Great Northern Highway

Muchea to Wubin Upgrade - Stage 2

MAIN ROADS WESTERN AUSTRALIA

Muchea North - SLK 38.6 - 51.4 | Environment | Purpose Permit to Clear Native Vegetation - Supporting Information

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1	04-04-2016	Draft	Cross Discipline Review / Technical Review
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Glossary

Abbreviation	Description
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AHA	*Aboriginal Heritage Act 1972*
AHD	Australian Height Datum
AHIS	Aboriginal Heritage Inquiry System
APHA	American Public Health Association
ARI	Average Recurrence Interval
ARRB	Australian Road Research Board
AS	Australian Standards
ASD	Approach Sight Distance
ASJV	Arup Jacobs Joint Venture
ASRIS	Australian Soil Resource Information System
ASS	Acid Sulfate Soils
ASST	Applied Scientific Services and Technology
ASTM	American Society for Testing and Materials
ATLM	Audio tactile line marking
ATLS	Atterberg Limits and linear shrinkage
AUL	Auxiliary Left turn treatment
AUR	Auxiliary Right turn treatment
BAL	Basic Left turn treatment
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BAR	Basic Right turn treatment
BGL	Below ground level
BH	Borehole
BoM	Bureau of Meteorology
CARS	Main Roads WA Crash Analysis Reporting System
CBA	Cost Benefit Analysis
CBR	California Bearing Ratio
CEMP	Construction Environmental Management Plan
Cha	Chainage
CHL	Channelised Left
CHR	Channelised Right
CN	Contract Number
CN0X	Contract 03 – Muchea North
CPTED	Crime prevention through environmental design

Abbreviation	Description
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAA	Department of Aboriginal Affairs
DAFWA	Department of Agriculture and Food WA
DBYD	Dial Before You Dig
DCP	Dynamic Cone Penetrometer
DEM	Digital Elevation Model
DER	Department of Environment and Regulation
DGS	Digital Ground Survey
DoEE	Department of the Environment and Energy
DoW	Department of Water
DSEWPaC	Department of Sustainability Environment Water Planning and Community
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
ESA	Environmentally Sensitive Area
FWD	Falling Weight Deflectometer
GDA94	Geocentric Datum of Australia 1994
GDE	Groundwater Dependent Ecosystems
GIS	Geographic Information System
GNH	Great Northern Highway
GPS	Global Positioning System
ha	Hectare
HWL	High Wide Loads
IBA	Important Bird Area
IBRA	Interim Biogeographic Regionalisation of Australia
ICP-OES	Inductively coupled plasma optical emission spectrometry
IRIS	Integrated Road Information System
IS	Infrastructure Sustainability
IUCN	International Union for Conservation of Nature
km	Kilometre
LGA	Local Government Authority
LISC	Low Impact Screening List (Main Roads)
m	Metre
Ma	Mega-annum (period of 1 million years)

Abbreviation	Description
Main Roads WA	Main Roads Western Australia
Ma	Mega-annum (period of 1 million years)
MC	Moisture content
MDCS	Maximum dry compressive strength
MDD	Maximum Dry Density
MGA94	Map Grid of Australia 1994
MI	Municipal Inventory
MNES	Matters of National Environmental Significance
mm	Millimetre
MMDD	Maximum Modified Dry Density
MoU	Memorandum of Understanding
M2W	Muchea to Wubin
M2W team	Muchea to Wubin Integrated Project Team, comprising Main Roads WA and industry partners Jacobs and Arup
NATA	National Association of Testing Authorities
NNTT	National Native Title Tribunal
NVCP	Native Vegetation Clearing Permit
OMC	Optimum Moisture Content
OSOM	Over Size Over Mass
PAG	Project Advisory Group
Parks and Wildlife	Department of Parks and Wildlife
PDNH	Perth to Darwin National Highway
PEMP	Principal's Environmental Management Plan
PDO	Property Damage Only
PEC	Protected Ecological Communities
PEIA	Preliminary Environmental Impact Assessment
Phoenix	Phoenix Environmental Sciences
Project Area	Refers to the entire upgrade project. The project area extends 218 km between Muchea and Wubin along the GNH.
PP	Pavement pit
PSD	Particle size distribution
RACWA	Royal Automobile Club of WA
RAV	Restricted Access Vehicle
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
Regolith	Layer of loose material covering the bedrock of the earth and moon, etc, comprising soil, sand, rock fragments, volcanic ash, glacial drift etc.

Abbreviation	Description
RISC	Roadside Impact Severity Calculator
RIWI	Rights in Water and Irrigation (Act)
RRM	Road Reference Marks
RRPM	Retro-reflective Pavement Markers
RTE	Road and Traffic Engineering Branch of Main Roads WA
RTK	Real Time Kinematic GPS observation method
SiD	Safety in Design
SISD	Safe Intersection Sight Distance
SSD	Stopping Sight Distance
SLIP	State Land Information Portal
SLK	Straight Line Kilometre
SPT	Standard penetration test
SSM	State Survey Marks
STATS	Specialist Testing and Technical Services
SWALSC	South West Aboriginal Land and Sea Council
t	Metric tonne
tc	Time of concentration
TEC	Threatened Ecological Communities
TP	Test pit
USEPA	United States Environmental Protection Agency
WA	Western Australia
WAOL	Western Australian Organism List
WAPC	Western Australian Planning Commission
WARES	Main Roads WA Road Evaluation System
WC Act	Wildlife Conservation (Act)
WCLT	Wide Centreline Treatment
WoNS	Weeds of National Significance

1. Introduction

1.1 Great Northern Highway: Muchea to Wubin Upgrade Stage 2

In 2014 Main Roads Western Australia (Main Roads) established the Muchea to Wubin Integrated Project Team (M2W Team), comprising Main Roads and industry partners Arup and Jacobs (combining to form Arup Jacobs Joint Venture, ASJV) to conduct a comprehensive planning review of the full Muchea to Wubin link along the Great Northern Highway (GNH). This planning review is a critical component of the Great Northern Highway: Muchea to Wubin Upgrade Stage 2, which has been funded with $384.8 million from the Commonwealth and State Governments.

Among the improvements to be considered as part of the planning review were additional passing lanes, flattening crests and easing curves, safer roadsides, more rest stops and additional facilities for heavy vehicles. The review examined the previous upgrade strategy developed in the 1990s and, having carefully considered current requirements for the movement of people and freight, delivered a revised upgrade strategy.

The M2W team has identified and prioritised construction packages to be delivered over the four-year period from 2015/16 to 2018/19. The construction programme includes the currently funded sections New Norcia Bypass (7 km), Miling Straight (22km), Miling Bypass (9km), Pithara (16km), Muchea North (13km), Dalwallinu to Wubin (33km) and Walebing (18km), and identifies additional priority packages to be constructed as funding becomes available.

1.2 Scope and Purpose of this Document

This document has been prepared to support an application for a Native Vegetation Clearing Permit (NVCP) (Purpose Permit) under Section 51E of Part V of the *Environmental Protection Act 1986* (EP Act). It is proposed to clear up to 53 hectares (ha) of native vegetation within a Purpose Permit area (application area) of 262.54 ha. The location of the proposed works and the NVCP application area are shown in **Figure 1**.

This document includes:

- an overview of the works required for the Muchea North alignment and description of the clearing activities to be undertaken;
- an overview of the existing physical and biological environment;
- the environmental management measures to be implemented to minimise potential clearing impacts; and
- an assessment of the proposed clearing against the ten Clearing Principles, as defined in Schedule 5 of the EP Act.

On 2 March 2016, a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was submitted to the Department of Environment and Energy (DoEE) for Muchea North (EPBC 2016/7656). On 10 May 2016, DoEE notified Main Roads WA that the referral was determined to be a controlled action, with the controlling provision being “listed threatened species and communities” with assessment by preliminary documentation. A variation for the proposed action was submitted on 19 August 2016 and accepted by the DoEE on 19 October 2016. On 4 November 2016, a request for “additional information required for preliminary documentation” was received by the M2W team with the requested preliminary documentation submitted to DoEE on 13 March 2017.

1.3 Muchea North

The Muchea North section of the GNH is located approximately 63 km north east of Perth, in the Swan Coastal Plain and Jarrah Forest Bioregions of Western Australia. The works will be constructed between Straight Line Kilometre (SLK) 38.6 and SLK 51.4. Muchea North works commence at the northern extent of the Perth–Darwin National Highway (Swan Valley Section) [also known as Northlink WA Section 3] and extends north past Sugar Gum Drive and Blue Plains Road before tying into the existing highway near the Chittering Roadhouse.

The works to be undertaken for Muchea North will comprise a temporary tie-in to the existing GNH at the southern end, pending completion of the Perth–Darwin National Highway (Swan Valley Section). Works associated with the temporary tie-in to the existing GNH and ultimate tie-in to the Perth–Darwin National Highway (Swan Valley Section) fall under the Perth–Darwin National Highway (Swan Valley Section) environmental approvals (EPBC 2013/7042 and WA Ministerial Statement of Approval 1036) and are not included in this NVCP application.

The planning review undertaken by the M2W team identified various deficiencies on the existing Muchea North section of the GNH, including sharp crests and sags, tight bends, uneven surfaces and unforgiving roadside areas with trees close to the seal edge. Due to the age and condition of the current GNH, the planned works will largely involve the construction of a new road adjacent to the existing road, with some sections of online reseal and widening. The proposed alignment is predominantly to the east of the existing GNH with a section between (approximately) SLK 48.2 and SLK 50.4 constructed to the west.

1.4 Location and Land Ownership

The tenure of the proposed application area is majority freehold and road reserve. The Muchea North alignment traverses the following land parcels:

- Great Northern Highway road reserve (PINs 11726209, 11726211, 11727263, 11727264 and 11727265);
- Sugar Gum Drive road reserve (PIN 11086676);
- Blue Gum Way road reserve (PIN 11086892);
- Blue Plains Road road reserve (PIN 11513729);
- Maddern South Road road reserve (PIN 11726213);
- Reserve Road road reserve (PIN 11726219);
- Wandena Road road reserve (PIN 11726212);
- Old Gingin Road road reserve (PIN 11727261);
- Un-named Shire road reserves (PINs 1233233, 1258680, 1338948, 1338949, 1338950, 1338953, 11201126, 11201140, 11320253, 11429047, 11320250, 11513726, 11756006, 11756034, 11756041, 11756040, and 11819629;
- Lot M1157 Volume 1496, Folio 0090 on Diagram 5050;
- Lot M1264 Volume 1881, Folio 901 on Deposited Plan 5369;
- Lot M1909 Volume 1378, Folio 574 on Diagram 11298;
- Lot M1920 Volume 1242, Folio 289 on Diagram 12777;
- Lot M1957 Volume 1920, Folio 198 on Diagram 13411;
- Lot 4 Volume 1900, Folio 210A on Diagram 19099;
- Lot 3 Volume 585, Folio 14A on Diagram 25291;
- Lot 9 Volume 1244, Folio 506 on Diagram 25711;
- Lot 1 Volume 1242, Folio 288 on Diagram 25838;
- Lot 3 Volume 1580, Folio 198A on Diagram 35291;
- Lot 4 Volume 670, Folio 5A on Diagram 35291;
- Lot 5 Volume 5540, Folio 127A on Diagram 36593;
- Lot 7 Volume 1345, Folio 256 on Diagram 42945;
- Lot 6 Volume 1912, Folio 963 on Diagram 53408;

- Lot 8 Volume 1504, Folio 896 on Diagram 54332;
- Lot 9 Volume 1504, Folio 897 on Diagram 54332;
- Lot 9 Volume 1549, Folio 497 on Diagram 57633;
- Lot 22 Volume 1849, Folio 971 on Diagram 76077;
- Lot 301 Volume 2158, Folio 509 on Diagram 96028;
- Lot 302 Volume 2158, Folio 510 on Diagram 96028;
- Lot 80 Volume 2140, Folio 998 on Diagram 96040;
- Lot 81 Volume 2140, Folio 999 on Diagram 96040;
- Lot 50 Volume 2190, Folio 777 on Diagram 99189;
- Lot 12 Volume 1950, Folio 284 on Deposited Plan 13680;
- Lot 13 Volume 1950, Folio 285 on Deposited Plan 13680;
- Lot 83 Volume 1540, Folio 958 on Deposited Plan 28306;
- Lot 201 Volume 2528 Folio 972 on Deposited Plan 34420;
- Lot 202 Volume 2528 Folio 973 on Deposited Plan 34420;
- Lot 203 Volume 2528 Folio 974 on Deposited Plan 34420;
- Lot 204 Volume 2528 Folio 975 on Deposited Plan 34420;
- Lot 205 Volume 2549 Folio 982 on Diagram 39319;
- Lot 206 Volume 2549 Folio 983 on Diagram 39319;
- Lot 105 Volume 2529 Folio 693 on Diagram 42252;
- Lot 850 Volume 2573 Folio 966 on Diagram 42736;
- Lot 851 Volume 2573 Folio 967 on Diagram 42736;
- Lot 510 Volume 2597 Folio 37 on Diagram 43861;
- Lot 77 Volume 259 Folio 627 on Diagram 43751;
- Lot 9500 Volume 2616 Folio 895 on Diagram 50560;
- Lot 18 Volume 2704 Folio 65 on Diagram 59611;
- Lot 16 Volume 2704 Folio 67 on Deposited Plan 59609;
- Lot 17 Volume 2704 Folio 66 on Deposited Plan 63597;
- Lot 195 Volume 2775 Folio 250 on Deposited Plan 59350;
- Lot 22 Volume 22 Folio 249 on Deposited Plan 59350;
- Lot 101 Volume 2862 Folio 382 on Deposited Plan 401347;
- Crown Reserves 2008670, 2014706, 3259381, 3259384, 3851338;
- Other Reserves 3055998, 3057263, 3570270, 3903507; and
- Easements 3676973 and 3676974.

Under the *Land Administration Act 1997*, Main Roads has the ability to compulsorily acquire land required for works associated with the construction of the Muchea North section of GNH. A corridor of land surrounding the alignment will ultimately be acquired by Main Roads from the individual landowners and transferred from freehold (or other) land to road reserve. As it is expected that the majority of clearing required will be carried out

on land that will ultimately be owned by Main Roads at the time of the clearing, authorisation from individual land owners has not been sought at this time. To this end, no clearing will be undertaken for the purposes of this project until an approved purpose permit is in place and either of the following conditions is met:

1. The land in question has been acquired by Main Roads; or
2. Written authorisation to clear the land has been obtained from the relevant landowner(s).

2. Description of Clearing Activities

Vegetation clearing will be required for the following activities:

- construction of approximately 3.7 km of dual carriageway from the end of the Perth – Darwin National Highway (Swan Valley Section) [also referred to as Northlink]. Each carriageway will be a 9.0 m wide seal on an 11.0 m wide formation;
- construction of approximately 5.7 km of single carriageway with a 10 m wide seal on a 12 m wide formation;
- construction of approximately 1.4 km of four lane carriageway with two 3.5 m wide northbound and southbound lanes, separated by a minimum 4.65 m median;
- widening of approximately 2 km of the existing GNH;
- realignment of the intersections at Old Gingin Road, Reserve Road, Wandena Road, Maddern South Road and Sugar Gum Drive;
- construction of access roads with consolidated access to the highway to service properties near Reserve Road, Sugar Gum Drive, at approximately SLK 48.8 and opposite the Chittering Roadhouse;
- provision of new intersections to link the existing GNH (retained as a local access road) to the new sections of the GNH;
- construction and realignment of private driveways;
- upgrade and installation of culverts;
- removal of redundant, existing road reserve fence and installation of new road reserve fence;
- installation of signage and line markings and removal of redundant signage;
- installation of safety barriers where required;
- relocation of utilities within the road reserve corridor (communications and power); and
- installation of road lighting.

Laydown areas, vehicle turnaround bays and other ancillary areas required for construction of the permanent works will be located in previously cleared (paddock) areas, where practicable.

Clearing of native vegetation will be undertaken using standard earthmoving equipment, such as bulldozers, to provide a surface free of vegetative matter, though some roots may remain. Topsoil will be stripped separately to vegetation, stockpiled for later reuse in reinstatement, landscaping and revegetation activities. Where required, topsoil and vegetation stockpiles will be segregated according to their weed and *Phytophthora cinnamoni* (Dieback) status and managed through the Principal's Environmental Management Plan (PEMP) and contractors Construction Environmental Management Plan (CEMP).

3. Existing Environment

3.1 Climate

The NVCP application area experiences a semi-arid warm Mediterranean climate with warm dry summers and cool wet winters (Phoenix, 2015). The Bureau of Meteorology (BoM) weather station at Muchea Tree Farm (Station Number 009029), which is 3.0 km south of the southern extent of the NVCP application area, only records rainfall data. The closest BoM station which provides records of temperature and rainfall is Pearce Royal Australian Air Force (RAAF) (Station Number 008151), which is approximately 12 km south of the NVCP application area (Bureau of Meteorology, n.d.). The average annual rainfall for Pearce RAAF is 678.3 mm while the average annual rainfall for Muchea Tree Farm is 747.5 mm (Bureau of Meteorology, n.d.). Average monthly temperatures at Pearce RAAF range from an average minimum of 8.2 degrees Celsius in August to an average maximum of 33.5 degrees Celsius in January (**Table 3-1**).

Table 3-1 : Climate Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pearce RAAF Average maximum temperature (ºC)	33.5	33.3	30.6	26.4	22.0	18.8	17.8	18.4	20.0	23.4	27.2	30.3
Pearce RAAF Average minimum temperature (ºC)	17.0	167.6	16.0	13.4	10.8	9.4	8.4	8.2	8.8	10.1	12.5	14.5
Pearce RAAF average rainfall (mm)	7.6	12.2	15.1	34.8	85.3	133.4	134.4	104.2	70.1	36.2	23.7	10.6
Muchea Tree Farm average rainfall (mm)	10.7	10.6	19.1	37.3	96.0	150.2	153.4	118.9	73.9	44.4	21.2	10.1

3.2 Land Use

The predominant land use in the region is mixed agricultural (including horticulture and viticulture) and small private rural and industrial properties. Additional land uses include forestry (both native forests and pine plantations) and nature conservation (for example Barracca Nature Reserve). The Australian Defence Force has a number of facilities in the Muchea to Bindoon region, including RAAF Base Pearce, the Muchea Air Weapons Range and Bindoon Defence Training Area.

3.3 Soils and Landforms

Four land systems mapped by the Department of Agriculture and Food WA (DAFWA) occur within the NVCP application area as follows:

- Reagan System – gentle slopes from the Dandaragan plateau to the Pinjarra plain. Brown, yellow and pale sands that may be shallow to very deep with clay or duricrust underlying. Variable low woodland and shrubland of eucalypts, *Banksia* and *Acacia*.
- Yanga System – poorly drained plain with pale sands and deep sandy duplex, wet, semi-wet and saline wet soils. *Banksia*-pricklybark-Marri-swamp sheoak-paperbark woodlands.
- Mogumber System – gentle to moderate sloping sandplain, varying from pale to yellow clayey sand with gravel and laterised ridges. Low woodland and shrubland of *Corymbia calophylla*, *Banksia* and *Acacia* species, some tall *C. calophylla* and *Eucalyptus marginata*.
- Dandaragan System – subdued dissected lateritic plateau, undulating low hills and rises with narrow alluvial plains. Variable deep sands and sandy gravels plus minor earths, duplexes and clays. Marri woodlands and shrublands.

3.4 Flora and Vegetation

Muchea North is located within the Swan Coastal Plain Bioregion and the Northern Jarrah Forest sub-region of the Jarrah Forest Bioregion as defined by the Interim Biogeographic Regionalisation for Australia (IBRA), version 7 (Department of the Environment, 2012). The Swan Coastal Plain bioregion consists of the Dandaragan Plateau and the Perth Coastal Plain. It is dominated by Banksia or Tuart on sandy soils and paperbark in swampy areas with sheoak on outwash plains (McKenzie *et. al.*, 2003). Soils include white/grey or yellow sands and limestones with laterites and gravels occurring in the east near the Darling Scarp (McKenzie *et. al.*, 2003).

The Jarrah Forest bioregion is located on the Yilgarn block inland plateau, consisting of wooded valleys. The dominant ecosystem is Jarrah forest, which is characterised by tall open forest in which the dominant overstorey tree is Jarrah (*Eucalyptus marginata*) (Williams and Mitchell, 2001). Soils in the Jarrah Forest are fertile, but often salt laden. Both bioregions provide food and shelter for endangered species including Carnaby's Black Cockatoo (Desmond, A, 2001; Williams and Mitchell, 2001).

Phoenix Environmental Sciences (Phoenix) completed an initial spring season flora and vegetation field survey in October 2014, covering an approximately 40 m wide survey area (the existing road reserve) from SLK 37.1 to SLK 45.7. A second field survey was undertaken on 17 - 29 September 2015 and included additional areas which had not been surveyed in spring 2014. Additional targeted searches were also conducted for particular species in May 2015. All of the survey information was collected and consolidated into a single report titled *Flora and fauna assessment for Muchea North and Chittering study area* (Phoenix, 2015). Details on the survey method are provided in Section 3 of Phoenix (2015) (**Appendix A**).

An additional survey was undertaken between October and November 2016 to provide coverage of areas not previously surveyed in Spring, for example locations of private driveways or utilities relocations. This survey also included intensive transect searches for Threatened orchids listed under the EPBC Act, detailed field assessment and mapping distribution of the EPBC Act-listed Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community (TEC) and survey of black cockatoo species including potential breeding trees, roosting and breeding sites, and mapping of breeding and foraging habitat. The information from the follow up survey is provided in the report titled *Flora and fauna assessment for Muchea North and Chittering study area – Report Addendum* (Phoenix, 2017) (**Appendix B**).

The combined extent of all Phoenix surveys in relation to the proposed NVCP application area for the action is provided in **Figure 2**.

3.4.1 Vegetation

3.4.1.1 Vegetation Types

Based on vegetation mapping undertaken by Beard (1981) and Shepherd *et al*. (2002), the regional vegetation consists of the following vegetation associations:

- 4: Medium woodland; marri & wandoo.
- 965: Medium woodland; jarrah & marri.
- 968: Medium woodland; jarrah, marri & wandoo.
- 973: Low forest; paperbark (*Melaleuca rhaphiophylla*).
- 1014: Mosaic: Low woodland; banksia / Shrublands; teatree thicket.
- 1018: Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; teatree / Low woodland; *Casuarina obesa*.
- 1020: Mosaic: Medium forest; jarrah-marri / Medium woodland; marri-wandoo.
- 1027: Mosaic: Medium open woodland; jarrah & marri, with low woodland; banksia / Medium sparse woodland; jarrah & marri.

- 8001: Medium forest; jarrah-marri.

Vegetation mapped by Phoenix (2015; 2017) comprised the following 20 vegetation associations. (**Figure 3**):

- 4: Medium woodland; marri & wandoo.
- 23: Low woodland; Jarrah-Banksia.
- 27: Low woodland; paperbark (*Melaleuca* sp.)
- 37: Shrublands; tea-tree thicket.
- 48: Shrublands; scrub-heath.
- 49: Shrublands; mixed heath.
- 946: Medium woodland; Wandoo.
- 949: Low woodland; Banksia.
- 965: Medium woodland; jarrah & marri.
- 968: Medium woodland; jarrah, marri & wandoo.
- 975: Low woodland; Jarrah.
- 992: Medium forest; Jarrah & Wandoo (*Eucalyptus wandoo*).
- 999: Medium woodland; Marri.
- 1003: Medium forest Jarrah, Marri and Wandoo.
- 1006: Medium woodland Jarrah, Wandoo and Powderbark.
- 1008: Medium open woodland; Marri.
- 1017: Medium open woodland; Jarrah and Marri, with low woodland; Banksia.
- 1019: Medium sparse woodland Jarrah and Marri.
- 1027: Mosaic Medium open woodland Jarrah-marri with low woodland banksia/medium sparse woodland Jarrah-Marri.
- 1182: Medium woodland: *Eucalyptus rudis* and *Melaleuca rhaphiophylla*.

Low to medium woodland associations were most prevalent, representing 15 of the 20 vegetation associations mapped for the survey area. Areas described as road, cleared (townships, driveways), cleared and planted (non-indigenous species) and pasture account for approximately 58% of the NVCP application area.

Eleven of the mapped vegetation types are considered underrepresented, as the current extent of these is less than 30% of the pre-European extent. Vegetation types 4, 23, 48, 946, 949, 965, 968, 975, 992, 999, 1003, 1019 and 1182 may be considered to be locally significant as they represent habitat for the conservation significant flora recorded in the study area, include patches of the Banksia Woodland of the Swan Coastal Plain TEC, or have patches which are in excellent or pristine condition (Phoenix 2015; 2017).

3.4.1.2 Banksia Woodlands of the Swan Coastal Plain Threatened Ecological Community

On 16 September 2016 the Banksia Woodlands of the Swan Coastal Plain was listed as a TEC under section 226B of the EPBC Act. The TEC is listed as endangered and is defined in the approved conservation advice as "woodland associated with the Swan Coastal Plain of southwest Western Australia, [the key diagnostic feature of which is] a prominent tree layer of *Banksia*, with scattered eucalypts and other tree species often present among or emerging above the *Banksia* canopy" (Threatened Species Scientific Committee, 2016).

Phoenix assessed the vegetation of the Muchea North area during the Spring 2016 surveys in line with the diagnostic criteria outlined in the approved conservation advice for this TEC. Four patches of the TEC were identified (

Figure 4 and **Table 3-2**). Two of these patches extend across the existing GNH as the gap is less than the 30 m required to define patch boundaries, as stipulated by the approved conservation advice (Phoenix, 2017).

Table 3-2 : Banksia Woodlands of the Swan Coastal Plain Muchea North Patch Sizes

Patch Name	Area of Patch (ha)	Buffer Area (ha)	Total Area (ha)
TEC01	4.02	6.27	10.30
TEC02	3.71	5.34	9.05
TEC03	8.82	10.56	19.38
TEC04	8.03	12.94	20.98

3.4.1.3 Vegetation Condition

The condition of vegetation in the application area ranged from Completely Degraded to Pristine (**Figure 5**). A large proportion (58%) of the application area passes through cleared areas classed as Completely Degraded (paddocks, roads and other infrastructure) and cleared and revegetated non-indigenous woodlands, which provide little value to fauna in terms of habitat or as ecological corridors. Of the total area bounded by the NVCP application area, 2% (6.4 ha) has been recorded as being in Pristine condition, 8% (20.1 ha) as Excellent, 17% (44 ha) as Very Good, 8% (20.7 ha) as Good and 7% (17.5 ha) as Degraded. The areas of the vegetation recorded to be in Excellent or Pristine condition may be considered locally significant as they represent patches of comparatively high native species diversity in otherwise degraded vegetation (Phoenix 2015 and 2017).

3.4.1.4 Vegetation Extent

Based on the information provided in the 2015 State-wide Vegetation Statistics (Department of Parks and Wildlife (Parks and Wildlife), 2014), 11 of the vegetation types identified in the application area represent 'Endangered' or 'Vulnerable' communities and may be considered to have regional conservation significance as they have less than 30% of pre-European extent remaining in the context of the NVCP application area location (**Table 3-3**). The national objectives and targets for biodiversity conservation in Australia has a target to prevent clearing of ecological communities with a current extent less than 30% of the pre-European extent (Commonwealth of Australia, 2001). The application area as a whole is not considered an extensively cleared landscape with more than 40% of the area within 10 km of the application area covered by native vegetation.

Table 3-3 : Vegetation Representation for Vegetation Types within the NVCP Application Area

Vegetation Type	Vegetation Type Description (Shepherd et al. 2002)	Scale[1]	Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	Vegetation Status
4	**Medium woodland; Marri and Wandoo**	**SWA02**	**13,108**	**1,905**	**15**	**Vulnerable**
23	Low woodland Jarrah and Banksia	State	41,063	30,082	73	Least Concern
27	**Low woodland; paperbark (*Melaleuca* sp.)**	**SWA02**	**5,836**	**1,749**	**30**	**Vulnerable**
37	Shrublands; tea-tree thicket	SWA02	14,018	4,793	34	Depleted
48	Shrublands; scrub-heath	JAF01	76	26	34	Depleted

Vegetation Type	Vegetation Type Description (Shepherd et al. 2002)	Scale[1]	Pre-European Extent (ha)	Current Extent (ha)	% Pre-European Extent Remaining	Vegetation Status
		State	30,814	11,961	39	Depleted
49	Shrublands; mixed heath	State	52,492	26,136	50	Depleted
946	**Medium woodland; Wandoo**	**State**	**53,225**	**14,145**	**27**	**Vulnerable**
949	Low woodland Banksia	JAF01	1,218	438	36	Depleted
		SWA02	184,476	104,079	56	Least Concern
965	**Medium forest; Jarrah-Marri**	**JAF01**	**227**	**6**	**3**	**Endangered**
		State	9,356	5,182	55	Least Concern
968	**Medium woodland; Jarrah, Marri and Wandoo**	**SWA01**	**136,188**	**9,052**	**7**	**Endangered**
975	Low woodland; Jarrah	JAF	2,051	1,827	89	Least Concern
		State	17,276	15,570	90	Least Concern
992	**Medium forest Jarrah and Wandoo**	**JAF**	**121,370**	**31,100**	**26**	**Vulnerable**
		State	**122,049**	**31,780**	**26**	**Vulnerable**
999	**Medium woodland; Marri**	**SWA**	**102,177**	**9,451**	**9**	**Endangered**
1003	Medium forest Jarrah, Marri and Wandoo	JAF01	18,053	7,958	44	Depleted
		State	20,109	8,975	45	Depleted
1006	Medium woodland Jarrah, Wandoo and Powderbark	JAF01	44,908	21,815	49	Depleted
		State	44,908	21,815	49	Depleted
1008	**Medium open woodland; Marri**	**SWA01**	**130**	**14**	**11**	**Vulnerable**
1017	**Medium open woodland; Jarrah and Marri, with low woodland; Banksia**	**Shire of Chittering**	**1,282**	**242**	**19**	**Vulnerable**
1019	**Medium sparse woodland Jarrah and Marri**	**JAF01**	**58**	**14**	**24**	**Vulnerable**
		Shire of Chittering	511	181	35	Depleted
1027	Mosaic Medium open woodland Jarrah-marri with low woodland banksia/medium sparse woodland Jarrah-Marri	JAF01	275	96	35	Depleted
		Shire of Chittering	12,176	5,590	46	Depleted
1182	**Medium woodland: *Eucalyptus rudis* and *Melaleuca rhapiophylla***	**JAF01**	**261**	**17**	**7**	**Endangered**
		SWA02	**12,309**	**1,416**	**12**	**Vulnerable**

Notes: [1] As the Jarrah Forest Bioregion only covers a small portion of the NVCP application area, information for the next most cleared scale has also been provided. SWA = Swan Coastal Plain Bioregion; SWA01 = Dandaragan Plateau Subregion; SWA02 = Perth Subregion; JAF = Jarrah Forest Bioregion; JAF02 = Northern Jarrah Forest Subregion. Grey colouring indicates vegetation types below the 30% threshold.

3.4.2 Flora

A total of 33 conservation significant flora species including 18 Threatened species (17 taxa listed under the EPBC Act; 18 listed under the Wildlife Conservation Act 1950 (WC Act)) and 15 Priority flora species were identified in the desktop and literature review undertaken by Phoenix (2015). Of these, eight were recorded during the surveys undertaken by Phoenix (2015; 2017) (**Table 3-4** and

Figure 6).

Table 3-4 : Conservation Significant Flora Recorded during 2014, 2015 and 2016 Surveys (Phoenix 2015 and 2017)

Scientific name (common name)	Conservation Category	Total number of records
Darwinia foetida (Muchea Bell)	Threatened (CE) (EPBC Act) Schedule 2 (EN) (WC Act)	15 location records; 20 plants
Acacia drummondii subsp. *affinis*	Priority 3	148 location records; 906 plants
Anigozanthos humilis subsp. *chrysanthus* (Golden Catspaw)	Priority 4	1 location record; 3 plants
Eucalyptus caesia (Caesia)	Priority 4	Single plant
Haemodorum loratum	Priority 3	Single plant
Stylidium squamellosum (Maize Trigger Plant)	Priority 2	Two location records; 2 plants
Verticordia lindleyi subsp. *lindleyi*	Priority 4	Five location records; 133 plants
Verticordia serrata var. *linearis*	Priority 3	Eight location records; 70 plants

Notes: CE = Critically Endangered; EN = Endangered

3.4.3 Weeds

A total of 54 weed species were recorded for the Muchea North area, which includes five declared plants, **Asparagus asparagoides* **Echium plantagineum*, **Moraea flaccida*, **Moraea miniata* and **Zantedeschia aethiopica* (**Table 3-5** and

Figure 6) (Phoenix, 2015; 2017). **Asparagus asparagoides* is also a Weed of National Significance (WoNS). A large infestation of **Moraea miniata* was recorded in the southern section of the study area.

Table 3-5 : Declared Plants Recorded in the Study Area

Scientific name (common name)	Number of Locations	Number of plants
**Asparagus asparagoides* (Bridal Creeper)	7	10
**Echium plantagineum* (Paterson's Curse)	6	12
**Moraea miniata* (Two-leaf Cape Tulip)	19	>300
**Moraea flaccida* (One-leaf Cape Tulip)	1	100

Scientific name (common name)	Number of Locations	Number of plants
* *Zantedeschia aethiopica* (Arum Lily)	1	1

3.5 *Phytophthora* Dieback

Phytophthora cinnamomi (Dieback) is an introduced plant pathogen targeting the roots of susceptible plants, common in the south west of WA where the mean annual rainfall exceeds 400 mm (Dieback Working Group, 2015). Dieback poses a risk to the native vegetation within the Contract area, which experiences a mean annual rainfall of 519.4 mm.

A dieback assessment for Muchea North was undertaken by TerraTree Pty Ltd (TerraTree, 2015). In total 45.2 ha of the study area was identified as infested with *P. cinnamomi* (**Figure 7**). This is supported by historical positive sample results for *P. cinnamomi* which were identified during an interrogation of the Dieback Information Delivery and Information System (DIDMS) database. Positive sample results were extrapolated along drainage lines and slope gradients to identify all potentially infested areas. Uninterpretable areas were also identified with 8.62 ha of is classification mapped (TerraTree, 2015). These areas generally consist of Wandoo (*Eucalyptus wandoo*) woodland over *Acacia* and *Trymalium* spp. and contain no or very few disease indicator species.

Potential transmission pathways in the Muchea North area include roads (sealed and unsealed) and drainage (watercourses and culverts). A Dieback Management Plan has been developed in order to manage and mitigate potential for spread/introduction of weeds and disease and land degradation associated with this.

3.6 Fauna and Habitat

An initial fauna habitat assessment and significant black cockatoo tree assessment was undertaken between 16 October and 4 November 2014, from SLK 37.1 to 45.7 (approximately 8.6km) within the road reserve of Muchea North. A more comprehensive Level 1 fauna survey and complete black cockatoo tree assessment was completed in March and April 2015. A final round of field survey was undertaken from 7 to 8 October 2015, which included additional areas outside of the existing road reserve not surveyed in 2014. A subsequent site assessment of significant trees (Level 1) was undertaken on 1 and 6 November 2015 with Tony Kirkby to provide details with respect to breeding habitat for Black Cockatoos. Additional surveys were undertaken on 8 May 2016 and between 5 September and 15 December to provide coverage of areas not previously surveyed.

Details on the survey method are provided in Section 3 of Phoenix (2015) (**Appendix A**). Surveys were conducted in accordance with the following relevant State and Commonwealth guidelines:

- Environmental Factor Guideline - Terrestrial Fauna (Environmental Protection Authority (EPA), 2016);
- Technical Guidance - Terrestrial fauna surveys (EPA 2004a);
- Technical guide: Terrestrial vertebrate fauna surveys for environmental impact assessment (EPA & DEC 2010); and
- EPBC Act referral guidelines for three threatened black cockatoo species: Carnaby's Black Cockatoo, Baudin's Black Cockatoo and Forest Red-Tailed Black Cockatoo (Department of Sustainability Environment Water Populations and Communities (DSEWPaC, now DoEE) 2012).

3.6.1 Conservation Significant Fauna

The desktop review identified 21 conservation significant fauna species (excluding migratory species) that may occur in the vicinity of the NVCP application area (**Table 3-6**). A likelihood of occurrence assessment for these species has been included in **Table 3-6**.

Table 3-6 : Conservation Significant and Fauna Likelihood of Occurrence

Scientific Name (Common Name)	Conservation Category	Likelihood of occurrence
Birds		
Leipoa ocellata (Malleefowl)	Vulnerable (EPBC Act & WC Act)	**Unlikely** – habitat unsuitable (too degraded and fragmented)
Rostratula australis (Australian Painted Snipe)	Endangered (EPBC Act & WC Act)	**Unlikely** – no habitat present (shallow wetlands)
Calyptorhynchus banksii naso (Forest Red-tailed Black Cockatoo)	Vulnerable (EPBC Act & WC Act)	**Likely** – may forage and roost but unlikely to breed in the application area. Not recorded by Phoenix (2015; 2017).
Calyptorhynchus latirostris (Carnaby's Black Cockatoo)	Endangered (EPBC Act & WC Act)	**Recorded** - Recorded in study area and secondary evidence of foraging recorded in woodland habitats. Phoenix (2015; 2017) recorded a number of individuals and some breeding pairs within the application area.
Calyptorhynchus baudinii (Baudin's Black Cockatoo)	Vulnerable (EPBC Act) Endangered (WC Act)	**Possible** – study area north of modelled distribution but a few (potentially unreliable) NatureMap records as far north as New Norcia - may forage but unlikely to breed or roost in the NVCP application area. Not recorded by Phoenix (2015; 2017).
Botaurus poiciloptilus (Australasian Bittern)	Endangered (EPBC Act & WC Act)	**Unlikely** – no habitat present (wetlands)
Oxyura australis (Blue-billed Duck)	Priority 4	**Unlikely** – habitat not present (wetlands)
Ninox connivens connivens (Barking Owl (southern))	Priority 2	**Possible** – may occur in woodland, shrubland or forest habitats. Not recorded by Phoenix (2015; 2017).
Falco peregrinus (Peregrine Falcon)	Other Specially Protected Fauna (WC Act)	**Likely** – may forage and breed in woodland habitats where suitable large eucalypts present. Not recorded by Phoenix (2015; 2017).
Mammals		
Dasyurus geoffroii (Western Quoll)	Vulnerable (EPBC Act & WC Act)	**Possible** – suitable habitat present within the NVCP application area but limited and narrow, NatureMap record within 3 km west of Bullsbrook. Not recorded by Phoenix (2015; 2017).
Parantechinus apicalis (Dibbler)	Endangered (EPBC Act & WC Act)	**Unlikely** – the project is north of known current distribution; habitat unsuitable (too degraded and fragmented)
Leporillus conditor (Greater Stick-nest Rat)	Vulnerable (EPBC Act) Conservation Dependent (WC Act)	**Unlikely** – confined to a few localities all well outside the NVCP application area; habitat not present (arid semi-arid shrubland)

Scientific Name (Common Name)	Conservation Category	Likelihood of occurrence
Isoodon obesulus fusciventer (Southern Brown Bandicoot/ Quenda)	Priority 5	**Likely** – may occur in forest, woodland and shrubland habitats where suitable understory present; has been recorded within 1 km of the NVCP application area. Not recorded by Phoenix (2015; 2017).
Macropus irma (Western Brush Wallaby)	Priority 4	**Possible** – may occur in woodland or shrubland habitats. Not recorded by Phoenix (2015; 2017).
Reptiles		
Pseudemydura umbrina (Western Swamp Tortoise)	Critically Endangered (EPBC Act & WC Act)	**Unlikely** – the project is north of known distribution; habitat not present (freshwater wetlands)
Egernia stokesii badia (Western Spiny-tailed Skink)	Endangered (EPBC Act) Vulnerable (WC Act)	**Unlikely** – the project is outside of known distribution; habitat unsuitable (too degraded and fragmented)
Aspidites ramsayi (Woma Python (south-western))	Priority 1	**Unlikely** – the project is outside of the known distribution
Neelaps calonotos (Black-striped Snake)	Priority 3	**Possible** – may occur in shrubland habitat where suitable sandy substrates are present. Not recorded by Phoenix (2015; 2017).
Invertebrates		
Idiosoma nigrum (Shield-backed Trapdoor Spider)	Vulnerable (EPBC Act & WC Act)	**Unlikely** – south of known distribution
Leioproctus contrarius (a bee)	Priority 3	**Possible** – species of Goodeniaceae have been recorded in the NVCP application area. Not recorded by Phoenix (2015; 2017).
Throscodectes xederoides (Mogumber Bush Cricket)	Priority 3	**Unlikely** – habitat not present (white sands)

3.6.2 Fauna Habitats

Seven fauna habitat types were defined in the Muchea North NVCP application area (**Figure 8**):

- Cleared (agriculture, road, infrastructure) (44.1%).
- Woodland (Jarrah, Marri, Wandoo and/or banksia) (39.9%).
- Cleared and revegetated non-native woodland mosaic (14.1%).
- Shrubland (low heath/scrub) (1%).
- Shrubland (thicket) (0.8%).
- Woodland (paperbark or sheoak) (0.1%).

3.6.3 Black Cockatoo Habitat

3.6.3.1 Carnaby's Black Cockatoo

Surveys undertaken by Phoenix (2015; 2017) have recorded a total of 228.8 ha of foraging habitat for Carnaby's Black Cockatoo (**Figure 9**).

This consists of 178 ha of Quality foraging habitat and 50.8 ha of Low Value foraging habitat. Quality foraging habitat was defined by the presence of important foraging species (e.g. *Corymbia calophylla* and *Banksia* spp.) and foraging residues. Evidence (residues) of feeding by Carnaby's Black Cockatoo was observed in the survey area and was noted to be extensive at some locations, particularly near *Corymbia calophylla* and *Banksia attenuata* (Phoenix, 2015).

In addition to foraging habitat, 22 trees showing evidence of use by the species (known nesting trees), 32 trees with hollows suitable for use and 2,369 potential breeding trees (diameter at breast height greater than 500 mm) have been recorded within the proposal area. The breakdown of habitat as recorded during each survey (Phoenix 2015; 2017) is provided in **Table 3-7**.

Table 3-7 : Summary of Carnaby's Black Cockatoo Habitat Recorded by Survey Date

	2014 – 2015 Surveys (Phoenix 2015)	2016 Surveys (Phoenix, 2017)	Total
Known Nesting Trees	9	13	22
Trees with Suitable Hollows	12	20	32
Potential Breeding Trees	1,147	1,222	2,369
Foraging Habitat	92.80 ha	135.89 ha	228.8 ha

2016 survey data only includes records which are additional to the 2014 – 2015 survey records.

There are two properties in the vicinity of the proposed action which are considered of local importance for Carnaby's Black Cockatoo. These are Reserve 40350 (Main Roads WA gravel pit) and Lot 512 Great Northern Highway. These properties have an unusually high density of known nesting trees with nine known nesting trees recorded within 6.8 ha of vegetation at Reserve 40350 and seven known nesting trees within 15 ha of vegetation at Lot 512 Great Northern Highway (**Figure 9**).

3.6.3.2 Forest Red-tailed Black Cockatoo

Historically, Forest Red-tailed Black Cockatoos are not often recorded near application area; however there are some desktop records. No observations (either visual or heard calls) were made during the surveys by Phoenix (2015; 2017) and no residues were recorded. It is unlikely that the species breeds in the area and, if present, would be in low numbers either foraging or potentially roosting. The proposal area is not considered an important area for Forest Red-tailed Black Cockatoos for foraging, roosting or breeding (Phoenix, 2017).

Potential foraging habitat was identified by Phoenix (2015; 2017) in areas where their main food preference (Jarrah and Marri seed) was present. A total of 226.5 ha of potential foraging habitat was mapped by Phoenix (2015; 2017) (**Figure 10**).

3.7 Conservation Areas

Two conservation areas occur adjacent to the existing GNH in the Muchea North area. Barracca Nature Reserve (Class A) covers 17 ha is located to the west of the GNH between SLK 44.22 and 44.79 while Barracca Springs Reserve (Reserve 209, under a management order with the Shire of Chittering as the primary interest holder), also to the west of the existing GNH, is located between SLK 40.2 and 40.8.

3.8 Hydrology

Muchea North is located in the Ellen Brook sub-catchment of the Swan Avon Catchment. The area is within the Proclaimed Swan River System surface water area and the Proclaimed Gingin Groundwater Area (Department

of Water, 2009a, 2009b). In general, watercourses flow west and south to Ellen Brook via Rock Creek and Yalyal Brook (**Figure 11**).

The main hydrological feature is Rocky Creek, which runs along the western side of the existing GNH from SLK 40 up to SLK 44.5. Tributaries of Rocky Creek cross GNH between SLK 42.5 and SLK 44. Rocky Creek flows into Ellen Brook at the confluence with Chandala Brook.

Yalyal Brook collects surface water runoff from the northern section of the NVCP application area (north of SLK 47). Tributaries of Yalyal Brook cross GNH between SLK 47 and SLK 50. Yalyal Brook flows into both Chandala Brook and Rocky Creek via a series of drains, just south of the Tronox mineral sands processing plant on Brand Highway.

4. Potential Impacts

4.1 Vegetation and Flora

Up to 53 ha of native vegetation will be cleared for construction of the proposed upgrades to Muchea North section of the GNH. **Table 4-1** details the preliminary clearing requirements per vegetation type and vegetation condition. These numbers are based on current alignment designs and are subject to minor changes during the detailed design phase. Clearing will not exceed the maximum of 53 ha. Of the 53 ha to be cleared, 7.49 ha has been mapped as the Banksia Woodlands of the Swan Coastal Plain with a further 4.78 ha within the buffer zone for the TEC. Regionally the area is not an extensively cleared landscape, with 44.6% of the area within 10 km of the NVCP application area being covered by native vegetation.

Table 4-1 : Preliminary Clearing Requirements for Muchea North – Native Vegetation

Vegetation Type	Preliminary Clearing Amount by Vegetation Condition (ha)					Total (ha)
	Degraded	Good	Very Good	Excellent	Pristine	
4	0.15	0.22	3.36	-	-	**3.73**
23	0.23	0.73	1.50	0.67	-	**3.13**
27	0.33	-	0.40	-	-	**0.73**
37	1.65	-	-	-	-	**1.65**
48	1.90	-	0.02	-	-	**1.92**
946	-	-	0.20	-	0.27	**0.47**
949	0.07	0.14	1.12	2.25	1.11	**4.69**
965	1.79	2.09	1.02	0.65	0.72	**6.27**
968	0.73	1.23	0.60	2.90	-	**5.46**
975	-	0.05	0.96	1.06	-	**2.07**
992	0.68	-	1.11	0.42	-	**2.21**
999	0.28	0.01	0.67	0.89	-	**1.85**
1003	-	-	0.40	0.09	-	**0.49**
1006	-	3.98	0.08	0.18	-	**4.24**
1008	1.50	1.52	0.01	-	-	**3.03**
1017	0.57	0.32	5.18	0.43	-	**6.5**
1019	-	-	-	1.18	-	**1.18**
1027	-	-	2.62	-	-	**2.62**
1182	0.12	0.56	-	0.08	-	**0.76**
Total (ha)	**10.00**	**10.85**	**19.25**	**10.80**	**2.10**	**53.00**

Table 4-2 details the Priority Flora likely to be cleared. Areas of Priority Flora within and in close proximity to the NVCP application area that are not likely to be cleared will be marked on construction drawings as 'no-go' or 'avoidance areas'.

Table 4-2 : Priority Flora Likely to be cleared

Scientific name (common name)	Conservation Category	Number of records within the NVCP Application Area	Number of records outside the NVCP Application Area	Total number of records	Number of records likely to be cleared
Acacia drummondii subsp. *affinis*	Priority 3	119 location records; 769 plants	29 location records; 137 plants	148 location records; 906 plants	443 plants
Eucalyptus caesia (Caesia)	Priority 4	Single plant	None recorded by Phoenix (2015; 2017)	Single plant	1 plant
Haemodorum loratum	Priority 3	Single plant	None recorded by Phoenix (2015; 2017)	Single plant	1 plant
Verticordia serrata var. *linearis*	Priority 3	Single plant	Eight location records; 69 plants	Eight location records; 70 plants	1 plant

4.2 Fauna and Fauna Habitat

Table 4-3 details the clearing requirements per fauna habitat. These numbers are based on current alignment designs and are subject to minor changes during the detailed design phase.

Table 4-3 : Preliminary Clearing Requirements for Muchea North – Fauna Habitat

Habitat type	Area within NVCP Application Area (Phoenix 2015; 2017) (ha)	Clearing Amount (ha)
Cleared (agriculture, road, infrastructure)	114.51	54.51
Cleared and revegetated non-native woodland mosaic	36.63	16.10
Shrubland (low heath/scrub)	2.49	1.91
Shrubland (thicket)	2.13	1.66
Woodland (Jarrah, Marri, Wandoo and/or Banksia)	103.47	48.74
Woodland (paperbark or sheoak)	0.24	0.23

Fauna habitat is variable, ranging from completely degraded (low value) areas to good quality habitat. Good quality habitat was recorded in woodlands that are contiguous with larger pockets of native vegetation (Phoenix, 2015). Low value fauna habitat was associated with areas of degraded vegetation which was narrow and fragmented.

An assessment of the likelihood of occurrence of all potential conservation significant species identified in the desktop review was undertaken based on known distribution, desktop records, habitat preferences and the habitats present within the NVCP application area (Phoenix, 2015) (**Table 3-4**). Many of the species are unlikely to occur within the NVCP application area mainly due to lack of suitable habitat (degradation, fragmentation and habitat too small in size). The habitats likely to support conservation significant species are the larger areas of

forest, woodland and shrubland. The narrow habitat corridors are unlikely to support most of the conservation significant species as core habitat but may provide some linkage value to some species. The areas of native vegetation where Carnaby's Black Cockatoo were recorded are of value for this species, especially in regard to food resources.

The existing GNH alignment would currently present a barrier to some fauna movements, particularly ground dwelling fauna. The upgraded GNH is unlikely to significantly worsen this barrier to fauna movement.

Of those conservation significant species potentially occurring in the vicinity of the NVCP application area, the most likely to occur were Carnaby's Black Cockatoo and Forest Red-tailed Black Cockatoo. The Forest Red-tailed Black Cockatoo may forage and roost within the NVCP application area but is unlikely to breed Phoenix, 2015; 2017). Carnaby's Black Cockatoo has been recorded in the NVCP application area (Phoenix, 2015; 2017).

The conservation significant fauna species most likely to be impacted by the upgrades proposed for Muchea North are Carnaby's Black Cockatoo, which has been recorded in the application area, and the Forest Red-tailed Black Cockatoo, as suitable foraging and roosting habitat has been identified. **Table 4-4** details the likely clearing requirements in relation to Black Cockatoo habitat. The initial stages of the design of the Muchea North alignment took into account the location of potential Black Cockatoo breeding trees and sought to minimise the clearing of these trees where practicable. The proposed alignment will result in a lesser impact to Black Cockatoo habitat than if the improvement works were to stay online and impact the existing road reserve vegetation present along the GNH.

Table 4-4 : Preliminary Clearing Requirements for Muchea North – Black Cockatoos

	Maximum Cleared	Mapped*
Carnaby's Black Cockatoo		
Known Nesting Trees	6	22
Trees with Suitable Hollows	7	32
Potential Breeding Trees	744	2,369
Breeding Habitat (ha)	44.2	200.26
Foraging Habitat (ha)	52.5	228.69
Forest Red-Tailed Black Cockatoo		
Potential Foraging Habitat (ha)	48.79	226.5

** Mapped by Phoenix (2015; 2017)*

Inspection of recent aerial photography for the wider area suggests that approximately 25,340 ha of suitable Carnaby's habitat occurs within 10 km of the NVCP application area.

4.3 Conservation Reserves

No land will be acquired from these reserves for the Muchea North project and any secondary impacts to these reserves will be managed through the project PEMP and CEMP.

4.4 Land Degradation, Water Quality and Flooding

The area surrounding the NVCP application area is not an extensively cleared landscape (44.6% of the area within 10 km of the NVCP application area is vegetated).

Given the linear nature and the amount of clearing required (53 ha of native vegetation), there is unlikely to be any increase in land degradation such as soil acidity or salinity, or flood risk as a result of these works.

Additionally, given the gentle slopes present, it is unlikely that clearing will result in increased erosion, particularly water erosion.

5. Environmental Management Framework

The mitigation hierarchy has been applied during the design phase for Muchea North as follows:

- **Avoid**: realignment of the GNH has allowed for avoidance of a significant amount of native vegetation, conservation significant flora and habitat for Carnaby's Black Cockatoo. The proposed realignment involves both online and offline construction. Offline construction has been adopted where significant horizontal and vertical realignments are required to improve safety and upgrade GNH to meet current road design guidelines. Impacts to native vegetation, conservation significant flora and habitat for Carnaby's Black Cockatoo have been minimised through the areas of offline works, and avoided where possible.
- **Minimise**: trees within the NVCP application area known to contain hollows suitable for use by Carnaby's Black Cockatoo and are outside the proposed disturbance footprint will not be cleared.
- **Rehabilitate**: cleared areas beyond the final road formation will be revegetated and landscaped, in line with the landscape design for Muchea North.

A PEMP has been developed to manage potential environmental impacts for the proposed works. The PEMP will address both preventative and management measures to be applied during construction phase to minimise environmental impacts and have been developed to capture regulatory and Infrastructure Sustainability Rating requirements, and guide the development of the Contractor's CEMP. The PEMP will consist of a number of sub-plans. Those sub-plans relevant to the management and mitigation of impacts related to the clearing of native vegetation will include (but not be limited to):

- Vegetation Clearing Management Plan:
  - Areas of native vegetation to be cleared will be clearly delineated onsite.
  - The construction contractor will be responsible for marking and avoiding "no-go" zones on site.
- Fauna Management Plan:
  - Trees known to contain hollows suitable for use by Carnaby's Black Cockatoo that are not within the proposed disturbance footprint will not be cleared. These trees will be identified as "no-go" zones in the CEMP and Construction Drawings.
  - During the breeding season (August – December) and prior to clearing, all known nesting trees and trees with hollows suitable for Carnaby's Black Cockatoo within the disturbance footprint will be surveyed by a suitably qualified person to determine if black cockatoos are using the hollow. If black cockatoos are found to be using a hollow, the hollow bearing tree will be marked as a "no-go" zone until such time as a suitably qualified person confirms the hollow is no longer in use by black cockatoos.
  - During construction, vehicle speed on site will be limited to reduce dust lift off and the risk of fauna collisions.
  - To replace known nesting trees that cannot be avoided and are cleared, artificial hollows will be installed. A suitably qualified person will advise on a suitable artificial hollow design and appropriate locations for artificial hollow installation.
  - The artificial hollow (HT04059) located within the disturbance footprint will be relocated to a suitable tree in proximity to the original location. A suitably qualified person will advise on an appropriate location for the artificial hollow.
- Weed and Disease Management Plan (including Dieback Management):
  - All plant and machinery to be certified clean prior to arrival at construction site.
  - All plant and machinery to be certified clean prior to leaving the construction site.

All Contractors are expected to adopt and conform to the requirements of the PEMP. The PEMP will provide direction on environmental issues, however, contractors are also required to develop and implement additional procedures where necessary in order to provide an acceptable level of environmental performance at all times, in accordance with the requirements of Main Roads WA AS2124 Specifications, in particular Environment (204), Clearing (301), Earthworks (302) and Landscaping and Revegetation (304). The management measures that will be provided in the PEMP are in addition to those detailed in the specifications.

6. Assessment Against the 10 Clearing Principles

Schedule 5 of the EP Act defines 10 Clearing Principles for native vegetation. These principles aim to ensure that all potential impacts resulting from removal of native vegetation can be assessed in an integrated way. Clearing required for construction of Muchea North has been assessed against the ten Clearing Principles, with each principle being assessed in accordance with the DER's A Guide to the Assessment of Applications to Clear Native Vegetation (Department of Environment Regulation, 2014) to determine whether the application is at variance to the principles. The assessment indicates that clearing is at variance with Principles (a), (b), (d) and (f) and may be at variance with Principles (e) and (h).

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Principle		Assessment	Outcome
A	Native vegetation should not be cleared if it comprises a high level of biological diversity.	A maximum of 53 ha of native vegetation will be cleared. The NVCP application area includes vegetation which is considered to be in very good, excellent or pristine condition. This vegetation typically comprises of high native species diversity than the surrounding, more degraded remnants Seven Priority listed flora species occur within or in the vicinity of the NVCP application area. Four patches of the EPBC listed TEC Banksia Woodlands of the Swan Coastal Plain have been mapped in the NVCP application area. Areas described as road, cleared (townships, driveways), cleared and planted (non-native species) and pasture accounted for the majority of the area surveyed, and account for approximately 48.7% of the NVCP application area.	**At Variance**
B	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia	The NVCP application area is within the known breeding range for Carnaby's Black Cockatoo and suitable breeding and foraging habitat has been identified within the NVCP application area. Breeding habitat and known nesting trees in particular are considered to be significant habitat for this species. Construction of the project will require clearing of 52.5 ha Carnaby's Black Cockatoo foraging habitat, 44.2 ha of breeding habitat and up to six known nesting trees and seven trees with suitable hollows will be cleared. Reserve 40350 (Main Roads WA gravel pit) is considered of local importance for Carnaby's Black Cockatoo due to the high density of known nesting trees. 48.79 ha of potential habitat for the Forest Red-tailed Black Cockatoo will be cleared however it is unlikely that the species breeds in the area and, if present, would be in low numbers either foraging or potentially roosting.	**At Variance**
C	Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No rare flora has been recorded in the NVCP application area.	Not at Variance
D	Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	Up to 7.49 ha of the Banksia Woodlands of the Swan Coastal Plain will be cleared. An additional 4.78 ha within the buffer area for the TEC will also be cleared.	**At Variance**

Principle		Assessment	Outcome
E	Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	Eleven of the mapped vegetation types are considered underrepresented as the current extent of these is less than 30% of the pre-European extent. However, the area within which the NVCP application area is located has not been extensively cleared with 44.6% of the area within a 10 km radius of the NVCP application area being covered by native vegetation.	May be at Variance
F	Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	Vegetation clearing will occur in the vicinity of Rocky Creek, associated with the upgrade of culverts on Reserve Road, and a number of un-named creek crossings along the main GNH alignment.	**At Variance**
G	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	Due to the linear nature and small scale of the required clearing, clearing of native vegetation is not expected to increase soil acidity or salinity. Given the gentle slopes present along the preferred alignment, it is also unlikely that clearing will result in increased erosion, particularly water erosion. Clearing activities are unlikely to increase the percentage coverage of weeds within the application area. Management controls will reduce the risk of the spread or introduction of weeds and disease in the application area. It is considered unlikely that the required clearing will cause appreciable land degradation.	Not at Variance
H	Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Barracca Nature Reserve is the only known Parks and Wildlife managed nature reserve within close proximity to the Muchea North proposed alignment. It is adjacent to the alignment between SLK 44.22 and 44.79. Barracca Springs Reserve (Reserve 209, under a management order with the Shire of Chittering as the primary interest holder) also borders the NVCP application area between SLK 40.2 and 40.8. Clearing within the vicinity of these areas will be managed in accordance with Main Roads AS2124 Specifications, the PEMP and/or CEMP.	May be at Variance
I	Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	Impacts to groundwater are not expected to occur as there are no surface expressions of the groundwater table within the application area and no direct interactions between clearing activities and groundwater. Clearing may result in increased sediment loads to local water courses, however given the gentle nature of the slopes within the NVCP application area, the risk of significant erosion is considered minimal.	Not at Variance
J	Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.	Given the limited amount of clearing of native vegetation required and linear nature of the project, it is unlikely that the clearing will cause, exacerbate of increase the incidence of flood in the application area or surrounds.	Not at Variance

7. References

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Figures

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Figure 1 : Location Plan

[refer to GNH-CN03-EN01-GIS-0039]

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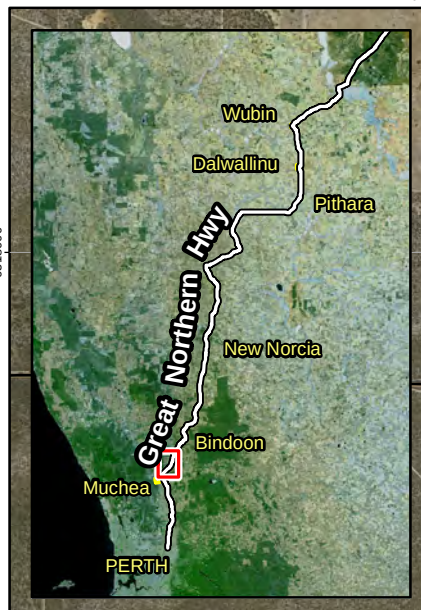

YALYAL
MARYLAND
BERGALA

52 51 50 49 48 47 46 45 44 43 42 41 40 39 38

Maddern Rd
Maddern South Rd
Great Northern Hwy
Reserve Rd
Yalyal Rd
Old Gingin Rd
Brand Hwy
Salmon Gum Cr
Sugar Gum Dr
Rosewood Dr
Ghost Gum Rdge
Blue Plains Rd
Leschenaultia Dr
Swallow Lane
Lorikeet Ct
Wisteria Way
Sussex Bend
Holstein Loop
Texon Rdge
Charbray Rd
Powderbark Rd
Nova Rise
Ayrshire Loop
Limousin Way
Charolais Trl
Galloway Rise
Murray Grey Cir
Devon Way
Wandena Rd
Sollya Rtt
Patens Dr
Caladenia Cl
Harris Rd
Muchea East Rd

PRELIMINARY PLANNING

Legend

- Town
- Straight Line Kilometre Marker (1km)
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Major Road
- Minor Road
- NVCP Application Area

Data Source: Main Roads WA, Landgate

Joint Venture Partners:

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Metres

Scale at A3 1:35,000

Coordinate System: GDA 1994 MGA Zone 50

NVCP Application Area

Drawing No: GNH-CN03-EN01-GIS-0039 | Issue: B

Task No: GNH-1329 | Drawing Status / Other: Draft

Date: 11/04/2017 | By: SR | Chkd: CG | Appd: XX

Main Roads Western Australia — Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2 — Project

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Figure 2 : Survey Area Extents

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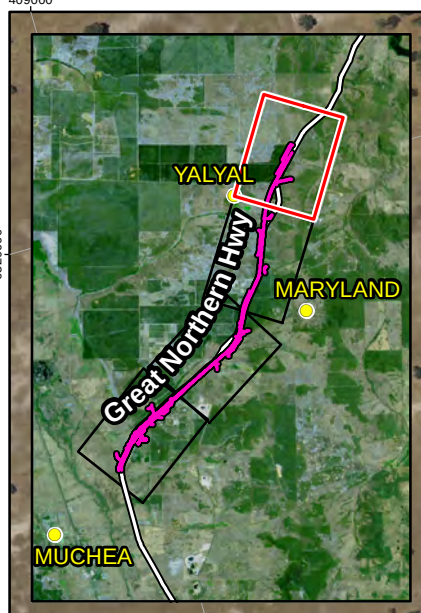

Great Northern Hwy
Sandalford Dr
Maddern Rd
53
52
51
50
YALYAL

PRELIMINARY PLAN ONLY

Legend

- Straight Line Kilometre Marker (1km)
- Town
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- NVCP Application Area

Enviro Study Areas (Phoenix, 15/02/2017)

- Flora - Surveyed
- Fauna - Surveyed
- Fauna - Unsurveyed

Data Source: Main Roads WA, Landgate

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Metres

Scale at A3
1:10,500

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2
Project

Ecological Survey Extents Map 1 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0040	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX

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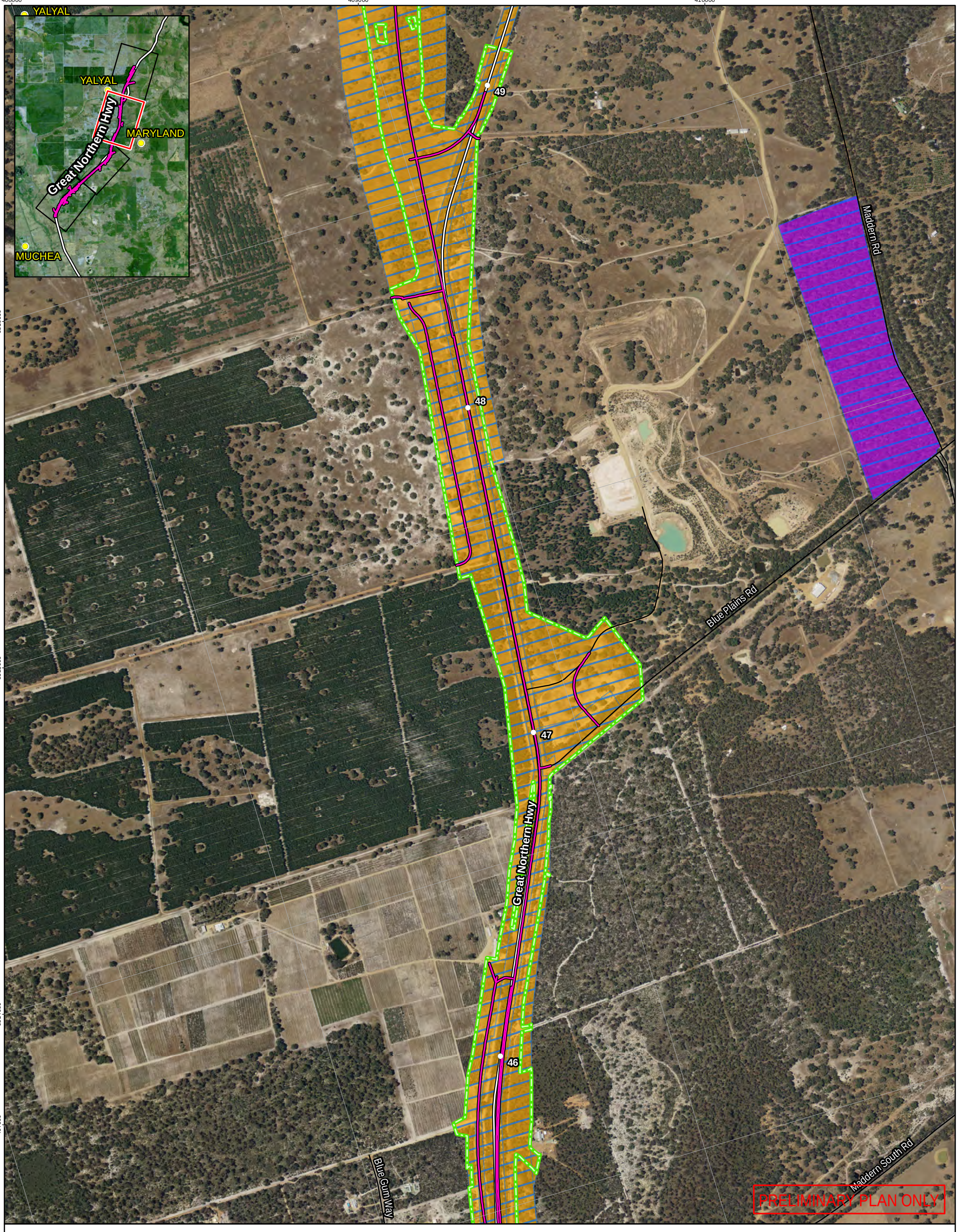

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Scale at A3 **1:10,500**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia — Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2 — Project

Ecological Survey Extents Map 2 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0040	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX

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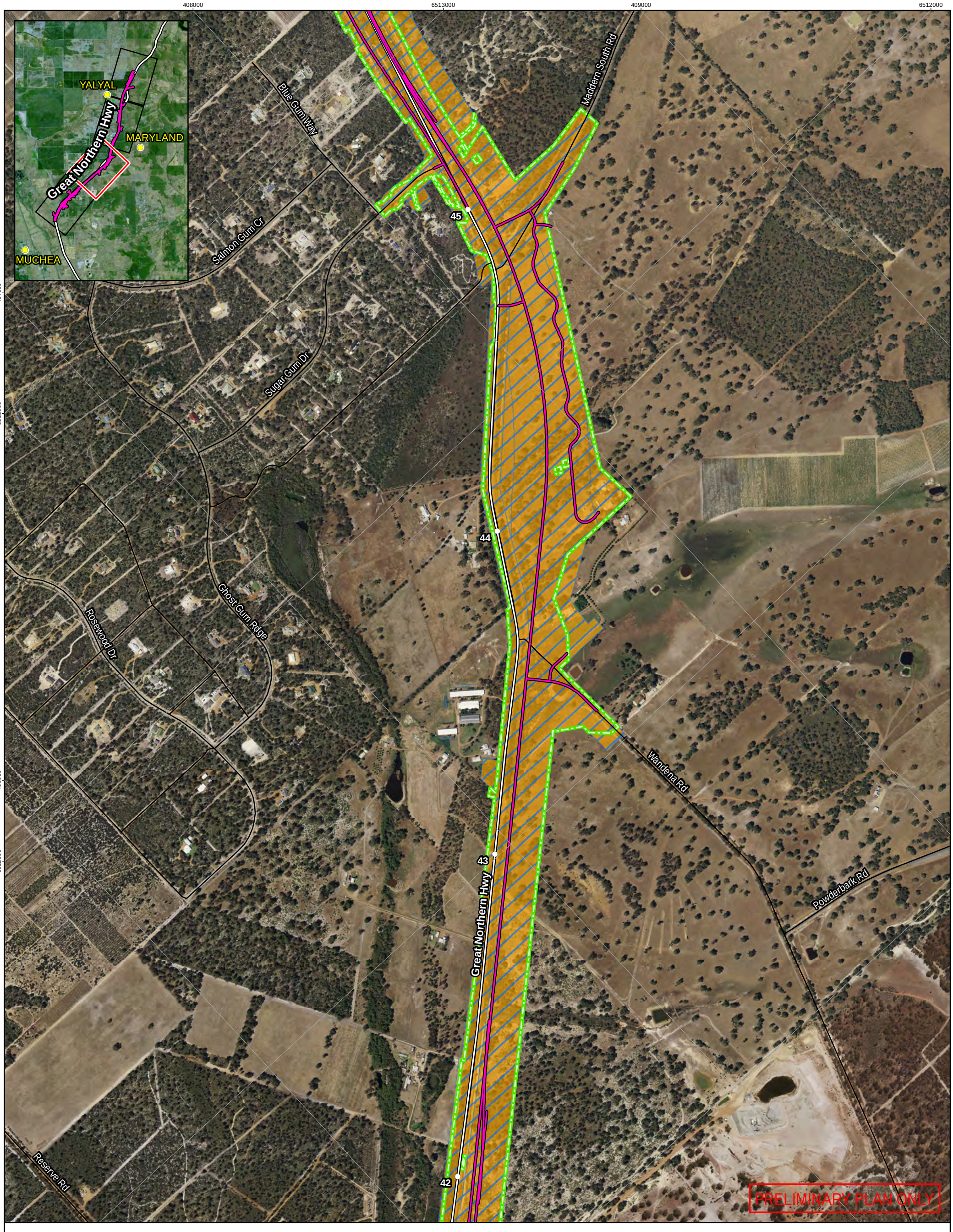

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Main Roads Western Australia
Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2
Project

Ecological Survey Extents Map 3 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0040	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
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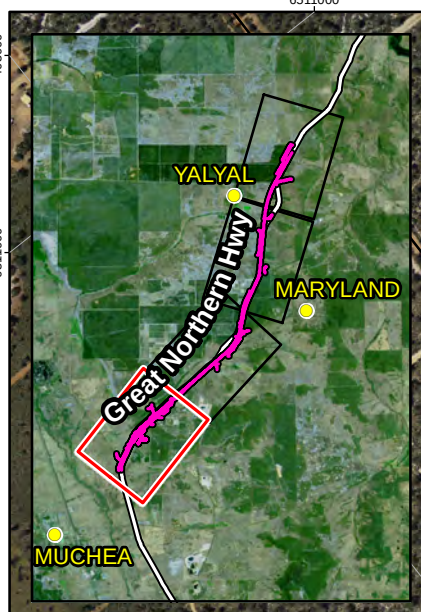

Rocky Creek Rise
Reserve Rd
Fern Glde
Wandena Rd
41
40
39
38
Great Northern Hwy
Old Gingin Rd

PRELIMINARY PLAN ONLY

Legend

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Coordinate System: GDA 1994 MGA Zone 50

mainroads WESTERN AUSTRALIA

GNH MUCHEA TO WUBIN

ARUP TRADING AS ASJV JACOBS

Main Roads Western Australia

Client

Project

Great Northern Highway
Muchea to Wubin Upgrade Stage 2

Ecological Survey Extents Map 4 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0040	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
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Figure 3 : Mapped Vegetation Associations

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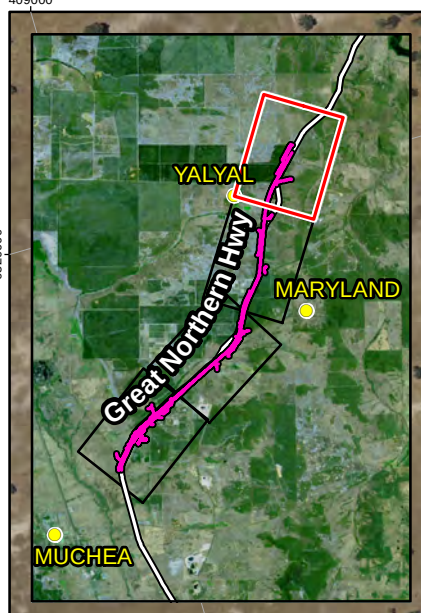

Vegetation Association (Phoenix, 15/02/2017)

- 968 - Medium woodland; Jarrah, Marri and Wandoo
- 992 - Medium forest jarrah and wandoo
- 1017 - Medium open woodland; Jarrah and Marri, with low woodland; Banksia
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

Sandalford Dr

53

52

51

50

Maddern Rd

Great Northern Hwy

YALYAL

PRELIMINARY PLAN ONLY

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Main Roads Western Australia
Client

Project
Great Northern Highway
Muchea to Wubin Upgrade Stage 2

Mapped Vegetation Associations Map 1 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0042	B

Task No	Drawing Status / Other
GNH-1329	Draft

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11/04/2017	SR	CG	XX

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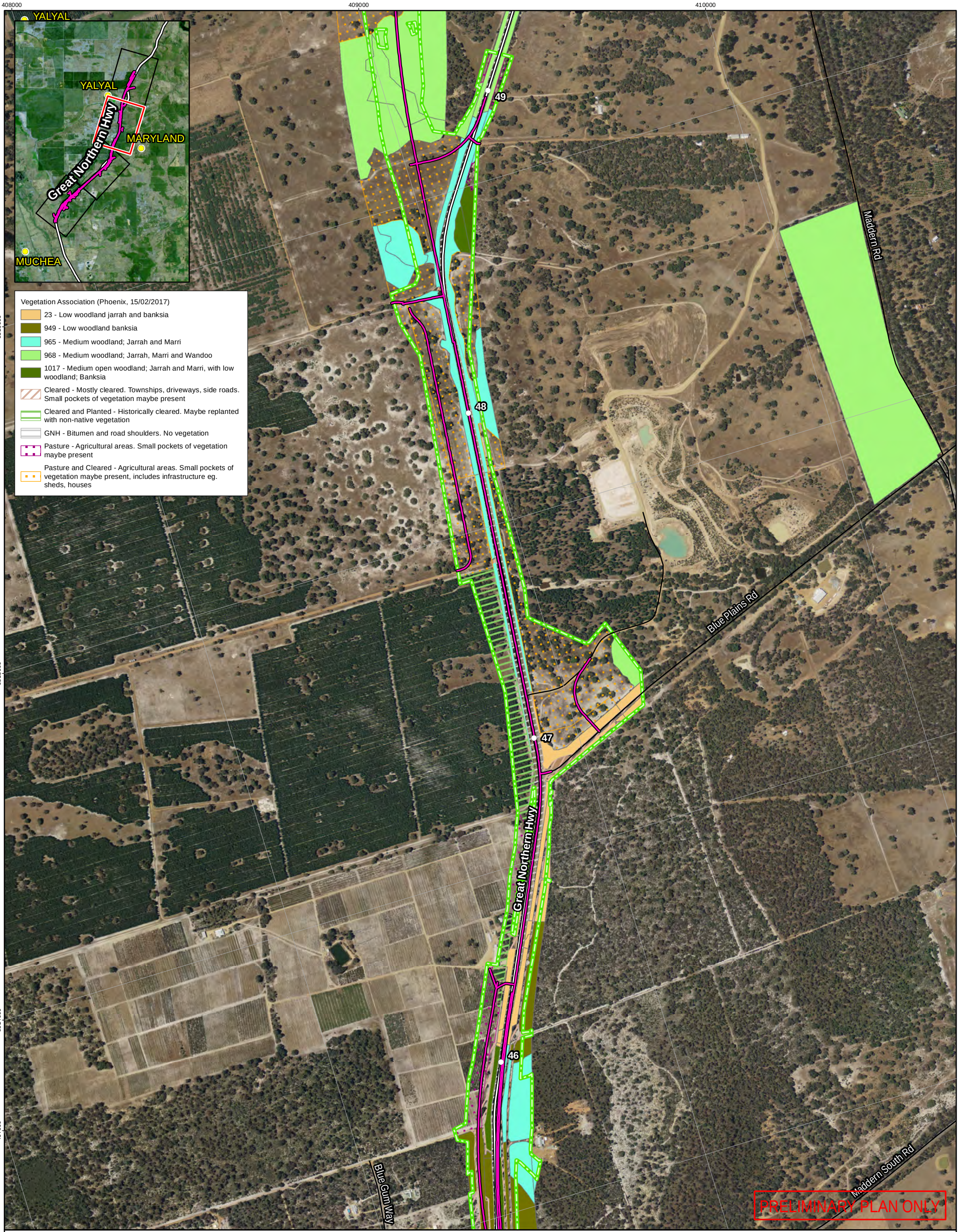

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Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia — Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2 — Project

Mapped Vegetation Associations Map 2 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0042	B

Task No	Drawing Status / Other
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11/04/2017	SR	CG	XX

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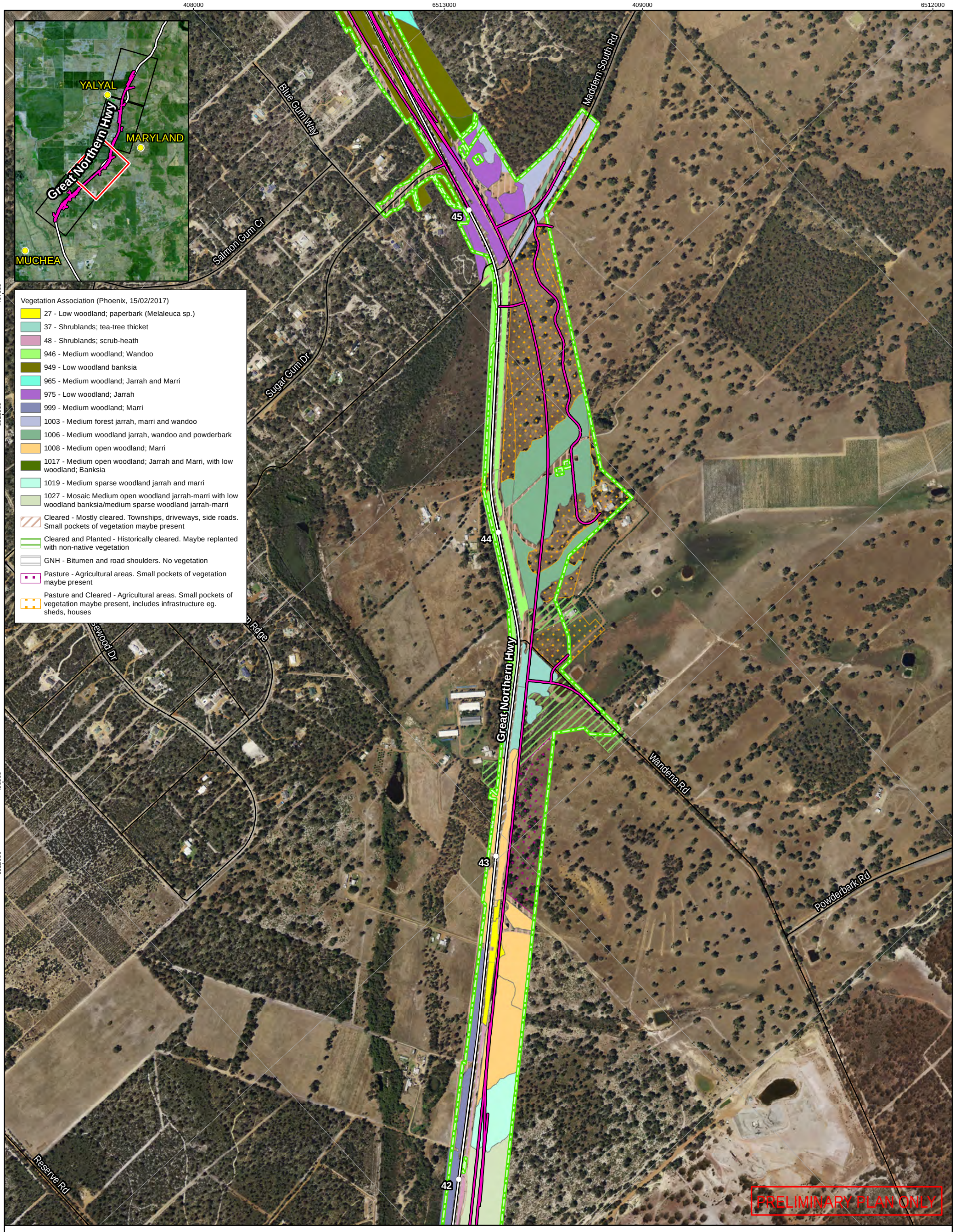

Vegetation Association (Phoenix, 15/02/2017)

- 27 - Low woodland; paperbark (Melaleuca sp.)
- 37 - Shrublands; tea-tree thicket
- 48 - Shrublands; scrub-heath
- 946 - Medium woodland; Wandoo
- 949 - Low woodland banksia
- 965 - Medium woodland; Jarrah and Marri
- 975 - Low woodland; Jarrah
- 999 - Medium woodland; Marri
- 1003 - Medium forest jarrah, marri and wandoo
- 1006 - Medium woodland jarrah, wandoo and powderbark
- 1008 - Medium open woodland; Marri
- 1017 - Medium open woodland; Jarrah and Marri, with low woodland; Banksia
- 1019 - Medium sparse woodland jarrah and marri
- 1027 - Mosaic Medium open woodland jarrah-marri with low woodland banksia/medium sparse woodland jarrah-marri
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

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Main Roads Western Australia
Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2
Project

Mapped Vegetation Associations Map 3 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0042	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX

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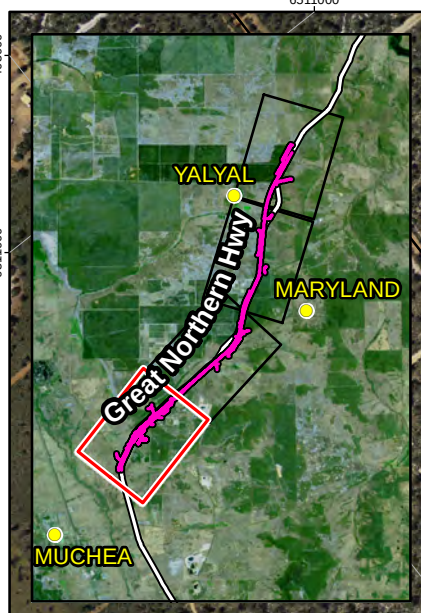

Rocky Creek Rise
Reserve Rd
Fern Glde
Wandena Rd
41
40
39
38
Old Gingin Rd
Great Northern Hwy

Vegetation Association (Phoenix, 15/02/2017)

- 4 - Medium woodland; Marri and Wandoo
- 23 - Low woodland jarrah and banksia
- 27 - Low woodland; paperbark (Melaleuca sp.)
- 48 - Shrublands; scrub-heath
- 49 - Shrublands; mixed heath
- 949 - Low woodland banksia
- 965 - Medium woodland; Jarrah and Marri
- 975 - Low woodland; Jarrah
- 999 - Medium woodland; Marri
- 1017 - Medium open woodland; Jarrah and Marri, with low woodland; Banksia
- 1027 - Mosaic Medium open woodland jarrah-marri with low woodland banksia/medium sparse woodland jarrah-marri
- 1182 - Medium woodland; Eucalyptus rudis and Melaleuca rhaphiophylla
- Cleared - Mostly cleared. Townships, driveways, side roads. Small pockets of vegetation maybe present
- Cleared and Planted - Historically cleared. Maybe replanted with non-native vegetation
- GNH - Bitumen and road shoulders. No vegetation
- Pasture - Agricultural areas. Small pockets of vegetation maybe present
- Pasture and Cleared - Agricultural areas. Small pockets of vegetation maybe present, includes infrastructure eg. sheds, houses

PRELIMINARY PLAN ONLY

Legend

- Straight Line Kilometre Marker (1km)
- Town
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- NVCP Application Area

Data Source: Main Roads WA, Landgate

Joint Venture Partners:

Arup Pty Ltd
Level 14 Exchange Tower
2 The Esplanade
Perth WA 6000
Tel +61 8 9327 8300 Fax +61 8 9481 1334
www.arup.com

Jacobs Group (Australia) Pty Ltd
Durack Centre, 263 Adelaide Terrace,
Perth WA 6000
Tel +61 8 9469 4400 Fax +61 8 9469 4488
www.jacobs.com

0 125 250 Metres

Scale at A3 **1:10,500**

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia — Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2 — Project

Mapped Vegetation Associations Map 4 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0042	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX

MXD Location: \\Jacobs.com\PERProjects\PBIF\Projects\PB50732\Technical\GIS\ArcMap\Environmental\CN03\GNH-CN03-EN01-GIS-0042-B.mxd

Figure 4 : Threatened Ecological Communities

[refer to GNH-CN03-EN01-GIS-0043]

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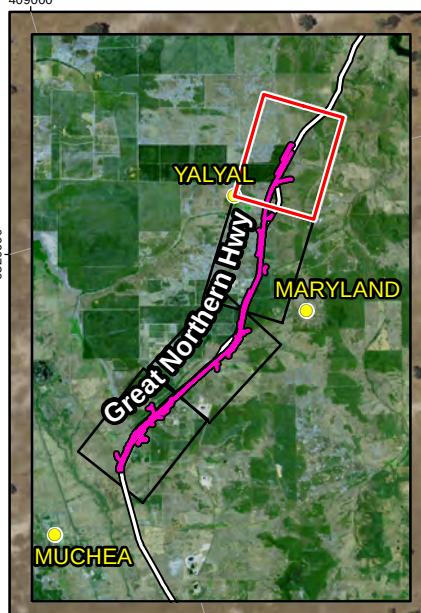

Sandalford Dr
53
52
51
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Great Northern Hwy
Maddern Rd
YALYAL
PRELIMINARY PLAN ONLY

Legend

- Straight Line Kilometre Marker (1km)
- Town
- Muchea North Alignment
- Existing GNH Alignment
- Freeway / Highway
- Minor Road
- NVCP Application Area

Data Source: Main Roads WA, Landgate

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Metres

Scale at A3
1:10,500

Coordinate System: GDA 1994 MGA Zone 50

Main Roads Western Australia
Client

Great Northern Highway
Muchea to Wubin Upgrade Stage 2
Project

Threatened Ecological Communities Map 1 of 4

Drawing No	Issue
GNH-CN03-EN01-GIS-0043	B

Task No	Drawing Status / Other
GNH-1329	Draft

Date	By	Chkd	Appd
11/04/2017	SR	CG	XX

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