- clearly define the allowable and non-allowable methods of clearing vegetation to minimise risk of injury or death to wild animals

Figure 5. 1 Lace Monitor Onsite 24.01.2020

5.1.4 Timing and Sequence of Vegetation Clearing

Vegetation clearing and earthworks should comply with specifications in 4.2 Protection of the *Ninox strenua* Powerful Owl. Additionally, whenever possible, vegetation clearing should be scheduled for mid to late summer so that:

- impacts on nesting and hatching avifauna and herpetofauna are minimized (greatest impacts in spring)
- likelihood of detection and capture of fauna is increased
- wildlife load reduction measures are most productive

Clearing of vegetation sequentially or segmentally encourages natural movement of native animals into habitat remnants and may be an appropriate measure when:

- suitable habitat of enough area and resources is adjacent to the vegetation clearing boundary
- target wildlife species possess the ability to avoid potential harm caused by vegetation clearing e.g. sequential clearing may be a sufficient measure to mitigate risk of harm to wallabies where suitable adjacent habitat exists, but is not an appropriate measure for arboreal fauna using tree hollows for nesting, or for herpetofauna, when clearing occurs during cold weather
- other mitigation measures are required to avoid or reduce harm to native animals that do not respond appropriately to sequential clearing e.g. erection of wildlife-proof fences to prevent wildlife moving on to roads or into built-up areas
- sequential clearing should not be used as a substitute for wildlife load reduction, when wildlife load reduction is essential for proper management of wildlife in the present circumstance e.g. sequential clearing must not be used as a primary fauna management measure when remnant habitat is likely to be insufficient to sustain displaced fauna, or is deficient in key resources, such as water sources, food trees or shelter opportunities or refugia

5.1.5 Preservation of Tree Hollows and other Habitat Features

Preservation of tree hollow integrity and structure in trees which are to be removed should be preserved wherever possible. These should be relocated to appropriate habitat retained on or close to site or to predetermined stockpile location for future use.

Important ground layer habitat features such as large fallen logs, log piles, rock piles or outcrops etc should be preserved onsite as much as possible. Removed material should translocated or stockpiled and re-established at appropriate habitat creation or enhancement areas.

To adhere to “no net loss” of tree hollows, in instances in which natural tree hollows are destroyed, the replacement of artificial hollows occurs at a rate of 4 artificial replacements per natural hollow destroyed.

5.1.6 Vegetation and Rubble Piles

Structural habitat features such as log piles, rocky outcrops, riparian and wetland areas should be indicated on the site map prepared by a wildlife spotter/catcher and receive consideration as potential habitat. Less important surrounding habitat areas should be cleared prior to disturbing or clearing identified habitat areas. This holds importance as it provides opportunities for intensive trapping around features and affords greater flexibility to apply less destructive clearing methods.

Piles of rubble, felled timber or any other material, proposed to be burnt, buried or chipped may quickly become occupied by wildlife seeking refuge during vegetation clearing and earthworks. Consideration needs to be given to the prospect of injuring wildlife in the secondary disturbance of stock piled vegetation or rubble.

5.1.7 Wildlife Handling

The ideal outcome for wildlife removed from a site during operational works is to be relocated back to the same site at the completion of works. This limits any potential adverse ecological consequences associated with translocation and the potential adverse effects (on the individual) of placement in unfamiliar territory are avoided. Translocation of animals is not a preferred option unless retention at, or relocation back to, the original site is inappropriate.

In order of preference, outcomes for removed wildlife are as follows:

- relocation back to suitable and sufficient habitat on original site following operational works
- translocation to suitable habitat adjacent to site
- translocation to distant suitable habitat
- placement in captive institution for conservation, educational or research purposes
- euthanasia.

5.1.8 Retention of Material for Reuse over the Site

Vegetative material required to be removed is to be retained for mulch, compost, habitat or site stabilisation as appropriate (7.5.1). The cleared vegetation is to be stockpiled separately as per its end use as landscape elements, habitat or compost. Stockpiling of felled timber to be as follows:

- Ground covers, shrubs, tree leaf litter and branches <50mm diameter
- Medium to large branches 50 - <200mm diameter and 2 -3 metre lengths
- Large branches > 200mm - < 300mm diameter and 2 – 3 metre lengths
- Tree barrels > 300mm diameter cut as long as feasible
- Hollows to remain intact

Fauna will quickly utilise piles as habitat soon after their formation. This must be considered when deconstruction of the piles for reuse occurs (Refer 5.1.6 Vegetation and Rubble Piles).

5.1.9 Hygiene

A strict hygiene protocol is essential to prevent the spread of pathogens, including *Phytophthora cinnamomi,* Myrtle Rust and weed propagules.

Procedures and guidelines should include disinfecting machinery, PPE, tools and equipment prior to entering and when leaving the site. Protocol details can by sourced from the following link, ‘Bushland Hygiene Protocols for Phytophthora’ and ‘Preventing spread of Myrtle Rust in bushland below: http://www.hornsby.nsw.gov.au/environment/flora-and-fauna/bushland-management/bushcare/volunteer-resources

6. Habitat Management

6.1 Management Zone Description

The proposal to rehabilitate the Quarry requires clearing of vegetation within the Impact Area as part of the Earthworks. To comply with the Secretary's Environmental Assessment Requirements (EAR No 1167) dated 6 September 2017 and the proposed Biodiversity Offset Strategy, Council plans to undertake vegetation management of the bushland occupying the Site and ensure the protection of its Biodiversity in-perpetuity. This Vegetation Management Plan (VMP) and Habitat Creation and Enhancement Plan (HCEP) addresses mechanisms to regenerate and revegetate areas of the Site. The intention is to sustainably conserve biodiversity by improving the Site's ecological integrity. The strategy is to work with the staging of the Hornsby Park Project and beyond to ensure the aims and objectives of this VMP and HCEP are achieved. Management actions to achieve these are as follows:

- protect existing vegetation that is providing a buffer along the Impact Area interface prior to, and during construction regardless of species
- when planning and designing future work for possible structural or safety issues, prioritised rehabilitation is required to reinstate buffers
- strategically plan a staged approach to the timing, location and extent of weed removal through best practice bush regeneration throughout the site (Appendices A and F)
- propagate from locally sourced plant material
- engineer site soils to reflect benchmark data for both plant communities as a medium for revegetation within the Impact Area
- revegetate with locally provenant species to mimic natural succession within the Impact Area and where required with the Site
- identify future threats to the natural environment and mitigate effects

To implement these management actions, the Impact area and the Site have been divided into Management Zones based on vegetation type and vegetation condition (Figure 6.1). Predominately, condition is reflective of the level of site disturbance and therefore, weed density. The main types of disturbance on the Site have been vegetation clearing and soil disturbance because of historic agriculture and mining practices (excavation, piling of tailings or 'scree' and erosion). Other types of disturbance include anthropogenic activities including surrounding lands use and construction, track construction, sewer easements and water management. Each Zone has been allocated management actions to be implemented and monitored (Appendix A). The results of monitoring will be key indicators for adaptive management (Appendices E and F).

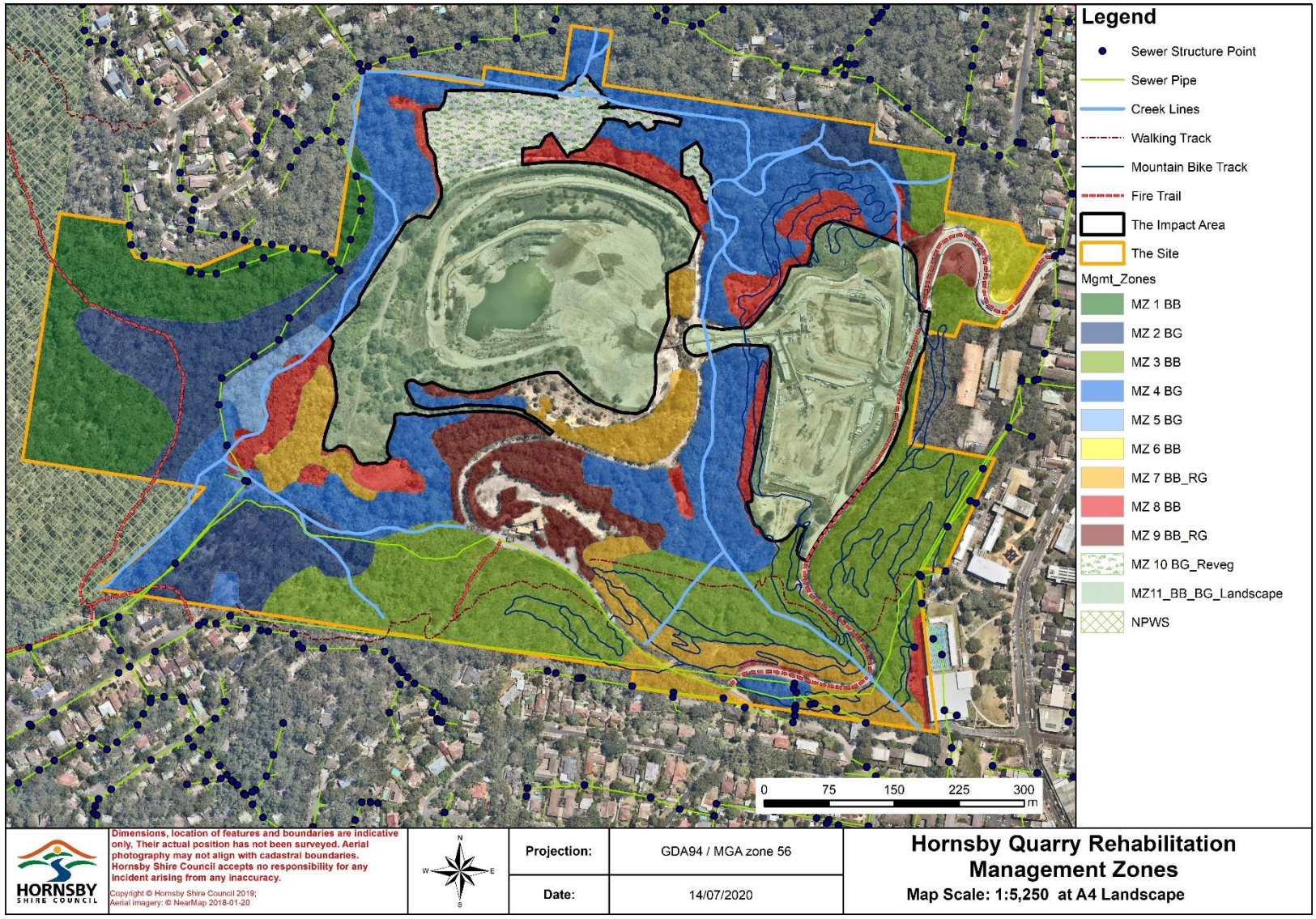

Figure 6. 1 Management Zones

6.1.1 Management Zone 1 (MZ1) BBGF Good

Management Zone 1 consists of 4.87 hectares of good condition Blackbutt Gully Forest (BBGF) in the most western area of the Site. It is beyond the Impact Area and bordered by the Berowra Valley National Park (BVNP) to the south and west, and private properties containing bushland to the north. The topography is that of steep slopes facing north and south with a depression running in an east west direction between the slopes. Large sandstone outcrops and boulders are present amounts a fern understorey on both sides. The soils in this zone are relatively undisturbed except for the fire trail, that rises from Rosemead Road and then along the depression towards Fishponds, and the sewer easements on the bushland and private property interface. The resilience of this zone is good, however bird, wind and water dispersed weed may periodically be present.

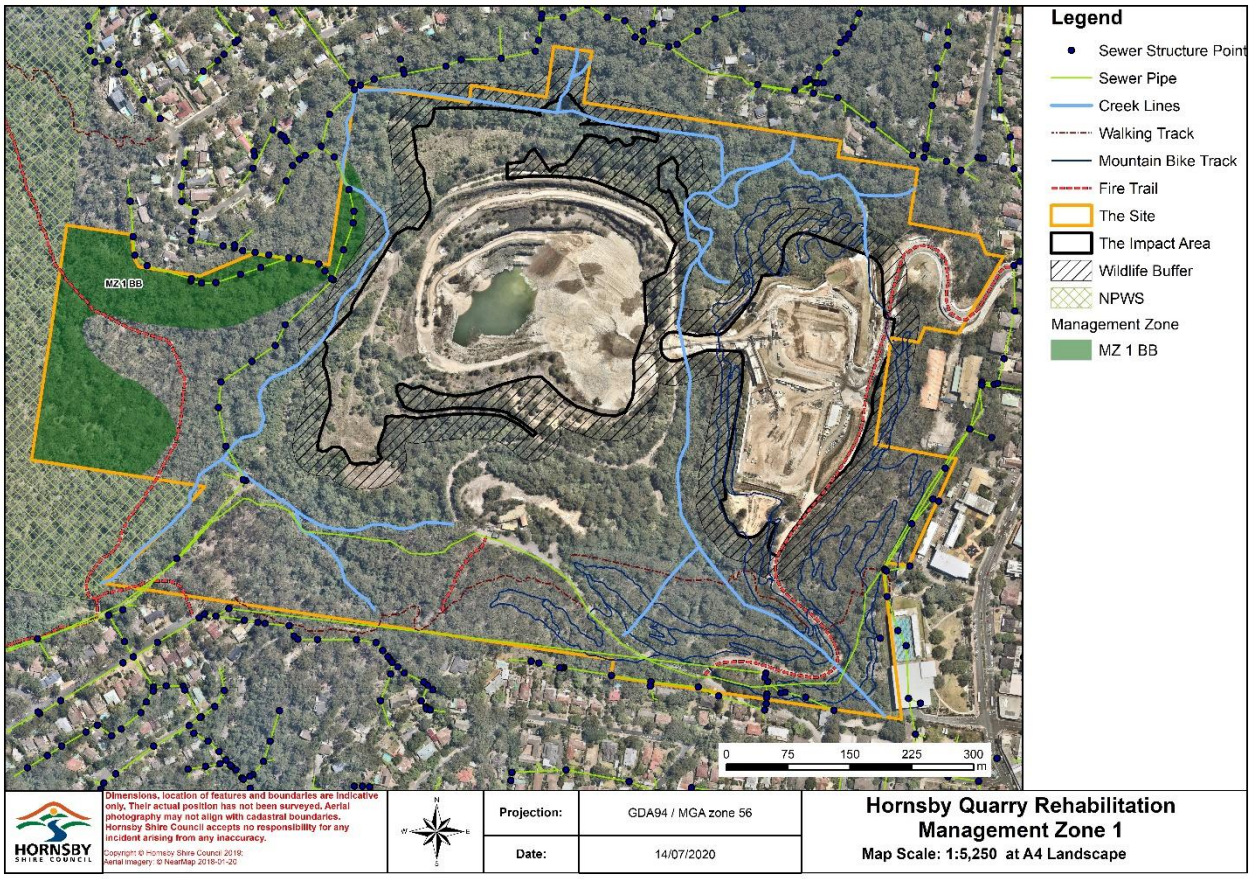

Figure 6. 2 Management Zone 1

6.1.2 Management Zone 2 (MZ2) BGDF Good

Management Zone 2 consists of 4.9 hectares of good condition Blue Gum Diatreme Forest (BGDF). It is represented by three separate areas of land.

MZ 2.1: The area to the west and consists of 2.5 hectares where vegetation transitions from the BBGF to BGDF as the topography slopes in an easterly direction towards the creek line. The zone is bordered by the BVNP to the south and zones of poorer quality BGDF to the east and north.

MZ 2.2: The area to the south consists of 1.86 hectares of relatively low gradient at the end of Rosemead Road. It encompasses the Rosemead Park and abuts fill material from mining activities to the north.

MZ 2.3: The area to the north east consists 0.6 hectares on a steep south-west facing slope. The soils in this zone are relatively undisturbed except for the sewer easement and a series of informal tracks throughout the two areas in the south. The resilience of this zone is high however weeds from neighbouring bushland of less quality or bird, wind, water dispersed weeds may periodically be present.

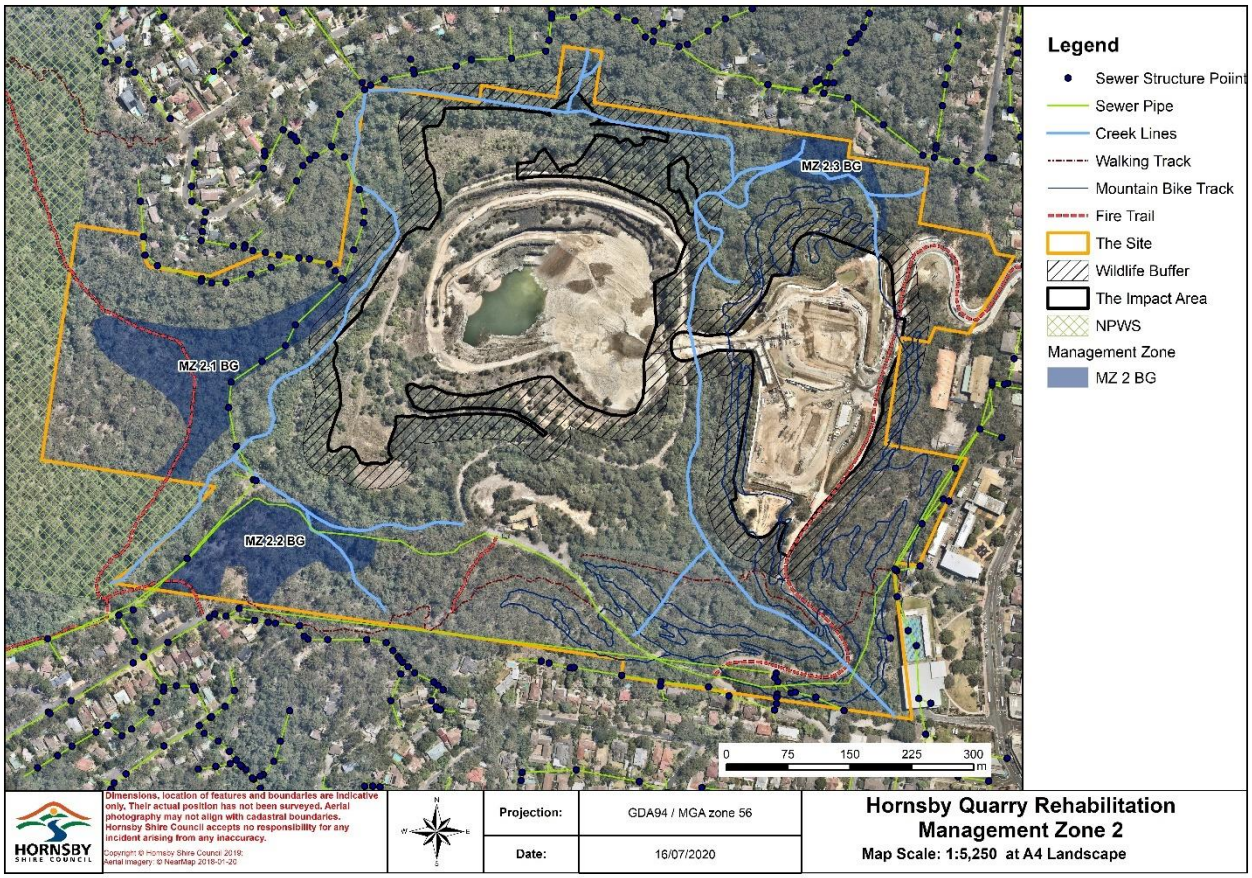

Figure 6. 3 Management Zone 2

6.1.3 Management Zone 3 (MZ3) BBGF Fair

Management Zone 3 consists of 10.04 hectares of BBGF in fair condition. It dominates the higher areas south, east and south-east of the Site. The topography features gradual slopes with some rocky outcrops. In the more sheltered area below Quarry Road and along the creek line in the south of the site, the midstorey is denser and mesophyllic than the higher slopes above Quarry Road and above the fire trail. An existing mountain bike track occupies approximately 70% of the Zone and a significant amount of midstorey is visibly absent in these areas.

The soils in this Zone have been disturbed along the Site boundary near the pool, the TAFE and along the mountain bike track. Bird, wind and water dispersed weeds are present in this zone. Woody weeds dominate the more sheltered areas particularly along edges and the riparian corridor. Climber, ground cover and herbaceous weeds are also present on the more exposed areas particularly along edges.

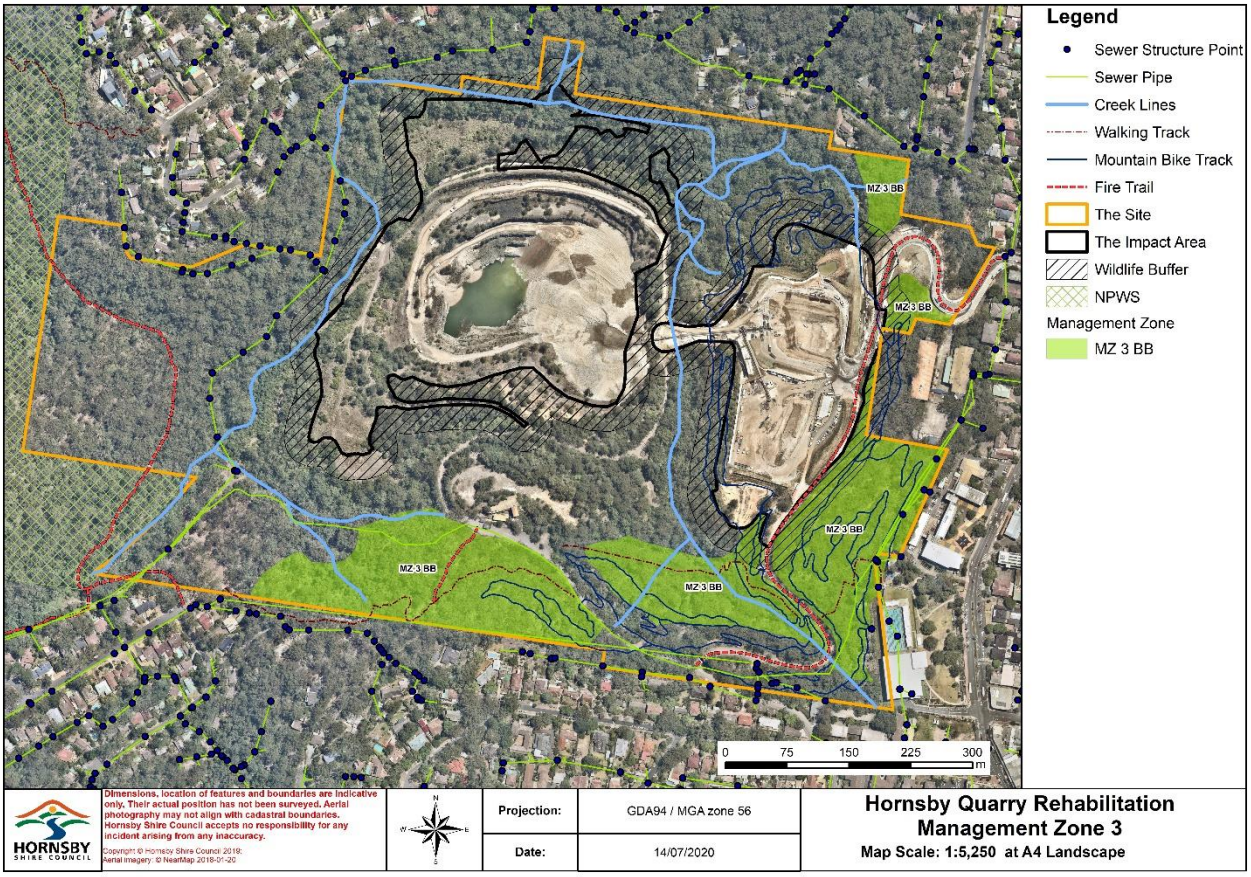

Figure 6. 4 Management Zone 3

6.1.4 Management Zone 4 (MZ4) BGDF Fair

Management Zone 4 consists of 10.75 hectares of BGDF in fair condition. It currently occupies areas stretching from the south west of the Site in a north easterly diagonal direction, surrounding most of the quarry void, to the north east of the Site. The topography varies as the position in the landscape and the level of soil disturbance due to mining practices varies. The condition of the zone also varies because of its position in the landscape but also because of water movement throughout the zone. The dominant weeds in this zone are *Ligustrum lucidum* and *Ligustrum sinense* Large and Small- leaved privet. They create a midstorey monoculture under a Eucalypt canopy and provide significant habitat (2.9.6).

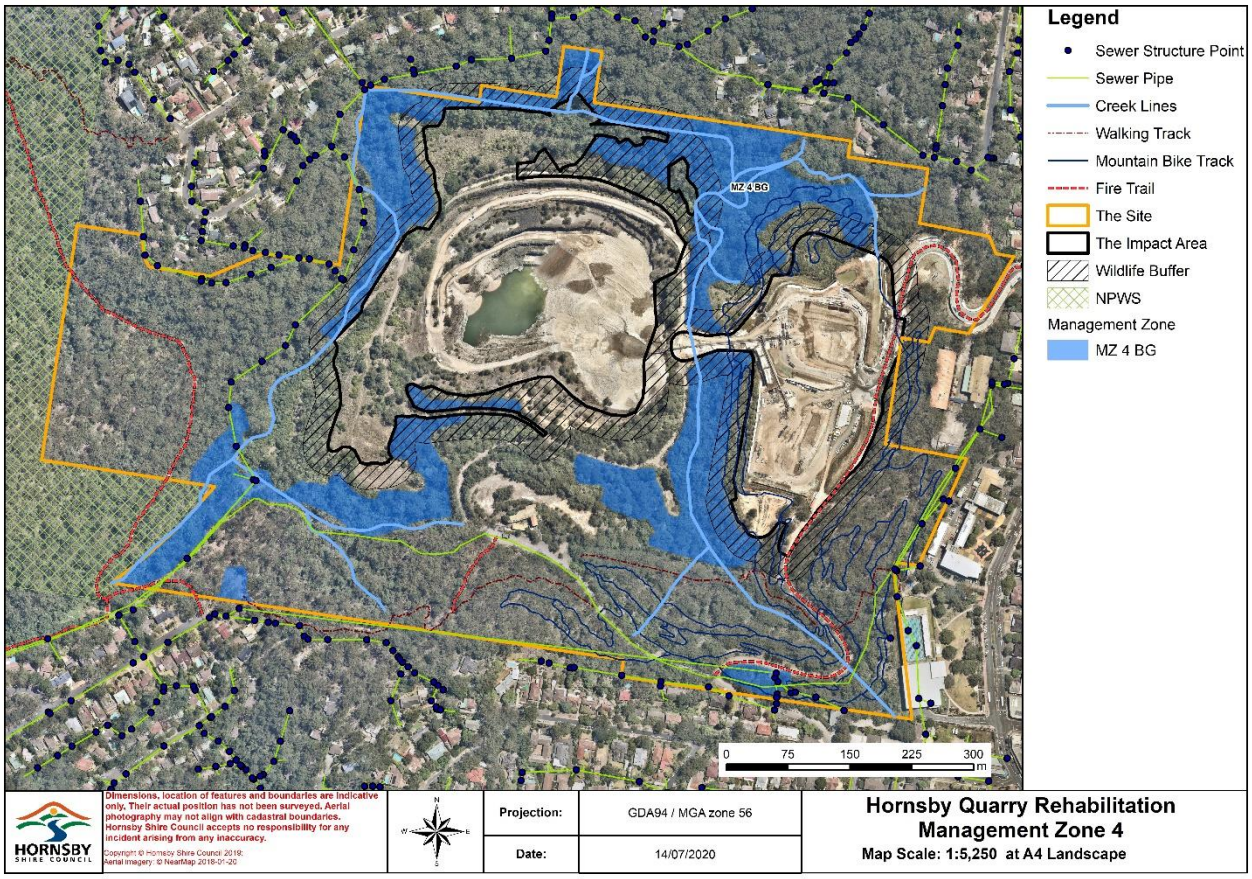

Figure 6. 5 Management Zone 4

6.1.5 Management Zone 5 (MZ5) BGDF Riparian

Management Zone 5 consists 0.47 hectares of BGDF in fair condition. It occupies a transitional area between the BGDF on the west of the Site and the overburden or 'scree' of the south west mound. The creek line (riparian corridor), water flow discharge pipe outlet, weed maturity and weed density are features which delineate this Zone from the surrounding zones. As a result, this Management Zone has specific management actions requirements, particularly in relation riparian corridor and weed treatment. The dominant weeds in this zone are *Ligustrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet It forms a midstorey monoculture under a Eucalypt canopy.

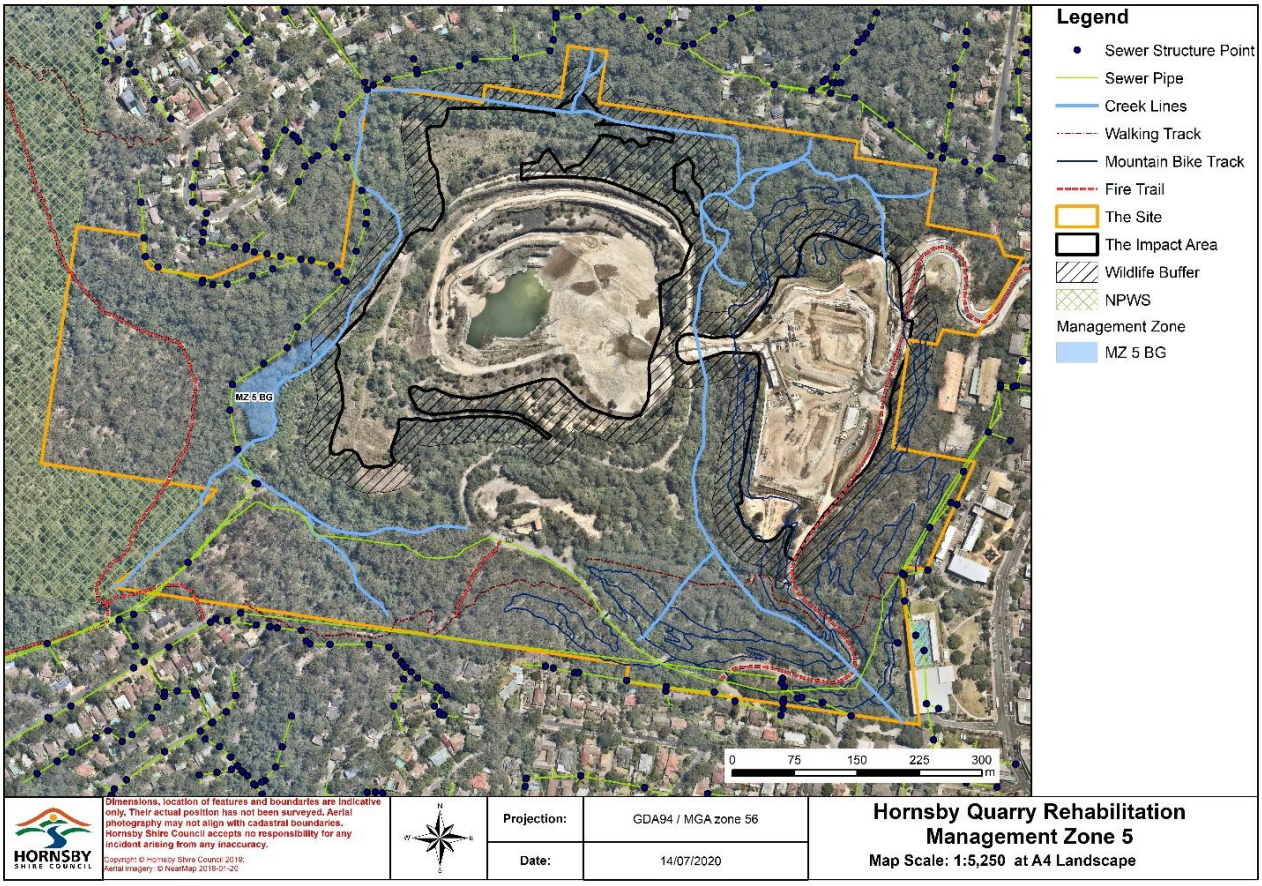

Figure 6. 6 Management Zone 5

6.1.6 Management Zone 6 (MZ6) BBGF Poor

Management Zone 6 consists of 0.49 hectares of BBGF in poor condition. Prior to filling the Quarry by North Connex, this zone was contiguous to what is now Management Zone 3, BBGF in fair condition. The Quarry filling process required construction of an access road to Old Mans Valley via Bridge Road Hornsby. The current Zone and its condition are a result of these works. The topography is a steep south west facing slope. The soil in this zone is a mixture of imported soil with a high soil pH, a form of spray-crete and exposed shallow natural soils. Weeds species are representative of those found on road corridors, particularly wind dispersed species.

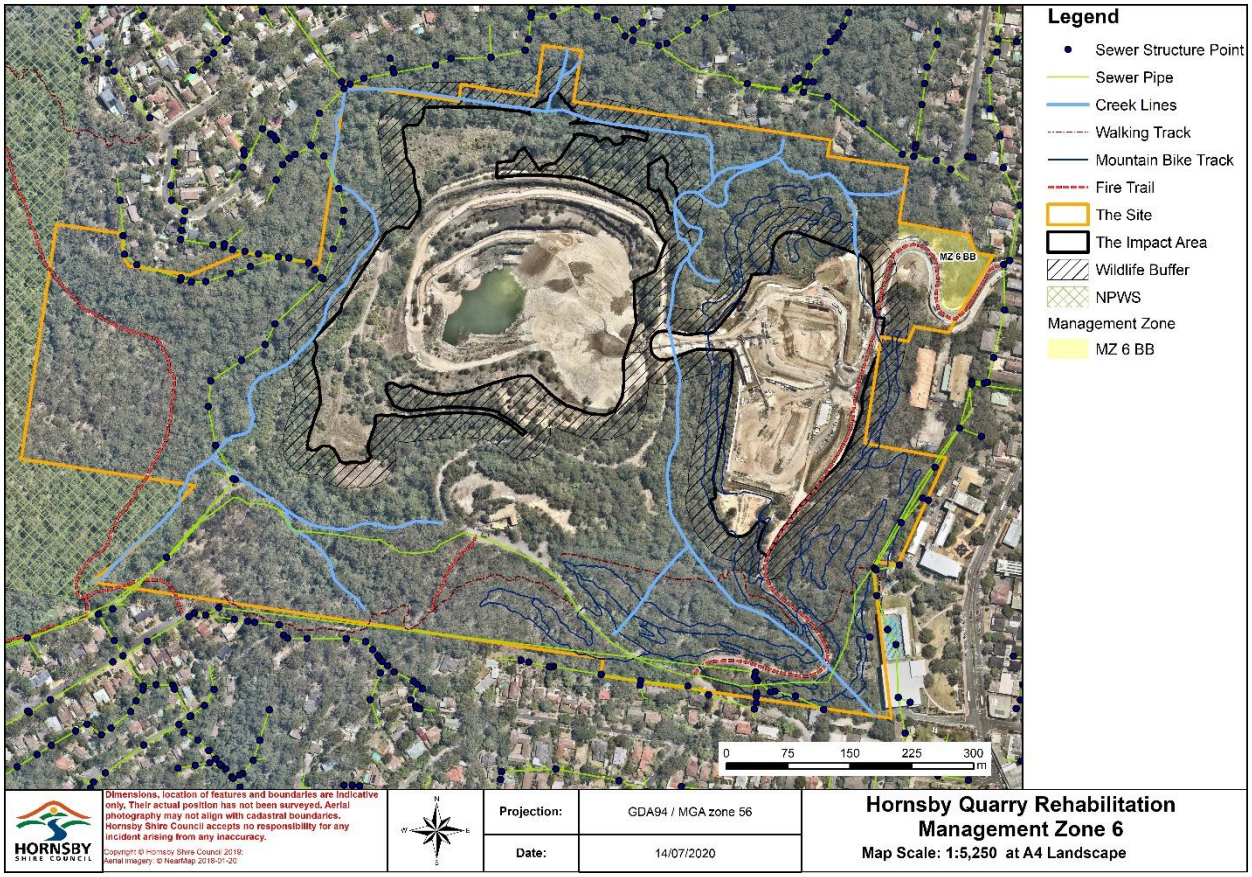

Figure 6. 7 Management Zone 6

6.1.7 Management Zone 7 (MZ7) BBGF Regrowth Poor

Management Zone 7 consists of 3.69 hectares of BBGF in poor condition. It is represented in 3 areas, all of which have had different soil disturbances.

MZ 7.1: The first area in the south west part of the site and to the west of the crusher plant consists of 0.73 ha of an area referred to as the 'south west mound'. Historical aerial photographs show this area clear of vegetation dating back to 1939 (Figure 2.4). Modifications to the soil and shape of the area appear to have commenced in the 1960's and by 1985 (Figure 2.7), the mound was the shape it is today, a terraced slope of overburden. Soil test results indicate soils are not engineered and vary in type and structure between the terraced slope and the plateau. The terraced slope has been filled with clayey gravel sands, large boulders and a variety of dumped manmade objects. In contrast, the plateau is composed of sandy gravels, cobbles and boulders. Whilst this section of the south west mound holds significant numbers of mature *Eucalyptus*

saligna Blue Gums, the vegetation of the area has been mapped as Blackbutt Gully Forest (BBGF) (Figure 2.13). The zone is predominately a wood and herbaceous weed understorey with a Eucalypt canopy.

MZ 7.2: The second area is located on the south east wall of the quarry void and occupies a steep area of 1.94 hectares. The current vegetation is growing in highly modified and eroded material from the void wall above. The canopy species is predominately *Casuarina cunninghamiana* River Oak. As this species is not endemic to the area, its origin in unknown. It is likely to have been planted as part of a previous rehabilitation/revegetation exercise and has since become naturalised. Weeds present are predominately woody and herbaceous weed species.

MZ 7.3: The third area consists of 2.01 hectares along the verge of Quarry Road. The soil has been highly disturbed and significantly modified. This is most likely to have occurred during the construction of Quarry Road. The slope drops steeply from the road along the extent of the northern side and is dominated by a midstorey of *Ligsutrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet. Exotic climbers *Ipomoea indica* Morning Glory and *Asparagus aethiopicus* Asparagus Fern have a significant presence in this Zone.

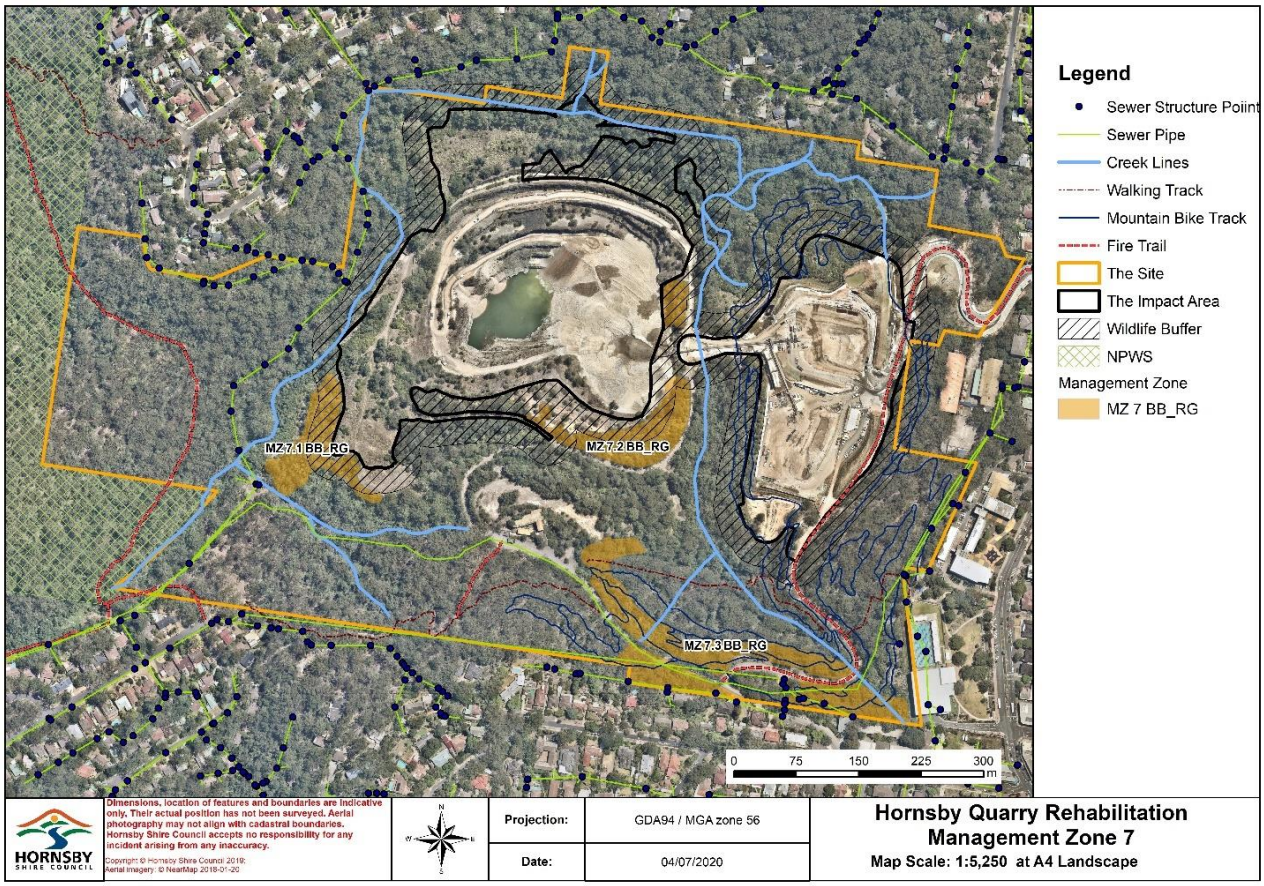

Figure 6. 8 Management Zone 7

6.1.8 Management Zone 8 (MZ8) BBGF Very Poor

Management Zone 8 consists of 3.15 hectares of very poor BBGF occupying seven areas outside the Impact Area. All areas except for the area below the pool, have direct contact with BGDF of fair condition. All soils in these areas have been highly modified.

MZ 8.1: This area of the south west mound is a terraced slope of overburden containing a mixture of clayey gravel sands, cobbles, large boulders and a variety of dumped manmade objects. The existing vegetation is a mixture of canopy species growing within midstorey and ground cover weed species.

MZ 8.2 The area to the west of the north mound is a *Ligustrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet midstorey monoculture under a Eucalypt canopy. This area is critical roosting habitat. The long strip of the MZ 8.2 above the drainage channel in the north mound is a steep gradient with exposed rock forming a cliff like structure. Weeds in this location dominate the vegetation type and are a mixture of opportunistic water loving herbaceous and woody weeds.

MZ 8.3: The area north of Old Mans Valley is predominately low growing herbaceous weeds that provide a Grassland habitat adjacent to Management Zone 4. Mountain Bike Tracks occupy a portion of this Zone.

MZ 8.4: The area west of Old Mans Valley and adjacent to the Cemetery is a corridor of mature *Ligustrum lucidum* and *Ligustrum sinens*e Large and Small-leaved Privet that has created a mesophyllic monoculture of weeds under a Eucalypt canopy on disturbed soils. Mountain Bike Tracks occupy the majority of the area adjacent to Old Mans Valley.

MZ 8.5: The area on the interface of both the pool and the Quarry Road fire trail is a corridor of mature *Ligustrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet that supports climbing weed species and a ground cover of herbaceous and annual weeds under a Eucalypt canopy on disturbed soils.

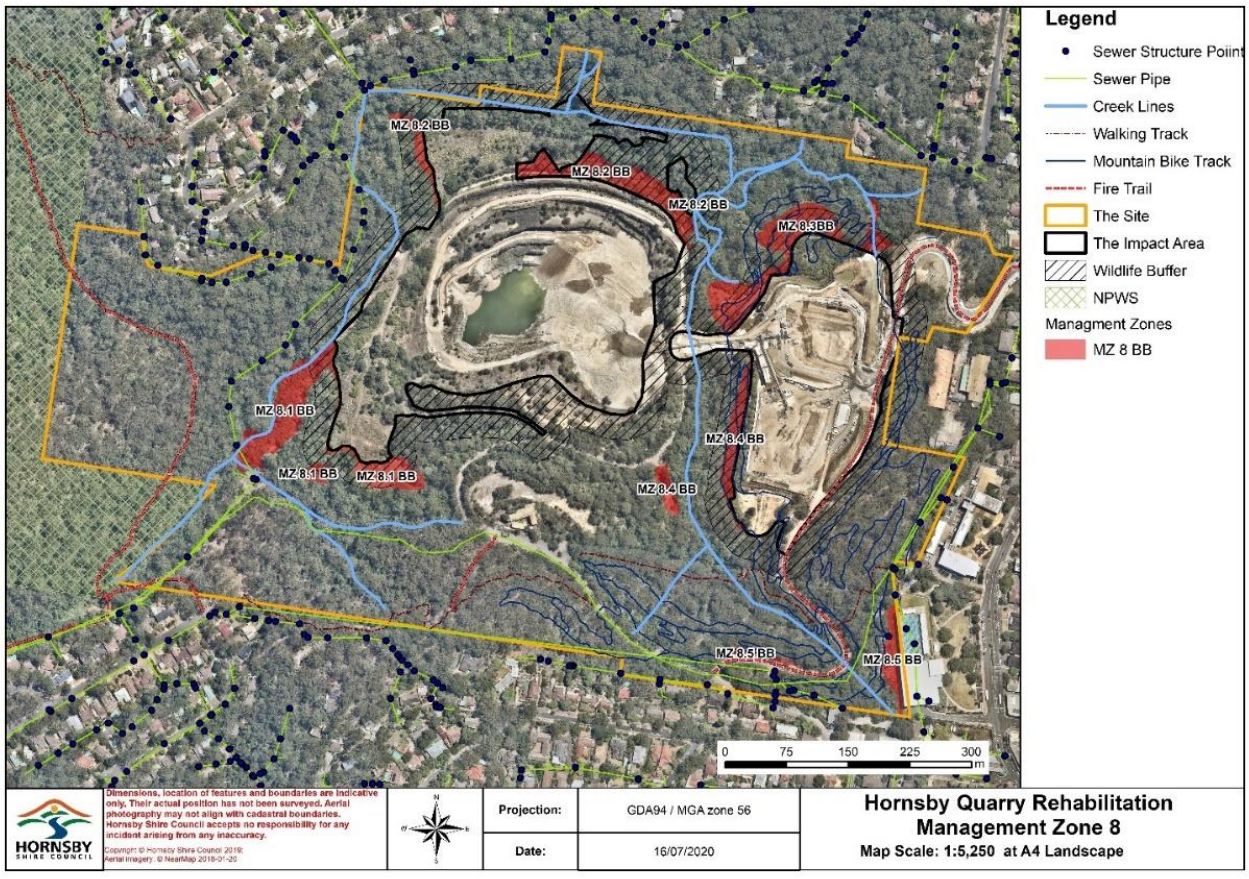

Figure 6. 9 Management Zone 8

6.1.9 Management Zone 9 (MZ9) BBGF Very Poor

Management Zone 9 consists of 2.15 hectares of very poor BBGF regrowth.

MZ 9.1: As with Management Zone 6, this area has been impacted by the Bridge Road construction for the purposes of filling the Quarry by North Connex. The area is steep and erodible with imported soil with a very high pH. The regrowth is herbaceous and grass weeds species are representative of those found on road corridors.

MZ 9.2: The area below the crusher plant is a monoculture of a *Ligsutrum lucidum* and *Ligustrum sinense* Large and Small-leaved Privet under a *Casuarina cunninghamiana* River Oak canopy and a sparse Eucalypt canopy. The stability of the soil in-situ requires assessment and geotechnical advice prior to any vegetation management.

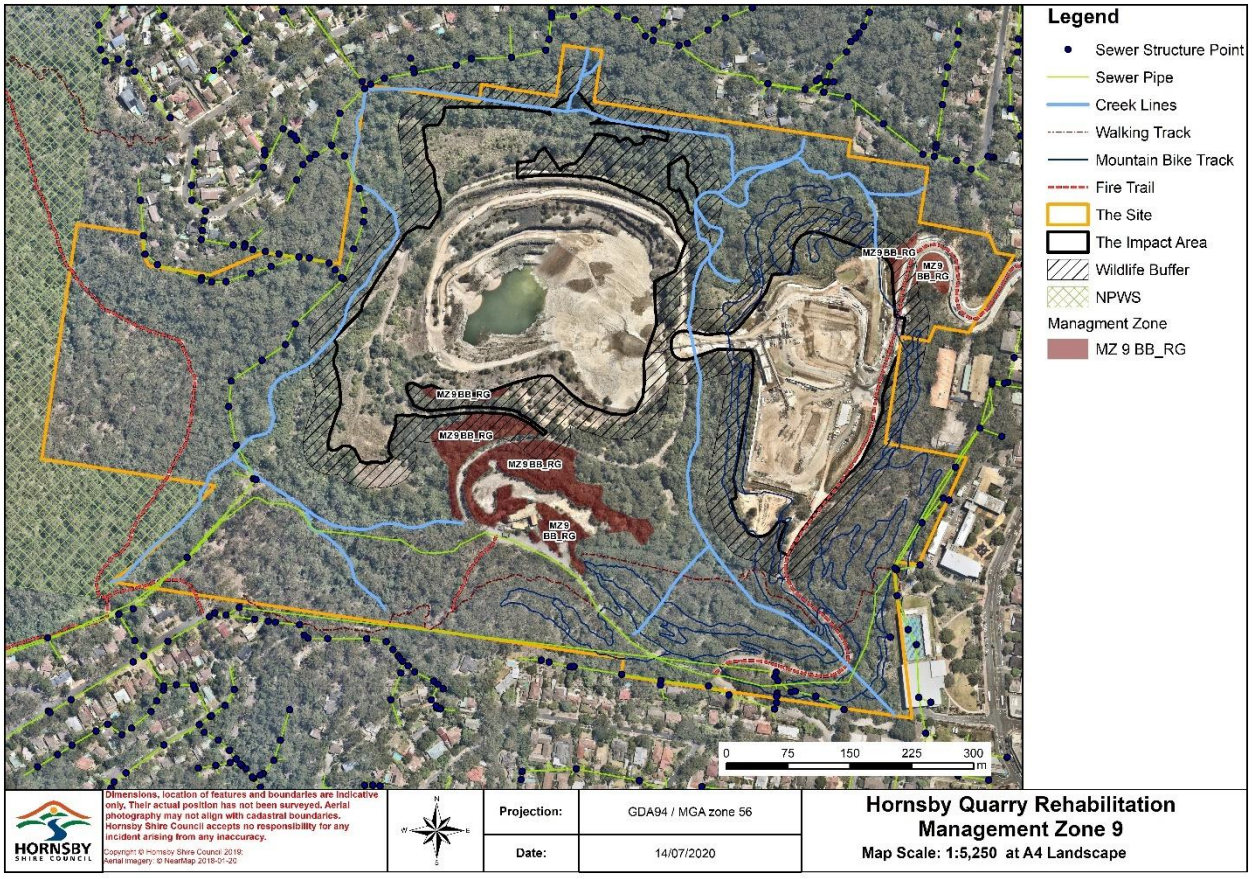

Figure 6. 10 Management Zone 9

6.1.10 Management Zone 10 (MZ10) Impact Area North Spoil Mound

The north spoil mound is a steep wall on the northern boundary above the quarry and this is clearly identified in the current LiDAR image (Figure 2.9). Historical photographs indicate its creation during the 1960's and then further excavation occurred from the eastern edge of the north mound from around 1989 resulting in a modified slope of 1:1.2. Soil testing results indicate both varying soil profile types and depths. Geotechnical reports indicate localised high levels of instability. Current access for management is limited due to the steep slope.

Weed density is high and consists of woody and wind dispersed weed species. The weeds present are a source of weed seed within the Impact Area, the Site and beyond to adjoining land. Of concern is the large population of *Cortaderia selloana* Pampas Grass that dominates the mound face.

The proposal is to stabilise the area and reduce the slope with earthworks to make the area safe and improve access for vegetation management. Some of the material from the slope will be used to partially fill the void. The vegetation on the north spoil mound has been mapped as Blue Gum Diatreme Forest (BGDF), Blackbutt Gully Forest (BBGF) and BBGF Regrowth (GHD 2019). Where earthworks are undertaken revegetation will be carried out. Improved site soils to support BGDF and BBHF PCTs are to be engineered and applied prior to planting.

6.1.11 Management Zone 11 (MZ11) Impact Area Old Mans Valley and the Quarry Void

Old Mans Valley was previously a non-engineered fill area (PSM 2006) with a low vegetative cover consisting predominately of weed species. NorthConnex occupied and reshaped the area for transporting and partially filling the void with material excavated from the NorthConnex tunnel. The proposal is to use this area as the main access point to the Hornsby Park are as well as to provide a sports field and other recreation activities. The void has been largely filled with material from the NorthConnex tunnel and re-shaped in preparation for further fill and final landscaping as a recreational area for public use. Landscape plans for both areas should incorporate planting with both BBGF and BGDF species to increase the connective integrity within the site.

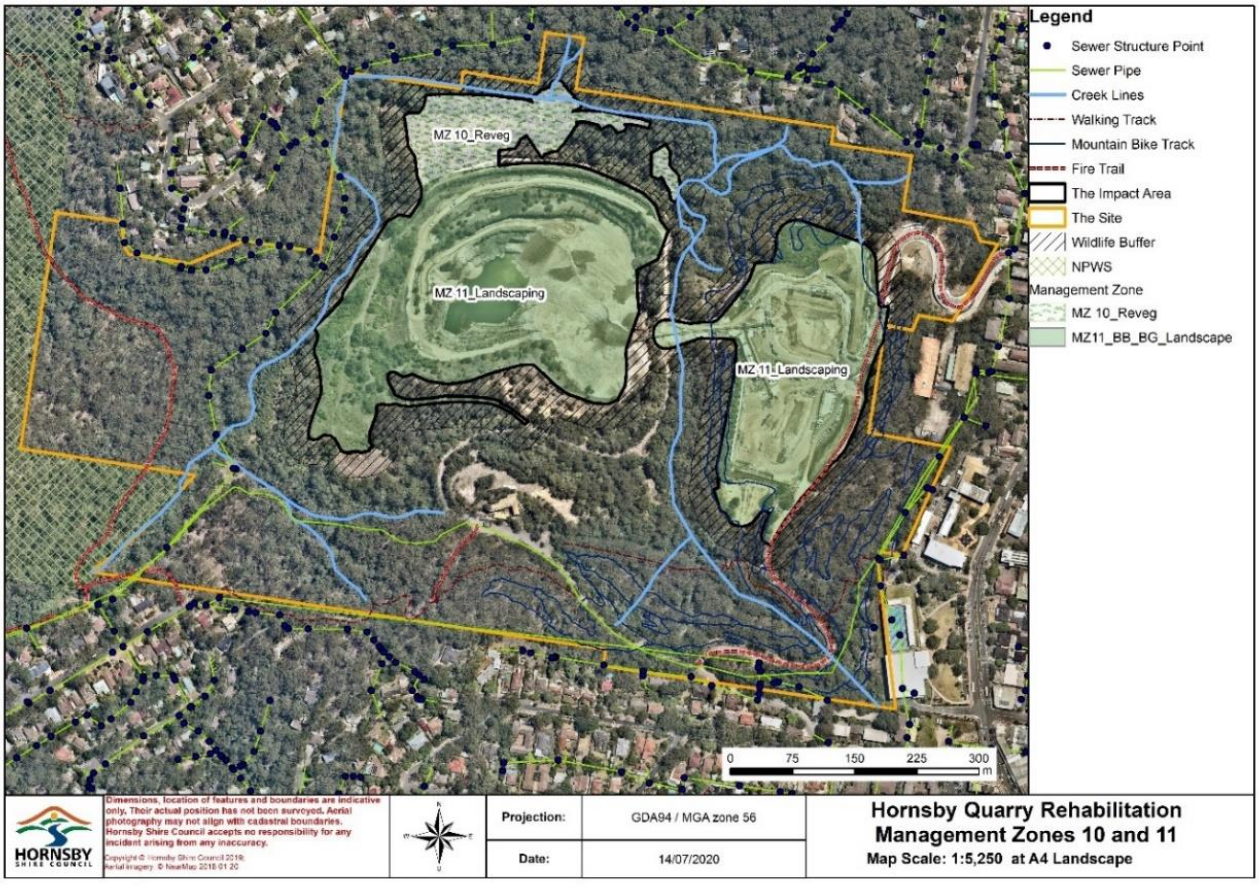

Figure 6. 11 Management Zones 10 and 11

6.2 Management Actions

Management actions have been prepared for each management zone based on the vegetation condition assessment (2.6.2) and to underpin Council's proposed Biodiversity Offset Strategy. With reference to choosing species for revegetation, it should be noted that there are plant species represented in both BGDF and BBGF. Considering this overlap will be of value in landscape transitional areas or on the south west mound mapped as BBGF. *Eucalyptus saligna* Sydney Blue Gum has been recorded as the predominant canopy species (Arterra 2019) and the location within the centre of the diatreme indicates that it could more than likely have originally been Blue Gum Diatreme Forest (BGDF). All management actions as mechanisms to achieve the aims of this report have been itemised in Appendix A.

6.3 Weed Control Methods

Weed control is required to restore the native plant communities and therefore improve the ecological integrity of the Site. It is necessary to assist the natural systems present by removing competition from weeds and prevent further spread of weeds. Best practice bush regeneration works from 'good' bush to 'poor' bush, thus allowing natural processes the best opportunity to re-establish and defend against potential weed incursions. Weed treatment is to be undertaken in the following stages:

- Primary – the initial weed treatment. The appropriate timing, area and method of treatment is determined by weed species, weed density, site resilience, adjoining land use and the weeds potential to stabilise soil structure or habitat.
- Secondary – weed control that is follow-up work required after primary weed control. Work is targeted on germinating weed seed in the soil or opportunistic weed spread following primary weed treatment. Secondary weed control can be the most time consuming and expensive weed management stage. Timing of works is crucial to efficient and effective secondary weed treatment.
- Maintenance – this final stage of work is to be applied following restoration success. The amount of maintenance required depends on whether the cause of weed incursion has been sufficiently managed.

Weed control is to be undertaken by professional bush regenerators who are adept in undertaking integrated weed management. The complexity of the Site and the nature and extent of degradation will require a combination of management methods. These may include the following:

- Manual hand removal
- Biological control
- Herbicide application
- Slashing, mowing
- Flame or steam weeding
- Fire
- Supplementary Planting
- Surface capping and mulching

6.4 Revegetation vs Regeneration

Bush Regeneration is the dynamic and specialised process used to restore an altered natural area to a healthy and sustainable representation of its original composition of Australian Plant Community Types (PCT). It is a complex and evolving process requiring strategic methods, precise observations and adaptive management to relieve the native plants from existing impacts, favour their growth and allow for germination of the native seed bank and spores in the soil whilst protecting habitat.

Natural bush regeneration involves controlling weeds using weed control methods. Assisted regeneration combines the natural regeneration methods with revegetation. Revegetation is the process of artificially reintroducing native plant material through a variety of methods including planting, transplanting, direct seeding, surface capping, mulching, hydromulching or brushmatting.

Best practice bush regeneration only considers revegetation in areas that have been extensively modified for a long period of time resulting in little or no native seed bank within the soil and a low likelihood of natural regeneration. The act of revegetation reintroduces native plants to provide an environment conducive to further native germination, out compete exotic weed species, create buffers on good bush interfaces and restock the native seed bank.

7. Revegetation

7.1 Propagation and Planting protocols

All plant material to be used for revegetation is to be locally provenant species sourced from similar Plant Community Types (PCTs) including the neighbouring BGDF. Where planting requires propagation, the material required will be propagated in Council's Community Nursery or similar. The Community Nursery has NIASA accreditation (2005-2019) and EcoHort Certification (2017-2019). There is currently Blackbutt Gully Forest (BBGF) seed stock available in the Nursery Seed Bank collected from the Bridge Road area prior to NorthConnex occupation of the site.

Planting material is to be a combination of Hiko Cells or tubestock. The optimum planting density is between five and eight plants per square metre. As planting is to reflect the existing plant communities, densities from each stratum should be based on the mature PCTs.

If a situation arises where hydromulching is deemed to be the best solution for stabilising soil profiles, a mixture of sterile grasses and a native grass mix can be used prior to planting.

To assist establishment, each plant should be planted into a pre-watered hole with water-holding crystals and slow-release fertiliser then watered in post planting.

7.2 Seed and propagule collection

7.2.1 Tree Canopy

Wherever Eucalyptus spp. trees are to be removed for earthworks seed should be taken from the crowns before the material is chipped or disposed of. This must happen on the day of felling as the seed is quickly released once sap flow is stopped.

For every 10 trees felled, seed should be collected from at least one (10% of trees felled are then sampled). At least three branches of seed-bearing material should be reserved. Branches would ideally be 10cm in diameter at the cut end and be approximately 2-3 m in length. These must then have the fruit removed as soon as possible into a bag/container.

7.2.2 Mid-storey/Understorey smaller trees and shrubs

These species either have seed held within the canopy available 12 months of the year, or, they are shed annually in a short window of time and hence are only available once a year. As such, species with seed available 12 months of the year can be treated as per 7.2.1 Tree Canopy.

The other plants will need to be targeted when they have seed shed imminent. These species need to be identified and mapped in order of abundance on the Site before clearing can occur. Most of these species have seed available in autumn if they are of mesophylic origin or in November/ December if they are of sclerophylic origin. Seed for both types of plants are hand harvested from the individuals following Florabank Guidelines.

7.2.3 Ground layer

Ground layer consists of grasses, herbs and groundcovers. Many can be propagated by cloning if seed is unavailable at the time of collection. This is best undertaken in cooler months. Grasses generally shed seed over mid-summer to early autumn depending on species. They can easily be collected in volume by hand collecting. As with shrubs these species need to be identified and mapped in order of abundance on site for targeted seed collecting before clearing can occur.

Natural areas abundant in seed and propagules outside of the Impact Area and the Site should be identified as donor sites to provide seed where critical species for PCT to be restored are missing or unavailable in the Site itself.

7.3 Revegetation timing

Timing of planting will be subject to the completion of the earthworks program. Ideally planting should be undertaken in Autumn to enable the plants to establish prior to hot Summer weather conditions. Spring has been viewed as the next best time for planting as Winter has been deemed to be too cold and Summer too hot for new plants to establish. However, due to Sydney's recent climate exhibiting dry Spring, wet Summer and relatively warm Winter conditions, consideration can be given to altering the timing of planting and adapted to suit long term weather forecasts.

Staged and supplementary planting will be necessary to enable successional growth and assist with maintenance. Some locations will primarily be planted with fast growing canopy and shrub species representative of primary succession species (Fabaceae Family species). This will deter annual weed establishment by creating shade cover and nurture the soil for secondary succession (longer lived slower growing species).

7.4 Planting schedules

A list of suitable species currently being propagated by Council's Community nursery and suitable for both revegetation of natural and landscape areas is available (Appendix B).

7.5 Revegetation Site Preparation

7.5.1 Earthworks

Earthworks is required on the north spoil mound to stabilise the soil and provide detailed contouring to prevent erosion and reflect the adjacent environment. Earthwork planning and design is to accommodate extraction of different soil types to be stockpiled and used in soil profile engineering. The success of revegetation will depend highly on the quality of the engineered soils and early consideration of the soil properties required is highly recommended.

Once soil profiles are established, landscape features are required to assist with stabilisation and erosion control. They will also create microclimate pockets to 'kick-start' habitat creation and provide decomposition elements. These are to include but are not limited to rock boulders, natural debris and any timber required to be felled as part of the works. Landscape features are to mimic the natural environment. While random in their

location, they should follow contours and maintain connectivity. Earthworks planning, and design is to include survey and stockpile areas for any material that can be used for habitat. Any machines used for earthwork should aerate soils as they exit the site to avoid risk of soil compaction.

7.5.2 Soils

As it is Council's intention to utilise the Site soils for all revegetation on site, namely the Breccia, sourced from stockpiles around the Quarry void or excavated soils from the north mound, and crushed sandstone deposited in the Quarry void by North Connex.

The objective of the soil assessment report by SESL (2019) was with respect to examining the feasibility of, and directions to, engineering the site soils for re-establishing and supporting both BGDF and BBGF vegetation.

Testing of the two soil types available have indicated they both need a level of engineering to improve their soil chemical structure, so they can suitably support establishment of BGDF and BBGF species as part of the revegetation proposal. Specifications for soil improvement have been developed with the aim of formulating topsoils and subsoil horizons to reflect the soil profiles found at BH1 and BH4 for sandstone soil profile (BBGF) and BH14 and BH16 for breccia soil profile (BGDF) (SESL 2019).

A trial is currently underway to test recommended treatments on both soil types and their ability to support native vegetation (Figure 7.1). Results of the trial will direct soil treatment specifications for revegetation and landscaping.

Figure 7. 1 Planted soil trial plots

7.6 Revegetation maintenance

Follow up watering will be required. Deep watering on a weekly basis until plant establishment is optimal (at least 6 weeks). Additional water may be required depending on weather conditions. Watering to be via a water

breaker to ensure the soil surface structure is not damaged, runoff is minimised, and water reaches the roots of the plants where it is required.

Weed management during the establishment phase will be necessary. All weeds should be treated with the aim of breaking the life cycle, i.e. prior to flowering and seeding.

A planting schedule will be required to monitor plant survival and replacement requirements. Monitoring of plants for herbivory will indicate the necessity for protective fencing.

8. Monitoring and Reporting

Monitoring the effectiveness of implementing flora and fauna management on this Site will be necessary to ensure the aims and objectives are met. Monitoring is to be carried out on an annual basis to assess the response of the Site to works, to the use of the Site as a parkland and to identify any successes or threats that may be presented. Results of monitoring will be used to plan future works as part of an adaptive management process.

8.1 Monitoring methods

8.1.1 Fauna surveys

Quantitative data is required to measure changes at the Site against baseline data over time. The data collected to date and collaborated in this report is to be supplemented with additional fauna data due to be collected in Winter 2020 and again in Summer 2021. Further fauna survey effort will extend the timeframe over different seasons and also include nocturnal surveys, wildlife cameras and specific fauna survey equipment. The data collected is to be analysed by an ecologist and results presented in a report.

8.1.2 Citizen Science

Robust evidence has been recorded by members of the local community to suggest a breeding pair of *Ninox strenua* Powerful Owls are currently using the Site. The evidence is scientifically being collated and monitored by Birdlife Australia through the “Powerful Owl Project” and has now been provided to the Quarry Rehabilitation Project Team.

As a keystone species, the presence of *Ninox strenua* Powerful Owls indicates the good health and function of the existing ecosystem. The Birdlife Australia monitoring program provides evidence on the health of *Ninox strenua* Powerful Owl prey, chicks and genetic transfer. Monitoring Owl movements through Citizen Science provides extremely valuable insight and direction to guide conservative and adaptive Site management. It is not surprising that the presence of the breeding pair has sparked great excitement in the Quarry Rehabilitation Project and the value of its natural area as an asset to be protected. The momentum of this excitement is to be utilised to encourage more education about the *Ninox strenua* Powerful Owl and more training of survey methods for the wider community. Even though *Ninox strenua* Powerful Owls have never been recorded as utilising a constructed nesting box, other Fauna, *including Ninox* strenua Powerful Owl prey, have been known to. It is recommended that nesting box design, construction and monitoring is incorporated into a citizen science objective (Figures 8.2 to 8.3).

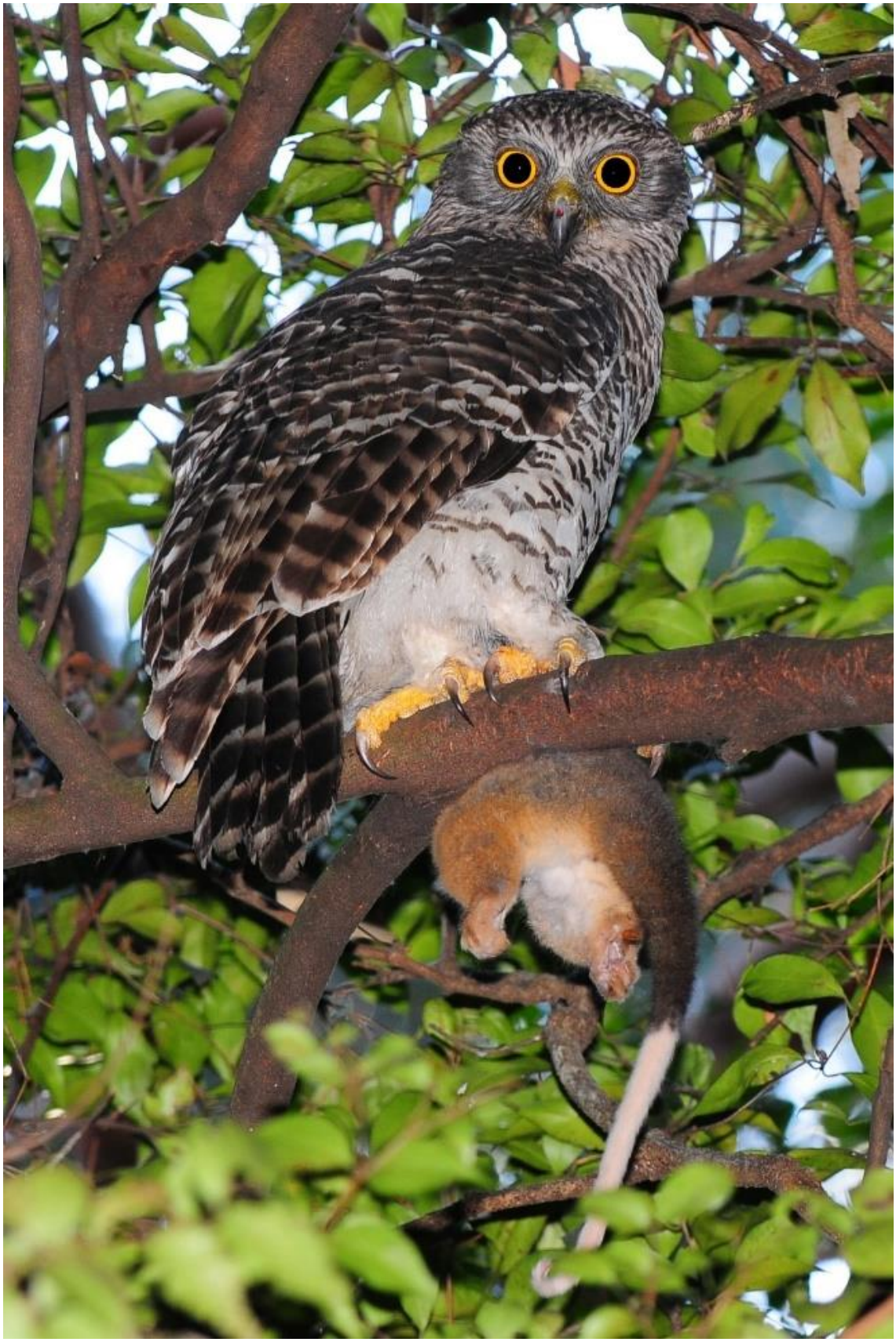

Figure 8. 1 *Ninox strenua* Powerful Owl © Birdlife Australa

Figure 8. 2 Nest box created by Denman and Murrundi Mens Sheda

Figure 8. 3 Next Box created by Merriwa Mens Shed and Microbat Box

8.1.3 Rapid Data Points and Vegetation Condition

Rapid data points were collected by Kleinfelder in 2016/17 (Appendix E). The points are to be revisited at the commencement of the project and those points which will best indicate change over time are to be determined (Figure 8.4). Additional points are to be added to the current data at the commencement of the project where there is no point in the centre of a Management Zone (Figure 6.1). These points will formalise baseline data that can be used to monitor and compare the percentage of canopy cover, native understorey cover and exotic species in each Management Zone. The results will also provide information to support the preparation of ongoing vegetation condition mapping using The National Trust of Australia (NSW) bushland condition methodology (2.6.2) and compare the condition to the baseline results and map in this report (Figure 2.14).

8.1.4 Photo monitoring points

Photo monitoring points are to be set up at the project commencement. There is no restriction to the amount of photo points however there must be at least one with each rapid data point. A photo point is to be indicated with a painted survey peg or yellow star picket and labelled 'Photo Point No. x'. The focal points should be a labelled yellow star picket and positioned a suitable distance from the photo point to capture the surrounding landscape. As a rule, the preferred distance is 10 metres but this can vary depending upon the topography and density of the weed plume. An additional reference point such as a tree, rock or feature in the distance is useful. All photo points to be GPS referenced with a bearing to the focal point. Photographs are to be taken from the photo point with a digital camera on an annual basis, preferably at the same time of day and with cloud cover to eliminate dappled light. Each photograph is to be labelled with the photo point number, date taken and a description of the vegetation present.

8.1.5 Revegetation monitoring

All revegetation is to be documented with a map showing the location of the area planted and the number and species of plants installed. It will be necessary to evaluate, identify and mitigate fatality causes where practical prior to installing replacement plants.

8.1.6 Tree register

An annual tree register is to be prepared supplementing Council's current tree data. The register is to record numbers of tree failures, deaths and management requirements. Ongoing monitoring will be a valuable tool in monitoring tree health and canopy connectivity as part of adaptive management strategies.

8.2 Reporting

Bush regeneration is to be undertaken on a regular basis to achieve aims and address performance criteria (Appendix F). All work is to be reported following each work session. Information required to include: date and time worked, area covered, type of work, treatment, major weeds targeted, fauna observed, site or work constraints, incidents and recommendations, and a map of work location.

An annual report is to be prepared to present a consolidation of monitoring results and the works undertaken. The report is to also address the items in the performance criteria, with a description of successes or failures and short- and long-term recommendations for future works (Appendix F).

The management actions are to be reviewed after five years. Any changes to be presented and justified on a case by case basis for approval by Council's Offset representative in the Natural Resources Branch.

8.2.1 Performance criteria

The role of vegetation management in the creation and enhancement of habitat has formed the basis of this document. Its success will depend on works addressing the performance criteria. Specifications have been summarised in Appendix A and monitoring works will be assessed against the performance criteria and timing of work specifications in Appendix F.

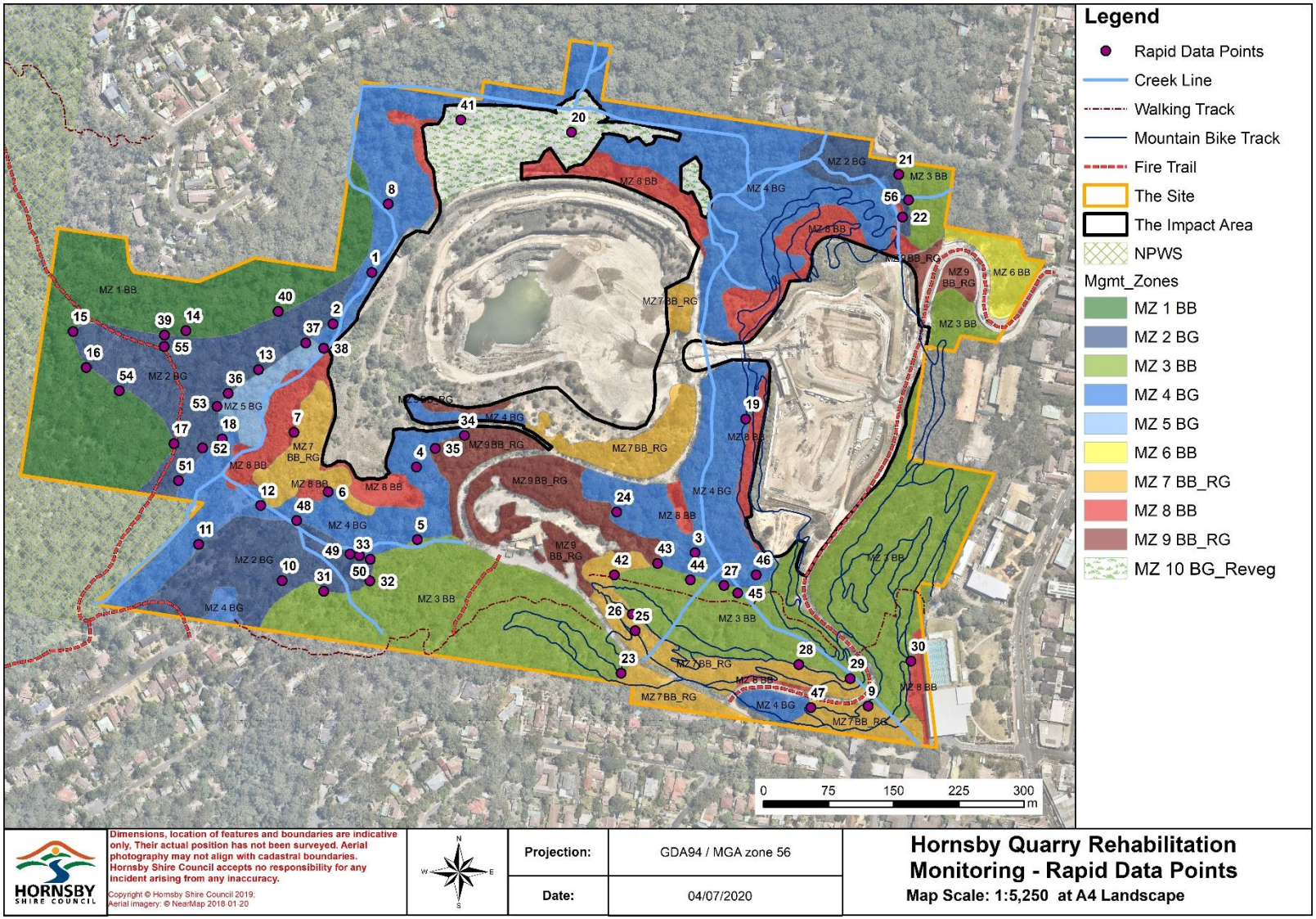

Figure 8. 4 Rapid data point locations

9. Implementation

The responsibility for the implementation of this VMP and HCEP will be upon Hornsby Shire Council. The Natural Resources Branch should be assigned to the management of bushland areas. All project management meetings and decisions should be inclusive of the assigned project manager. It should be noted, activities can directly or indirectly impact the surrounding bushland, in this regard the precautionary principle should be applied.

Any weed management should be undertaken by suitably qualified and experienced bush regenerators with a TAFE Certificate IV in Conservation and Land Management or similar. All works should comply with best practice bush regeneration techniques within an adaptive management program (Buchanan 2009).

10. Summary and Recommendations

Hornsby Park is to be developed as a parkland which supports recreational pursuits and prioritises conservation of its natural areas. To obtain such conservation and recreation objectives, priority is to be given to managing impacts on the natural area from the threatening process of fragmentation, edge effects and loss of habitat. This can be achieved by increasing areas of core native vegetation, connectivity and appropriate access as discussed. The final detail on management actions for the Site are to be developed in accordance with the principles of this VMP and HCEP and recommendations are as follows:

- the discussion of the Key Threatening Processes should serve to inform the prioritised avoidance, modification or mitigation of these processes and associated impacts on site in all activities including future planning
- the *Ninox strenua* Powerful Owl is known to be highly sensitive to disturbance and.strong consideration should be given to the life cycle of this Keystone Species in planning works and bushland access. Refer to Birds Australia for Citizen Science data (Figure 4.2)
- prepare an ongoing fauna monitoring program incorporating increased spatial and temporal sampling to enhance the current fauna baseline data and fauna representation across the site and adjacent areas.
- survey open rocky areas to the north and south of the quarry for fauna to assist future management recommendations
- retain canopy and understory vegetation cover as an important aspect in maintaining a moist microclimate (Paris 2002) with the additional benefits of ground debris for refuge and shelter from predation (Ferraro and Burgin 1993)
- consider seasonal timing and sequencing of mosaic removal of weeds and replacement via regeneration or revegetation with native trees to maintain canopy connectivity and the current moist and cool microclimate of riparian wildlife corridor (Figure 2.15)
- a precautionary approach is to be taken in all vegetation clearing so as not to directly harm fauna
- avoid the removal of hollow bearing trees
- any tracks should preferably be limited and well maintained, canopy connection retained above tracks, recommended buffer distances maintained from sensitive areas, and creek crossings be limited maintained and fixed
- all accessible access tracks be designed wherever possible to mitigate noise likely to deter wildlife

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Appendix A: Management Actions per Zone

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
MZ 1	BBGF	Good	Western Boundary	Intact	<5%	High	Minimal disturbance	1.1	Monitor for bird, wind and water dispersed weeds biannually
							Fire trail	1.2	Monitor track for evidence of erosion and track side weeds
							Residential boundaries	1.3	Monitor boundaries for encroachment, garden escapes, dumping
							Sewer easement	1.4	Monitor sewer easement for system failures
MZ 2	BGDF	Good	MZ2.1 Western Boundary	Intact	<5%	High	Some disturbance	2.1	Monitor for bird, wind and water dispersed weeds biannually
							Fire trail	2.2	Monitor track for evidence of erosion and track side weeds
							Sewer easement	2.3	Monitor sewer easement for system failures
							Impact Area	2.4	Monitor buffer adjacentt to MZ4 for unforeseen vegetation damage
			MZ 2.2 Southern Boundary	Intact	<5%	High	Riparianwildlife corridor	2.5	Monitor for bird, wind and water dispersed weeds: monitor for erosion
							Walking track	2.6	Monitor track for evidence of erosion and track side weeds
							Sewer easement	2.7	Monitor sewer easement for system failures
			MZ 2.3 North-Eastern Bndry	Intact	<5%	High	Creek wildlife corridor	2.8	Monitor for bird, wind and water dispersed weeds: monitor for erosion
							Steep slope	2.9	Monitor for erosion
							Residential boundaries	2.10	Monitor boundaries for encroachment, garden escapes, dumping
MZ 3	BBGF	Fair	Eastern and Southern Boundaries	Disturbed	20%	Mod-Low	Moderate disturbance	3.1	Monitor for bird, wind and water dispersed weeds in actively growing months
							Weed encroachment	3.2	Maintain edges to prevent encroachment of weeds from neighbouring zones and protect zone core
							Mountain bike track Walking track Fire trail	3.3	Reinstate representation of all strata levels with species from BBGF PCT
								3.4	Regulate and remediate track erosion, widening and any illegal work. Undertake measures to prevent future damage.
								3.5	Record senescing tree, tree repair and tree removal to establish a canopy replacement strategy
								3.6	Retain all dead timber and rocks for habitat
							Riparian wildlife corridor	3.7	Monitor creek line for weeds, erosion and rubbish
							Impact area	3.8	Revegetate to create a dense vegetation buffer to Impact Area

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
MZ 4	**BGDF**	**Fair**	Centre of the Site including the Impact Area interface	Disturbed	20%	Mod-Low	Moderate disturbance	4.1	Monitor for bird, wind and water dispersed weeds in actively growing months
							Weed encroachment	4.2	Maintain edges to prevent encroachment of weeds from neighbouring zones and protect zone core
							Historic clearing and weed species dominating mid storey	4.3	Establish strategic mosaic mid storey weed removal. Consider existing canopy, evidence of native species present in any strata and the value of weeds as habitat
								4.4	Allow vegetation structure to be reinstated prior to connecting cleared mosaic areas with further weed removal
								4.6	Assist regeneration with revegetation in areas exhibiting low resilience using species representing all strata levels from BGDF PCT
							Riparian wildlife corridor	4.7	Maintain habitat value of weeds along the riparian corridors of the creek line
								4.8	Establish mesophyllic native species amongst weed plumes as replacement habitat prior to weed removal
								4.9	Monitor creek line for weeds, erosion and rubbish
							Steep slope	4.10	Prevent erosion with the retention of structural elements (dead timber and rocks) and strategic weed removal
							Mountain bike track	4.11	Regulate and remediate track erosion, widening and any illegal work. Undertake measures to prevent future damage.
								4.12	Record senescing trees, tree repair and/or tree removal to establish a canopy replacement strategy
								4.13	Retain all dead timber and rocks for habitat
							Impact Area	4.14	Revegetation to repair any damage by machines on their approach to the knoll during stabilisation work should be a priority. It is highly likely that immediate supplementary planting within bushland north of the north mound will be necessary to re-establish mesic corridor as quickly as possible.
								4.14	Maintain all vegetation directly adjacent to impact area in buffer regardless of species until construction works have been completed. Suppressing and containing climbers may be preferred over eradication depending on location, species and adjacent bushland condition

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
MZ 5	**BGDF**	**Good**	Western Riparian Corridor	Modified	20%	High	Moderate disturbance	5.1	Monitor for bird, wind and water dispersed weeds in actively growing months
							Weeds dominate mid storey	5.2	Establish strategic mosaic mid storey weed removal. Consider existing canopy, evidence of native species present in any strata and the value of weeds as habitat
								5.3	Allow vegetation structure to be reinstated prior to connecting cleared mosaic areas with further weed removal
								5.4	Assist regeneration with revegetation in areas exhibiting low resilience using species representing all strata levels from BGDF PCT
							Riparian corridor and drainage channel	5.5	Maintain habitat value of weeds along the riparian corridors of the creek line
								5.6	Establish mesophyllic native species amongst weed plumes as replacement habitat prior to weed removal
								5.7	Monitor creek line for weeds, erosion and rubbish
							Impact Area	5.8	Maintain all vegetation directly adjacent to impact area in buffer regardless of species until construction works have been completed
MZ 6	**BBGF**	**Poor**	North East Corner - Bridge Street	Disturbed	50%	Low	Vegetation clearing Road construction	6.1	Treat weed species
								6.2	Revegetate with species from all strata levels of BBGF PCT
MZ 7	**BBGF**	**Poor**	MZ 7.1 South West Mound	Scree	50%	Low	Highly modified soils Regrowth from mining period	7.1	Establish strategic mosaic midstorey weed removal within the core - concentrate on existing canopy, evidence of any native species present and value of weeds as habitat
								7.2	Allow vegetation structure to be reinstated prior to connecting mosaic areas or clearing weeds from interface with further weed removal
								7.3	Revegetate with species from all strata levels of BGDF PCT
							Impact Area	7.4	Enhance buffer on Impact Area interface by installing shrub species from BBGG and BGDF PCTs amongst existing weed species.
			MZ 7.2 Quarry Road verge	Disturbed	60%	Low	Weed encroachment/fill from road and housing development	7.5	Prevent spread of weeds into MZ 3
								7.6	Treat weeds and revegetate in low resilient areas
								7.7	Retain weeds as a buffer from road verge until revegetation within the Zone establishes and is stabilised

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
							Riparian corridor and drainage channel	7.8	Maintain habitat value of weeds along the riparian corridors of the creek line
								7.9	Establish mesophyllic native species amongst weed plumes as replacement habitat prior to weed removal
								7.10	Monitor creek line for weeds, erosion and rubbish
			MZ 7.3 Quarry walls - South east	Disturbed	30%	Low	Excavation	7.11	Manage vegetation with respect to quarry wall stability and safety
								7.12	Replace any necessary vegetation removal with revegetation using low growing or shrub species from BBGF or BGDF PCTs that exhibit a dense fibrous root system and a thick foliage cover (see planting schedule Appendix B)
								7.13	Treat weed species with the aim to prevent spread of weed propagules
MZ 8	**BBGF**	**Very Poor**	MZ 8.1 South West Mound	Scree	>61%	Low	Highly modified soils Regrowth from mining period	8.1	Establish and maintain buffer on the MZ 5 edge and the Impact Area interface
								8.2	Maintain habitat value of weeds along the riparian corridors of the creek line
								8.3	Revegetate with species from all strata levels of BGDF PCT
							Riparian corridor and drainage channel	8.4	Maintain habitat value of weeds along the riparian corridors of the creek line
								8.5	Establish mesophyllic native species amongst weed plumes as replacement habitat prior to weed removal
								8.6	Monitor creek line for weeds, erosion and rubbish
							Impact Area	8.7	Create a buffer with revegetation where none exists. Supplement vegetation with shrub species where canopy is present
			MZ 8.2 North Mound - North West Strip and rock shelf on south edge	Scree	>61%	Low-Mod	Highly modified soils on a steep slope with midstorey weedy regrowth	8.8	Maintain a buffer on the Impact Area interface until MZ 10 revegetation is established and able to provide buffer to edge effects and habitat
								8.9	Enhance buffer with revegetation incorporating species from all strata levels BGDF PCT once MZ 10 revegetation is established. Establish strategic mosaic midstorey weed removal. Focus on maintaining vegetative structure and value of weeds as habitat.

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
								8.10	Maintain buffer to upslope vegetation until revegetation following earthworks has established. Treat priority weeds (Table 2.5)
			MZ 8.3 North of Old Mans Valley	Disturbed	>61%	Low-Mod	Highly modified soils	8.11	Establish a buffer on the Impact Area interface and connectivity with MZ 4, through weed treatment and revegetation using representatives from all strata levels of BGDF PCT
								8.12	Treat weed species with the aim to maintain soil cover but to prevent the spread of weed propagules
			MZ 8.4 West of Old Mans Valley	Disturbed	>61%	Low-Mod	Highly modified soils	8.13	Enhance buffer with revegetation incorporating species from all strata levels BGDF PCT. Establish strategic mosaic midstorey weed removal. Focus on maintaining vegetative structure and value of weeds as habitat and protection for MZ4.
			MZ 8.5 Below pool and Quarry Road entrance	Disturbed	>61%	Low-Mod	Fill from pool development	8.14	Establish a buffer on the pool interface and connectivity with MZ 3 by revegetating with nutrient and moisture tolerant species from BBGF PCT
							Fire trail entrance	8.15	Revegetate edge to fire trail. Use the opportunity to improve aesthetics of entrance
							Mountain bike track	8.16	Regulate track erosion, widening and illegal work
								8.17	Record senescing tree, tree repair and tree removal to establish a canopy replacement strategy
								8.18	Retain all dead timber and rocks for habitat
MZ 9	**BBGF**	**Very Poor**	MZ 9.1 Below Crusher Plant	Scree	>61%	Very Low	Vegetation clearing Highly modified soils Regrowth from mining	9.1	Geotechnical advice required prior to improving soils and revegetating with BGDF PCT species
			MZ 9.2 Bridge Road	Imported	>61%	Nil	Vegetation clearing Road construction Inappropriate imported soils	9.2	Improve soils as per specifications from current soil trials
								9.3	Prevent erosion, provide erosion control and habitat with structural elements such as timber logs and rocks. Size of each can vary from small to large
								9.4	Revegetate with all strata levels of BBGF

Mgmt Zone	PCT	Condition	Location	Soil	Weed %	Resilience	Management Issue	Action	Management Actions
MZ 10	**BGDF**	**Very Poor**	North Mound Impact Area	Scree Disturbed	>61%	Very Low	Vegetation clearing Highly modified soils Regrowth from mining	10.1	Reshape mound based on current geotechnical advice
								10.2	Improve soils as per specifications from current soil trial
								10.3	Prevent erosion and create habitat with structural elements salvaged from earthworks
								10.4	Revegetate mesic corridor with primary successional species, both fast growing shrub and canopy layer species, and mesophyllic species tolerant of high levels of light/ heat and low levels of available moisture
								10.5	Revegetate whole area with all strata levels of BGDF PCT
MZ 11	**BGDF and BBGF**		Landscaping	Improved			Earthworks	11.1	Planting schedules for landscaped areas are to compliment the surrounding plant communities by utilising plant species representative of BGDF and BBGF PCTs and suitable to landscaping
Whole site								12.1	Target climbers and *Cortaderia selloana*

Appendix B: Planting Schedule

		Plant Community Type		Suitablity					Habitat		
Botanical Name	**Common Name**	**BGDF**	**BBGF**	**Mesophyllic**	**Primary**	**Long Lived**	**Landscaping**	**Stability**	**Shelter**	**Foraging**	**Breeding**
TREES											
Acmena smithii	Common Lilly Pilly	x	x	x					x	x	
Allocasuarina littoralis	Black Sheoak		x		x				x	x	
Allocasuarina torulosa	Forest Oak	x	x			x			x	x	
Angophora costata	Sydney Red Gum	x	x			x			x	x	x
Angophora floribunda	Rough-barked Apple	x	x			x			x	x	x
Backhousia myrtifolia	Grey Myrtle	x	x	x					x	x	
Ceratopetalum apetalum	Coachwood	x	x	x		x			x	x	x
Doryphora sassafras	Sassafras	x		x					x	x	x
Elaeocarpus reticulatus	Blueberry Ash	x	x	x	x				x	x	
Eucalyptus pilularis	Blackbutt	x	x	x		x			x	x	x
Eucalyptus resinifera	Red Mahogany	x	x			x			x	x	x
Eucalyptus saligna	Blue Gum	x	x	x		x			x	x	x
Ficus coronata	Sandpaper	x	x	x		x			x	x	x
Ficus rubiginosa	Rusty Fig or Port Jackson Fig		x	x		x			x	x	
Glochidion ferdinandi	Cheese Tree	x	x	x	x				x	x	
Syncarpia glomulifera	Turpentine Tree	x	x			x			x	x	x
Tristaniopsis laurina	Water Gum	x	x	x					x	x	
SHRUBS											
Acacia floribunda	Gossamer Wattle	x	x				x			x	
Acacia implexa	Hickory Wattle	x	x							x	
Acacia linifolia	White Wattle	x	x				x			x	
Acacia longifolia subsp. longifolia	Sydney Golden Wattle	x	x				x			x	
Acacia longissima	Long-leaf Wattle	x	x							x	
Acacia myrtifolia	Myrtle Wattle	x	x							x	
Acacia stricta	Straight Wattle, Hop Wattle	x	x							x	
Acacia terminalis	Sunshine Wattle	x	x				x			x	
Acacia ulicifolia	Prickly Moses	x	x						x	x	
Banksia serrata	Old Mans Banksia	x	x			x	x		x	x	
Banksia spinulosa	Hairpin Banksia	x	x				x			x	
Breynia oblongifolia	Coffee Bush	x	x		x					x	
Bursaria spinosa	Blackthorn, Sweet Bursaria	x	x						x		
Callicoma serratifolia	Black Wattle	x		x							
Ceratopetalum gummiferum	NSW Christmas Bush	x	x				x				
Daviesia ulicifolia	Gorse Bitter Pea	x	x								
Dodonaea triquetra	Large-leaf hop-bush	x	x		x		x			x	
Eupomatia laurina	Native Guava	x							x	x	
Grevillea linearifolia	Linear-leaf Grevillea	x	x				x			x	

		Plant Community Type		Suitablity					Habitat		
Botanical Name	**Common Name**	**BGDF**	**BBGF**	**Mesophyllic**	**Primary**	**Long Lived**	**Landscaping**	**Stability**	**Shelter**	**Foraging**	**Breeding**
Leptospermum polygalifolium	Tantoon, Jellybush	x	x				x		x		
Leptospermum trinervium	Flaky-barked Tea-tree	x	x				x		x		
Leucopogon lanceolatus	Lance-leaved Beard Heath	x	x				x			x	
Myrsine howittiana	Brush Muttonwood	x		x		x			x	x	
Ozothamnus diosmifolius	Rice Flower	x	x				x				
Persoonia laurina	Laurel Geebung	x	x							x	
Pittosporum revolutum	Rough Fruit Pittosporum	x	x				x			x	
Platylobium formosum	Handsome Flat Pea	x	x				x			x	
Pultenaea flexilis	Graceful Bush-pea	x	x	x			x			x	
Pultenaea retusa	Notched bush-pea	x	x							x	
Synoum glandulosum	Scentless Rosewood	x	x	x		x			x	x	
Trema tomentosa var. aspera	Native Peach	x	x		x		x			x	
Trochocarpia laurina	Tree Heath	x	x			x			x	x	
Zieria smithii	Smithian Zieria	x	x				x				
GROUND COVERS											
Adiantum aethiopicum	Common Maidenhair	x	x				x				
Calochlaena dubia	Rainbow Fern	x	x		x				x		
Coronidium elatum subsp. Elatum	White Paper Daisy	x	x								
Coronidium scorpioides	Button Everlasting	x	x								
Dichondra repens	Kidney Weed	x	x		x		x				
Pterostylis curta	Blunt Greenhood Orchid	x	x								
Viola hederacea	Native Violet	x	x				x				
VINES											
Billarderia scandens	Apple Berry	x	x							x	
Clematis glycinoides	Headache Vine	x	x								
Eustrephus latifolius	Wombat Berry	x	x							x	
Gynochthodes jasminoides	Sweet Morinda	x	x							x	
Hardenbergia violacea	Purple Coral Pea	x	x				x				
Hibbertia dentata	Toothed Guinea Flower	x	x				x				
Hibbertia scandens	Golden Guinea Vine	x	x				x				
Pandorea pandorana	Wonga Wonga Vine	x	x				x			x	
Tylophora barbata	Bearded Tylophora	x	x								
GRASSES											
Cymbopogon refractus	Barbed Wire Grass	x	x				x	x		x	
Dichelachne rara		x	x							x	
Echinopogon ovatus	Forest Hedgehog/Echidna grass	x	x							x	
Entolasia marginata	Bordered Panic	x	x							x	

		Plant Community Type		Suitablity					Habitat		
Botanical Name	**Common Name**	**BGDF**	**BBGF**	**Mesophyllic**	**Primary**	**Long Lived**	**Landscaping**	**Stability**	**Shelter**	**Foraging**	**Breeding**
Entolasia stricta	Wiry Panic	x	x							x	
Imperata cylindrica	Blady Grass	x	x		x			x	x	x	
Microlaena stipoides	Weeping Rice Grass	x	x		x		x			x	
Poa affinis	Poa	x	x				x			x	
Rytidosperma tenuius	Wallaby Grass	x	x							x	
Themeda triandra	Kangaroo Grass	x	x				x	x	x	x	
RUSHES/SEDGES/LILIES											
Arthropodium milleflorum	Pale Vanilla-Lily	x	x								
Dianella caerulea	Blue Flax-Lily	x	x				x	x	x	x	
Gahnia spp.	Saw Sedge	x	x				x	x	x	x	
Juncus usitatus	Common Rush	x	x		x			x	x	x	
Lomandra longifolia	Spiny-headed Mat-rush	x	x		x			x	x	x	
Lomandra multiflora	Many-flowered Mat-rush	x	x								

Appendix C: Native Species List

Native Species List	
Trees	**Shrub**
Angophora costata	*Banksia spinulosa*
Angophora floribunda	*Boronia ledifolia*
Casuarina cunninghamiana	*Bossiaea ensata*
Corymbia gummifera	*Bossiaea obcordata*
Corymbia maculata	*Breynia oblongifolia*
Eucalyptus pilularis	*Dillwynia retorta*
Eucalyptus piperita	*Epacris pulchella*
Eucalyptus saligna	*Gompholobium latifolium*
Syncarpia glomulifera	*Hakea sericea*
	Hibbertia bracteata
Small Trees	*Hovea linearis*
Allocasuarina littoralis	*Lambertia formosa*
Banksia serrata	*Micrantheum ericoides*
Callicoma serratifolia	*Persoonia linearis*
Callistemon salignus	*Pittosporum revolutum*
Clerodendrum tomentosum	*Platysace linearifolia*
Elaeocarpus reticulatus	*Polyscias sambucifolia*
Pittosporum undulatum	*Pultenaea retusa*
	Pultenaea villosa
Ferns	
Blechnum ambiguum	
Blechnum cartilagineum	**Sedge**
Calochlaena dubia	*Cyperus sp*
Cheilanthes sieberi subsp. sieberi	*Gahnia aspera*
Cyathea australis	*Gahnia erythrocarpa*
Doodia caudata	*Gahnia sieberiana*
Pellaea falcata	*Gahnia sp.*
Pteridium esculentum	*Juncus usitatus*
Selaginella uliginosa	*Lepidosperma filiforme*
	Lepidosperma laterale

Native Species List	
Grass/Ground Covers	**Climbers**
Aristida pubescens	*Billardiera scandens*
Aristida vagans	*Clematis aristata*
Cynodon dactylon	*Clematis glycinoides*
Dianella caerulea	*Eustrephus latifolius*
Dianella prunina	*Geitonoplesium cymosum*
Dichelachne micrantha	*Hibbertia dentata*
Dichondra repens	*Hibbertia scandens*
Echinopogon caespitosus	*Marsdenia sp*
Entolasia marginata	*Morinda jasminoides*
Entolasia stricta	*Pandorea pandorana*
Gonocarpus teucrioides	*Passiflora herbertiana*
Goodenia heterophylla subspeglandulosa	*Sarcopetalum harveyanum*
Imperata cylindrica	*Smilax australis*
Lepidosperma laterale	*Smilax glyciphylla*
Lomandra filiformis subsp *filiformis*	*Stephania japonica*
Lomandra glauca	
Lomandra gracilis	**Orchids**
Lomandra longifolia	*Cryptostylis erecta*
Lomandra multiflora subsp. multiflora	*Dipodium punctatum*
Lomandra obliqua	*Dipodium sp.*
Microlaena stipoides	
Opercularia diphylla	
Oplismenus aemulus	
Oxalis perennans	
Panicum simile	
Poa affinis	
Poranthera microphylla	
Pratia purpurascens	
Pseuderanthemum variabile	
Themeda australis	
Vernonia cinerea	
Veronica plebia	
Xanthorrhoea arborea	
Xanthorrhoea media	
Xanthosia tridentata	

Appendix D: Fauna Survey Results

Fauna Group	Common Name	*Scientific Name*	Exotic	BC Act	EPBC Act	Gecko/Future Ecology (2020)	GHD	Eco Aus	PB	Aquilla(2011)	Kleinfelder
Birds	Australian Brush-turkey	*Alectura lathami*				*O*	*O*	*O*			
Birds	Australian King-Parrot	*Alisterus scapularis*				*W*	*W*	*O*	*O*		
Birds	Australian Magpie	*Cracticus tibicen*				*W*	*W*	*O*	*O*		
Birds	Australian Raven	*Corvus coronoides*				*W*		*O*	*O*		
Birds	Bellbird	*Manorina melanophrys*				*W*		*W*			
Birds	Black-faced Cuckoo-shrike	*Coracina novaehollandiae*					*O*	*O*	*O*		
Birds	Brown Gerygone	*Gerygone mouki*				*W*	*W,E*				
Birds	Brown Thornbill	*Acanthiza pusilla*				*O,W*			*O*		
Birds	Buff-rumped Thornbill	*Acanthiza reguloides*							*O*		
Birds	Channel-billed Cuckoo	*Scythrops novaehollandiae*					*O*	*O*			
Birds	Crimson Rosella	*Platycercus elegans*							*0*		
Birds	Dollar Bird	*Eurystomus orientalis*					*O*				
Birds	Double-barred Finch	*Taeniopygia bichenovii*				*W*					
Birds	Eastern Rosella	*Platycercus eximius*							*O*		
Birds	Eastern Spinebill	*Acanthorhynchus tenuirostris*				*W*	*0*				
Birds	Eastern Whipbird	*Psophodes olivaceus*				*W*			*0*		
Birds	Eastern Yellow Robin	*Eopsaltria australis*				*O*	*O*		*O*		
Birds	Fan-tailed Cuckoo	*Cacomantis flabelliformis*					*W*				
Birds	Galah	*Eolophus roseicapilla*							*O*		
Birds	Golden Whistler	*Pachycephala pectoralis*				*W*	*W*		*O*		
Birds	Grey Butcherbird	*Cracticus torquatus*						*W*			
Birds	Grey Fantail	*Rhipidura fuliginosa*				*W*	*O*		*O*		
Birds	Grey Shrike-thrush	*Colluricincla harmonica*					*0*				
Birds	Jacky Winter	*Microeca fascinans*							*O*		
Birds	Laughing Kookaburra	*Dacelo novaeguineae*				*O*	*O*	*W*	*O*		
Birds	Lewins Honeyeater	*Meliphaga lewinii*				*W*	*O*				
Birds	Little Corella	*Cacatua sanguinea*					*O*				
Birds	Magpie-lark	*Grallina cyanoleuca*							*O*		
Birds	Noisy Friarbird	*Philemon corniculatus*							*O*		
Birds	Noisy Miner	*Manorina melanocephala*					*O*		*O*		
Birds	Pacific Black Duck	*Anas superciliosa*				*O*	*O*	*O*			

Fauna Group	Common Name	*Scientific Name*	Exotic	BC Act	EPBC Act	Gecko/Future Ecology (2020)	GHD	Eco Aus	PB	Aquilla(2011)	Kleinfelder
Birds	Pied Butcherbird	*Cracticus nigrogularis*				*w*					
Birds	Pied Currawong	*Strepera graculina*				*w*		*w*			
Birds	**Powerful Owl**	***Ninox strenua***		***v***		*o*		*H*			*o*
Birds	Rainbow Lorikeet	*Trichoglossus haematodus*				*w*	*w*		*o*		
Birds	Red Wattlebird	*Anthochaera carunculata*				*w*	*o*		*o*		
Birds	Red-browed Firetail	*Neochmia temporalis*				*o,w*			*o*		
Birds	Red-whiskered Bulbul*	*Pycnonotus jocosus**	*				*o*		*o*		
Birds	Sacred Kingfisher	*Todiramphus sanctus*					*o*				
Birds	Scarlet Honeyeater	*Myzomela sanguinolenta*				*w*	*o*				
Birds	Silvereye	*Zosterops lateralis*				*o*			*o*		
Birds	Southern Boobook Owl	*Ninox novaeseelandiae*					*o,w*		*o*		
Birds	Spotted Pardalote	*Pardalotus punctatus*				*w*					
Birds	Striated Thornbill	*Acanthiza lineata*				*w*	*o*				
Birds	Sulphur-crested Cockatoo	*Cacatua galerita*				*w*	*o*		*o*		
Birds	Superb Fairy-wren	*Malurus cyaneus*					*o*	*o*			
Birds	**Varied Sitella**	***Daphoenositta chrysoptera***		***v***						***o***	
Birds	Variegated Fairy-wren	*Malurus lamberti*				*o,w*	*o*			*o*	
Birds	Welcome Swallow	*Hirundo neoxena*								*o*	
Birds	White-browed Scrubwren	*Sericornis frontalis*				*o,w*	*o*				
Birds	White-throated Gerygone	*Gerygone olivacea*							*o*		
Birds	White-throated Treecreeper	*Cormobates leucophaea*				*o*					
Birds	Wonga Pigeon	*Leucosarcia picata*					*w*				
Birds	Yellow Thornbill	*Acanthiza nana*							*o*		
Birds	Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*				*w*					
Birds	Yellow-throated Scrubwren	*Sericornis citreogularis*				*o,w*					
Frogs	Common Eastern Froglet	*Crinia signifera*				*w*	*w*		*o*		
Frogs	Dusky Toadlet	*Uperoleia fusca*				*w*					
Frogs	Peron's Tree Frog	*Litoria peronii*					*w*				
Mammals	Brown Antechinus	*Antechinus stuartii*							*o*		
Mammals	Brush-tailed Possum	*Trichosurus vulpecula*							*o*		
Mammals	Bush Rat	*Rattus fuscipes*							*o*		
Mammals	Common Ringtail Possum	*Pseudocheirus peregrinus*				*o*	*0*		*0*		

Fauna Group	Common Name	*Scientific Name*	Exotic	BC Act	EPBC Act	Gecko/Future Ecology (2020)	GHD	Eco Aus	PB	Aquilla(2011)	Kleinfelder
Mammals	**Eastern Bentwing-bat**	***Miniopterus orianae oceanensis***		***v***			***U***				
Mammals	Forest Bat	*Vespadelus sp.*	*				*U*				
Mammals	Fox*	*Vulpes vulpes**				*P*	*O,P*				
Mammals	Gould's Wattled Bat	*Chalinolobus gouldii*						*U*			
Mammals	**Grey-headed Flying-fox**	***Pteropus poliocephalus***		***v***					***O***		
Mammals	Little Forest Bat	*Vespadelus vulturnus*						*U*			
Mammals	Short-beaked Echidna	*Tachyglossus aculeatus*					*F,X*				
Mammals	Swamp Wallaby	*Wallabia bicolor*				*O*	*O*	*O*	*O*		
Mammals	White-striped Freetail Bat	*Tadarida (Austronomus) australis*						*U*			
Reptiles	Dark-flecked Garden Sunskink	*Lampropholis delicata*					*O*				
Reptiles	Eastern Water Dragon	*Physignathus lesueurii*				*O*		*O*	*O*		
Reptiles	Red-bellied Black Snake	*Pseudechis porphyriacus*						*O*			
Birds	Richard's Pipit	*Anthus novaeseelandiae*							*O*		

Key

Bold and v – Vulnerable

Obervation codes

E - nest

F – tracks/traces

H – feathers

L – possible identification from anabat recording

O – observed

P – scats

U – anabat recording

W – heard

X – in scat

Appendix E: Rapid data point results (Kleinfelder 2017)

Point No.	Mgmt Zone	Direction_1	CanopCov1	NtvUnd1	Exotic1	Direction_2	CanopCov2	NtvUnd2	Exotic2
1	MZ4	E	10% - 50%	<10%	10% - 50%	W	10% - 50%	>50%	<10%
2	MZ2/MZ4	E	<10%	<10%	>50%	W	10% - 50%	10% - 50%	<10%
3	MZ4	E	10% - 50%	<10%	>50%	W	10% - 50%	<10%	>50%
4	MZ4	SE	10% - 50%	<10%	10% - 50%	NW	10% - 50%	<10%	>50%
5	MZ3/MZ4	N	10% - 50%	<10%	>50%	S	>50%	>50%	<10%
6	MZ3/MZ8	SE	10% - 50%	<10%	>50%	NW			
7	MZ7/MZ8	E	10% - 50%	<10%	>50%	W	<10%	<10%	>50%
8	MZ4	SE	10% - 50%	<10%	>50%	NW	>50%	10% - 50%	10% - 50%
9	MZ7/MZ8	N	>50%	>50%	<10%	S	10% - 50%	<10%	>50%
10	MZ2	NW	>50%	>50%	<10%	SE	>50%	>50%	<10%
11	MZ2/MZ4	S	>50%	10% - 50%	<10%	N	10% - 50%	<10%	>50%
12	MZ4	N	10% - 50%	<10%	>50%	S	>50%	>50%	<10%
13	MZ2/MZ5	E	10% - 50%	<10%	>50%	W	>50%	>50%	<10%
14	MZ 1/MZ2	S	>50%	>50%	<10%	N	>50%	>50%	<10%
15	MZ 1/MZ2	E	>50%	>50%	<10%	W			
16	MZ 1/MZ2	N	>50%	>50%	<10%	S	>50%	>50%	<10%
17	MZ 1/MZ3	W	>50%	>50%	<10%	E	10% - 50%	>50%	<10%
18	MZ4	W	>50%	>50%	<10%	E	10% - 50%	<10%	>50%
19	MZ4	W	10% - 50%	<10%	>50%	E	<10%	<10%	>50%
20	MZ10	E	10% - 50%	<10%	>50%	W	<10%	<10%	>50%
21	MZ2/MZ3	E	>50%	>50%	<10%	W	<10%	<10%	>50%
22	MZ2/MZ8	E	>50%	>50%	<10%	W	<10%	<10%	>50%
23	MZ3/MZ7	W	>50%	>50%	<10%	W	>50%	<10%	>50%
24	MZ9/MZ4	E	10% - 50%	<10%	>50%	E	<10%	<10%	>50%
25	MZ7	NE	10% - 50%	10% - 50%	<10%	SW			
26	MZ3/MZ7	E	10% - 50%	10% - 50%	<10%	W	10% - 50%	<10%	>50%
27	MZ3/MZ4	N	10% - 50%	<10%	>50%	S	10% - 50%	>50%	<10%
28	MZ3/MZ7	N	>50%	>50%	<10%	S	>50%	<10%	>50%
29	MZ3/MZ7	S	>50%	<10%	>50%	S	>50%	>50%	<10%
30	MZ3/MZ8	E	<10%	>50%	10% - 50%	W	>50%	>50%	<10%
31	MZ2/MZ3	S	>50%	>50%	<10%	N	>50%	>50%	<10%
32	MZ2/MZ4	E	>50%	>50%	<10%	W	>50%	>50%	<10%
33	MZ2/MZ4	N	10% - 50%	<10%	>50%	S	>50%	>50%	<10%
34	MZ4/MZ9	W	10% - 50%	<10%	>50%	E	10% - 50%	<10%	>50%
35	MZ4/MZ9	SE	10% - 50%	<10%	>50%	NW	10% - 50%	<10%	>50%
36	MZ2/MZ5	E	10% - 50%	10% - 50%	10% - 50%	W	>50%	>50%	<10%
37	MZ2/MZ5	E	10% - 50%	10% - 50%	10% - 50%	W	>50%	>50%	<10%
38	MZ4/MZ5	E	<10%	<10%	>50%	W	10% - 50%	<10%	10% - 50%
39	MZ 1/MZ2	N	>50%	>50%	<10%	S	>50%	>50%	<10%
40	MZ 1/MZ2	N	10% - 50%	>50%	<10%	S	>50%	>50%	<10%
41	MZ10	E	10% - 50%	<10%	>50%	W	10% - 50%	<10%	>50%
42	MZ3/MZ7	W	<10%	<10%	>50%	E	>50%	>50%	<10%
43	MZ3/MZ9	W	<10%	<10%	>50%	E	<10%	10% - 50%	>50%
44	MZ3/MZ4	S	>50%	>50%	<10%	N	10% - 50%	<10%	>50%

Point No.	Mgmt Zone	Direction_1	CanopCov1	NtvUnd1	Exotic1	Direction_2	CanopCov2	NtvUnd2	Exotic2
45	MZ3/MZ4	N	>50%	>50%	<10%	S	>50%	>50%	<10%
46	MZ3/MZ4	E	>50%	>50%	<10%	W	>50%	>50%	<10%
47	MZ4/MZ7	W	10% - 50%	<10%	<10%	E	>50%	<10%	10% - 50%
48	MZ2/MZ4	S	>50%	>50%	<10%	N	10% - 50%	<10%	>50%
49	MZ2/MZ5	N	10% - 50%	<10%	>50%	S	>50%	>50%	<10%
50	MZ2/MZ6	N	10% - 50%	<10%	>50%	S	>50%	>50%	<10%
51	MZ2/MZ3	W	>50%	10% - 50%	<10%	SE	10% - 50%	10% - 50%	10% - 50%
52	MZ2/MZ3	W	>50%	10% - 50%	<10%	E	10% - 50%	<10%	>50%
53	MZ2/MZ5	E	10% - 50%	10% - 50%	>50%	W	>50%	>50%	<10%
54	MZ 1/MZ2	N	>50%	>50%	<10%	S	>50%	>50%	<10%
55	MZ2	N	>50%	>50%	<10%	S	>50%	>50%	<10%
56	MZ2/MZ3	S	>50%	10% - 50%	10% - 50%	N	>50%	>50%	<10%

Appendix F: Performance Criteria

Management Zone	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
All zones																				
Brief of works prepared																				
Area of primary work decided upon and marked out																				
Area of revegetation mapped and plants ordered																				
Climbers and Priority Weed species treated and suppressed																				
Budget prepared and contractor/s engaged																				
Site set up including photo points																				
All tree work recorded in register																				
Fauna monitoring																				
Annual report and recommendations																				
Management Zones 1 and 2																				
Core, edges, tracks, easements and boundaries monitored for weeds and dumping																				
Core, edges, tracks, easements and boundaries in good condition																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 3																				
No encroachment of weeds from neighbouring zones																				
Riparian corridor free of weeds and rubbish																				
Tracks surveyed, maintained, any damaged prevented mitigated																				
Revegetation																				
Revegetation maintained																				
CanopCov >50%: NtvUnd 10-50%: Exotic <10%																				

Management Zone	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 4																				
No encroachment of weeds from neighbouring zones																				
Riparian corridor free of weeds and rubbish																				
Tracks surveyed and maintained. Any damaged prevented/mitigated																				
Revegetation – North Mound Knoll																				
Revegetation - Impact Area Interface																				
Revegetation maintained																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic 10-50%																				
CanopCov >50%: NtvUnd 10-50%: Exotic 10-50%																				
CanopCov >50%: NtvUnd 10-50%: Exotic <10%																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 5																				
Riparian corridor free of rubbish																				
Strategic weed removal to maintain habitat																				
Revegetation																				
Revegetation maintained																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic 10-50%																				
CanopCov >10%: NtvUnd >10%: Exotic 10-50%																				
CanopCov >10%: NtvUnd >10%: Exotic <10%																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 6																				
All weeds treated																				
Revegetation																				
Revegetation maintained																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				

Management Zone	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
Management Zone 7																				
Revegetation - Quarry Road verge, SE Quarry walls, SWM buffer																				
Revegetation maintained, replacement planting undertaken																				
All Zone boundaries contained, no weeds spreading to Zone 3																				
Weeds treated prior to spread of weed propagules																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic 10-50%																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic <10%																				
CanopCov >50%: NtvUnd 10-50%: Exotic <10%																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 8																				
Weedy buffer maintained above MZ5																				
Weedy buffer maintained next to Western edge of MZ10																				
Weeds not acting as buffer treated prior to spread of weed propagules																				
Revegetation - SWM, NWS, pool batter, FT and Impact Area buffers																				
Revegetation maintained, replacement planting undertaken																				
Tracks survey and maintained																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic 10-50%																				
CanopCov 10-50%: NtvUnd 10-50%: Exotic <10%																				
CanopCov >50%: NtvUnd 10-50%: Exotic <10%																				
CanopCov >50%: NtvUnd >50%: Exotic <10%																				
Management Zone 9																				
Improvement mechanisms for slope explored																				
Soils improved - area enhanced with habitat elements- Bridge Road																				
Revegetation - Bridge Road																				

Management Zone	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15	Yr 16	Yr 17	Yr 18	Yr 19	Yr 20
Revegetation maintained																				
Management Zone 10																				
Mound stabilised																				
Soils improved - area enhanced with habitat elements																				
Revegetation																				
Revegetation maintained, replacement planting undertaken																				
Management Zone 11																				
Soils improved																				
Landscape embellishments explored																				
Landscape construction and planting commenced																				
Whole Site																				
Climbers and priority weed species have been treated and suppressed																				

Appendix G: Photo Points

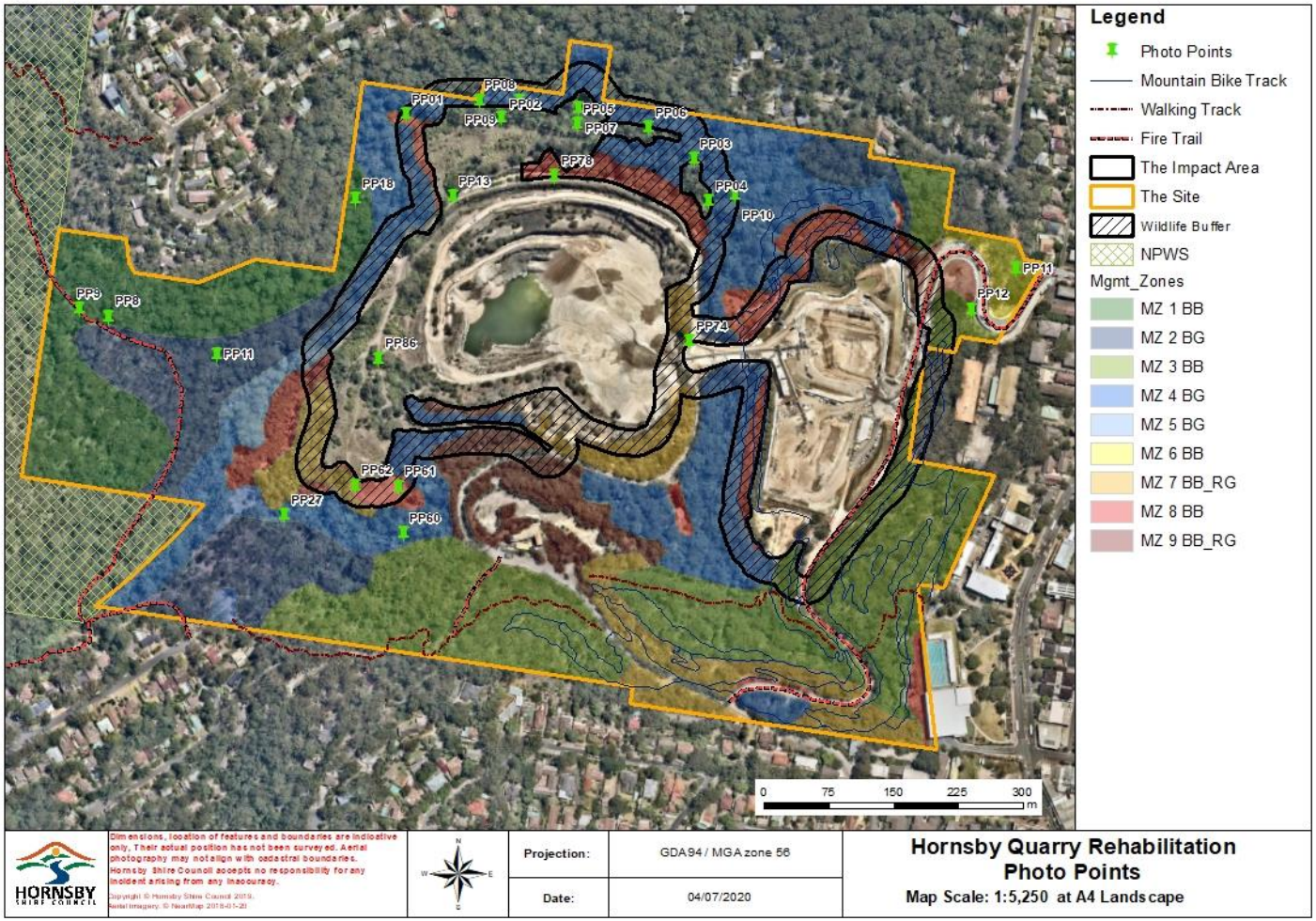


Photo Point 01 – MZ8 – View over Quarry to OMV and southern rockface

Photo Point 02 – MZ10 – Pampas Grass.on north mound and view to southern rockface

Photo Point 05 – MZ10 – Top of North Spoil Mound View East

Photo Point 05 – MZ10 – Top of North Spoil Mound View South East

Photo Point 06 – MZ4 – back of North Spoil Mound

Photo Point 07 – MZ4 – low point back of North Spoil Mound

Photo Point 08 – MZ4 - back of North Spoil Mound west view

Photo Point 08 –MZ4 - back of North Soil Mound north west view

Photo Point 09 – MZ4 – back of North Spoil Mound southern view

Photo Point 09 – MZ4 – back of North Sppoil Mound west view

Photo Point 03 - Impact Area – Top of unstable soils with dense privet – view south west

Photo Point 03 – Impact Area – Top of unstable soil with dense privet – view south

Photo Point 03 – Impact Area – MZ4 Interface – Top of unstable soils with dense privet

Photo Point 03 – Impact Area – MZ4 Interface

Photo Point 04 – MZ4 – Base of unstable mound to be removed - Privet habitat to be retained

Photo Point 04 – MZ 4 – Base of unstable mound to be removed – Privet habitat along corridor

Photo Point 10 – MZ4

Photo Point 10 – MZ4

Photo Point 11 – MZ7 – View south west

Photo Point 11 – MZ7 – View west

Photo Point 12 – MZ3 and MZ9 Interface – View south west

Photo Point 12 – MZ3 and MZ9 Interface – View north west

Photo Point 12 – MZ3 and MZ9 Interface – View east

Photo Point 74 – View west

Photo Point 74 – View north west

Photo Point 78 – View south east

Photo Point 13 – Panoramic view south – south eat

Photo Point 78 – MZ 8 – View up North Spoil Mound

Photo Point 78 – MZ 8 – View up North Spoil Mound

Photo Point 61 – MZ 8 and Impact Area interface - View north west from South West Mound

Photo Point 62 - MZ 8 and Impact Area interface – View north from South West Mound

Photo Point P60 – MZ4 and MZ 8 interface – Privet buffer as habitat

Photo Point 86 – Impact Area – Privet on each of Quarry void

Photo Point 27 – MZ2 and MZ 7 interface – buffer to be maintained

Photo Point 27 – M2 and MZ7 interface – buffer to be enhanced with revegetation

Photo Point 11 MZ2 looking east to MZ5

Photo Point 11 – MZ 2 looking east north east

PP8 – MZ1 - BBGF – south facing slope

PP9 – MZ1 – BBGF north facing slope

Photos – Two examples of *Ninox strenua* habitat suitable for different stages of lige cycle

Privet Habitat for *Ninox strenua* Powerful Owl

***Ninox strenua* Powerful Owl**

4. Staging Plan

Condition from Record of Deferral:

> *"Provide additional information regarding staging of the project. The Staging Plan should address works, stabilisation, rehabilitation and revegetation required in each stage as well as how each stage relates to other stages across the site;"*

A Staging Plan has been completed highlighting earthworks will not be undertaken within the recommended Powerful Owl exclusion zones if a breeding pair are occupying a nest on Site. The Staging Plan also details revegetation works commencing prior to, during and after earthworks construction. The Staging Plan and plan showing the various areas of the site is shown below.

HORNSBY QUARRY BULK EARTHWORKS STAGING PLAN

DESCRIPTION	2020												2021												2022											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Biodiversity Offset Package								PUBLIC CONSULTATION																												
Vegetation Management Plan (VMP)																																				
Habitat Creation and Enhancement Plan (HCEP)																																				
Eastern Diatreme face (including consultation with Geological Society of Australia)																																				
Sydney North Planning Panel Meeting																																				
Construction (Quarry including Western Platform & South West Fill Area)																																				
Construction (Northern Spoil Mound - Powerful Owl Exclusion Zone) **																POWERFUL OWL BREEDING																				
Construction (Northern Spoil Mound - Outside Powerful Owl Exclusion Zone)																																				
Construction (Old Mans Valley)																																				
Hornsby Park Implementation of VMP																																				
Hornsby Park Implementation of HCEP																																				

POWERFUL OWL BREEDING

**** NOTE**
Management and construction works associated with the Powerful Owl exclusion zone are to be undertaken strictly in accordance with the requirements of the Vegetation Management Plan.


Manor Rd
Fern Tree Cl
Quarry North
Park Entry
Bridge Rd
Quarry West
Quarry Void
Old Mans Valley
Peats Ferry Rd
South West Precinct
Higgins Cemetery
Jump Track
Crusher Plant
Horsnby Park & HALC
Rosemead Rd
Dural St
Hornsby Station

Hornsby Quarry Diatreme

Condition from Record of Deferral:

> *"Provide further information on the Volcanic Diatreme located on the eastern face of the quarry void. The Diatreme must be clearly identified on relevant plans and cross sections and the Panel needs advice from the Applicant regarding how the Diatreme is incorporated in the proposal in terms of the level of fill, treatment, rehabilitation and protection whilst appropriately reflecting it's geological significance. The Panel recommends this work be undertaken in consultation with geological societies who have the appropriate expertise in this field."*

Dr Ian Percival, a representative from The Geological Society of Australia (GSA), and a local geologist (a member of STEP Inc) visited the quarry site on Wednesday, June 10, 2020. The outcome of the site visit has resulted in the GSA noting that it is apparent that Council now recognises the geoheritage significance of the site. The GSA has acknowledged the protection measures, proposed treatment and access which Council intends to provide. The response from the Geological Society of Australia, and the photograph of the eastern quarry Diatreme face are shown below.

GEOLOGICAL SOCIETY OF AUSTRALIA
Incorporated

Registered Office
Suite 8, Front Office, Level 2
141 Peats Ferry Road
Hornsby, NSW 2077, Australia

Phone: (02) 9290 2194

Email: info@gsa.org.au
Web: www.gsa.org.au
ABN 93 652 757 443

Redevelopment of Hornsby Quarry by Hornsby Shire Council (2019SNH025)

Observations on a recent visit to the quarry by a representative of the Geological Society of Australia

Background

Following submissions put to the Sydney North Planning Panel at public hearing on May 6 2020 by various groups including the Geological Society of Australia (GSA), planning approval for the proposed redevelopment of the former Hornsby Quarry was deferred pending satisfactory resolution of several issues broadly including access to and visibility of the diatreme exposed in the eastern face of the quarry (see Appendix herein). Subsequently an invitation was extended to the Geoheritage Subcommittee of the NSW Division of GSA by Craig Clendinning (Project Manager, Major Projects in the Design & Construction section of Hornsby Shire Council) to participate in a field visit to the quarry site, now partly infilled by spoil obtained during construction of the North Connex tunnel. This site inspection was conducted on the afternoon of Wednesday June 10, from 1.30 – 3 pm. Due to COVID-19 restrictions, and Council WHS requirements, only two persons (the driver and one passenger) were permitted per vehicle. Ellen Robertshaw (Planning Consultant engaged by Council to independently assess the Development Application prepared by Hornsby Council on the redevelopment for the quarry site) drove a second car, thus providing an opportunity for John Martyn, local geologist and member of STEP (which had also put in a submission to the Planning Panel) to participate in the field inspection.

Observations

The eastern face of the quarry exposes a near-complete cross section through the dish-shaped beds of the diatreme, together with the contact with the enclosing Hawkesbury Sandstone. The site, even after having been infilled to RL53 (about half its depth), is immense. The eastern face had been cleaned of nearly all the excess spoil, which was delivered by a mobile conveyer system that discharged directly over this face. Only small pockets of pebble- and cobble-size white Hawkesbury Sandstone remained in crevices on the face, contrasting with the dark grey volcanoclastic breccia forming the diatreme layers. The compacted spoil material infilling the void occupied two planar levels on the floor of the quarry. The higher layer, adjacent to the eastern quarry face, is approximately 5 m higher than the planar level extending to the south to the low point of the quarry void. Craig Clendinning informed us that Council's plan was to excavate the higher level, removing about 5 m depth of spoil which would be redistributed over the lower level. This redistribution of the spoil would have the effect of creating, at RL48, a lower level adjacent to the eastern face that would be the site of

a water retention area, forming a lake that would be a central feature of the proposed redevelopment. The effect on the diatreme cross section would be to initially expose a further 5 m at the base of the section where more of the dish beds would appear to be flattening out in the centre of the visible structure. However, the depth of water in the lake may somewhat reduce this additional exposure. The important point is that the Council is not wanting to cover up any more of the significant features of the diatreme, but is intent on actively increasing the visibility of the dish beds.

There are two bench levels retained from the original quarrying operations still exposed across the eastern face. The lower one is perhaps 5-10 m above the current infill level of RL53, while the higher bench is at RL88. We were subsequently driven from the quarry floor up an access road to a point where we could easily walk along the bench at RL88. This bench has a constant width of several metres, with a 35 m dropoff into the quarry (directly above the proposed water feature). Craig discussed Council's preliminary plans to construct an accessible raised boardwalk along this bench, flanked on one side by a safety fence adjacent to the cliff edge, and on the other by a chainlink (or similar) fence that would permit largely unrestricted visibility of the bedding comprising the diatreme but preventing visitors from actually touching or closely examining the rock face. This barrier was necessary to prevent vandalism of the beds, and as a safety measure to guard against rocks from the face being dislodged (and potentially being thrown over the edge into the water below).

I enquired as to whether some system, such as a lockable gate in the chainlink fence, might be able to be installed to permit strictly controlled access to the rockface for authorised groups. This could allow university geology students, geoscientists or participants in organised local and international scientific excursions, to examine the component clasts in the rock face at close quarters (with hand lens), to undertake limited scientific sampling for Council-approved research purposes, or simply to take close-up photographs of the structure and lithology of diatreme the beds (Fig. 1). Though no commitment could be given, Craig thought that this idea would be worthy of consideration by Council.

There were other safety aspects to protect visitors to the site that were brought to my attention. Several trees, some of considerable height, are growing in precarious positions right on the edge of the quarry void. With almost no ground support evident, these trees could readily fall in a storm, or simply topple over without warning, dislodging large rocks on to the bench below. Council would need to remove these trees for public safety. Other, smaller, trees and vegetation that were growing on the benches could also be considered for removal, not so much for safety as to enhance the view of the diatreme cross section from within the quarry void and to clear the path for the accessible boardwalk to be constructed.

Impressions gained from the site visit

This was my first visit into the quarry site since 1978, when I inspected the eastern face of the quarry (at that time owned and being actively operated by Farley & Lewers) when I was compiling a report on the geoheritage of NSW for the Heritage Commission. I compared the photo I took then (Fig. 2) with that taken on this visit (Fig. 3) and was surprised that the appearance of the cross section through the diatreme was so similar. Essentially the final level proposed for the quarry floor in the redevelopment will be entirely comparable with the exposure more than four decades ago. The depth to which the diatreme cross section has been visible has certainly been greater in the past prior to dumping of spoil into the quarry void, but

the practicality of the situation is that the extent to which the dish structure of the diatreme is currently exposed is as good as can be reasonably expected.

I was particularly encouraged by Council's plans to permit public access along the bench at RL88 by providing a safe, accessible boardwalk. This would be an ideal place to install an interpretative sign drawing the public's attention to the national (and international) significance of the site. The Geological Society of Australia would be able to direct Council to experts who could assist in the wording and images for such an interpretative sign, as per the recommendation by the Sydney North Planning Panel in their deferral of the development application (see Appendix).

Conclusions

It is apparent that Council now recognises the geoheritage significance of its own "Jurassic Park" (a reference to the known age of the diatreme) which is right in its backyard. As the centrepiece of the redevelopment of the old Hornsby Quarry it will no doubt be a remarkable tourist drawcard if properly protected, allowing public (and restricted research/educational) access with suitable interpretation.

While the field inspection focused on the east face (which prominently displays the dish structure, surge deposits, rock lenses, breccia layers, lapilli, amongst other geological attributes), it should be noted that some of the other quarry faces potentially display volcanogenic phenomena that complement or add to those mentioned previously. In particular, the adjoining face extending to the south is significant in showing the contact between the diatreme and the sedimentary rocks of the Sydney Basin through which it intruded. Previous geological investigations of the entire site have revealed the presence of slumped bedding, sandstone dykes, surge- and pebble-rich layers, and a great variety of ejecta associated with the violent intrusion, including basalt bombs with chilled margins, lithic fragments of charcoal in breccia layers, accretionary lapilli, and xenoliths. As many of these unusual geological features were recorded when the quarry was operational, it is unknown what remains of them, or whether new structures and volcanogenic phenomena will be revealed as covering vegetation and unstable spoil heaps are removed during redevelopment of the site. It is therefore vitally important, as recommended by the Sydney North Planning Panel (see Appendix), that Council maintains liaison with the Geological Society of Australia who can contact experts to advise on preservation and interpretation of these features as they are revealed, so fully developing the potential of the Hornsby Diatreme as a nationally (and internationally) significant educational, geoheritage and geotourism site.

Dr Ian Percival

representing the Geoheritage Subcommittee,
NSW Division, Geological Society of Australia
Sydney, 14th July, 2020

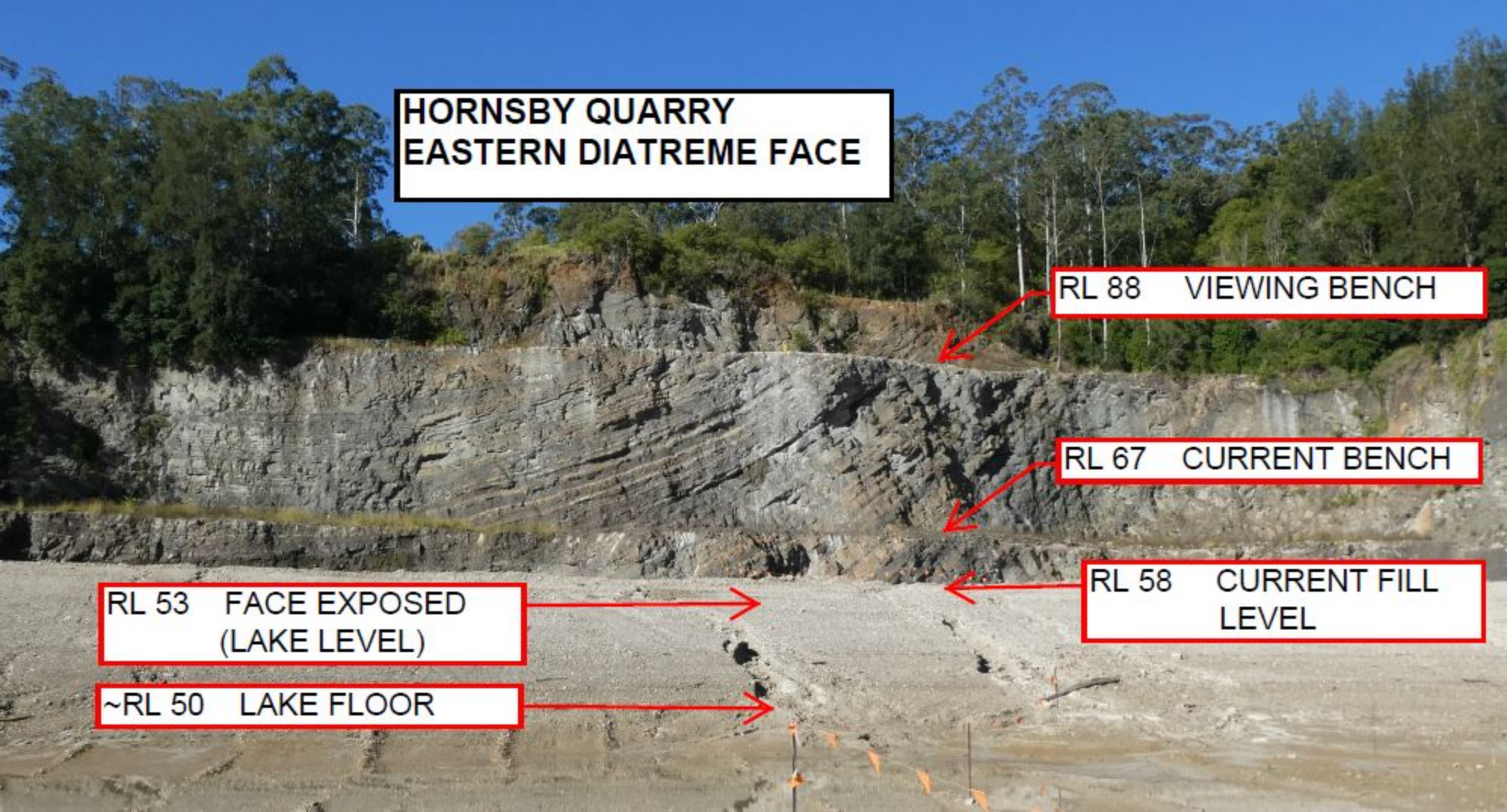
Fig. 1. Close up view of the dipping dish beds of the diatreme and the varied lithological components (including angular clasts and fine-grained volcaniclastic material forming the matrix) of the diatreme. Geological hammer for scale. Image taken on bench at RL88. Note that such a view, displaying details of great significance for researchers and student, would only be possible from a position less than 1m from the quarry face, not behind a chainlink fence. Photograph by Ian Percival on 10th June, 2020.

Fig. 2. View of the eastern face of Hornsby Quarry in 1978 (then actively being worked). Photograph by Ian Percival.

Fig. 3. View of the same eastern face of the now partly-infilled and inactive Hornsby Quarry, taken during the site visit facilitated by Hornsby Shire Council on 10th June 2020, for comparison with Fig. 1. The higher bench at RL88, extending from the dark green vegetation on the left and marked by small flags along the cliff edge, is the site of the proposed boardwalk. The compacted spoil in the foreground of the image will be excavated by a further 5 m. Photograph by Ian Percival (note that the quality of this image was affected by the showery and overcast conditions on the day of the field inspection).

Appendix: Extract from Reasons for Deferral of Application to Redevelop Hornsby Quarry

4. Provide further information on the Volcanic Diatreme located on the eastern face of the quarry void. The Diatreme must be clearly identified on relevant plans and cross sections and the Panel needs advice from the Applicant regarding how the Diatreme is incorporated in the proposal in terms of the level of fill, treatment, rehabilitation and protection whilst appropriately reflecting it's geological significance. The Panel recommends this work be undertaken in consultation with geological societies who have the appropriate expertise in this field.


HORNSBY QUARRY
EASTERN DIATREME FACE
RL 88 VIEWING BENCH
RL 67 CURRENT BENCH
RL 58 CURRENT FILL LEVEL
RL 53 FACE EXPOSED (LAKE LEVEL)
~RL 50 LAKE FLOOR

6. Final Comment

Condition from Record of Deferral:

> *"Make any subsequent changes to the proposed rehabilitation of the Hornsby Quarry as a result of the above".*

The above additional information provided in Sections 2 to 5 above has not required any changes to the proposed impact area of the works.