

## 4.4 Key Environmental Factor – Inland Waters

The ESD for the Proposal refers to the EPA factors “Hydrological Processes” and “Inland Waters Environmental Quality”. On 27 June 2018, the EPA combined these two factors into the new “Inland Waters” environmental factor. The Proponent has chosen to align the ERD with the current EPA environmental factors and present the information required by the ESD under the heading of “Inland Waters”.

### 4.4.1 EPA Objective

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

### 4.4.2 Policy and Guidance

The following EPA policy and guidance have been considered during the preparation of this ERD and the supporting technical studies:

- Statement of environmental principles, factors and objectives (EPA 2016a)
- Environmental factor guideline – hydrological processes (EPA 2016h)
- Environmental factor guideline – inland waters environmental quality (EPA 2016i)
- Environmental factor guideline – inland waters (EPA 2018b).

Other policy and guidance considered during the preparation of this ERD and the supporting technical studies includes:

- Geomorphic wetlands of the Swan Coastal Plain dataset (DBCA 2016)
- Hydrogeological reporting associated with a groundwater well licence (DoW 2009)
- Stormwater management manual for WA (DoW 2004)
- State planning policy 2.9: water resources (WAPC 2006)
- Guidelines for treatment of stormwater runoff from the road infrastructure (Austroads 2003)
- Roads near sensitive water resources (DoW 2006a)
- Australian and New Zealand guidelines for fresh and marine water quality (ANZECC & ARMCANZ 2000)
- WA environmental offsets policy (Government of WA 2011)
- WA environmental offsets guidelines (Government of WA 2014a)
- WA environmental offsets template (Government of WA 2014b).

### 4.4.3 Receiving Environment

#### 4.4.3.1 Soil Landscapes

As the soils of the Development Envelope are generally deep sands, infiltration rates are anticipated to be high and, correspondingly, runoff low.

#### Acid Sulfate Soils (ASS)

The Australian atlas of acid sulfate soils (ASS—ASRIS 2011) shows that the majority of the Development Footprint is located in areas with extremely low probability (1-5%) of occurrence of ASS. However, there is a small section of the Development Footprint near the Bindoon-Moora Road interchange that is categorised as having low probability (6-70%) of occurrence of ASS, likely to be associated with wetlands identified in this area (**Chapter 4.4.3.3**). An isolated area with a high probability (< 70% chance) of ASS occurrence is located within the project area at Lake Nangar near Mooliabeenee Road (**Figure 4-20**). These soils are classified as potential

ASS (PASS) as they have the potential to oxidise, but oxidation has not occurred. PASS are sensitive to changes in groundwater levels and disturbance which can occur during construction activities.

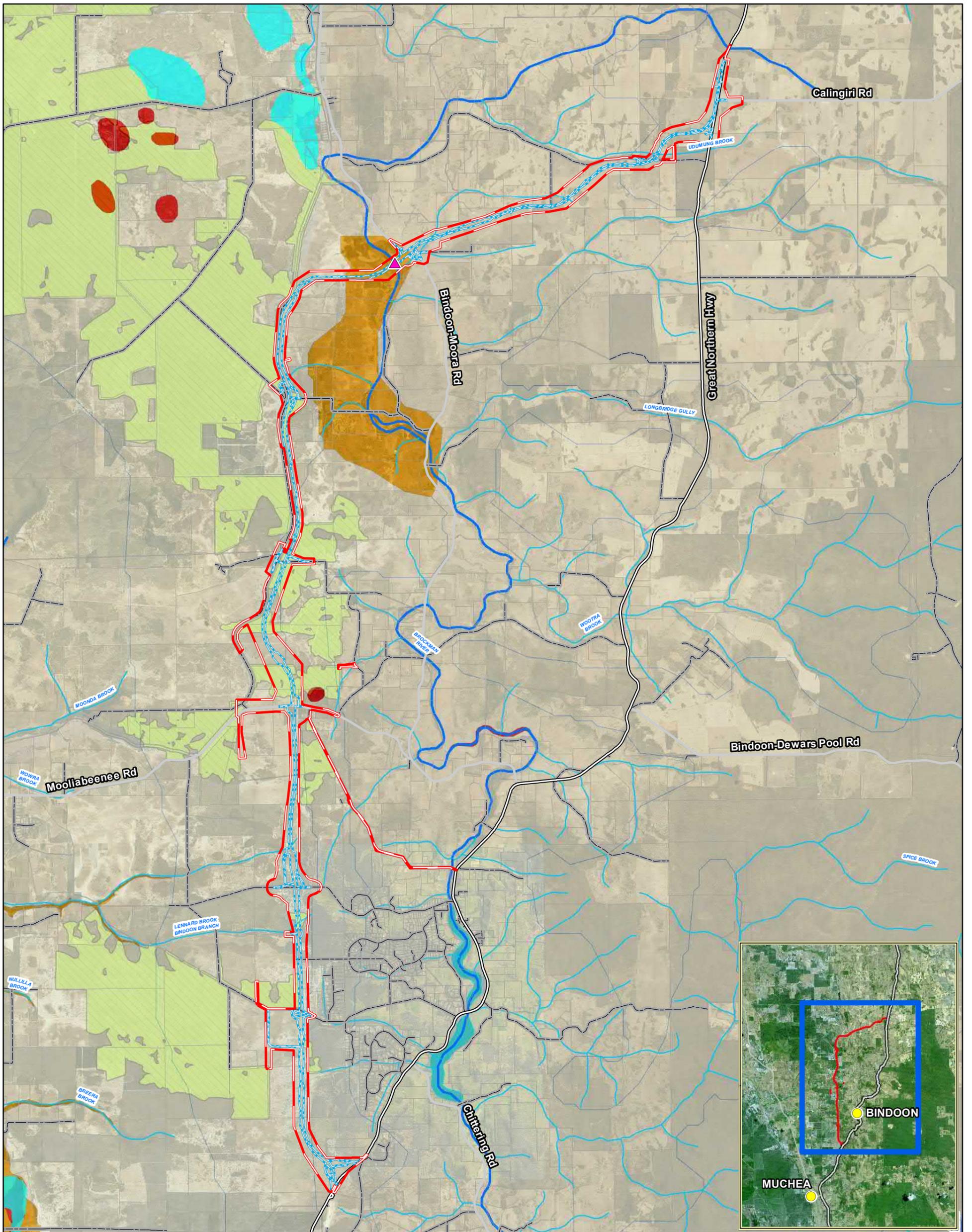
### Salinity

A report card completed by the DPIRD shows that the Development Envelope covers two expanses of mapped salinity risk: the Dandaragan Plateau and the Eastern Darling Range. The Dandaragan Plateau is identified as an area at high risk of dryland salinity expansion, where recent trends indicate the condition is degrading due to rising groundwater levels and the high quality of agricultural land available (Simons, George & Raper 2013). Superficial soils in the Development Envelope have been heavily modified through agricultural practices. The Eastern Darling Range was identified as being at moderate risk of dryland salinity expansion where generally stable groundwater levels were observed (Simons, George & Raper 2013). Soil salinity levels are of consideration for the construction phase of the Proposal.

Limited groundwater salinity data available from bores within the Bindoon area indicates that the groundwater quality varies from fresh to saline, where the majority of results are less than 3000 mg/L—i.e. non-saline. These results are limited in their quantity and spatial extent, where the closest location is approximately 9 km from the Development Envelope. Generally, for aquifers within the Perth basin, the groundwater salinity increases in the direction of flow (typically southwards in the Development Envelope) and with depth in the aquifer (Appleyard 2003). The Gingin groundwater allocation plan (DoW 2015) provides the total dissolved solids (TDS) typically encountered within the aquifers located in the project area and are presented in **Table 4-34**.

**Table 4-34: Extract of Typical TDS of Groundwater Aquifers within the Development Envelope (DoW 2015)**

Aquifer	TDS (mg/L)	General Classification
Surficial	< 1000	Fresh
Mirrabooka	< 1000	Fresh
Fractured rock	Variable	Variable
Leederville – Parmelia	< 1000	Fresh



**Legend**

- Development Envelope
- Development Footprint
- ▲ Proposed Bridge
- Cadastral Boundary
- Highway
- Major Road
- Minor Road
- Major Watercourse
- Minor Watercourse
- Directory of Important Wetlands in Australia
- Australian Acid Sulfate Soils**
- Probability of Occurrence**
- A: High; >70% chance (13)
- B: Low; 6-70% chance (3)
- C: Extremely Low; 1-5% chance (4)
- Banksia Woodlands Patch



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0 1,250 2,500  
Metres

Coordinate System: GDA 1994 MGA Zone 50

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Client: **Great Northern Highway Bindoon Bypass**

Project: **Environmental Review Document**

**Acid Sulfate Soil Risk Areas in the Development Envelope**  
Figure: 4 - 20

Drawing No <b>GNH-CN12-EA-PER-0001</b> 4-20	Issue <b>1</b>		
Task No <b>ERD</b>	Drawing Status / Other <b>Draft</b>		
Date <b>13/03/2020</b>	By <b>BG</b>	Chkd <b>LB</b>	Appd <b>TJ</b>

#### 4.4.3.2 Groundwater

##### Groundwater Aquifers and Yields

Four aquifers are present within the study area (DoW 2015):

- an unconfined surficial aquifer
- the Mirrabooka semi-confined aquifer west of the Darling Fault
- a fractured rock aquifer east of the Darling Fault
- the semi-confined Leederville-Parmelia aquifer.

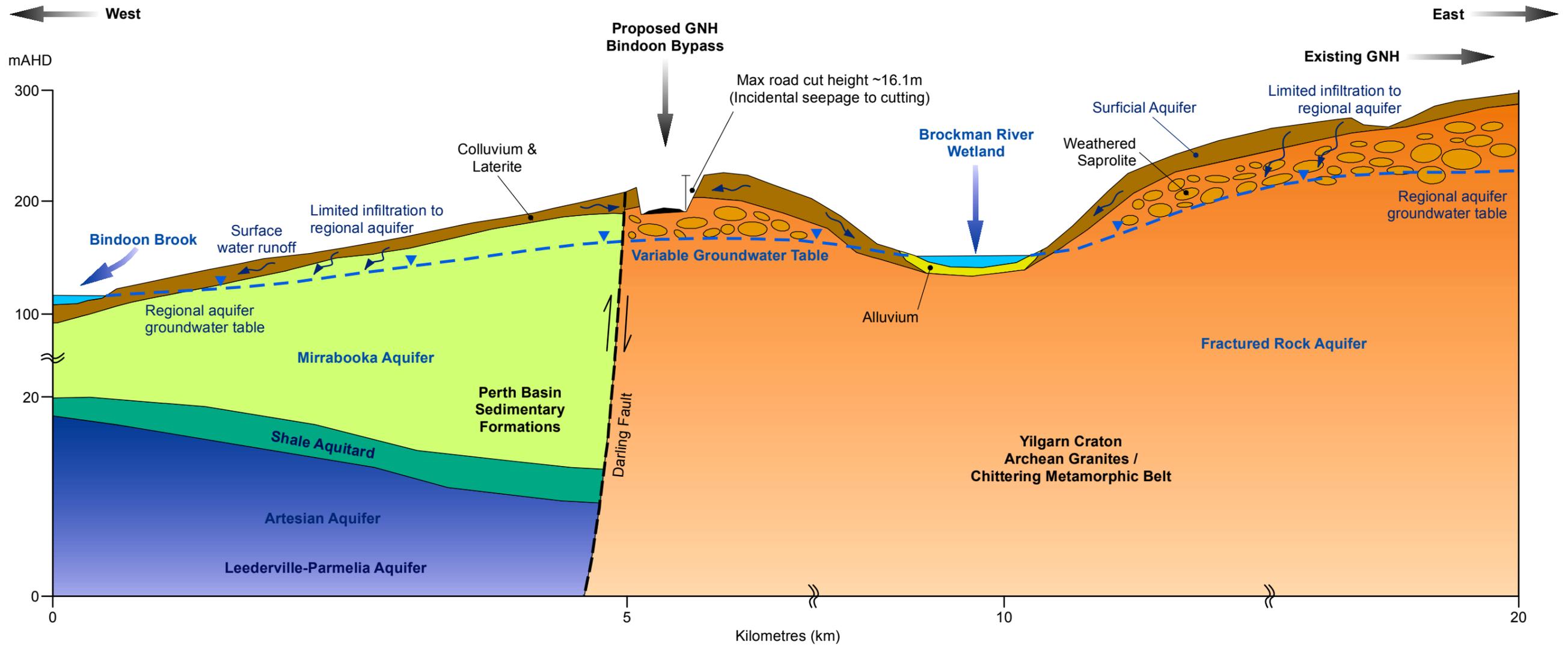
It is anticipated that the Proposal will primarily interact with the superficial, Mirrabooka and fractured rock aquifers, with possible indirect impacts to the Leederville-Parmelia aquifer. An excerpt of the Perth Basin stratigraphy and corresponding aquifers is shown in **Figure 4-21**. Of the four aquifers present, the Leederville-Parmelia aquifer generates the best bore yields with up to 3000 kL/day of fresh groundwater.

The surficial aquifer in the Bindoon area comprises colluvium and lateritised soil profiles, including a combination of colluvial and lateritic clays, sands, ferricrete and gravels that are intersected by alluvial deposits associated with natural drainage lines. The extent and thickness of the sand, gravel and clay deposits in the valleys are variable. The surficial aquifer tends to be thickest in the Brockman River valley and very thin, if present, along the tributaries of the Brockman River (Smith 2002). The aquifer is therefore thin and often unsaturated (DoW 2015) within the study area. Surface expressions of the aquifer include the wetlands and lakes that are common in the vicinity of the Proposal (shown previously in **Figure 2-11**). Yields from the surficial aquifer are typically small—less than 100 kL per day.

The Mirrabooka aquifer is comprised of the Lancelin Formation, which includes variably lateritised glauconitic sands and clays, and the Osbourne Formation, which includes glauconitic siltstone, claystone, shale and sandstone, where the Kardinya Shale Member acts as a basal aquitard (Commander 2003; Geological Survey of Western Australia 1978). The aquifer is hydraulically connected to the surficial aquifer and is recharged in the north of the Perth Basin (Commander 2003). The Mirrabooka aquifer contributes to the summer flows in the headwaters of the Gingin Brook and maintains summer flows in the Moore River (DoW 2015). The aquifer is partially saturated, variable in thickness and is connected with the shallow water table in certain areas. As the aquifer's thickness is variable, yields from the Mirrabooka aquifer vary from location to location (DoW 2015).

The fractured rock aquifer comprises fractured and weathered crystalline bedrock with small groundwater storage capacity (DoW 2015). Low groundwater yields can be obtained from the base of the weathered zone in the saprolite, generally at approximately 25 m depth; however, water-bearing fractures in the granitic rock are widely spaced and springs can occur below the laterite (Commander 2003). It is anticipated that the aquifer is recharged by the surficial aquifer.

The Leederville-Parmelia aquifer is an interconnected aquifer of the Leederville Formation and Parmelia Group comprising of sandstone and shale aquitards, which is semi confined and recharged by the Gngangara mound approximately 15 km west of the Development Envelope before becoming confined to the south of the Gingin proclaimed groundwater area (DoW 2015). The Leederville aquifer is also referred to as the 'shallow artesian aquifer' and is used for public water supply (Commander 2003). Similar to the Mirrabooka aquifer, the Leederville-Parmelia contributes to the baseflow of the Gingin Brook and is important for maintaining summer flow in the Moore River (DoW 2015). The bores supplying water to the town of Bindoon draw water from the Leederville-Parmelia aquifer and report yields of 1360 kL/day.



**PRELIMINARY PLAN ONLY**

- Legend**
- Conceptual hydrogeology
- Surface Water
  - Weathered Saprolite
  - Alluvium
  - Shale Aquitard
  - Surficial Aquifer
  - Leederville-Parmelia Aquifer
  - Mirrabooka Aquifer
  - Fractured Rock Aquifer
  - Fault
  - Groundwater Level (GWL)

Data Source: Anup 2017

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**Figure A-10  
Conceptual hydrogeological model**

Drawing No <b>GNH-CN12-RW01-GIS-0017</b>	Issue <b>C</b>		
Task No <b>1717</b>	Drawing Status / Other <b>Draft / Other Info</b>		
Date <b>7/12/2017</b>	By <b>BS</b>	Chkd <b>XX</b>	Appd <b>XX</b>

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## Groundwater Quality

Limited groundwater quality testing is available for the aquifers in the study area. The Chittering borefield abstracts groundwater from the Leederville aquifer to supply town water to Bindoon and Chittering. Groundwater from the Leederville aquifer is currently used by the Water Corporation, industry and local government for public water supplies, irrigation, horticulture and industry and these uses will continue into the future (Department of Health et al. 2013). An extract from the aesthetic and health-related detections for raw water from this supply, based on the 2004 Australian Drinking Water Guidelines (ADWG—NHMRC 2004), are presented in **Table 4-35**.

The raw water from Chittering borefield is of fair quality, with the exception of high iron and manganese concentrations, pH and turbidity. Colour and turbidity in the raw water are occasionally above the ADWG value due to the precipitation of iron. pH levels are occasionally more acidic than the ADWG aesthetic level after treatment, with no threat to human health (DoW 2007).

**Table 4-35: Extract of Groundwater Quality Data for the Chittering Borefield (DoW 2007)**

Parameter	Unit	ADWG value	Chittering Borefield Raw Source	
			Range	Median
Aluminium unfiltered	mg/L	N/A	<0.008 – 0.032	<0.008
Chloride <sup>5</sup>	mg/L	250	145 – 160	152.5
Colour – True	TCU	15	<1 – 10	2
Conductivity at 25 °C	mS/m	N/A	51 – 89	56
Hardness as calcium carbonate	mg/L	200	45 – 48	46.5
Iron unfiltered	mg/L	0.3	3.2 – 13	7.5
Manganese unfiltered	mg/L	0.1	0.055 – 0.18	0.101
pH	-	6.5 – 8.5	5.73 – 6.16	5.94
Sodium <sup>1</sup>	mg/L	180	82 – 86	84
Sulfate <sup>1</sup>	mg/L	250	18	18
Total filterable suspended solids <sup>1</sup>	mg/L	500	334 – 350	342
Turbidity	NTU	5	<0.1 – 90	0.6
Barium <sup>1</sup>	mg/L	0.7	0.03 – 0.035	0.03
Baron <sup>1</sup>	mg/L	4	<0.02 – 0.034	0.03
Fluoride	mg/L	1.5	0.3 – 0.35	0.325
Manganese unfiltered	mg/L	0.5	0.055 – 0.18	0.101
Nitrate as nitrogen <sup>1</sup>	mg/L	00.29	0.039 – 0.21	0.1245
Nitrite as nitrogen <sup>1</sup>	mg/L	0.91	0.007 – 0.011	0.009
Sulfate <sup>1</sup>	mg/L	500	18	18

<sup>5</sup> Limited sampling available

## Groundwater Users

A search of the DWER’s Water Information Sites dataset of groundwater bores in WA was conducted for a 2 km buffer of the Development Envelope, resulting in 81 bores being identified (**Figure 4-22**). The bores are owned by a variety of asset owners including state government, commercial, agriculture, private owners and a number that currently have no owner identified. The purposes of the bore installations included household/domestic use, production, irrigation, livestock, exploration and monitoring. These bores are important at both a local and regional level for water supply.

The DWER has designated a wellhead protection zone around the Bindoon-Chittering water reserve. The 300 m wellhead protection zone is intended to protect the drinking water from contamination and is proclaimed under the *WA County Areas Water Supply Act 1947*. The Development Envelope is approximately 600 m east of the wellhead protection zone boundary, and there are no other known operational water supply bores within 2 km of the Development Envelope.

## Groundwater Allocation Plan

The north-south alignment of the Development Envelope (south and west of Bindoon-Moora Road) is located within the Gingin groundwater allocation plan area (DoW 2015). The plan covers all four aquifers described in **Table 4-34**. The allocation limits assigned by the plan for the surficial, Mirrabooka and Fractured Rock aquifers are presented in **Table 4-36**.

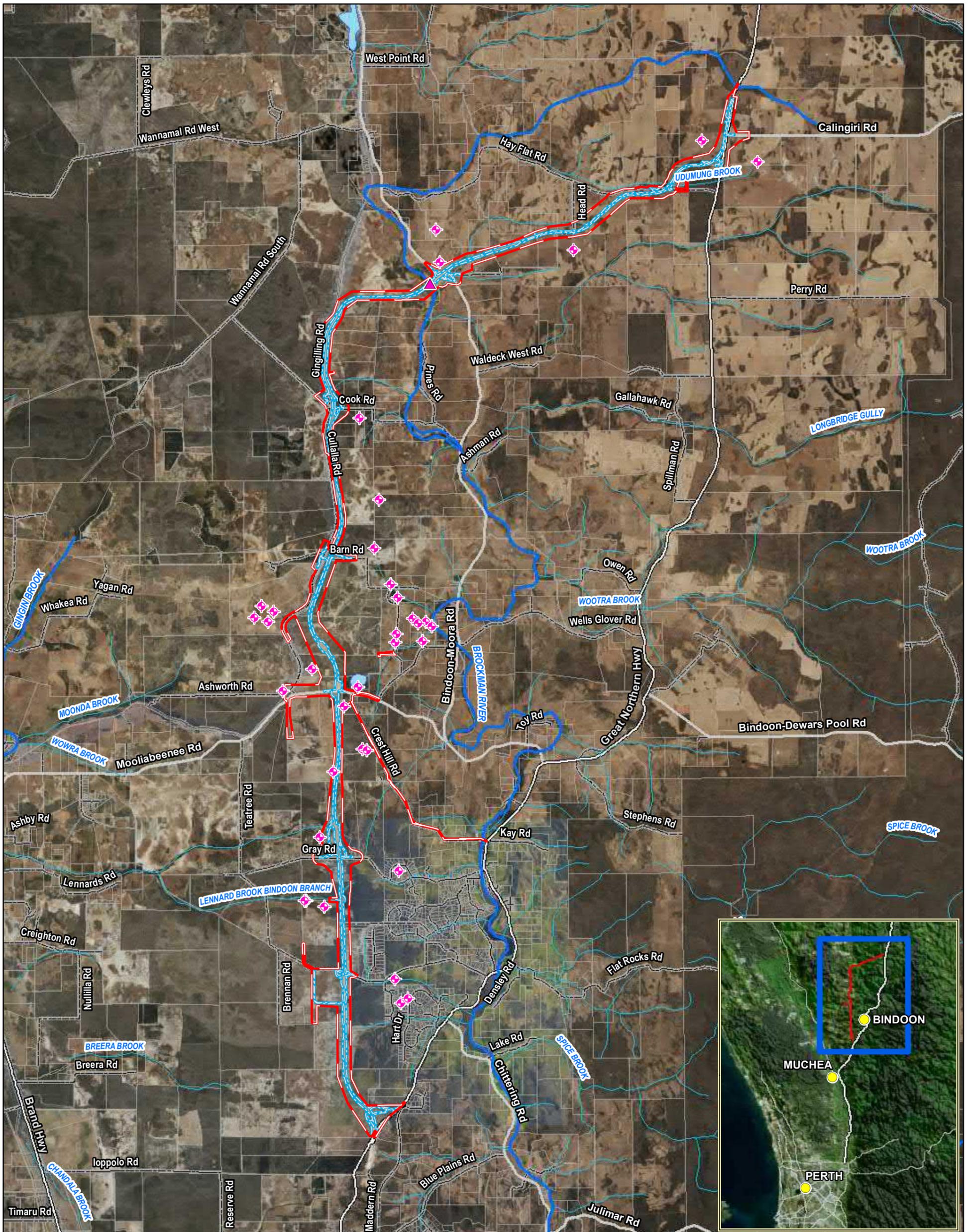
**Table 4-36: Allocation Limits for the Gingin Plan Area (Department of Water, 2015)**

Plan Sub-area	Aquifer	Allocation Limit Components (ML/year)				
		Total Allocation Limit	Licensable Allocation		Unlicensable Allocation	Reserved Allocation
			General	Public Water Supply	Exempt	Public Water Supply
Bindoon	Surficial	2400	1925	0	475	0
Central scarp	Mirrabooka	1500	1135	0	365	0
	Fractured rock	50	50	0	0	0
Southern scarp	Mirrabooka	800	285	0	515	0
	Fractured rock	50	50	0	0	0

Groundwater remaining in the aquifers after the allocation limits were set is to support groundwater dependent environments and social values, baseflows in the Gingin Brook and Moore River and protect aquifers from seawater intrusion (DoW 2015). The estimated percentage of recharge left in these aquifers is provided in **Table 4-37**.

**Table 4-37: Excerpt of Percentage of Recharge Retained in Aquifers within the Gingin Plan Area (DoW 2015).**

Aquifer	Percentage of Recharge Left in the Aquifer
Surficial	20
Mirrabooka	80
Leederville – Parmelia	10



**Legend**

- Development Envelope
- Development Footprint
- ▲ Proposed Bridge
- ◆ WIN Sites
- Highway
- Major Road
- Minor Road
- Cadastral Boundary
- Major Watercourse
- Minor Watercourse
- Lake

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**Great Northern Highway Bindoon Bypass**  
 Environmental Review Document

Locations for Inclusion of Fauna Underpasses in Detailed Design

Figure: 4- 22

Drawing No GNH-CN12-EA-PER-00001 - F4-22	Issue 1
Task No ERD	Drawing Status / Other Draft
Date 22/08/2019	By BG
Chkd LB	Appd TJ

#### 4.4.3.3 Surface Water and Wetlands

The Bindoon Bypass is mainly located within the Swan river system and borders the Gingin Brook catchment area in the north-west portion of the proposed alignment, both of which are proclaimed *Rights in Water and Irrigation Act 1914* (RIWI Act) surface water areas.

The Development Envelope traverses three river catchments: Brockman River, Gingin Brook and Ellen Brook. The majority of the Development Envelope is in the Brockman River catchment, with smaller sections in the Gingin Brook and Ellen Brook catchment areas. Within these river catchments the Development Envelope crosses two surface water features: Brockman River (and its tributaries, the most significant of these being Udumung Brook) and Lennard Brook. The Brockman River that runs sub-parallel to most of the proposed alignment is a tributary of the Avon River and ultimately the Swan River which flows through the centre of the Perth metropolitan area. Gingin Brook is a tributary of the Moore River located west of the project area. Both river systems provide economic and environmental benefits in their catchments for tourism, agriculture and groundwater-dependent ecosystems.

Water flows in the Brockman sub-catchments are generally in an easterly direction relative to the north-south section of the proposed alignment. Flow is typically in a westerly direction relative to the alignment, where the alignment runs approximately west-east. Water flows in the Gingin Brook sub-catchments are generally in a westerly direction.

There are two wetlands listed in the Directory of Important Wetlands of Australia within the Bindoon area (DoEE 2005). The Wannamal Lake System is located approximately 3.5 km north-west of the Development Envelope and the Chittering-Needonga Lake System is approximately 3.8 km east of the Development Envelope.

Ten wetlands defined by the DBCA's *Geomorphic wetlands of the Swan Coastal Plain* dataset (2016) occur within or adjacent to the Development Envelope, including three conservation category (CC) wetlands which form part of the Brockman River consanguineous suite. These wetlands are detailed in **Table 4-38**. These wetlands, along with the other water features within or adjacent to the Development Envelope, are shown previously in **Figure 2-11**.

**Table 4-38: Geomorphic Wetlands within or Adjacent to the Development Envelope**

Wetland (UFI <sup>1</sup> )	Management Category	Wetland Type	Area (ha)
12840	CC wetland (Brockman River)	Floodplain	56.02
12838	Resource enhancement (RE) wetland (Brockman River)	Sumpland	12.68
12762	Multiple-use (MU) wetland (Brockman River)	Palusplain	75.08
12841	MU wetland (Brockman River)	Dampland	50.77
12839	RE wetland (Brockman River)	Palusplain	71.60
12777	CC wetland (Lake Nangar)	Sumpland	18.43
12776	RE wetland	Sumpland	2.83
12778	MU wetland	Palusplain	6.84
12779	CC wetland (Teatree Road)	Floodplain	5.15
15154	CC wetland (Teatree Road)	Palusplain	30.30

<sup>1</sup> unique feature identifier

Surface water in the Bindoon area is predominantly used for irrigating agricultural or horticultural land and for domestic purposes. Most of the water users take water by direct pumping, with some users having dams to capture winter flows. A water resource allocation plan has been developed for Brockman River to maintain reliability of the current supply. For Lennard Brook, the allocation is regulated by the Gingin surface water allocation plan (DoW 2011). Allocation limits for Lennard Brook and Brockman River are shown in **Table 4-39**.

These limits demonstrate the importance of maintaining reliability of current supply levels within the local area and region as a whole, and minimising risk to the riverine environment.

In the future, it is expected that rainfall levels and groundwater discharge—which maintains summer flow—will continue to decline. This will impact the reliability of supply for current and future water users, as well as the ecological and social values associated with the resource (DoW 2011).

**Table 4-39: Allocation Limits for the Brockman River and Lennard Brook**

Resource	Allocation Limit (kL/year)	Allocation Limit Components (kL/year)	
		Unlicensable (Exempt Use, including Riparian Rights)	Licensable (General Licensing)
Brockman River	481 890	18 000	463 890
Lennard Brook	2 434 310	25 000	2 409 310

### Studies and Survey Undertaken

Surface water (other than wetlands) has been assessed through desktop studies only. Desktop studies used information from previously published surface water studies relevant to the study area, as well as data from two DWER monitoring stations. The DWER monitoring stations that have been used are Tanamerah (616006), which is located upstream of the town of Bindoon, and Yalliwirra (616019), which is located close to the confluence of the Brockman and Avon Rivers (**Figure 2-11**).

Wetlands within the study area have been assessed using both desktop and field studies. Desktop studies reviewed publically available databases, relevant spatial data and web-based mapping tools, including:

- a review of DBCA geomorphic wetlands database to identify the current boundary, geomorphic category classification (wetland type) and management category as recorded in the Swan Coastal Plain dataset (DBCA 2016)
- hydrology data (as available)
- geology and soil data (regional data)
- vegetation data (regional data, previous field surveys and other sources).

Field surveys for wetlands were undertaken in conjunction with flora, vegetation and fauna surveys discussed in **Chapter 4.2** and **Chapter 4.3**. An additional survey of the wetlands near the intersection of Bindoon-Moora Road and the Development Envelope was undertaken in mid-November 2017. This survey focused on soil and vegetation sampling within wetland areas to define the wetland boundaries and confirm their characteristics.

### Surface Water Flow

Surface water flows of the Brockman River are measured by two DWER-managed flow gauges. The upstream flow gauge, Tanamerah (616006), is located a few kilometres upstream of the town of Bindoon; the second flow gauge, Yalliwirra (616019), is situated close to the confluence with the Avon River. Data from these gauges are highly variable, but show that surface water flows have been reducing over the past ten years due to a decline in groundwater contribution, rather than a decline in rainfall, which appears to be less variable from year to year (DoW 2010). Flows throughout the year are variable, with the highest flows occurring within the winter months and the river ceasing to flow during summer months in certain sections. This cessation is due to an increase in summertime abstraction for the irrigation of orchards, vineyards and wine grapes, and for domestic purposes.

Surface water flows at Lennard Brook have been determined using previously published data. These data show that Lennard Brook has similar flow trends to Brockman River, particularly in terms of mean annual flows being below the long-term average and trending downwards over the past ten years. However, Lennard Brook

experiences less seasonal variance than Brockman River as it is fed by groundwater, and therefore does not cease to flow during summer months (Tuffs 2010).

For detailed surface water flow information refer to the surface water report attached at **Appendix F**.

## **Surface Water Quality**

### *Stream Salinity*

For the Brockman River and its tributaries, salinity (as electrical conductivity—EC) has been measured at the Tanamerah flow gauge since 1991. These data show that the river is brackish to saline with higher salinity levels during the summer. The average EC is 6.3 mS/cm, which is consistent with a long-term stream salinity assessment conducted by Mayer, Ruprecht and Bari (2005) that estimated the mean annual TDS of 3400 mg/l. A study by Angell (2000) suggested that salinity of the Brockman River is contributed to by saline groundwater sources. The groundwater technical investigation undertaken for the Proposal highlighted that the groundwater salinity varies from saline to fresh within the project area (**Appendix G**).

Salinity at Lennard Brook was studied by the DoW (2012) between February and April 2011. This report found that salinity levels are marginal with EC measurements being below 1.5 mS/cm.

### *Heavy Metals*

There is limited heavy metal data available for Brockman River with the most representative information being provided by a water quality snapshot program conducted by the Ellen Brockman Integrated Catchment Group (EBICG—2015a). EBICG sampled for aluminium, arsenic, chromium, copper, lead and zinc at two sites along Brockman River and five sites along tributaries of the Brockman River on 7 August 2014 and 19 September 2014. The results of the EBICG program were assessed against guidelines for freshwater quality (ANZECC & ARMCANZ 2000). It was found that concentration of arsenic, chromium and lead were below the freshwater quality trigger values on both sampling occasions for all monitoring sites. However, copper and zinc were reported to exceed the trigger values at one location in the Marbling area, one of the tributaries of the lower Brockman River, approximately 12 km south-southeast and downstream of the Development Envelope. Aluminium was found to exceed freshwater quality trigger values for both sites at Brockman River, at its tributaries at Aquila (approximately 2.5 km east and downstream of the Development Envelope) and Marbling (GNH IPT 2018a).

No data is available for heavy metal concentrations at Lennard Brook (EBICG 2015b), as it was not considered a strategic sampling site during the abovementioned water quality program.

### *Nutrients*

The EBICG also reported on sampling of total nitrogen (TN) and total phosphorous (TP) at Brockman River (2015a) and Lennard Brook (2015b) in 2014. Samples were taken from 26 sites along Brockman River and its tributaries on 7 August and 19 September 2015, and samples were collected on four occasions at Lennard Brook between June and September 2014. Five of these sites were located along the main stem of the Brockman River. Samples at four of the five sites exceeded the freshwater guideline trigger values for TN in August, while none of the sites exceeded trigger values in September. No samples exceeded the freshwater trigger levels for TP (EBICG 2015a).

At Lennard Brook, all samples exceeded the freshwater trigger levels for TN and TP (EBICG 2015b). Average TN across the samples was 3.8 mg/L and average TP was 0.19 mg/L. On the majority of sampling occasions, most sites were consistently above the freshwater quality guideline value of 1.2 mg/L of TN for lowland river systems and ecosystem health. Lennard Brook is located downstream of agricultural areas where runoff of nutrients is common due to poor-quality soils. The majority of sites were also consistently higher than the TP guideline value of 0.065 mg/L on all four sampling occasions. Similar to TN, there appears to be a general trend in the data showing that sub-catchments to the west of the Ellen Brook have higher levels of nutrients in the runoff than those to the east, due to changes in soil type (EBICG 2015b).

## *Sediments*

Total suspended solids (TSS) is an indicator of sediment levels in water. There is currently no freshwater guideline for TSS, but an interim trigger value was developed by Water and Rivers Commission (2000) for the Wilson Inlet report to community, and this value of 6 mg/L has since been adopted by DWER as an interim trigger value.

The EBICG also reports on TSS at Brockman River (2015a) and Lennard Brook (2015b). In the absence of more recently TSS data the EBICG studies have been used as indicators of TSS levels. EBICG results showed that four of the five sites at Brockman River exceeded the guidelines value of 6 mg/L for TSS (2015a). This was potentially due to stock access to waterways, lack of riparian vegetation and high levels of cleared vegetation in the catchment. Results from the Lennard Brook sampling showed that in all but one instance TSS remained below the 6 mg/L trigger value (2015b).

### **4.4.4 Potential Impacts**

#### **4.4.4.1 Groundwater**

The following groundwater impacts may occur through implementation of the Proposal:

- changes to groundwater levels, flow, connectivity and groundwater storage, particularly due to the influence of road cuttings, fill areas and subsurface compaction
- temporary changes to groundwater quality from:
  - ▶ accidental spills and leaks from construction plant, machinery and equipment
  - ▶ dewatering and/or excavation exposing PASS
  - ▶ drainage maintenance issues and polluted surface water runoff entering groundwater systems
  - ▶ water usage practices on site
  - ▶ excavation across aquifer boundaries leading to cross contamination of aquifers
- impacts to groundwater users.

#### **4.4.4.2 Surface Water and Wetlands**

The following impacts to surface waters and wetlands may occur through implementation of the Proposal:

- changes in surface water runoff volumes due to increased impervious areas
- changes in water quality during construction due to disturbance of PASS, transportation of sediments from exposed soils, discharge of groundwater abstracted during construction activities (e.g. from bridge construction or excavation for cuttings) and accidental spills of construction related chemicals
- changes in surface water flow paths/hydrological regimes due to construction of road embankments or other permanent structures
- changes in water quality during road operation from surface runoff, transporting pollutants discharged to the road surface (e.g. fuel, litter, heavy metals from brake pads).

The location of the proposed Brockman River bridge and adjacent wetland is shown in **Figure 4-23**. This figure will be referred to throughout the following impact assessment.



**Legend**

- Bridge Location
- Bindoon Bypass Design
- Cadastral Boundary
- Major Road
- Minor Road

**Geomorphic Wetlands Swan Coastal Plain**

- Conservation
- Multiple Use
- Resource Enhancement

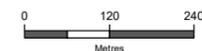


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Scale at A3  
**1:10,000**

Coordinate System: GDA 1994 MGA Zone 50



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Great Northern Highway  
 Bindoon Bypass  
 Environmental Review Document

**Regional and Local Ecological Linkages**

Figure: 4-16

Drawing No  
**GNH-CN12-EA-PER-00001**  
 - F4-16

Issue  
**1**

Task No  
**ERD**      Drawing Status / Other  
**Draft**

Date	By	Chkd	Appd
13/03/2020	BG	LB	TJ

#### 4.4.5 Assessment of Impacts

##### 4.4.5.1 Groundwater

#### Site Preparation and Cut/Fill Areas

The Proposal has road cuttings and fill areas up to 16.1 m and 17.2 m in height respectively. Preparation of the cut and fill foundations will include surface compaction of materials, which may use suitable existing in-situ material or imported engineering fill (where in-situ material is not suitable). This preparation phase is likely to increase areas of low permeability of the road foundation relative to the existing sub-surface, which may result in the reduction of surface runoff infiltrating the surficial aquifer.

Localised consolidation (compaction) of the surficial aquifer can be caused by the placement of temporary and permanent fill during the construction period. In turn, this can increase or reduce groundwater flow rates, redistribute flow paths and affect the connectivity of the local surficial aquifer to the regional aquifer. These impacts depend on the material used, the level of compaction and the depth of the surficial aquifer.

Where there are deep sands present beneath the Swan Coastal Plain area of the Development Envelope, little impact from compaction and fill activities on hydraulic conductivity is expected. Low hydraulic connectivity is predicted in clay areas, with resulting low infiltration rates from localised consolidation. In areas of no infiltration there will be no impact. It should be noted that the exact locations of construction water sources are not yet known and will be identified as part of project startup.

Groundwater resources within the area that also coincides with the EPBC Act listed Banksia Woodlands TEC are managed under the Rights in Water and Irrigation Act 1914 (RIWI Act) and therefore approval and licencing to abstract groundwater is required. Licences are assessed on a case by case basis by DWER with assessment undertaken in accordance with the requirements of the Gingin groundwater allocation plan (DoW, 2015). This plan includes a requirement to protect groundwater dependant ecosystems from over-abstraction.

Groundwater required during construction of the proposed action will therefore be taken either from already licenced bores or will require applications for permits and licencing if new bores are required. Where water is taken from existing bores, abstraction volumes will not exceed the licenced volume.

#### Dewatering and Road Cuttings

Rainfall recharge to the surficial aquifer, particularly in winter months, has the potential to result in the groundwater table becoming temporarily raised and the surficial aquifer seeping from the cut faces. It is unlikely, however, that any cut will go below the historical maximum groundwater levels.

Where local fractured rock aquifers occur, common construction practice is to capture the seepage in the temporary construction drainage network, which can then be reused on-site or treated and disposed of in the correct manner. When cuts are made within sand, this practice will not be required. Construction practices are discussed in greater detail in **Chapter 4.4.6**.

Groundwater dewatering will be required to facilitate the construction of a bridge over the Brockman River, where the groundwater levels are relatively close to the surface and will interfere with construction activities. This will result in temporary lowering of groundwater levels, though this is anticipated to be localised and within the seasonal variability of groundwater levels.

#### Groundwater Quality

It is considered unlikely that any additional water required for construction activities (such as dust suppression or sub-surface drilling) will affect the surficial aquifer, due to the limited extent and duration of these activities.

Hydrocarbon spills or leaks during construction have the potential to contaminate the surficial aquifer and regional aquifers if left untreated. Depending on the hydrocarbon type, this contamination may float on top of the

groundwater table or sink to the base of the regional aquifer. Spill response mechanisms will be employed during construction activities to prevent any spills from entering the groundwater table.

The potential for aquifer cross-contamination is dependent on the depth of excavation, with no cuts predicted to occur in the rock containing the surficial aquifer. As the surficial aquifer likely drains into the underlying aquifer, it is unlikely that any cuts to rock containing the surficial aquifer would significantly impact the underlying water quality. Surface storages employed during the construction phase are likely to capture any free draining water from the cut, providing minimal opportunity for underlying aquifer infiltration. It is expected that cuts into rock at the surface within the Development Envelope will result in no impact to groundwater quality.

Salinity, cumulative volume required and disposal location need to be considered if groundwater is abstracted and used for construction activities. Limited groundwater salinity data is available for the Development Envelope, but in general the more saline groundwater is expected to occur towards the southern end. If this more saline groundwater is used in areas of lower salinity, the water quality could be affected by the leaching of additional salts (i.e. increased salinity).

### **Acid Sulfate Soils**

Changes to groundwater levels during construction—particularly from temporary activities such as dewatering, excavation, groundwater activities or permanent earthworks—could result in the oxidisation of PASS present in the Development Envelope (**Figure 4-20**). If this occurs, resulting in the creating of actual acid sulfate soils (AASS), acidic groundwater may be released into the environment, potentially impacting vegetation and other groundwater users' ability to utilise their allocated resources. However, the potential for ASS is either very low or low in the Development Envelope (**Chapter 4.4.3.1**).

The proposed road alignment within the Development Envelope is either level with the existing ground surface, or requires fill embankments to maintain the correct geometry in areas with a risk of PASS exposure. With the exception of the Brockman River bridge (see below and **Figure 4-23**), it is unlikely that groundwater levels will be lowered and/or that PASS will be exposed as a result of permanent earthworks (e.g. cuttings).

Dewatering for construction of the Brockman River bridge will be temporary and localised, and will be managed to prevent the long-term exposure of PASS and potential creation of AASS. Once bridge construction is complete, the water table will return to its original level and soils will re-saturate, removing the potential for these soils to oxidise.

### **Groundwater Users**

Abstraction of groundwater for construction purposes may adversely impact other groundwater users by reducing the amount of groundwater available, particularly in the surficial aquifer where yields are typically low. Groundwater abstraction also has the potential to impact the health of groundwater dependent vegetation should abstraction lower the local water table significantly. The dominant Banksia species of the EPBC Act listed Banksia Woodlands of the Swan Coastal Plain TEC are considered to be (at least partially) groundwater dependent (Threatened Species Scientific Committee 2016). Short-term changes to groundwater levels may impact the health of deep rooted Banksia species, leading to the death of these individuals and change in structure of the community. However, this is considered extremely unlikely as high rates of groundwater abstraction within short periods of time are not envisaged as part of construction activities.

Long-term changes in groundwater levels have the potential to change species composition over time, as species better able to cope with the lower groundwater levels replace those that cannot. Where species other than Banksia exploit this, the species composition may change to the extent that it is no longer representative of the TEC. It is predicted that the limited period of construction activities will not result in any long-term changes to groundwater levels.

#### 4.4.5.2 Surface Water

##### Surface Water Flows

Construction of the Proposal may result in the obstruction of, or changes to, natural surface water flow paths. Water movement across the landscape has been taken in account during the concept design phase, particularly for the crossing of drainage lines and in areas where farm dams are in close proximity to the Development Footprint. Road culverts and the Brockman River bridge (**Figure 4-23**) have been designed to maintain existing flow paths and regimes. Sizing of culverts for minor watercourse crossings is based on peak flows for 20 and 50-year annual recurrence interval (ARI) events for side-roads and the highway respectively. The preferred minimum sizing for culverts is 600 mm-diameter reinforced concrete pipe culverts and 1,200 mm by 375 mm reinforced concrete box culverts. It is expected that obstruction of, or changes to, natural flow paths as a result of culvert installation will be negligible.

The Brockman River bridge will span the main channel and allow flows to proceed unimpeded. A causeway structure is required to span the associated floodplain and wetland. This structure includes a series of culverts which will maintain flows across the extent of the wetland. Analysis of the concept design of the crossing shows that retention times and water levels during a 1 in 100-year average recurrence interval (ARI) event will be similar to that currently experienced (GNH IPT 2017). The final design will ensure that water levels will be no more than 100 mm above current levels while the change in flood extent is negligible (**Figure 4-23**).

Fill embankments and road cuttings have the potential to interrupt overland sheet flows across the Development Envelope, however this is considered unlikely due to the minimal amount of overland flows throughout the project area and the fact that they are considered minor forms of water transport. As the soils of the Development Envelope are generally deep sands, infiltration rates are anticipated to be high and close to source, and correspondingly, runoff low. In the scarp area, the principle water flow is through existing channels (creeks and rivers). In addition, the Development Footprint is mainly located close to the edges of the catchments it crosses. It is therefore expected that any changes to overland flows would be minor, particularly at a catchment scale. Impacts to water inflows to local dams may occur where these dams are reliant on overland sheet flow.

Where the Proposal is alongside the existing railway, there is unlikely to be any additional impact above that already resulting from the presence of the railway formation.

Following construction of the proposal, surface water volumes should not increase due to the increase in impervious surfaces associated with the road. Due to the underlying sands, drainage should be directed to basins via swales to infiltrate as close to the source as possible. Given the size of the Brockman River catchment the total runoff from the road will be minor compared to the contribution from the whole catchment. However, it is likely that some small streams close to the Development Envelope may be influenced by increased runoff from time to time.

##### Surface Water Quality

Surface water runoff from rainfall events during construction has the potential to carry pollutants from construction areas to local waterways. As no chemicals will be stored outside of the Disturbance Footprint, the likelihood of surface runoff transporting pollutants to local water ways is considered to be low. High-intensity rainfall events have the potential in result in significant erosion of cleared areas, particularly on steep slopes with loose soil or substrate.

Water quality may also be impacted during operations from contaminated surface runoff from the road. Substances such as litter, nutrients, petroleum products and heavy metals from brake linings, tyres and other motor parts are likely to be discharged along the Bindoon Bypass. These substances will then be transported to the drainage network in runoff and either infiltrated as close to the source as possible or discharged to another water body. The method of infiltration (for example vegetated/grassed swales/verge, soak well type pits or retention/detention basins) is dependent on whether the section of the alignment is kerbed or unkerbed and its location and proximity to sensitive values. Infiltration assists in removal of contaminants through settling, filtering

process and/or biological action prior to discharge to surface waters or the land. Any road drainage that is discharged to another water body will be treated prior to discharge.

## **Dewatering**

Abstraction and disposal of groundwater during construction may have an impact on surface water quality within the Development Envelope, depending on the volume of dewatering required. Release of excess groundwater to surface waters should not be required and should be reinfiltrated where possible. Any release is likely to be for very low flows only. As dewatering is a temporary activity with a short duration, an increase in salinity or the concentrations of other compounds is expected to be temporary. Normal conditions will return following winter rains when flushing of the system and diluting of pollutants and other compounds that have increased in concentration naturally as a result of reduced flows during the summer months will occur.

Large volumes of dewatering may cause temporary variation to stream flows. However, the effect will be temporary in nature and of an insignificant in volume compared to the average flows of the Brockman River (particularly in winter). Should disposal of dewatering discharge to the Brockman River occur, the volumes are expected to be within the seasonal variability of the river.

## **Wetlands**

Accidental spills of hydrocarbons and other chemicals used on site, such as asphalt, diesel, hydraulic fluids and other automotive fluids, may enter local waterways causing pollution in the immediate vicinity and, depending upon the volume of the spill, downstream of the Development Envelope. This could cause negative impacts to the health of downstream ecosystems and wetlands.

As the Wannamal Lake System is located upstream and approximately 3.5 km north-west of the Development Envelope, it is unlikely that any impacts to the wetland will occur as a result of this Proposal.

The Chittering-Needonga Lake System is downstream of the Development Envelope, which crosses waterways feeding into the lake system at two main locations: Teatree Road and the Brockman River Crossing at Wannamal. The Proposal footprint crosses the top edge of the catchment of the Teatree Road wetland and associated watercourse, which flows into the Chittering-Needonga Lake System approximately 4 km to the east (as measured along the watercourse). There are two dams and a broad swamp area along this watercourse which would reduce the flow velocity of surface waters, thereby limiting the potential for any increased sediment loads or accidental spills of pollutants generated as a result of the Proposal to reach the Chittering-Needonga Lake System. Construction activities and related water quality issues such as increased sedimentation, accidental spills of hydrocarbon and potential discharge of highly saline water from dewatering and abstraction to the natural drainage without treatment may impact the Chittering-Needonga Lake System. The Brockman River crossing is located approximate 35 km upstream of the Chittering-Needonga Lake System (as measured along the watercourse). Given this, it is unlikely that any indirect impacts will occur to the Chittering-Needonga Lake System as a result of construction works at the Brockman River crossing.

The Proposal will directly impact five wetlands as defined by the DBCA Geomorphic Wetlands of the Swan Coastal Plain dataset (**Table 4-40**). Impacts to ecological values of these wetlands is addressed in **Chapter 4.2**.

Multiple-use (MU) wetlands retain few ecological functions and attributes, but retain a hydrological function. The MU wetland to be impacted by the Proposal is in cleared farmland and has two small dams within its boundaries. This wetland, like many other MU wetlands, is therefore considered to have low ecological value, and impacts to the wetland are predicted to have no environmental impacts (including hydrological) beyond that detailed in **Chapter 4.2**.

One resource enhancement (RE) wetland (unique feature identifier—UFI—12838) will be directly impacted by the Proposal. This wetland has been significantly impacted and modified by historical clearing. It is actively managed for farming and grazed by sheep and cattle as summer pasture. The area of wetland to be impacted is cleared paddock with no remnant trees. There will be no fragmentation of this wetland as the area impacted is on the edge to the mapped wetland. Impacts to this wetland are not considered significant due to the degraded nature of the wetland and small area impacted (3.39%).

**Table 4-40: Direct Impacts to Geomorphic Wetlands**

Wetland UFI	Wetland Category	Total Wetland Area (ha)	Area within Disturbance Footprint (ha)	% of Wetland Disturbed
12779	CC Wetland (Teatree Road)	5.15	0.34	6.60
15154	CC Wetland (Teatree Road)	30.30	0.13	0.43
12840	CC Wetland (Brockman River)	56.02	1.98	3.53
12838	RE Wetland (Brockman River)	12.68	0.43	3.39
12778	MU Wetland	6.84	0.50	7.31

CC wetland 12840 is associated with the Brockman River and is located at the point where the Proposal crosses the river. Similar to the RE wetland (UFI 12838), this wetland has been highly modified by historical clearing and farm management practices. It is used by the landowner as a summer pasture and the vegetation within the Development Footprint has been mapped as Completely Degraded – Degraded pasture with scattered trees. **Figure 4-24** shows the wetland at the crossing point of the Development Footprint. There is potential for fragmentation of this wetland as this is the location of the Brockman River crossing. Consultation in relation to the Brockman River crossing was undertaken with the Chittering Landcare Centre (R Hindmarsh 2018, pers. comm., 23 January) and the DBCA (R Huston 2018, pers. comm., 14 February). The only concern raised was the potential for increased salinity upstream should the crossing result in damming of river flows. As described previously, the river channel will be spanned by a bridge with causeway sections required to cross the remainder of the floodplain and wetland. These sections will include a series of culverts to maintain water flows and paths. Given the highly modified state of the wetland, the use of culverts to maintain water flows and pathways, and the small area of disturbance in relation to the entire area of the wetland (3.53%) impacts to this wetland are not considered significant.

The two CC wetlands at Teatree Road (UFI 12779 and UFI 15154) are adjacent to each other. The works required within the wetland boundary comprise a tie-in of the new intersection of Teatree Road with the Bindoon Bypass and improving drainage. Drainage improvements are likely to improve the quality of water in the portion of the wetland north of Teatree Road, through improving the flow of water into the rest of the wetland and downstream. Given the small amount of clearing required in CC wetland 15154 and the presence of the existing road, impacts are unlikely to be significant. While 6.6% of CC wetland 12779 will be directly disturbed, the presence of the existing road and likely improvement of wetland functions, particularly for the portion of the wetland north of the road, are considered to reduce the significance of the impacts.

Impacts to CC wetlands are considered to be regionally significant if:

- they reduce the proportion of CC wetlands within any impacted consanguineous suite of wetlands to below 10%
- or
- any CC wetland within a consanguineous suite of wetlands whose proportion of CC wetland is already below 10%.

All three CC wetlands impacted are part of the Brockman River consanguineous suite: over 50% of this consanguineous suite is made of CC wetlands (**Table 4-41**). The impacts to the CC wetlands within the Development Footprint result in a 0.2% reduction in the extent of CC wetlands within the consanguineous suite. As such, impacts to the CC wetlands are not regionally significant.



**Figure 4-24: Photograph of Approximate Location of Wetland Crossing (13 February 2018)**

**Table 4-41: Extent of Proposal Impacts on Consanguineous Suite**

Consanguineous Suite	Impacted CC Wetlands	Total Area CC Wetland in Consanguineous Suite (ha)	% CC Wetland in Consanguineous Suite	Direct loss of CC Wetland from the Proposal (ha)	% CC Wetland in Consanguineous Suite after Proposal
Brockman River	12840, 12779 and 15154	765.9	53.7	2.45	53.5

**Acid Sulfate Soils**

The area of the Brockman River crossing has been mapped as being underlain by soils with low probability of ASS occurrence (6-70%). Dewatering and excavations in this area have the potential to disturb PASS. If ASS are present within the Development Footprint, disturbance will result in negative impacts on water quality. An ASS investigation for the Brockman River crossing will be undertaken during the detailed design phase, in accordance with the DWER’s *Identification and investigation of acid sulfate soils and acidic landscapes* (DER 2015a).

#### 4.4.5.3 Cumulative Impacts

Impacts on the groundwater and surface waters of the Development Envelope and surrounds as a result of the Proposal, are not anticipated to significantly add to the impacts already experienced within the Brockman River catchment or groundwater aquifers. As detailed in the sections above, impacts on the environment are principally attributable to agricultural activities and an increased demand for water resources.

Allocation limits have been set for each of the aquifers in the area (DoW 2015), and any water resources required for construction of the Proposal will comply with the DWER's guidelines, including requirements for licences under section 5C and 26D of the RIWI Act. These processes are expected to manage any cumulative impacts from water abstraction, and allow for maintenance of the environmental water requirements of the Bindoon region.

The Bindoon Bypass is located over 10 km from the Gnangara Groundwater Mound (Perth's drinking water supply) and, given the limited extent of groundwater impacts from this Proposal, will not result in any cumulative impact to this resource. The Bindoon town water supply borefield is located approximately 1 km from the Development Envelope. This borefield draws water from the Leederville aquifer, which is not anticipated to be impacted by the Proposal.

At the time of writing, Main Roads is unaware of any other development proposals within the Brockman River catchment, that could contribute to cumulative impacts on groundwater and surface water in the area.

#### 4.4.6 Mitigation

To reduce the Proposal's impact to existing hydrogeological regimes and quality during construction and operation, the mitigation hierarchy (**Chapter 4.2.6**) has been applied during Proposal design and in the development of appropriate mitigation and management strategies.

##### 4.4.6.1 Groundwater

Dewatering or abstraction activities are expected to result in the most significant changes to the groundwater regime during construction. The main impacts are likely to be in relation to ASS, groundwater-dependent ecosystems (GDEs) and groundwater salinity. Dewatering and abstraction activities have the potential to result in PASS becoming AASS which can result in an impact on GDEs and groundwater quality. In addition, any significant alteration to groundwater levels can result in a degradation of GDEs in the area.

To minimise any impacts on GDEs and PASS, dewatering and abstraction activities should be limited both spatially and temporally, with consideration given to the following during construction:

- the drawdown curve zone of influence
- duration of dewatering
- depth and extent of PASS within the anticipated zone of influence
- distance to GDEs from the abstraction point

An ASS investigation will be undertaken in the detailed design phase to confirm if AASS or PASS occur in the Brockman River bridge area (**Figure 4-23**). Should ASS presence be confirmed within the Disturbance Footprint, an ASS management plan will be developed in consultation with the DWER and in accordance with DWER guidance. Implementation of these management measures will result in negligible risk to soils and terrestrial environmental quality from ASS, in both the short and long term.

Should groundwater extraction be required during construction activities, consideration of source salinity and end-use location will be given. The introduction of salts to groundwater with relatively lower salinity levels may affect GDEs and other groundwater users; therefore, the abstracted groundwater salinity should not be significantly higher than the levels of the groundwater in the area it is to be used.

During the operational phase of the project, it is anticipated that no specific controls will be required for protection of groundwater. Any monitoring implemented during the construction phase should be continued into the operation phase, particularly at sites in close proximity to deep cutting/fill locations, GDEs, significant areas of vegetation clearing or if a local groundwater user has been affected.

While the exact locations of construction water sources are not yet known, abstraction of groundwater for construction purposes will require approval under the RIWI Act. A groundwater operating strategy will also be required for approval by the DWER. In order to avoid construction water abstraction impacts to the EPBC Act listed Banksia Woodlands TEC and all other GDEs, bores will be located such that the potential drawdown below identified occurrences of the TEC is less than 0.5 m, in accordance with ecological water requirements criteria set out by the DWER (DoW 2006b).

#### **4.4.6.2 Surface Waters**

Impacts to surface water within, below and adjacent to the Development Footprint have been, and will continue to be, minimised through the following management actions and design principles:

- The detailed design phase will assess the viability of alignment adjustments and design criteria, such as steepening of cut/fill batter slopes, to minimise the area of CC wetlands impacted.
- Permanent earthworks will not extend below the natural groundwater level.
- Preference will be given to undertaking roadworks on the northern side of Teatree Road to minimise impacts to the CC wetland at this location.
- Where practicable construction of the Brockman River crossing will be scheduled for the drier months of the year (October-April), in order to maximise the depth to groundwater and reduce dewatering requirements.
- Dewatering impact mitigation measures (including ASS and salinity management) will be developed as part of the construction environmental management plan (CEMP) and implemented in support of any application for dewatering works. A groundwater operating strategy will be developed and implemented as necessary to support the supply of construction water.
- Detailed ASS investigations will be undertaken for the Brockman River crossing during the detailed design phase, to confirm the presence/absence of PASS and identify construction management requirements.
- Should AASS or PASS be encountered during the investigation, the ASS management plan prepared in consultation with the DWER shall include impact mitigation measures consistent with the *Treatment and management of soil and water in acid sulfate soil landscapes* (DER 2015b).
- Drainage design standards, through the Proposal's drainage strategy, shall be implemented during detailed design. The objective of the drainage strategy is to maintain drainage across the site to as close to the pre-development condition as practicable. This will be achieved in accordance with the DWER's principles of water resource management, as detailed in the *Stormwater management manual for Western Australia* (DoW 2004) and the *Decision process for stormwater management in Western Australia* (DWER 2017).
- Site-specific erosion and sediment control measures will be developed as part of the CEMP, to minimise environmental impacts of stormwater runoff during construction activities. It may include use of silt fences and sediment traps to prevent soil export to waterways and wetlands, particularly during wet seasons; this will be determined during detailed design.
- All fuels and chemicals will be stored in secure, impervious, bunded areas at least 50 m from drainage lines, in the construction compound. Individual substances will be stored in accordance with the relevant material safety data sheet specifications.
- All relevant construction areas will be equipped with spill kits near construction works, and a spill response procedure will be established for the Proposal.

- A refuelling procedure will be established and implemented for on-site refuelling and refuelling within the construction compound. No refuelling will be undertaken within 50 m of watercourses/waterbodies.
- Additional groundwater salinity testing will be undertaken prior to construction to establish the pre-construction salinity regime.
- Water quality monitoring will be undertaken at the Brockman River crossing and the Teatree Road watercourse to establish a pre-impact baseline.
- A section 17 permit under the RIWI Act (also known as a bed-and-banks permit) will be applied for, seeking approval for river bed and banks works associated with construction of the Brockman River bridge. This application and permit will also address the mitigation of potential direct impacts to wetlands from road construction.
- Water quality monitoring will be conducted at strategic locations prior to construction, throughout the construction period and for a period after project completion (**Appendix F**). The purpose of the monitoring regime will be to assess whether the mitigation and management strategies described herein are effective relative to existing surface water quality.
- The proposed new Brockman River bridge will not exacerbate flooding, as it will be designed to accommodate backwater from a 1 in 100-year ARI event to no more than 100 mm higher than current water levels.
- Swales, and an emergency response procedure, will be implemented during the road operations phase to mitigate water pollution from the road surface.
- The banks of watercourses disturbed by construction will be stabilised and revegetated.

A summary of the predicted impacts, management and mitigation measures, residual impacts on inland waters is provided in **Table 4-42**.

#### **4.4.7 Predicted Outcome**

##### **4.4.7.1 Groundwater**

Construction dewatering and water abstraction may result in localised, temporary drawdown of groundwater levels. Following detailed design and identification of water abstraction locations (where not subject to an existing bore/licence), an investigation into water abstraction requirements will be undertaken to understand the extent and scale of potential impacts to groundwater. Construction water abstraction bores will be sited and operated such that drawdown impacts to GDEs (such as the EPBC Act listed Banksia Woodlands TEC) are within typical seasonal variations of groundwater levels. Any dewatering and groundwater abstraction will be undertaken in accordance with approved licences and associated management plans, including the CEMP.

Hydrocarbon leaks and spills may occur on site; if left in situ, such spills could contaminate groundwater if clean-up or containment procedures are not implemented before a rainfall event. In consideration of the mitigation measures and procedures to be implemented for leaks and spills discussed previously, potential impacts are expected to be minor.

Significant residual impacts on groundwater are unlikely during the operation phase. Contamination could occur in the event of a significant spill from a road user; for example, from a vehicular accident where contamination cannot be prevented from entering the road or natural drainage network, however major incidents are obvious and readily mitigated. Pollution from road drainage will be managed through passive drainage. However, as the Proposal is designed to improve road users' safety, the likelihood of a major vehicular accident that poses significant risk to groundwater quality is anticipated to be low.

#### 4.4.7.2 Surface Waters and Wetlands

The potential impacts to surface waters and wetlands from the Bindoon Bypass are not expected to be significant. This is because the majority of impacts are most likely during the construction phase, which will be temporary and managed through construction methodology, permits and impact mitigation measures. Further, the large scale of the Brockman River catchment reduces the significance of any localised impacts caused during road operation.

Although impacts are unlikely to be significant, a range of mitigation measures will be in place to reduce impacts to as low as reasonably practicable. Implementation of these mitigation measures will result in the following minor residual impacts to surface water and wetlands:

- minor localised alteration to surface water flows during construction phase
- minor increase in runoff volume and contaminant concentrations in streams due to drainage of road runoff during operation phase
- minor direct loss of wetland habitat due to construction of road and bridge structures in wetland areas
- no significant increase in flooding as a result of the proposal upstream of the Brockman River crossing. .

The proposed road alignment has been designed to maintain drainage across the Development Envelope to as close as practicable to the pre-development condition. The proposed new Brockman River bridge will be constructed to include culverts, to be used to manage surface water flows beneath the highway within existing paths.

A summary of the predicted impacts, management and mitigation measures, residual impacts on inland waters is provided in **Table 4-42**.

**Table 4-42: Summary of Potential Impacts, Mitigation Measures and Residual Impacts to Inland Waters**

ID	Aspect	Potential Impact	Magnitude of Impact	Mitigation and Management	Residual Impact
<b>Construction Phase</b>					
1	Vegetation clearing	<ul style="list-style-type: none"> <li>Localised increase in surface water runoff volume</li> </ul>	Negligible	<ul style="list-style-type: none"> <li>Implementation of a drainage management strategy</li> </ul>	<p>Negligible</p> <p>Minor localised alteration to surface water flows</p>
2	Excavations for road cuts	<ul style="list-style-type: none"> <li>Localised increase in surface water runoff volume</li> </ul>	Low	<ul style="list-style-type: none"> <li>Road sub-surface will be constructed above the high (wet) groundwater table</li> <li>Where groundwater is intersected, seepage water will be collected for construction purposes, or drained to an infiltration basin based on drainage management strategy</li> </ul>	Negligible
3	Stockpiling of earthworks and fills, and storage of chemicals	<ul style="list-style-type: none"> <li>Increased movement of sediments during and after rainfall events</li> <li>Accidental spills of chemicals and hazardous materials with potential surface and groundwater contamination</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Development of a CEMP to prevent erosion and chemical spills, and procedures for remediation in the event of contamination</li> </ul>	Low
4	Construction of road embankments and fills	<ul style="list-style-type: none"> <li>Obstruction of the natural drainage pathways, leading to local ponding upstream</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Implementation of a drainage management strategy including the location of culverts to maintain flow connectivity</li> </ul>	Low
5B		<ul style="list-style-type: none"> <li>Oxidation of PASS during excavation which can contaminate groundwater and surface water, including wetland</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Prepare ASS management plan before construction</li> <li>Reduce duration of dewatering and use dewatering methods (e.g. wellpoint spears) that minimise the radius of influence in PASS and AASS areas</li> </ul>	Low

ID	Aspect	Potential Impact	Magnitude of Impact	Mitigation and Management	Residual Impact
5C		<ul style="list-style-type: none"> <li>Direct loss of wetland habitat due to placement of road and bridge structure</li> </ul>	Low	<ul style="list-style-type: none"> <li>Disturbance will be restricted to Development Footprint in the wetland system</li> </ul>	Low (partial loss of wetland vegetation and minor direct loss of habitat)
6	Operation and maintenance of plant and machinery	<ul style="list-style-type: none"> <li>Increased erosion from the traffic of construction vehicles</li> <li>Accidental spills of hydrocarbons and chemicals that can contaminate the groundwater and surface water</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Development of a CEMP to prevent erosion and chemical spills, and procedures for remediation in the event of contamination</li> </ul>	Negligible
<b>Operation Phase</b>					
7A	Physical presence of road	<ul style="list-style-type: none"> <li>Localised increase in stormwater runoff from road surface</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Effective, site-relevant stormwater treatment measures such as swales and infiltration basins will be implemented to promote infiltration as close to the source as possible, as well as promote controlled sedimentation prior to stormwater discharging to the wetland and waterways</li> </ul>	Low
7B		<ul style="list-style-type: none"> <li>Increased pollutant load to the receiving water bodies from road runoff</li> </ul>	Moderate		Low
8	Bridge and culvert system in the Brockman River	<ul style="list-style-type: none"> <li>Localised flooding upstream of culvert system.</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>Selection of the best alternative option that has the least impact to the existing hydrological characteristic of Brockman River through flood modelling study</li> </ul>	Low
9	Vehicle collision and spillage of hazardous waste	<ul style="list-style-type: none"> <li>Accidental spills of chemical and hazardous materials</li> </ul>	Low	<ul style="list-style-type: none"> <li>Implement specific procedures to collect and remediate in the event of contamination</li> </ul>	Negligible

## 4.5 Key Environmental Factor – Social Surroundings (Heritage)

### 4.5.1 EPA Objective

To protect social surroundings from significant harm.

### 4.5.2 Policy and Guidance

The following EPA policy and guidance have been considered during the preparation of this ERD and the supporting technical studies:

- Statement of environmental principles, factors and objectives (EPA 2016a)
- Environmental factor guideline - social surroundings (EPA 2016j)
- Guidance for the assessment of environmental factors in accordance with the EP Act: assessment of Aboriginal heritage (EPA 2004c).

### 4.5.3 Receiving Environment

#### 4.5.3.1 Aboriginal Heritage

The Bindoon Bypass is located within Yued Country—specifically, the Yued WC1997/071 Native Title Claim (NTC). This NTC is bounded by Leeman in the north, Lake Nedo and Dalwallinu in the north east, Wongan Hills in the southeast and Coondle, Chittering and Two Rocks in the south and west. The Yued people form the northernmost group of the South West Aboriginal groups, within a distinct cultural bloc defined by the distribution of the Nyungar languages.

The majority of the land within and adjacent to the Development Envelope is freehold private land, and therefore not subject to native title requirements. Any crown land not within the existing road reserves may be subject to native title rights.

A risk assessment was conducted by Brad Goode and Associates Pty Ltd (BGA) in accordance with the *Aboriginal Heritage Act 1972* (AH Act) Aboriginal heritage due diligence guidelines. This assessment determined the Proposal to be a Medium Risk, as it constitutes ‘significant disturbance’ over a ‘significantly altered environment’ (BGA 2018a; **Appendix H**).

Aboriginal heritage (archaeological and ethnographic) surveys of the Development Envelope were undertaken by BGA, to identify and characterise any Aboriginal heritage sites within the Development Envelope, as well as their relevance and importance to the Yued people and their culture (BGA 2018b; **Appendix H**). These surveys were carried out in accordance with the AH Act and the Aboriginal heritage guidance statement (EPA 2004c).

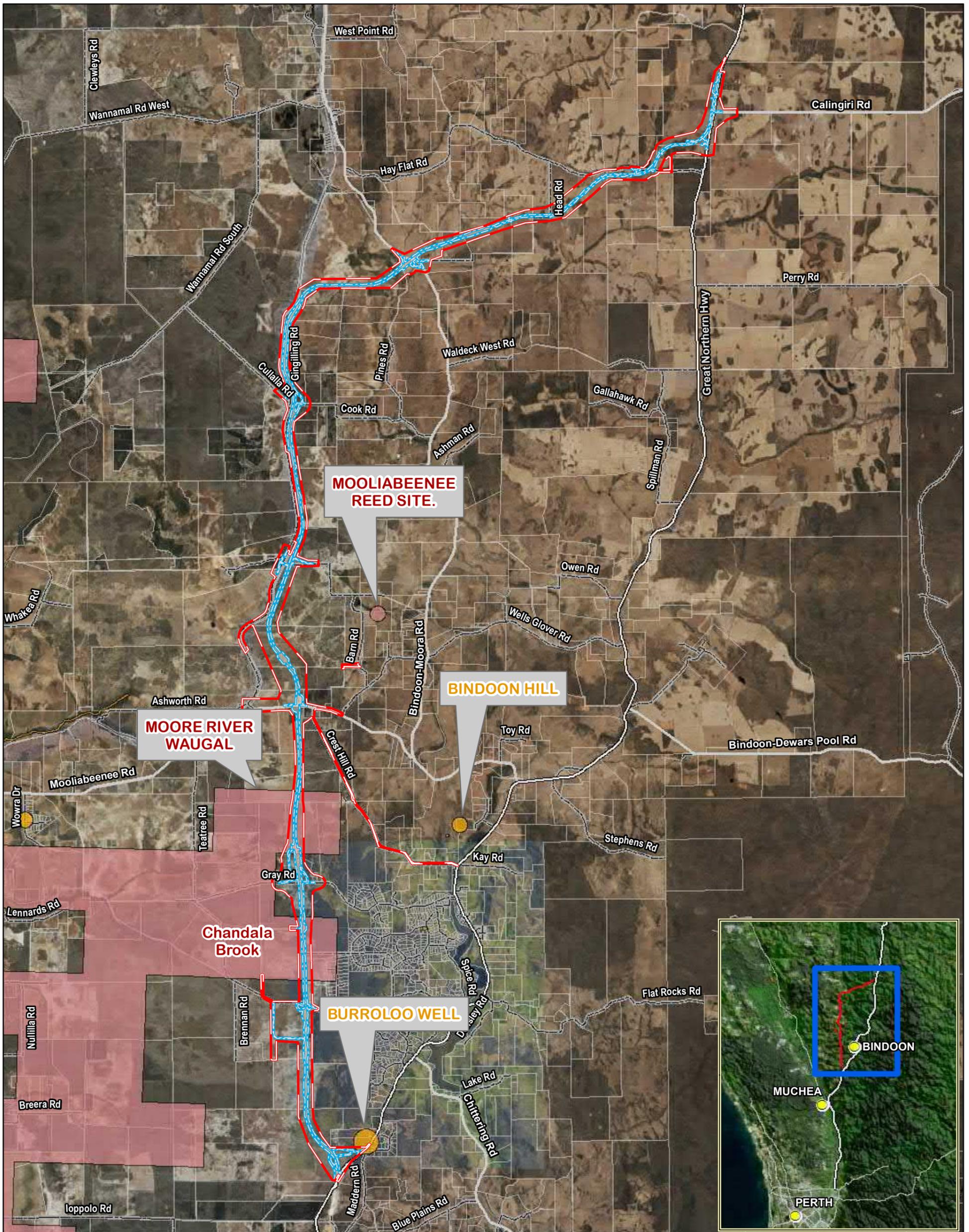
### Desktop Assessment Findings

Five Aboriginal heritage surveys, covering over half of the Development Envelope, have been conducted. These included an archaeological survey (Quartermaine 2004) and an ethnographic survey R & E O’Connor 2005), which covered a 500 m corridor westwards from the existing GNH, crossing the Bindoon Moora Road before it headed in a southerly direction to Gray Road (west of Bindoon).

Previous surveys conducted by BGA in the broader GNH project area determined that the Yued consider the waterways of the region as having mythological significance. They are connected with the Waugal, and BGA advises proponents to avoid impacts to waterways and wetlands where practicable (BGA 2016). The Yued representatives have previously identified Moodjar Trees (*Nuytsia floribunda*, WA Christmas Tree) as having spiritual significance in connection with burials (BGA 2016); however, due to the commonality of *N. floribunda* in the landscape, they are not considered sites under the AH Act (BGA 2008, 2014).

A search of the DPLH Aboriginal sites and places register was undertaken on 7 November 2017. Three registered sites and nine 'other heritage places' were identified from this search (**Figure 4-25** and **Table 4-43**). Two of the 'other heritage places' are archaeological: place ID 3528 (Burroloo Well) and place ID 22027 (Udumung Brook Artefact 1). All three registered sites and the remaining seven 'other heritage places' are ethnographic sites associated with watercourses, and have mythological significance to the Yued people.

The Gingin Brook Waggy (ID 20008) encompasses the Lennard Brook 'other heritage place' (ID 20650) in the area of the Bindoon Bypass. Both sites are ethnographic places and have mythological significance to the Yued and are associated with the Waggy—a major spirit of the Noongar culture, responsible for the creation of the Swan and Canning Rivers, as well as a number of other waterways and landforms around Perth and the south west (SWALSC 2018).



**Legend**

- Development Envelope
- Development Footprint
- Aboriginal Sites (DPLH)**
- Within Study Area**
- Registered Sites
- Other Places
- Highway
- Major Road
- Minor Road
- Cadastral Boundary

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Scale at A3  
1:112,500

0 1,300 2,600  
Metres

Coordinate System: GDA 1994 MGA Zone 50

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Aboriginal Heritage Sites Recorded from the DPLH Aboriginal Sites and Places Register  
Figure: 4-25

Drawing No: GNH-CN12-EA-PER-00001 - F4-25

Issue: 1

Task No: EDR	Drawing Status / Other: Draft		
Date: 22/08/2019	By: BG	Chkd: LB	Appd: TJ

MXD Location: \\jacobs.com\PER\Projects\BIF\Projects\B80732\Technical\GIS\ArMap\Environmental\CN12\ERD\Figures\GNH-CN12-EA-PER-0001-F4-25.mxd

**Table 4-43: Summary of Aboriginal Heritage Sites and Other Heritage Places within the Study Area**

ID	Name	Status	Access	Restriction	Location GDA94 Z50		Type
<b>Registered Aboriginal Sites</b>							
20008	Gingin Brook Waggy Site	Restricted site	Closed	Yes	NA	NA	Historical, myth, camp, hunting, plant resource, water source
20749	Moore River Waugal	Restricted site	Open	File not restricted	389582	6549648	Mythological
21620	Chandala Brook	Restricted site	Open	File not restricted	389626	6549540	Mythological
<b>Other Heritage Places</b>							
3528	Burroloo Well	Lodged awaiting assessment	Open	File not restricted	411039	6519849	Artefact scatter, water source
22027	Udumung Brook Artefact 1	Lodged awaiting assessment	Open	File not restricted	419398	6550809	Artefact scatter
20650	Lennard Brook	Lodged awaiting assessment	Open	File not restricted	389582	6549648	Mythological, natural feature, water source
21616	Boonanarring Brook	Lodged awaiting assessment	Open	File not restricted	396128	6561778	Mythological
21617	Wallerung Brook	Lodged awaiting assessment	Open	File not restricted	396128	6561778	Mythological
21618	Nullilla Brook	Lodged awaiting assessment	Open	File not restricted	396128	6561778	Mythological
21619	Breera Brook	Lodged awaiting assessment	Open	File not restricted	396128	6561778	Mythological
19138	Wetlands & Watercourses Moore River to Bullsbrook	Stored data/not a site	Open	File not restricted	396128	6561778	Mythological
19183	Red Gully Creek	Stored data/not a site	Open	File not restricted	396128	6561778	Mythological, plant resource

## Archaeological Survey Findings

Burroloo Well (ID 3528) 'other heritage place' consists of a permanent waterhole just off the existing GNH, with a few pieces of quartz close to the waterhole and downstream (approximately 100 m) on graded firebreaks (BGA 2018b). DPLH states that the coordinates given for the location of this place are unreliable (BGA 2018b). The location was visited during the Aboriginal heritage surveys and no permanent waterhole or Aboriginal archaeological artefacts or material were identified (BGA 2018b). As no material was found at the recorded coordinates, it has been assumed that the actual site is located within the Burroloo Well Nature Reserve. A sketch map on file with DPLH supports this (BGA 20178b). Burroloo Well Nature Reserve is not located within the Development Envelope.

Udumung Brook Artefact 1 (ID 22027) 'other heritage place' is described as a single basalt flake that was identified on the margin of Udumung Brook in 2005. BGA (2018b) notes that, although the coordinates are considered by DPLH to be accurate, they appear not to have been converted when the datum was changed from Geocentric Datum of Australia 1984 (GDA84) to Map Grid of Australia 1994 (MGA94). The location as given by the DPLH coordinates, and the location resulting from conversion of the coordinates from GDA84 to MGA94, were thoroughly searched during the surveys. No aboriginal heritage material was identified at either location (BGA 2016b).

Given that this basalt flake was initially identified in 2005, it is possible that natural factors, such as rain, sheet wash or the brook flooding, have either concealed the artefact or moved it to another place. Contemporary land use practices, such as tilling of fields, or animal activity may have similarly resulted in the basalt flake being concealed or moved.

As a result of archaeological assessments conducted by BGA in December 2017 and January 2018, it was established that no registered Aboriginal sites with an archaeological component occur within the study area.

## Newly Identified Sites

One new Aboriginal archaeological site was identified within the Development Envelope, and comprises quartz artefacts of Aboriginal origin (Archae-aus 2018). Although vehicle tracks that follow the fence line run through this site, and ploughing of the adjacent paddock has impacted the site, the assemblage does retain some archaeological integrity (Archae-aus 2018).

To note, two professional archaeologists have inspected this area (BGA and Archae-aus) as part of the Bindoon Bypass Proposal heritage investigations, and have varying views on whether the objects found near the Spring Valley Farm on Barn Road classify a site under the AH Act. One archaeologist has labelled these objects as likely to be of Aboriginal origin (Archae-aus 2018), and the other has not (BGA 2018b).

Generally, there is significant potential for sub-surface cultural material of both Aboriginal and non-indigenous origin. Artefacts that were not visible in the February 2018 site visits were observed semi-buried in the sand during the May and July 2018 site visits (Archae-aus, 2018). This indicates that buried cultural material is moving to the surface through natural (such as water and wind) and human (such as vehicle traffic) processes.

A heritage information submission form (HISF) has been submitted to DPLH for the abovementioned site. Whether this location does in fact constitute a site will be determined by the WA Aboriginal Cultural Material Committee via assessment of information within the HISF.

## Other Archaeological Findings

Three isolated artefacts were identified; however, these were determined not to constitute a site under Section 5 of the AH Act (BGA 2018b). The first isolated artefact identified was a longitudinally broken quartz flake that was identified on a low sandy rise, adjacent to a flooded area and next to a very narrow drainage feature in the northwest corner of the study area. The other isolated artefacts were a single rock platform core and a rock flake, both manufactured on dolerite, and both identified in a cleared paddock at the eastern end of the study

area. While they have been inferred as artefacts that have been lost, discarded, broken and/or abandoned, they still represent evidence of an Aboriginal presence in the area in the past (BGA 2018b).

### **Ethnographic Consultation**

Ethnographic consultation was held with 12 representatives of the Yued WC1997/071 NTC group on 13 and 14 March 2018. No new ethnographic sites of significance, as defined by Section 5 of the AH Act, were identified within the Bindoon Bypass study area.

Locations within the study area such as watercourses and known heritage sites were targeted during the consultation. These places, and the effects the Proposal would have at these locations, were discussed with the Yued. This included the following:

- The Udumung Brook located along Hay Flat Road, in the northeast of the study area, was considered generally significant in relation to Waugal beliefs, but no data pursuant to creation myth were provided apart from statements that the Yued believed that all watercourses were home to, and created by, the Waugal. No request to report the Udumung Brook under the AH Act was made by the group at the time of the survey.
- In the northern section of the study area, the proposed Brockman River crossing and bridge at an unnamed tributary and wetland, southwest of Bindoon-Moora Road and between Kangaroo Gully Road and Pines Road, was identified as of concern of the Yued. This was specifically regarding the potential environmental impacts that the alignment could have on this major wetland. The Yued requested that an alternative alignment be considered. No statements about this location's spiritual values were made, nor were requests to report the area under the AH Act made.
- A large *Nuytsia floribunda* (Christmas or Moodjar Tree) was identified as having important cultural significance to the Yued group. Despite the mythological associations with Moodjar Trees, their abundance in the landscape prevents them from being considered as sites under the AH Act (BGA 2008, 2014).
- The Yued advised that they were not aware of any specific stories or values at the two crossings within the DPLH extent of place ID 20650 (Lennard Brook) and site ID 20008 (Gingin Brook). They also advised that they would support a Ministerial consent notice under section 18 of the AH Act, subject to Yued monitors being present during works in this location, should the Proposal proceed.

### **Survey Limitations and Data Gaps**

There were a number of properties that could not be accessed/surveyed at the time of survey due to land access constraints. Other properties were also later added to the Proposal. The EPA was informed of these through the section 43a change notice discussed in **Chapter 2.2 (Appendix C)**.

The properties that were not included in the heritage surveys, but fall within the Development Envelope, include:

- Lot 20 (no. 504) Barn Road, Mooliabeenee
- Lot M1465 (no. 204) and Lot M2059 Cullalla Road, Mooliabeenee
- Lot 9503 and Lot 9504 Parkwood Properties Pty Ltd
- Lot 900 Odelon Pty Ltd (parts of)
- Lot 18 Great Northern Highway, Chittering (part of)

Desktop reviews determined that—with the exception of Lot 9503—no known heritage sites/places exist on these properties (BGA 2018b), nor were any structures identified from aerial photography assessment that were considered of heritage value (Archae-aus 2018). There is one registered Aboriginal heritage site overlain on Lot 9503: the large buffer of the Gingin Brook Waggyt Site (place ID 20008). It is not known, however, whether any new Aboriginal or non-indigenous sites of value exist on the unsurveyed properties.

All of these properties, including Lot 9503 but excepting Lot 900, are 'altered' landscape type (crop pasture land, road margins, public open space and other sandy exposures); there is thus a low risk of uncovering archaeological objects and material in these areas. The part of Lot 900 in the Development Envelope that is currently unsurveyed constitutes remnant vegetation landscape type. Conditions for site archaeological preservation are higher than the other zones, although the potential is less than the waterways; there is thus a medium risk of uncovering archaeological objects/material.

The Aboriginal heritage due diligence risk assessment matrix suggests reviewing the landscape and exercising caution in medium risk areas (BGA 2018a) by:

- consulting with relevant Aboriginal people regarding the proposed works  
and/or
- conducting an Aboriginal heritage survey  
or
- modifying the proposed activity to avoid or minimise any impact to previously-recorded Aboriginal heritage sites.

Main Roads commits to continuing ongoing consultation with the Yued people, in order to mitigate this risk. Future land acquisition will enable access to these outstanding properties for heritage investigations, where required.

#### **4.5.3.2 Non-Indigenous Heritage**

A number of places with non-indigenous heritage value occur within the Bindoon region. To assess whether the Proposal would impact on these or any other non-indigenous heritage values, Archae-aus was commissioned to undertake desktop assessments, consultation with stakeholders and field assessments in accordance with the *Heritage of Western Australia Act 1990* (Archae-aus 2018; **Appendix H**).

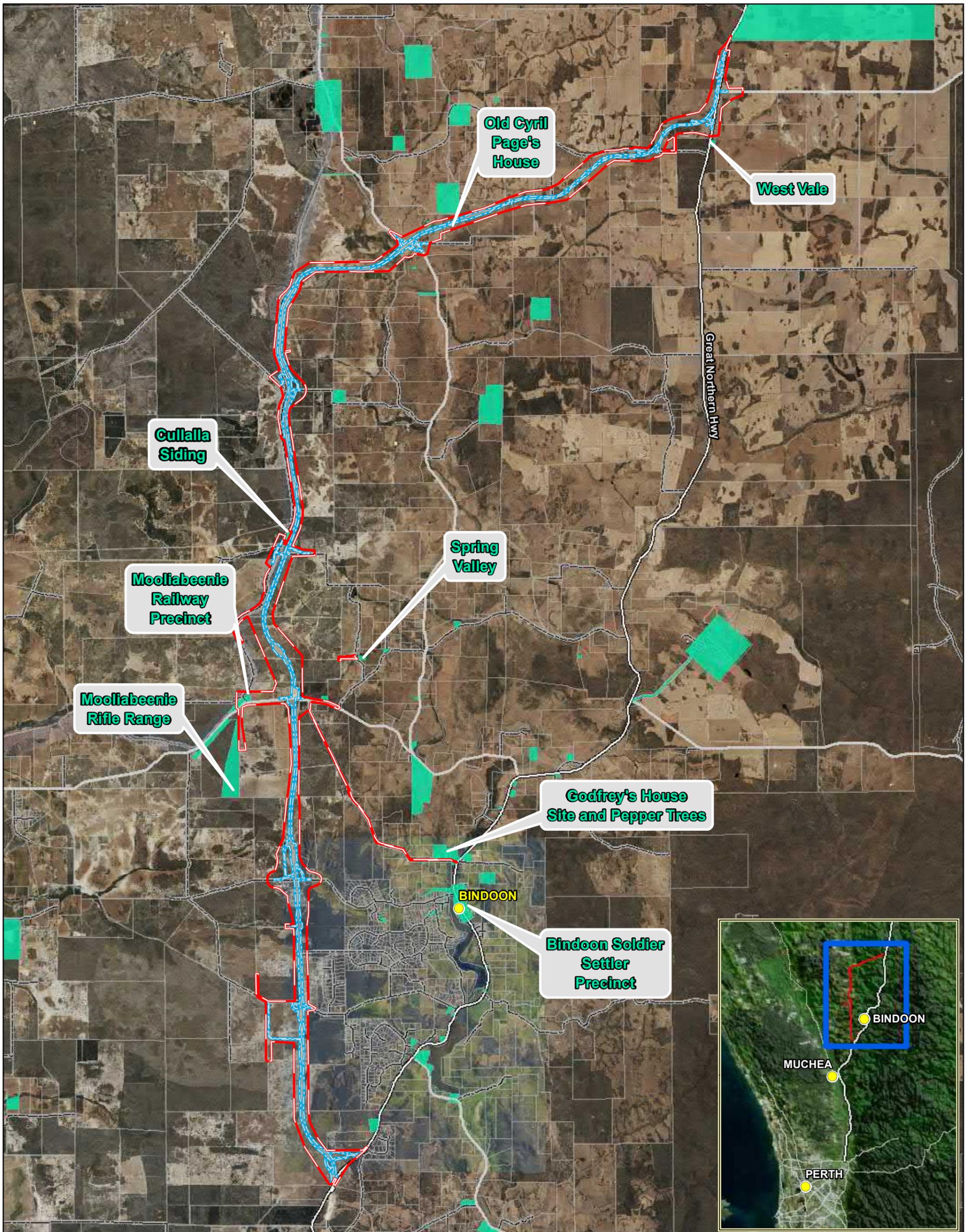
#### **Desktop Assessment Findings**

Various heritage database searches were undertaken to identify any non-indigenous heritage values listed on national, state or local heritage lists exist within the Development Envelope. No places listed under the *Heritage of Western Australia Act 1990* or the EPBC Act were identified within the study area.

Sixteen places were identified as having protection through the local government heritage list (non-statutory Municipal Inventory—MI; **Figure 4-26** and **Table 4-44**). Places on MI lists are assigned to one of five categories: Category 1 has the highest level of heritage significance at a local level and may have potential State heritage value, through to Category 5, which is typically assigned to places with few or no built features (for example, a commemorative plaque). Of the sites identified by Archae-aus (2018), one place is MI Category 2, four are MI Category 4 and eleven are MI Category 5.

#### **Field Assessment Findings**

A number of previously undocumented historical heritage places were identified during the Archae-aus field investigations, conducted between February and May 2018 (**Figure 4-27** and **Table 4-45**). These places were identified as having historical value, and may require submissions under the government heritage property disposal (GHPD) process if impacted by the Proposal.



**Legend**

-  Highway
-  Major Road
-  Minor Road
-  Cadastral Boundary
-  Development Envelope
-  Development Footprint

- Municipal Inventory (SHO-005)**
-  Municipal Inventory (SHO-005)



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0 1,250 2,500  
Metres

Coordinate System: GDA 1994 MGA Zone 50

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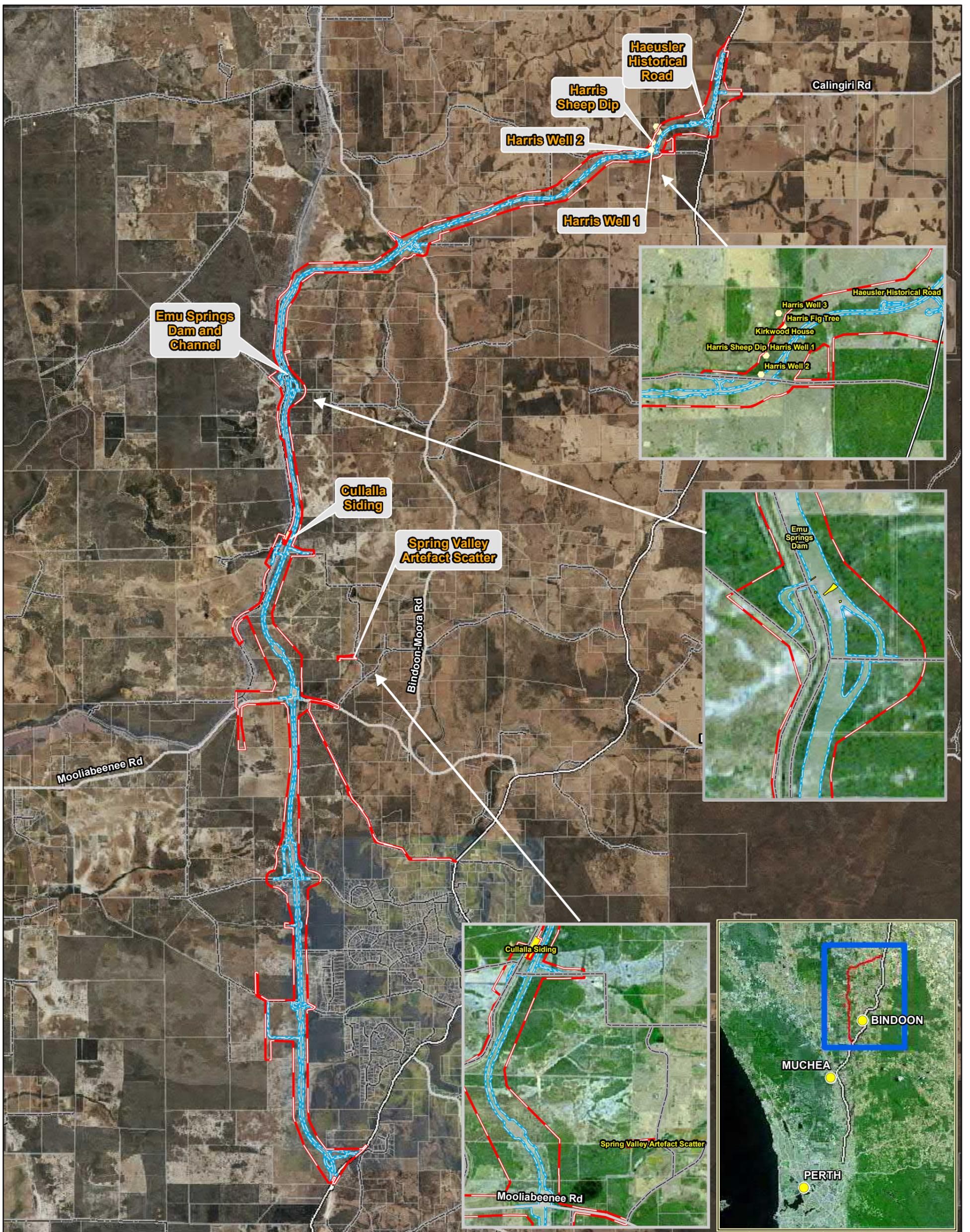
Client Project  
**Great Northern Highway Bindoon Bypass Environmental Review Document**

**Municipal Inventory Heritage Sites**

Figure: 4-26

Drawing No <b>GNH-CN12-EA-PER-00001 - F4-26</b>	Issue <b>1</b>		
Task No <b>ERD</b>	Drawing Status / Other <b>Draft</b>		
Date <b>30/05/2019</b>	By <b>BG</b>	Chkd <b>LB</b>	Appd <b>TJ</b>

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**Legend**

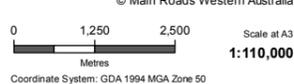
- Development Envelope
- Development Footprint
- Heritage Places
- Heritage Places
- Cadastral Boundary
- Highway
- Major Road
- Minor Road



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**Heritage Sites Identified During Site Investigations**  
 Figure: 4-27

Drawing No <b>GNH-CN12-EA-PER-00001-F4-27</b>		Issue <b>1</b>	
Task No <b>ERD</b>	Drawing Status / Other <b>Draft</b>		
Date <b>30/05/2019</b>	By <b>BG</b>	Chkd <b>LB</b>	Appd <b>TJ</b>

**Table 4-44: Summary of State Heritage Office Inherit Database-listed Heritage Sites**

Shire	SHO Place No.	Place Name	Location / Address	Heritage Listings	Condition
Chittering	14265	West Vale	Great Northern Hwy, Wannamal	MI (cat. 5)	Unknown
Chittering	14164	Old Cyril Page's House	Hay Flat Road, Wannamal	MI (cat. 4)	Intact
Chittering	14194	Cullalla Siding	Cullalla Road, Mooliabeenee	MI (cat. 5)	Site
Chittering	14190	Mooliabeenee Railway Precinct	Bindoon Gingin Road, Mooliabeenee	MI (cat. 5)	Site
Gingin	17904	Mooliabeenee Rail Siding Site	Mooliabeenee Road, Gingin	MI (cat. 4)	Site
Chittering	14191	Mooliabeenee Shop & Well	Bindoon Gingin Road, Mooliabeenee	MI (cat. 5)	Site
Chittering	14189	Mooliabeenee Rifle Range	Bindoon Gingin Road, Mooliabeenee	MI (cat. 5)	Site
Chittering	14203	Wards Saw Mill	Bindoon Gingin Road, Mooliabeenee	MI (cat. 5)	Site
Chittering	14201	Mooliabeenee School & Quarters	Bindoon Gingin Road, Mooliabeenee	MI (cat. 5)	Site
Chittering	14097	Doubleview	Crest Hill Road, Bindoon	MI (cat. 4)	Good
Chittering	14175	Godfrey's House Site and Pepper Trees; Niela (fmr), Alec De Marchi (fmr)	GNH & Crest Hill Road, Bindoon	MI (cat. 5)	Site
Chittering	14096	A de Marchi's House	GNH & Crest Hill Road, Bindoon	MI (cat. 4)	Good
Chittering	14070	Claremont Cottage (Clune's Bindoon Pony Club)	Gray Road, Bindoon	MI (cat. 2)	Good
Chittering	14170	Blacksmith	9 Gray Road, Bindoon	MI (cat. 5)	Site
Chittering	14169	Sandalwood Pool	Gray Road, Bindoon	MI (cat. 5)	Site
Chittering	14174	Bindoon Soldier Settler Precinct	GNH, Bindoon	MI (cat. 5)	Site

**Table 4-45: Summary of Heritage Places Recorded During the Bindoon Bypass Non-Indigenous Heritage Field Assessments**

Place Name	Location / Address	Description
Kirkwood House	Lot 3281 (no. 9071) GNH, Wannamal, 6505	Small timber-framed house on the Kirkwood property is clad and rooved with corrugated iron. Roughly dressed pieces of laterite have been laid with mortar to build a water tank stand and a wall base on the southern side of the building. The house is surrounded by a fenced yard that contains enclosures, yards, dongas and fowl coops.
Emu Springs <ul style="list-style-type: none"> <li>• Bore</li> <li>• Dam 1 and Channel</li> <li>• Building</li> <li>• Fruit Drying Rack</li> <li>• Dam 2 and Shed</li> </ul>	Lot 21 (no. 470) Cook Road, Mooliabeenee, 6504	Old water bore with a windmill and a small shed in the paddock directly in front of the house. The shed is constructed with bush poles, clad with corrugated iron with a corrugated iron skillion roof and a concrete floor. The south side of the structure is open for access and it may have housed a pump and / or generator.
		Circular, steep-sided farm Dam 1 that was holding water at the time of the site inspection. On the dam's southern side there is a small shed with bush pole uprights and jarrah beams, clad with corrugated iron, which presumably served as a pump house. Southwest of the dam, and feeding into it, there is a channel approximately 40 m long and 8 m wide with timber sleepers placed along its south and west sides. Both appear to be machine-excavated.
		Timber framed, steel clad Building. The building is constructed on metal stumps with pieces of laterite and concrete supporting its eastern end.
		Timber fruit drying rack. Mr Worth advised that the property was previously used as a vineyard and that the rack had been used for drying grapes to make sultanas.
		Farm Dam 2 and small timber and corrugated iron shed at the north end of the Worth property. The dam was almost dry at the time of the site inspection.
Harris <ul style="list-style-type: none"> <li>• Sheep Dip</li> <li>• Harris Well 1</li> <li>• Harris Well 2</li> <li>• Harris Well 3</li> <li>• Harris Fig Tree</li> </ul>	Lot 2138 (no. 1121) Hay Flat Road, Wannamal, 6505	Immediately southwest of Well 1 there is a stone-lined, horseshoe shaped pit used to dip sheep.
		Well 1 is round, approximately 2 m in diameter and does not appear to be stone-lined).
		Historical Well 2 is located next to a natural pool at the confluence of Udumung Brook and the tributary that flows south through the Harris property. It is approximately 2 m in diameter and is stone-lined.
		The timber lined historical Well 3 is located in the bed of the tributary of Udumung Brook that flows south through the Harris property, however, is outside of the study area.
		A large fig tree in his paddock that borders the Kirkwood property.
Spring Valley Artefact Scatter	Lot 1 Barn Road, Mooliabeenee, 6504	Site has historical heritage value as well as Aboriginal components.
Haeusler Historical Road	Lot 3246 GNH, Wannamal, 6505	A relict section of historical road runs for approximately 100 m on the Haeusler property. On the ground, the road is difficult to

Place Name	Location / Address	Description
		discern, but is characterised by a compact, fine gravel surface that has been cleared of larger stones and rocks. Mr Haeusler thinks that the historical road continued northeast then veered slightly to the east, to Rocky Hole Well approximately 2-3 km away, and was the original road from Perth to New Norcia. It is possible that the section of historical road on the Haeusler property was actually a stopping point along the road, close to Wannamal (Shannon's) Well, but on higher ground out of the creek bed and above the bank.

The Well 1, Well 2 and Sheep Dip sites on the Harris property are historically significant features that likely date to around the turn of the 20<sup>th</sup> Century (Archae-aus, 2018). Historical documents of the Wannamal area recorded that Henry Goate took up a 160-acre lease in the area in 1909, with mention of Goate 'sinking wells' (Archae-aus 2018). The wells on the Harris property may be those sunk by Goate, but it is also possible that Well 2 was constructed by the Benedictine monks of New Norcia in the mid to late 19<sup>th</sup> Century (Archae-aus 2018). Wannamal (Shannon's) Well, 1.6 km to the east of Well 2, is attributed to this period.

The landowner reported to the archaeologists that the wells on his property are all vital sources of water for the farm, and that in times of drought, the reliable water source from Well 2 is critical.

#### 4.5.4 Potential Impacts

The implementation, construction and operation of the Proposal will have both direct and indirect impacts on heritage sites and places. Potential impacts to Aboriginal and non-indigenous heritage may arise within the Development Envelope as a result of the following activities:

- earthworks, excavations and other construction activities
- vehicle movements (construction and operational road traffic)
- physical presence of the new road and associated infrastructure
- bridge construction and creek crossings
- construction and ongoing presence of cuts and embankments.

The following impacts may occur as a result of implementation of the Proposal:

- physical damage or loss of Aboriginal heritage sites, and subsequent impacts to mythological, cultural and heritage values
- loss of access to and use of Aboriginal heritage sites for Traditional Owners
- permanent loss of heritage sites due to clearing for construction
- fragmentation of existing heritage sites.

##### 4.5.4.1 Aboriginal Heritage

Of the sites identified by BGA and Archae-aus, four intersect the Development Envelope. These are the Gingen Brook Waggyl registered site, and Lennard Brook, Udumung Brook Artefact 1 and Burroloo Well 'other heritage places'. The three 'other heritage places' are currently lodged with DPLH, and awaiting assessment by the Aboriginal Cultural Material Committee for consideration.

The sites that fall within the Development Footprint will be directly disturbed by construction activities. Archaeological material can be salvaged during excavation or, if in areas of fill, can remain in situ. The

Development Footprint will directly intersect four registered or ‘other heritage sites’ (**Table 4-46**). The Proposal will also directly impact on one newly identified site, as identified by Archae-aus (2018).

Indirect impacts to the heritage sites may include:

- contamination of waterways and wetlands associated with ethnographic sites arising from hydrocarbon or other chemical leaks and spills
- increased sediment load to waterways and wetlands associated with ethnographic sites, arising from erosion of cleared areas or road formation
- sedimentation of waterways and soil
- habitat fragmentation for local fauna.

The waterways by which these sites are defined are ephemeral, so exposure of surface water in these watercourses will be minimal and intermittent. **Chapter 4.3** and **Chapter 4.4** respectively address the Proposal’s impact mitigation measures for the Key Environmental Factors of Terrestrial Fauna and Inland Waters.

Access restrictions for hunting and other traditional practices within known heritage sites/places as a result of the Proposal is expected to be low, as these sites are located on private freehold properties.

**Table 4-46: Direct Impacts to Aboriginal Heritage Sites**

ID	Name	Known Extent (ha)	Direct Impact (ha)	% of Site Impacted
<b>Registered Aboriginal Sites</b>				
20008	Gingin Brook Waggy Site	108 060.77	41.41	0.04
<b>Other Heritage Places (Lodged and Awaiting Assessment)</b>				
3528	Burroloo Well	51.32	0.00 <sup>1</sup>	0.00
20650	Lennard Brook	175.82	2.31	1.31
<b>Newly Identified Sites</b>				
NA	Spring Valley Artefact Scatter	0.57	0.15	26.32

<sup>1</sup> No impact is expected as archaeological surveys indicate the site is not located at the coordinates on file for this location.

#### 4.5.4.2 Non-Indigenous Heritage

There are a number of existing structures located in the Development Footprint that cannot be avoided, and will be directly impacted as a result of construction of the new road (**Table 4-47**). None of the new heritage places that may be impacted by the Proposal are likely to be assessed by the Heritage Council’s Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018).

Places will generally need to be considered as part of this process if they:

- are more than 60 years’ old
- are already listed on an existing heritage list, such as an MI
- display other evidence of potential significance in terms of aesthetic, historic, social or scientific value.

Notwithstanding this, any impacts to these places will require consultation by Main Roads with DPLH, to ascertain whether submissions under the GHPD process are required.

**Table 4-47: Impacts to Non-Indigenous Heritage Places**

ID	Name	Location MGA94 Zone 50		Impact
<b>Registered MI Places</b>				
14194	Cullala Siding	408665	6538814	Site will not be directly impacted by the Development Footprint; however, falls within the Development Envelope and is located immediately adjacent to proposed construction activities.
<b>Newly identified heritage places</b>				
NA	Emu Springs Bore	408767	6543807	Site will be completely impacted by the Development Footprint. May trigger GHPD process as it has local significance as an example of rural life and society, and may have been established around 60 years.
	Emu Springs Dam and Channel	408711	6543890	
	Emu Springs Dam and Channel	408711	6543890	
	Emu Springs Fruit Drying Rack	408609	6543963	
	Emu Springs Dam 2 and Shed	408509	6544228	
NA	Harris Well 2	420092	6550967	Site is unlikely to be directly impacted. Active management of the site during construction will be required to avoid unintentional impacts to the site. May trigger GHPD process as it has historical significance, and may have been established around 60 years.
NA	Haeusler Historical Road	421784	6551970	A portion of the site will be directly impacted. The rest of the site may be indirectly impacted. May trigger GHPD process as it has historical significance, is a relict section of the original road and may have been established around 60 years.
NA	Spring Valley Artefact Scatter	410778	6535053	A portion of the site (0.15 ha; 26.32%) will be directly impacted. The remainder may be indirectly impacted. May trigger GHPD process as it has historical significance, and may have been established around 60 years.

#### 4.5.5 Assessment of Impacts

##### 4.5.5.1 Aboriginal Heritage

A number of Aboriginal heritage values exist in the Development Envelope. Surveys, research and consultation undertaken as part of the impact assessment conclude that none of the potential impacts to the sites, or the physical and biological surroundings of these sites, will be of significance.

Targeted archaeological surveys found no archaeological objects in the DPLH-listed registered and other (lodged) Aboriginal sites or places (BGA 2018b). Therefore, it is unlikely that the Proposal will impact any material of archaeological value in these sites and places.

The newly identified site comprising artefacts of Aboriginal origin (Spring Valley Artefact Scatter) is located within the Development Footprint, and is likely to be directly impacted by the Proposal (**Figure 4-28**); however, the significance of impact will depend on whether this site is recognised under the AH Act. Furthermore, future consultation with the Yued for the Proposal will define significance of the Spring Valley Artefact Scatter, enabling refining of the road alignment during the detailed design phase. A Section 18 consent for disturbance to the Spring Valley artefacts would allow for these artefacts to be relocated.

All watercourses are considered culturally significant as they are associated with the mythological rainbow serpent Waugal. Place ID 20650 (Lennard Brook) and site ID 20008 (Gingin Brook Waggy) are considered to be associated with watercourses and are ethnographic sites. The Development Footprint will disturb approximately 2.31 ha of the Lennard Brook and 41.41 ha of the Gingin Brook Waggy sites (**Figure 4-28**).

No disturbance to the Burroloo Well site is anticipated, as archaeological investigation failed to find any artefacts and no presence of a permanent waterhole at the coordinates provided by DPLH. This indicates that the cadastral location of the Burroloo Well site as defined by DPLH is not accurate. It has been suggested that the site is instead location within Burroloo Well Nature Reserve, approximately 500 m further north along the existing GNH (BGA 2018b).

Ethnographic consultation conducted as part of this Proposal indicated that no new ethnographic sites exist within the Development Envelope (BGA 2018b). Any impacts as a result of the Proposal would therefore not be significant. Consultation with the Yued indicated that they would support a ministerial consent notice under section 18 of the AH Act, where the Proposal intersects the Lennard Brook and Gingin Brook Waggy sites (BGA 2018b). Impacts to these sites/places, and their biological and physical features, resulting from the Proposal are not considered significant, for to the following reasons:

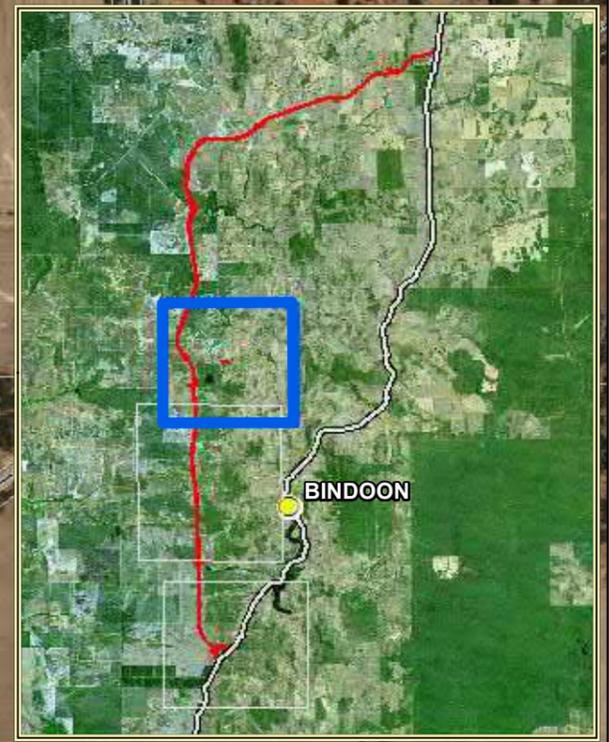
- The area of the place and sites intersected by the Proposal is predominantly in cleared paddock, as observed during the surveys (BGA 2018b).
- There were no archaeological objects found in any of the nine known sites and places during the surveys.
- Restriction to hunting and other traditional practices within known heritage sites/places, as a result of the Proposal, is expected to be low as these sites are located on private freehold properties.
- Installation of appropriate drainage infrastructure (as discussed in **Chapter 4.4**) will not significantly alter surface or ground water flow paths or quality.
- Impacts to flora and fauna habitat, particularly the Moodjar Trees, will be quantified and avoided/minimised during detailed design.
- The location error of place ID 3528 (Burroloo Well) led to the determination that this heritage place is not located within, nor extends over, any part of the study area (BGA 2018b).

The ethnographic consultation conducted for this Proposal did not raise any concerns about access to, or use of, these sites Traditional Owners; however, access and use were not directly addressed during these consultations. Future consultation with the Yued will further define these considerations, but it should be noted that, as sites are located on private property, there will not be any further loss/severance as a result of the Proposal.



**Spring Valley  
Artefact  
Scatter**

Barn Rd



**Legend**

- Development Envelope
- Cadastral Boundary
- Spring Valley Artefact Scatter
- Minor Road

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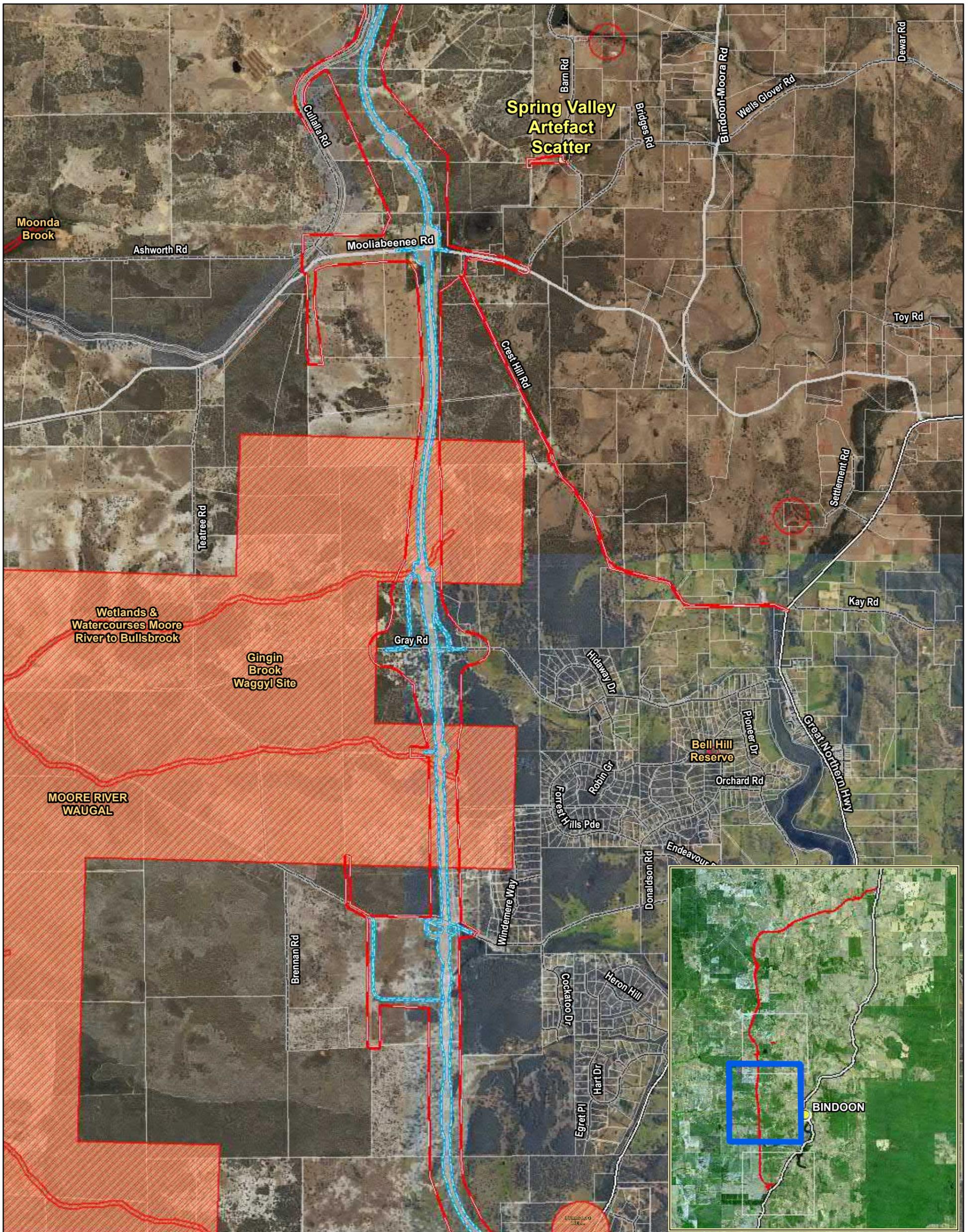
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Aboriginal Heritage Sites within the Development Footprint

Figure: 4-28 Page 1 of 3

Drawing No <b>GNH-CN12-EA-PER-00001 - F4-28</b>	Issue <b>1</b>		
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**Legend**

- Development Envelope
- Development Footprint
- Aboriginal Sites (Archae-aus)**
- Spring Valley Artefact Scatter
- Aboriginal Sites (DPLH)
- Cadastral Boundary
- Highway
- Major Road
- Minor Road

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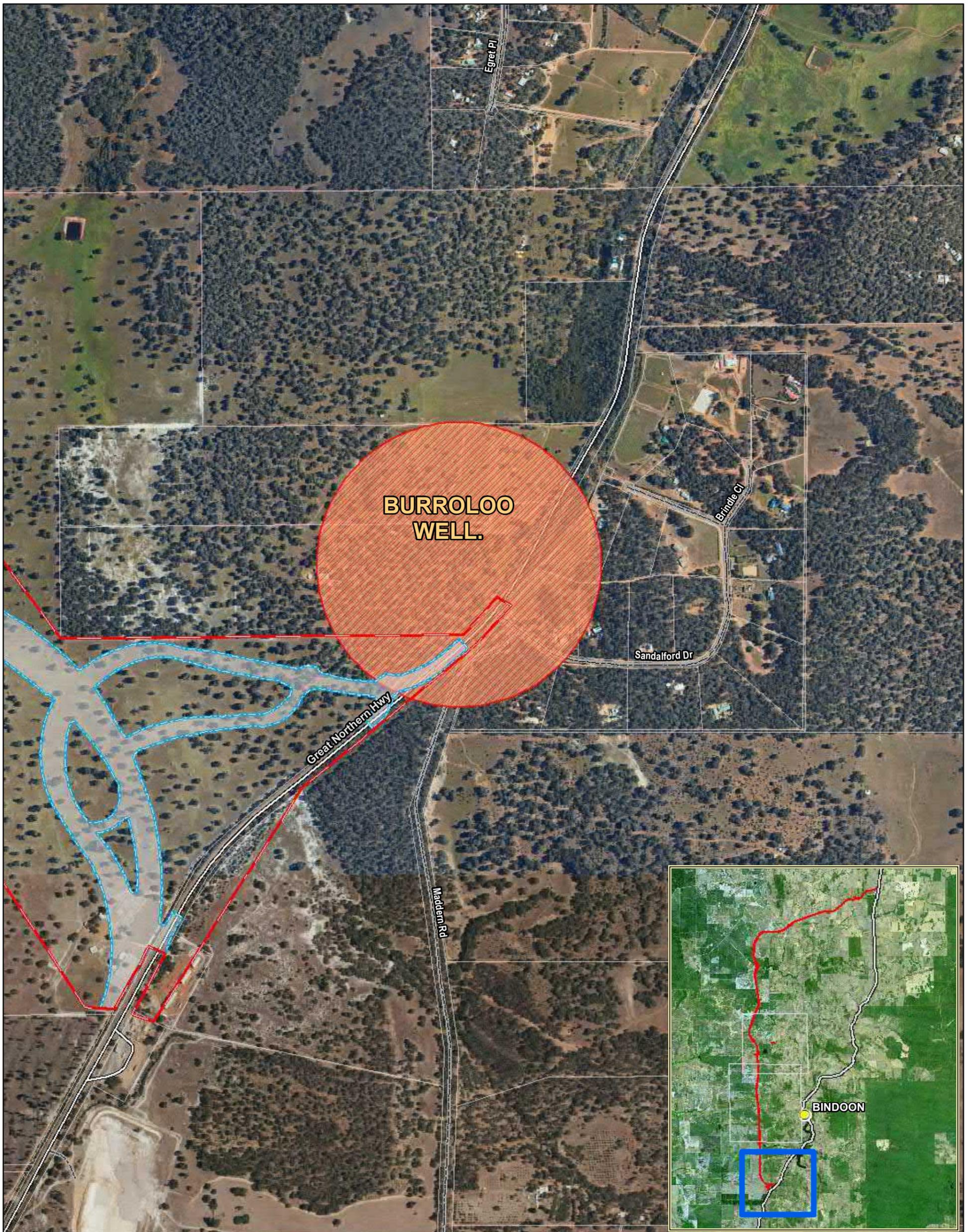
Aboriginal Heritage Sites within the Development Footprint

Figure: 4-28 Page 2 of 3

Drawing No: GNH-CN12-EA-PER-00001 Issue: 1  
- F4-28

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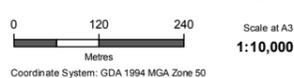
-  Development Envelope
-  Development Footprint
-  Aboriginal Sites (DPLH)
-  Cadastral Boundary
-  Highway
-  Minor Road



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Aboriginal Heritage Sites within the Development Footprint

Figure: 4-28 Page 3 of 3

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#### 4.5.5.2 Non-Indigenous Heritage

A number of existing structures are located in the Development Footprint and cannot be avoided by the Proposal (**Figure 4-29**). Impacts to these places through implementation of the Proposal are not considered significant, as none of these places are likely to be assessed by the Heritage Council's Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018). Notwithstanding this, any impacts to these places will require consultation by Main Roads with the DPLH to ascertain whether submissions under the GHPD process are required.

##### **Emu Springs – Bore, Dams, Building, Shed, Channel and Fruit Drying Rack**

The property with these historical features is located immediately to the east of the rail reserve, and was formerly used as a vineyard. The majority of this property and the historical features located here are within the Development Footprint, and will be demolished as a result. Main Roads will consult with the DPLH to ascertain whether submission under the GHPD process is required. These historical features were not deemed likely to be assessed by the Heritage Council's Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018).

##### **Harris Well 2**

Well 2 lies within the Development Envelope and immediately adjacent to the edge of the Development Footprint. Construction of the new road may affect the reliability and quality of the water in the well (Archae-aus 2018). This historical feature was not deemed likely to be assessed by the Heritage Council's Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018).

If construction of the road cannot avoid Well 2, with a reasonable buffer, Main Roads will consult with the DPLH to ascertain whether submission under the GHPD process is required. Monitoring of works by an archaeologist in close proximity to heritage places, and where there is considered to be potential for sub-surface historical materials, will be considered.

Well 1 and the Sheep Dip (and other historic features on this property) will be avoided by the Proposal.

##### **Haussler Historical Road**

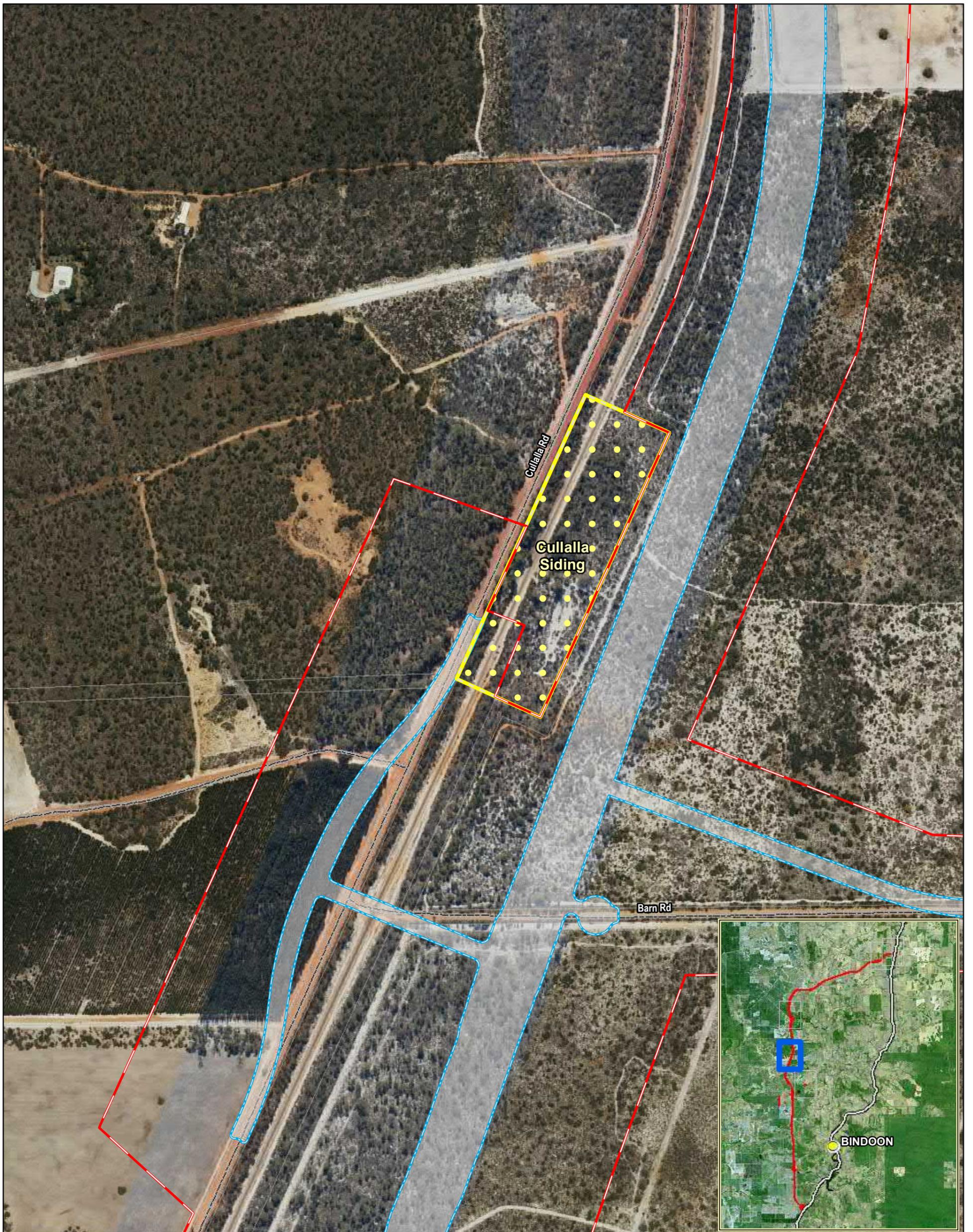
The southeast boundary of this section of Haussler Historical Road may be impacted by the Development Footprint. This property was heavily disturbed in the past, and there are no other historical features surviving there. This historical feature was not deemed likely to be assessed by the Heritage Council's Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018).

Consultation by Main Roads will be undertaken with the DPLH to ascertain whether a submission under the GHPD process is required. Main Roads will also consider using archaeological monitors for ground disturbing works in this area, to monitor and mitigate against the potential for impact to any sub-surface historical features or deposits.

##### **Spring Valley Artefact Scatter**

The Development Footprint impacts the area defined by Archae-aus (2018) as the extent of the Spring Valley Artefact Scatter. The artefact scatter (comprising both historical and Aboriginal objects) is located in the southeast corner of a cropped paddock, on the west side of where Barn Road crosses a watercourse, close to the historical Spring Valley farm. This historical feature was not deemed likely to be assessed by the Heritage Council's Register Committee as meeting the threshold for entry in the State Register of Heritage Places (Archae-aus 2018).

Consultation by Main Roads will be undertaken with the DPLH to ascertain whether a submission under the GHPD process is necessary for this place.



**Legend**

- Development Envelope
- Development Footprint
- Heritage Field Places
- Cadastral Boundary
- Minor Road

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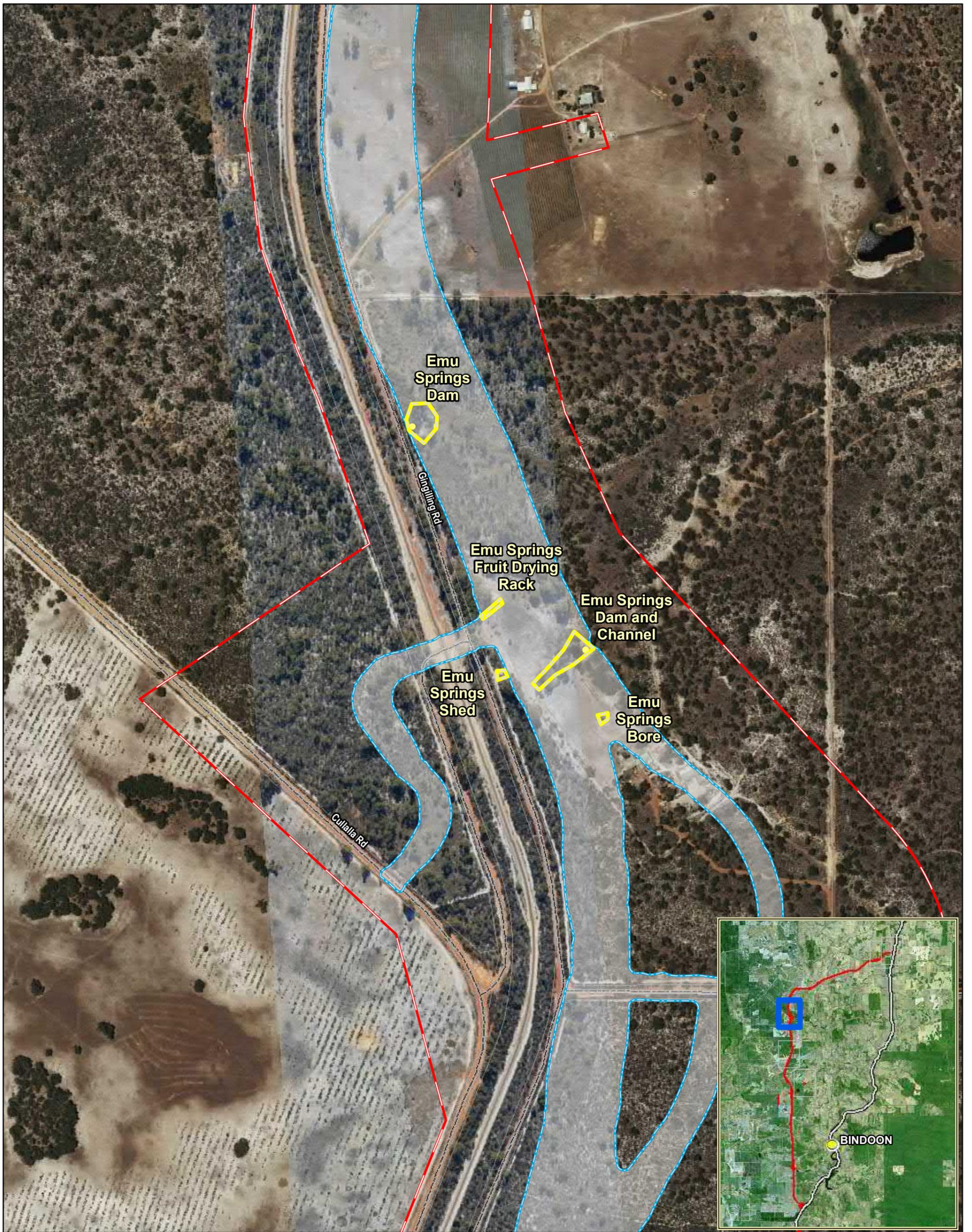
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Non-Indigenous Heritage Sites within the Development Footprint  
Figure: 4-29 Page 1 of 5

Drawing No: GNH-CN12-EA-PER-00001 - F4-29 Issue: 1

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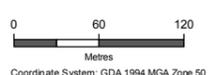
- Development Envelope
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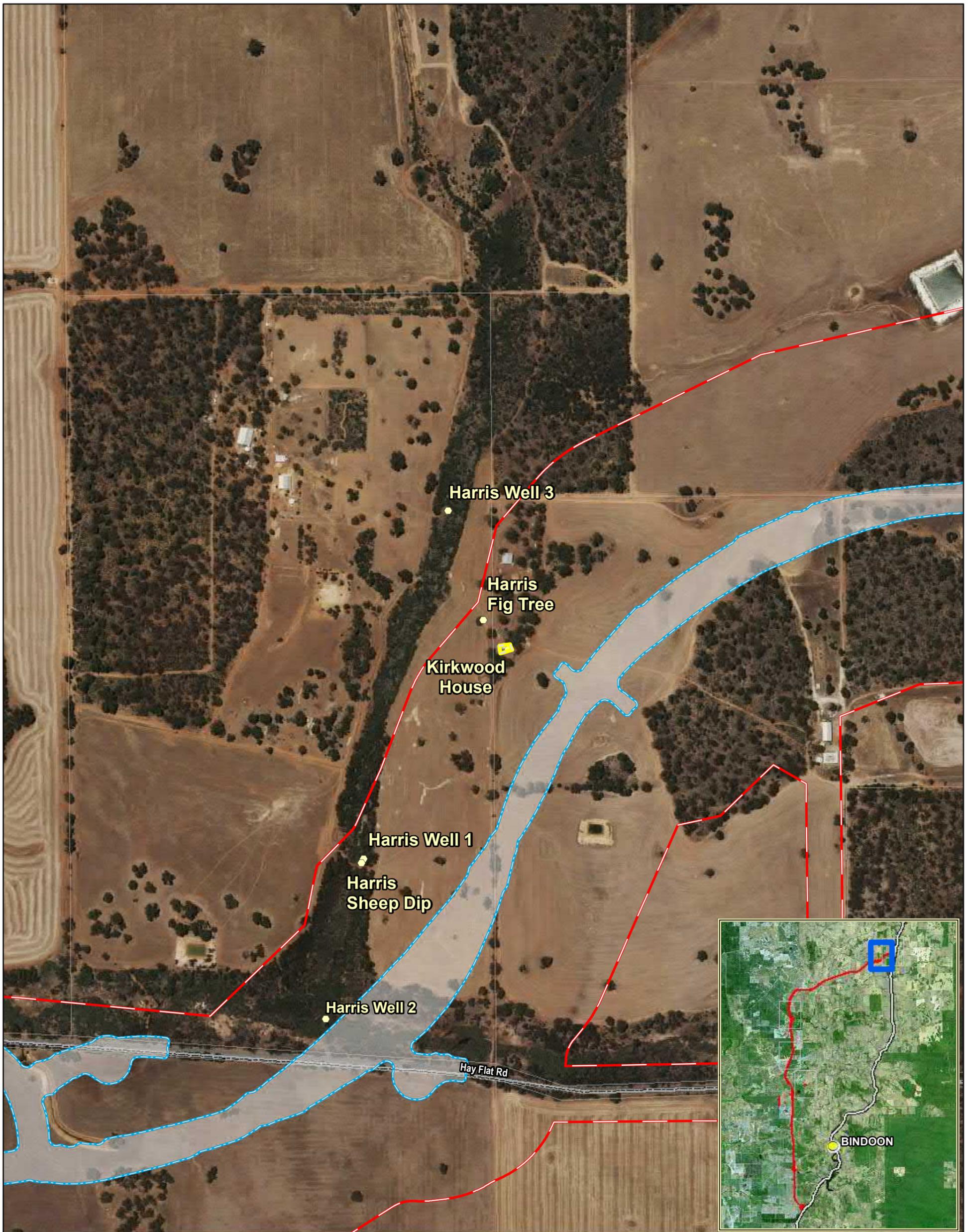
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Non-Indigenous Heritage Sites within the Development Footprint  
 Figure: 4-29 Page 2 of 5

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**Legend**

- Development Envelope
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- Heritage Places
- Heritage Field Places
- Cadastral Boundary
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 Figure: 4-29 Page 3 of 5

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**Legend**

- Development Envelope
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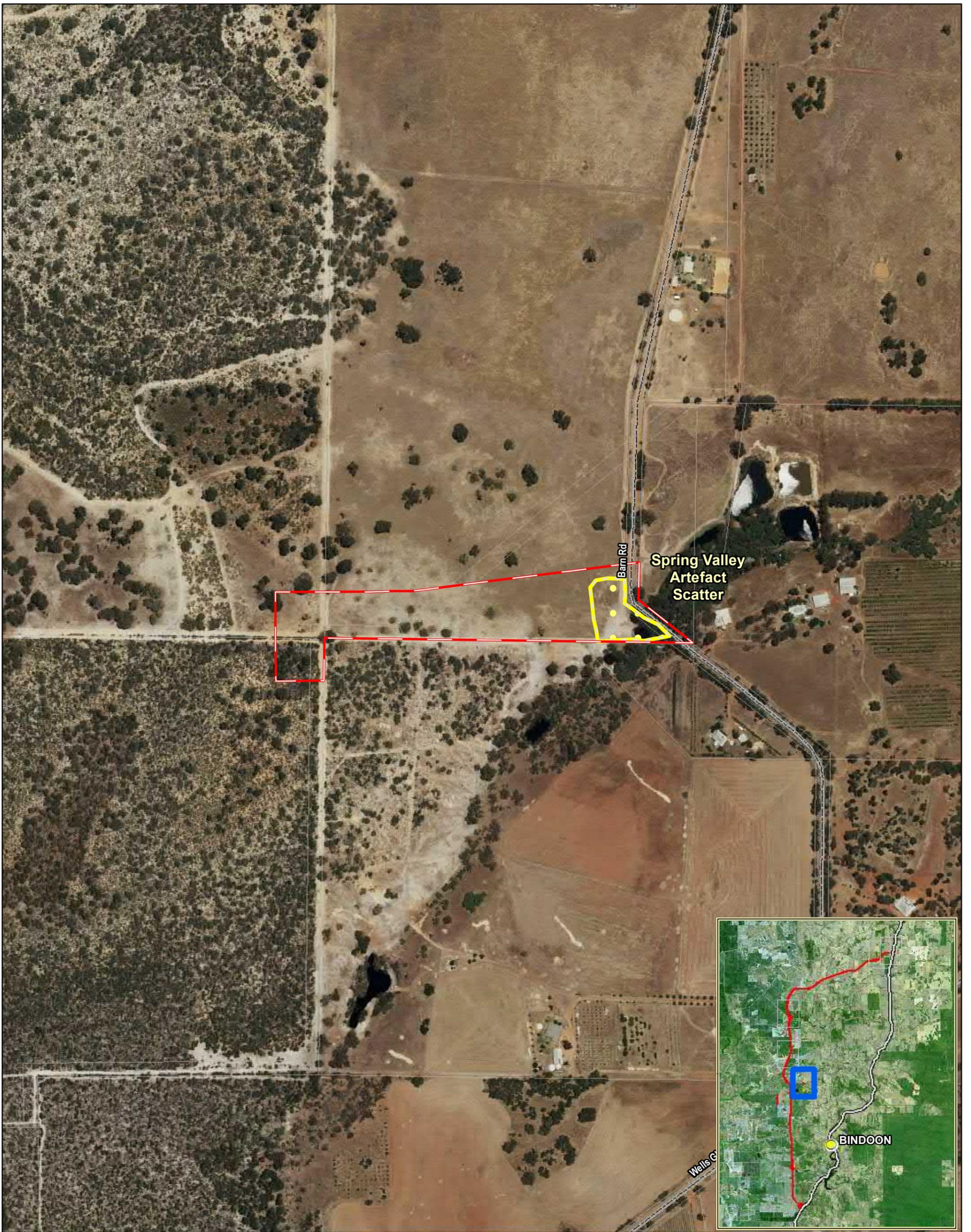
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Non-Indigenous Heritage Sites within the Development Footprint  
 Figure: 4-29 Page 4 of 5  
 Drawing No: **GNH-CN12-EA-PER-00001 - F4-29** Issue: **1**  
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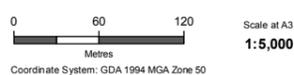
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 Figure: 4-29 Page 5 of 5

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## 4.5.6 Mitigation

### 4.5.6.1 Aboriginal Heritage

To reduce the Proposal's impacts to Aboriginal heritage, the mitigation hierarchy described in **Chapter 4.2.6** has been applied during the concept design phase, and in the development of appropriate mitigation and management strategies.

Impacts to Aboriginal heritage within and adjacent to the Development Footprint have been, and will continue to be, minimised through the following management actions and design principles:

- The detailed design phase will assess the viability of alignment adjustments to minimise or avoid impacts to the Aboriginal heritage sites and places, in particular the Spring Valley Artefact Scatter. Where this is not reasonably practicable, section 18 consent under the AH Act will be obtained by Main Roads to disturb this site. Artefacts will be recovered and relocated in consultation with archaeologists and/or the Yued.
- The bridge at the Brockman River crossing, and any culverts required along the alignment, will be designed and constructed to:
  - ▶ avoid ponding on the road and adjacent to the carriageway
  - ▶ prevent scour damage on the downstream side
  - ▶ include erosion protection or control measures on adjacent banks as required
  - ▶ avoid damming of flows and minimise the retention time of water on the upstream side, through design of culverts and bridge structures such that the change in water level for significant rainfall/flood events is no more than 100 mm on current conditions
  - ▶ maintain existing flow paths, quantities and velocities.
- All employees and contractors will be informed about the cultural heritage values of the Proposal and the presence and location of known Aboriginal archaeological sites, which areas are or may be considered Aboriginal sites under section 5(a) of the AH Act, and their obligations under section 15 of the AH Act (to report the discovery of any Aboriginal cultural material, which may be uncovered in the course of their work or any other activities).
- Prior to nearby ground development, all known sites not to be impacted by the Proposal will be clearly delineated as no-go zones using physical markers and/or fencing.
- Monitoring by archaeologists, and/or appropriately trained members of the Yued community, will take place in areas that have high potential for sites with some sub-surface archaeological integrity.
- In the event of potential heritage artefacts or skeletal material being discovered during construction activities, work will stop in the immediate vicinity of the find and an investigation undertaken to determine its origin and significance, including recovery of materials if required. In the case of skeletal material being uncovered, the WA Police will be notified. No disturbance to the site will be permitted until the investigation has been completed, or approval to do so has been granted by the relevant decision-making authority.

Other approvals required may include the following:

- A request for AH Act section 18 consent for disturbance to registered Aboriginal heritage sites or places will be submitted during the detailed design phase of the Proposal.
- For sites not yet formally registered, Main Roads will seek formal, written advice from the DPLH whether Ministerial consent is required under section 18 of the AH Act for the proposed works to disturb lodged heritage places.
- No disturbance to any Aboriginal heritage sites or places outside of that approved under section 18 of the AH Act will occur.

- Main Roads will continue consultation with the Yued Working Party, and provide further information on potential impacts to Aboriginal heritage sites, places and values as required.

#### **4.5.6.2 Non-Indigenous Heritage**

To reduce the Proposal's impacts to existing non-indigenous heritage sites, the mitigation hierarchy (i.e. avoid, minimise, rehabilitate/restore and offset) has been applied during the concept design phase, and in the development of appropriate mitigation and management strategies.

Impacts to non-indigenous heritage places within and adjacent to the Development Footprint have been, and will continue to be, minimised through the following management actions and design principles:

- The detailed design phase will assess the viability of alignment adjustments to minimise or avoid impacts to heritage sites and places; in particular, Harris Well 2 and the Spring Valley site.
- Consultation with the State Heritage Office on newly recorded places of potential heritage value will be undertaken, to determine if these places required assessment via the GHPD process.
- The GHPD process will be complied with by preparing a letter to the State Heritage Office, advising of impacts to those listed and newly identified heritage places as outlined in **Table 4-47**;
- Ongoing consultation will take place with the Shires of Chittering and Gingin regarding the heritage values within and adjacent to the Development Footprint.
- Non-indigenous heritage places in proximity to the Development Footprint and within the Development Envelope will be identified as no-go zones (for example, Harris Well 2), clearly demarcated on the ground prior to construction works commencing, and communicated to personnel via inductions and toolbox awareness sessions.
- All employees and contractors will be informed about the presence and location of non-indigenous heritage places identified within and adjacent to the Development Envelope, and their responsibilities in relation to these.

#### **4.5.7 Predicted Outcome**

##### **4.5.7.1 Aboriginal Heritage**

Of the twelve heritage sites (registered and other 'heritage places') that exist within the Development Envelope, nine of these have been avoided by the Proposal throughout the concept design phase. The detailed design phase will assess the viability of alignment adjustments to minimise or avoid impacts to the Aboriginal heritage sites and places, in particular the Spring Valley Artefact Scatter.

Those sites that are within, or partially within the Development Footprint that cannot be avoided, may be impacted by the Proposal. Where these sites contain artefacts, these will be recovered and relocated as required by any AH Act section 18 consent obtained for the Proposal. With the implementation of the management measures and design principles proposed in relation to Aboriginal heritage, it is expected that the EPA's objective can be met.

Potential impacts to Aboriginal heritage values of the wetlands and watercourses of the Development Envelope have been discussed with the Yued. The watercourses in the vicinity of the Development Footprint were identified by Aboriginal representatives as being sacred, through their association with the *Waugal*, and are of significant cultural value. These consultations indicate the impact is not significant, provided the management measures and design principles proposed are put in place. It is considered that the Proposal is likely to meet the EPA's objective with implementation of appropriate management measures for these sites, and other watercourses and wetlands.

The significance of impact to the newly identified Spring Valley Artefact Scatter will be determined during further consultation with the Yued, in future ethnographic consultations, and assessment of the HISF submission by the

Aboriginal Cultural Material Committee under section 5(a) of the AH Act. In the event that this location is deemed a site, any disturbance will require approval under section 18 of the AH Act.

#### **4.5.7.2 Non-indigenous Heritage**

Of the five newly identified existing structures that may pertain non-Indigenous heritage value (Archaeaus, 2018) and the 16 registered MI places, three of the newly identified structures and 15 registered MI places have been avoided by the Proposal. The avoidance to these has largely been as a result of design modifications throughout concept design phase. The Development Envelope intersects the boundary of the registered MI place Cullala Siding (Place ID 14194). The existing structures within this place will not be impacted by the Proposal.

Where non-indigenous heritage places within the Development Footprint cannot be avoided, these will not be retained and only some evidence may remain. The non-indigenous heritage places in the Development Footprint are not included on any Commonwealth or State statutory heritage lists; however, further consultation with the State Heritage Office regarding newly identified places will be required. The demolition/clearing of these places is not likely to adversely affect any historical or cultural associations. As such, the Proposal is expected to meet the EPA's objectives.

### **4.6 Key Environmental Factor – Social Surroundings (Amenity)**

#### **4.6.1 EPA Objective**

To protect social surroundings from significant harm.

#### **4.6.2 Policy and Guidance**

The following EPA policy and guidance have been considered during the preparation of this ERD and the supporting technical studies:

- Statement of environmental principles, factors and objectives (EPA 2016a)
- Environmental factor guideline - social surroundings (EPA 2016j).

Other policy and guidance considered during the preparation of this ERD and the supporting technical studies includes:

- State planning policy 3.7: planning in bushfire prone areas (Department of Planning & WAPC 2015a)
- State planning policy 5.4: road and rail transport noise and freight considerations in land use planning (WAPC 2009)
- Implementation guidelines for State planning policy 5.4 (Department of Planning & WAPC 2014)
- Australia/New Zealand Standard 1158 (2005): lighting for roads and public spaces
- Visual landscape planning in WA; a manual for evaluation, assessment, siting and design (WAPC & Department for Planning and Infrastructure 2007)
- Guidelines for landscape and visual impact assessment (Landscape Institute & IEMA 2013)

#### **4.6.3 Receiving Environment**

##### **4.6.3.1 Noise**

Noise monitoring and modelling was undertaken in order to establish the baseline noise conditions within the Development Envelope, model the expected noise emissions resulting from traffic travelling on the Bindoon Bypass (once constructed) and assess the impact of this on noise sensitive receivers. Noise sensitive receivers for the Proposal are limited to residences. No schools, hospitals or other noise sensitive receiver types are located within close proximity to the Proposal.

The full noise modelling and assessment report is provided in **Appendix I**.

### Existing Noise Conditions

Noise monitoring was undertaken at ten locations along the Development Envelope between January and March 2018. These locations are considered representative locations for all noise sensitive receivers within the Development Envelope. Noise monitoring was undertaken at eight of these sites over a ten-day period, while two sites were monitored for only four days due to access constraints. **Table 4-48** provide results of the monitoring while **Figure 4-30** shows the monitoring locations.

The results are representative of rural environments whereby activities contributing to noise would include traffic on local roads, operation of farm machinery and rural residential activities. The daytime noise levels at Location (2.4) 16 Cullalla Road and Location (2.8) 2087 Bindoon-Moora Road were higher than at the other monitoring locations. The owner of 16 Cullalla Road operated motorcycles on the site. The owner of 2087 Bindoon-Moora Road conducted bird-scaring techniques that were clearly audible by the noise monitoring equipment.

Additional monitoring of ambient noise conditions was undertaken at five locations along the existing alignment of the GNH near Bindoon, between 12 and 21 December 2017 (**Figure 4-30** and **Table 4-49**). These results were used to calibrate the model developed to estimate the future noise emissions resulting from the Bindoon Bypass.

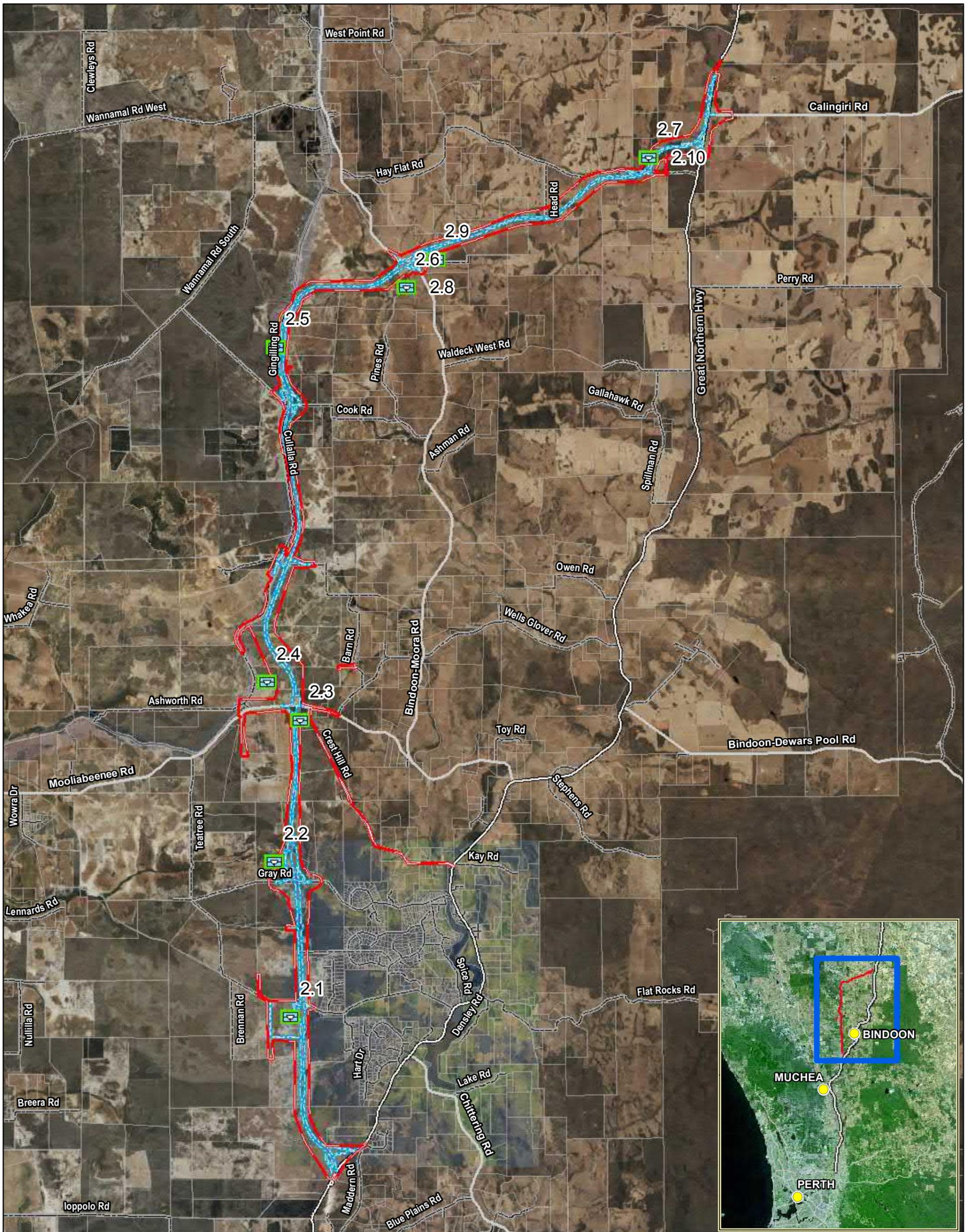
**Table 4-48: Ambient Noise Levels along the Development Envelope**

Measurement Position		L <sub>Aeq,16hours</sub> (day) dB	L <sub>Aeq,8hours</sub> (night) dB
2.1	Lot 1 (no. 537) Teatree Road, Bindoon	43	40
2.2	Lot 36 (no. 620) Gray Road, Bindoon	43	40
2.3	Lot 502 (no. 737) Crest Hill Road, Mooliabeenee	48	43
2.4	Lot M1364 (no. 16) Cullalla Road, Mooliabeenee	57	45
2.5	Lot 1 (no. 428) Gingilling Road, Mooliabeenee	47	43
2.6	Lot 53 (no. 644) Gingilling Road, Wannamal	47	37
2.7	Lot 1 (no. 2261) Bindoon-Moora Road, Wannamal	49	40
2.8	Lot 3 (no. 2087) Bindoon-Moora Road, Wannamal	61	36
2.9	Lot 2917 (no. 75) Kangaroo Gully Road, Wannamal	51	37
2.10	Lot 3281 (no. 9071) GNH, Wannamal	42	31

**Table 4-49: Ambient Noise Level along the Existing GNH near Bindoon**

Measurement Position		L <sub>Aeq,16hours</sub> (day) dB	L <sub>Aeq,8hours</sub> (night) dB
1.1	Lot 554 (no. 7372) GNH, Bindoon	71	50
1.2	Lot 5933 (no. 6486) GNH, Bindoon	68	62
1.3	Lot 501 (no. 5885) GNH, Bindoon	69	63
1.4	Lot 18 (no. 5077) GNH, Bindoon	71	60
1.5	Lot 151, 21 Sandalford Drive, Chittering*	61*	55*

\* Noise logger at this position failed after 2 days. This noise level therefore only includes measurements from a 2-day period.



**Legend**

- Development Envelope
- Development Footprint
- Cadastral Boundary
- Noise Measurement Locations
- Highway
- Major Road
- Minor Road

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Scale at A3  
1:113,073

0 1,300 2,600  
Metres

Coordinate System: GDA 1994 MGA Zone 50

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Project

Great Northern Highway  
Bindoon Bypass  
Environmental Review Document

Ambient Noise Monitoring Locations  
within the Development Envelope

Figure: 4-30

Drawing No GNH-CN12-EA-PER-00001 - F4-30	Issue 1		
Task No ERD	Drawing Status / Other Draft		
Date 30/05/2019	By BG	Chkd LB	Appd TJ

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#### 4.6.3.2 Visual Amenity, Dust and Light Spill

Landscape values of the Bindoon area have been determined based on a number of different factors, including landscape units and character types set by the planning framework, and physical characteristics of the area such as land use, topography and vegetation complexes (Arup 2018a).

The *Wheatbelt regional planning and infrastructure framework* (Department of Planning & WAPC 2015b) sets out four broad landscape character types that apply to the entire Wheatbelt area and which are applicable to the study area. These are: Coastal; Hills; Wheatbelt; and Woodlands (as shown on Map 6 of Department of Planning & WAPC 2015b). The Proposal is located on the border of Hills and Wheatbelt landscape units (Arup 2018a). The Wheatbelt landscape unit is expansive and undulating with a number of agricultural uses, including cereal crops and grazing. The Hills landscape unit has more extensive areas of remnant vegetation than the Wheatbelt landscape unit, and a number of drainage lines and lakes. However, the Hills unit also has expansive areas of cleared agriculture land with no remnant vegetation.

The *Shire of Chittering local planning scheme no. 6* (DPLH 2004) and associated policy categorises areas within the Shire into four geographical landscape character units. These are: Chittering Valley; Northern Broad Agricultural Area; Dandaragan Plateau; and Ellen Brook Pallus Plain.

The Proposal traverses the Dandaragan Plateau and the Northern Broad Agricultural Area, which have similar descriptions to the Wheatbelt and Hills landscape units (Department of Planning & WAPC 2015b).

Topographical mapping of the study area illustrates that the Development Envelope traverses undulating hills up to 200 m above sea level. The area is characterised by the Darling Plateau and Dandaragan Plateau which, due to erosion and clearing for agriculture, has exposed topography promoting views towards the Darling Fault (Arup 2018a). The topography of the Development Envelope is also characterised by a number of wetland systems and drainage lines, such as the Brockman River and associated tributaries and wetlands (Arup 2018a).

Land use in the area is typically rural residential, agricultural and occasionally forest plantation and orchards. The rural residential land use is located around the township of Bindoon and large agricultural lots are located throughout the area (Arup 2018a).

The vegetation cover from a visual and landscape character perspective developed for the visual impact assessment from in-field observations, were described using the following three descriptions:

- open Woodlands: consist of a Eucalypt canopy with *Eucalyptus marginata* and *Corymbia calophylla*. Occasionally, near granite outcrops, there is a Proteaceae understory of Acacia and Myrtaceae
- low Banksia Woodlands: consist of Banksias and Eucalyptus such as *Eucalypt todtiana*
- Wannamal Wandoo Woodlands: directly connected with drainage lines contains distinct species, predominantly *Eucalypt wandoo*, with occasional Acacia on dryer slopes.

Overall, the landscape character is distinctly rural. One of the more significant elements would be that the natural landscape forms rolling 'open woodlands', which occur consistently along the proposed alignment in slightly varied densities, trunk colour and texture. This is made more noticeable by the occasional denser, enclosed low Banksia Woodlands and Wannamal Wandoo Woodlands, which provide diversity in the road's sequential views.

**Table 4-50** summarises the landscape and visual amenity values of the Development Envelope, while **Figure 4-31** shows the landscape character areas.

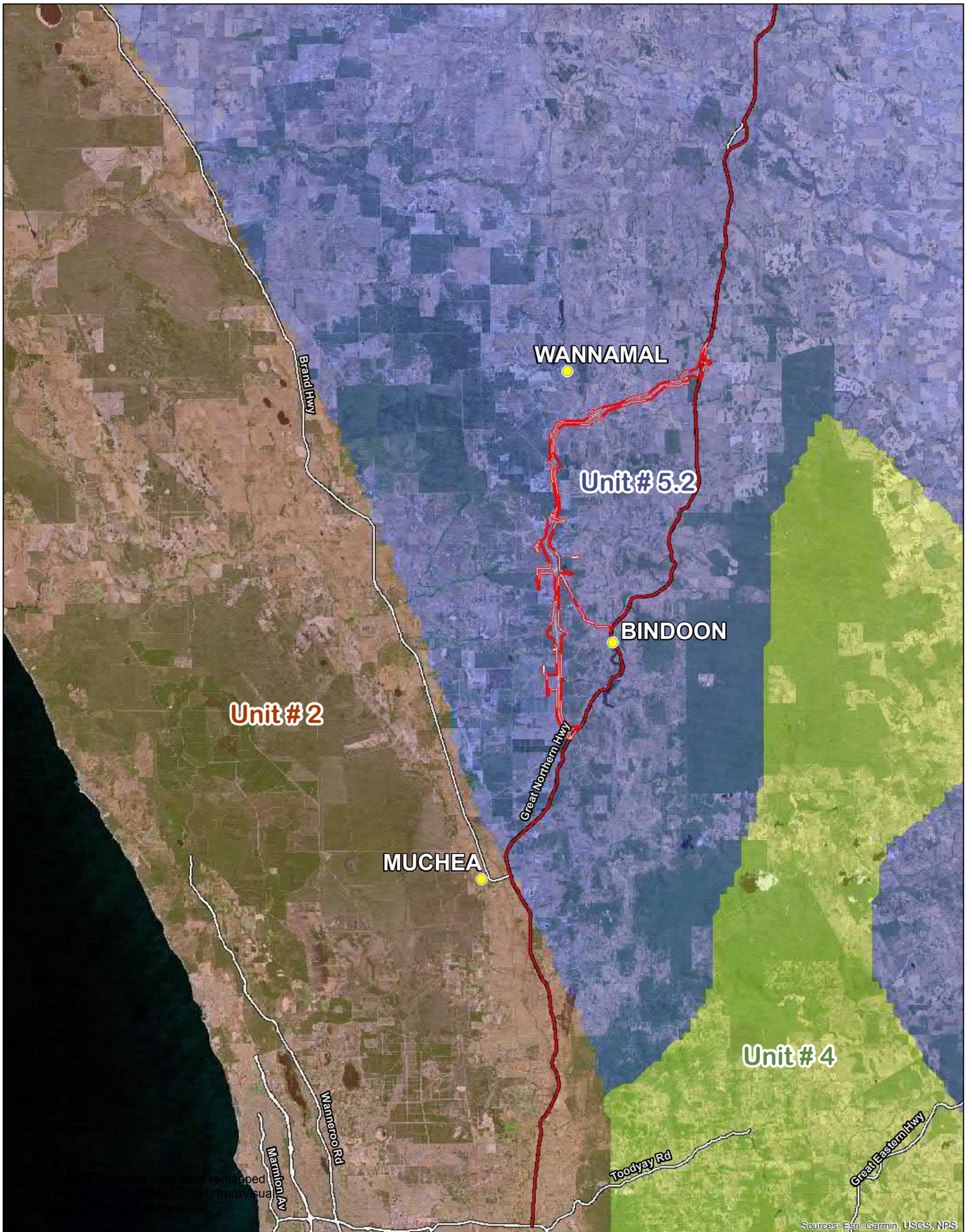
As described above, the Development Envelope is located in a rural area with the dominant activities being cropping and grazing. There are a number of rural residences throughout the Bindoon area with higher density housing near Bindoon (DPLH 2004). Bindoon town is the nearest settlement to the Bindoon Bypass. Bindoon is characterised by a number of small businesses operating throughout the day, and community services such as the local council buildings and town hall. A railway line/reserve exists along the north western edge of the Development Envelope.

The Development Envelope's rural environment is a mix of cleared agricultural paddocks and remnant native vegetation. As such, the Development Envelope is expected to experience elevated levels of dust from existing land uses and activities. In particular, cropping agriculture activities have the potential to generate noticeable levels of dust, with grazing activities also having the potential to form dust plumes from time to time. Given the expansive cleared areas and typically dry conditions, the area is susceptible to dust being generated from any activity that is not conducted on sealed surfaces.

As the Proposal is not in close proximity to towns or cities, existing artificial light levels across the Development Envelope are lower, and limited to lighting of residential dwellings and headlights from vehicles and farming equipment. The National Oceanic and Atmospheric Administration's Earth Observation Group provides a range of data and services in relation to global night-time observation of lights and combustions sources. The Visible Infrared Imaging Radiometer Suite indicates that the Development Envelope is likely to be affected by light pollution from the town of Bindoon and the Perth Metropolitan Area (Earth Observation Group 2018).

**Table 4-50: Landscape Character Descriptions (Source: Arup 2018a)**

	Open Woodlands	Low Banksia Woodlands	Wannamal Wandoo Woodlands
<b>Landform</b>	<ul style="list-style-type: none"> <li>The topography ranges from undulating moderate hills to dissecting higher topography to the north. Waterways and dry drainage lines are often associated at the base of shallow and deeper valleys. The landform of this character area provides views across pastures, and to the north from the tops of the higher hills and along the deeper valleys. Granite outcrops are found along the Darling Plateau.</li> <li>Orange laterite edges to roads and tracks are seen in breaks of pasture grass and topsoil.</li> </ul>	<ul style="list-style-type: none"> <li>The topography of the Dandaragan Plateau is undulating, including hills with shallow valleys of waterways and drainage lines from nearby lake systems. There is not much variation in the undulating form.</li> <li>Pale yellow to terracotta soils (clay) are evident</li> </ul>	<ul style="list-style-type: none"> <li>Deeply dissecting valleys and rising topography provide views out over the rural landscape and along valleys.</li> <li>Waterways and dry drainage lines carve through the landscape providing contrast in colour as vegetation becomes slightly denser as it adapts to the water table. Rocky granite outcrops provide a change in colour and texture and become feature focal points in a vista.</li> </ul>
<b>Vegetation</b>	<ul style="list-style-type: none"> <li>Primarily Eucalypt canopy generally <i>Eucalyptus marginata</i>, <i>Corymbia calophylla</i>, occasional Acacia and Myrtaceae, Proteaceae understory near the dryer granite outcrops. Some Eucalypt wandoo occur as well.</li> </ul>	<ul style="list-style-type: none"> <li>A mixture of Banksias and Eucalypts such as <i>Eucalypt todtiana</i> with some <i>Corymbia calophylla</i> open woodlands.</li> <li>The vegetation is a diverse mix of texture and colours of green compared with the open <i>Eucalypt woodlands</i>.</li> <li>The vegetation canopy can be lower and denser and enclose views in some locations.</li> </ul>	<ul style="list-style-type: none"> <li>Due to the connection with the drainage lines and waterways vegetation changes to distinct Eucalypt species, including <i>Eucalyptus wandoo</i> with occasional Acacia on the dryer side of the slopes.</li> <li>Colour and form of the wandoo is a rough white bark and wide canopy—an aesthetic setting when the species are grouped together.</li> </ul>
<b>Land Use</b>	<ul style="list-style-type: none"> <li>A mosaic of agricultural pasture with parcels and edges along clearing of remnant vegetation. Towards the south there is a focus on rural built form such as residences, fences, silos, cropping, sheds etc.</li> <li>There is a contrast in colour, texture and clean lines of built forms and surrounding pastures and canopy.</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural land use is still a feature of this character area where clean lines and colours of the built form of rural residences, silos, sheds, fences contrast with the softer fields of crops and surrounding landscape.</li> </ul>	<ul style="list-style-type: none"> <li>Agricultural land use is still a feature of this character area. As is typical with the region, the clean lines and colours of the built form of rural residences and farming infrastructure contrast with the softer pasture fields. The dissecting topography and higher peaks restrict diverse forms of agricultural use and livestock is more prominent.</li> <li>Fencing follows the undulating hills forming visual geometric lines across the landscape.</li> </ul>



Sources: Esri, Garmin, USGS, NPS

**Legend**

- Development Envelope
- Highway
- GNH Road Centreline (H006)

- WA Regional Landscape Character Units**
- 2
  - 4
  - 5.2



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 Great Northern Highway Bindoon Bypass  
 Environmental Review Document

Landscape Character Units of the Proposal  
 Figure: 4-31

Drawing No: GNH-CN12-EA-PER-00001 - F4-31  
 Issue: 1

Task No: ERD  
 Drawing Status / Other: Draft

Date	By	Chkd	Appd
13/08/2019	BG	LB	TJ

Scale at A3: 1:320,000  
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#### 4.6.4 Potential Impacts

The implementation, construction and operation of the Proposal will have both direct and indirect impacts to amenity sub-factors. Potential impacts to amenity may arise within the Development Envelope as a result of the following activities:

- earthworks, excavations and other construction activities
- vehicle movements (construction and operational road traffic)
- physical presence of the new road and associated infrastructure
- bridge construction and creek crossings
- construction and ongoing presence of cuts and embankments.

The following impacts may occur as a result of implementation of the Proposal:

- increase in noise levels and vibration for sensitive receptors in rural setting
- increase in dust emissions during construction
- reduced local amenity due to increase in road traffic, change in rural vista due to cuts or embankments, glare from headlights, presence of street lighting and proximity of national highway.

##### 4.6.4.1 Noise

The Bindoon Bypass has potential to cause noise disturbance to residences during construction and operation. Noise generating activities will include the following:

- construction activities such as blasting, piling, bridge construction, clearing and earth-moving
- vehicle noise during operation.

Potential impacts from these noise generating activities are a loss of amenity and changed behaviours of residents due to increased background noise.

##### 4.6.4.2 Visual Amenity, Dust and Light Spill

The Bindoon Bypass is a new major highway in an area previously serviced by local roads. This has the potential to alter the landscape and visual amenity of the surrounding environment. The construction and operation of the Bindoon Bypass also has potential to introduce additional light and dust impacts to the existing environment. **Table 4-51** outlines the general impacts on amenity and from changes to dust and light emissions. The main impacts of concern are visual intrusion (from passers-by) and the change to the views from residents' houses as a result of construction of the Bindoon Bypass. These impacts are addressed in detail in **Chapter 4.6.5.2**.

**Table 4-51: Potential Impacts During Construction and Operations**

Design Element	Description
Introduced texture and colour	Where fill is required, the Proposal may alter existing vistas by reducing the extent of the view. Introduction of hard surfaces such as the road embankment may also reduce the naturalness of the vista in areas dominated by native vegetation resulting in a modified view with reduced scenic appeal.
Cuttings and fill/earthworks	Scale of change in landform is high near major cuttings and fill embankments for the proposed Bypass and alters natural form
Highway follows an existing transport route	The Proposal meets the existing railway line for part of the alignment and becomes more sympathetic to existing patterns of the landscape
Clearing for earthworks	The Proposal will reduce existing native vegetation due to clearing during construction, changing the naturalness of the area. Revegetation following construction has the potential to introduce vegetation such as trees and shrubs into areas that were previously dominated by pasture, thereby improving the naturalness of the landscape.
Increased movement/ speed	The Proposal will introduce new movement to the existing landscape and introduce a major road within a rural context resulting in possible loss of tranquillity.
Change	Possible loss of place identity as a quiet rural area
Lighting design	Lighting design includes installing lights at a number of intersections and truck stops along the Bindoon Bypass. Lighting will be provided to achieve safety requirements and will be minimized where possible. Light spill from intersection and truck stopping bays has the potential to impact residents should they be close to the source of light.
Headlights during operation	Headlights from traffic on the Bindoon Bypass have potential to cause impacts due to glare through windows of local residents. These impacts are more likely at intersections where traffic is turning.
Dust during construction activities	Dust may be generated during construction activities from machinery and site vehicles moving on unsealed areas. This dust may become a nuisance to local residents and farm workers.

## 4.6.5 Assessment of Impacts

### 4.6.5.1 Noise

During construction, noise will be generated from the movement and operation of construction vehicles and machinery, as well as construction activities such as blasting, piling and bridge construction, and tree-felling. Construction noise will be intermittent and temporary in nature. Furthermore, construction activities will largely occur during the daytime, with night construction activities only occurring on an as needs basis and as approved by Main Roads. To determine the extent of the potential impacts from noise during the operation of the Bindoon Bypass, traffic noise models were setup and run using the following methodology (GNH IPT 2018b):

- construct a traffic noise model in SoundPLAN Version 8.0 of the terrain and sensitive receivers in the vicinity of the GNH
- apply the three-dimensional earthworks design for the Bindoon Bypass
- using year 2038 forecast traffic volumes, determine daytime and night-time source noise levels for the GNH; this has also been done for the year 2051 traffic volumes, as this is the ultimate design scenario for the Bindoon Bypass

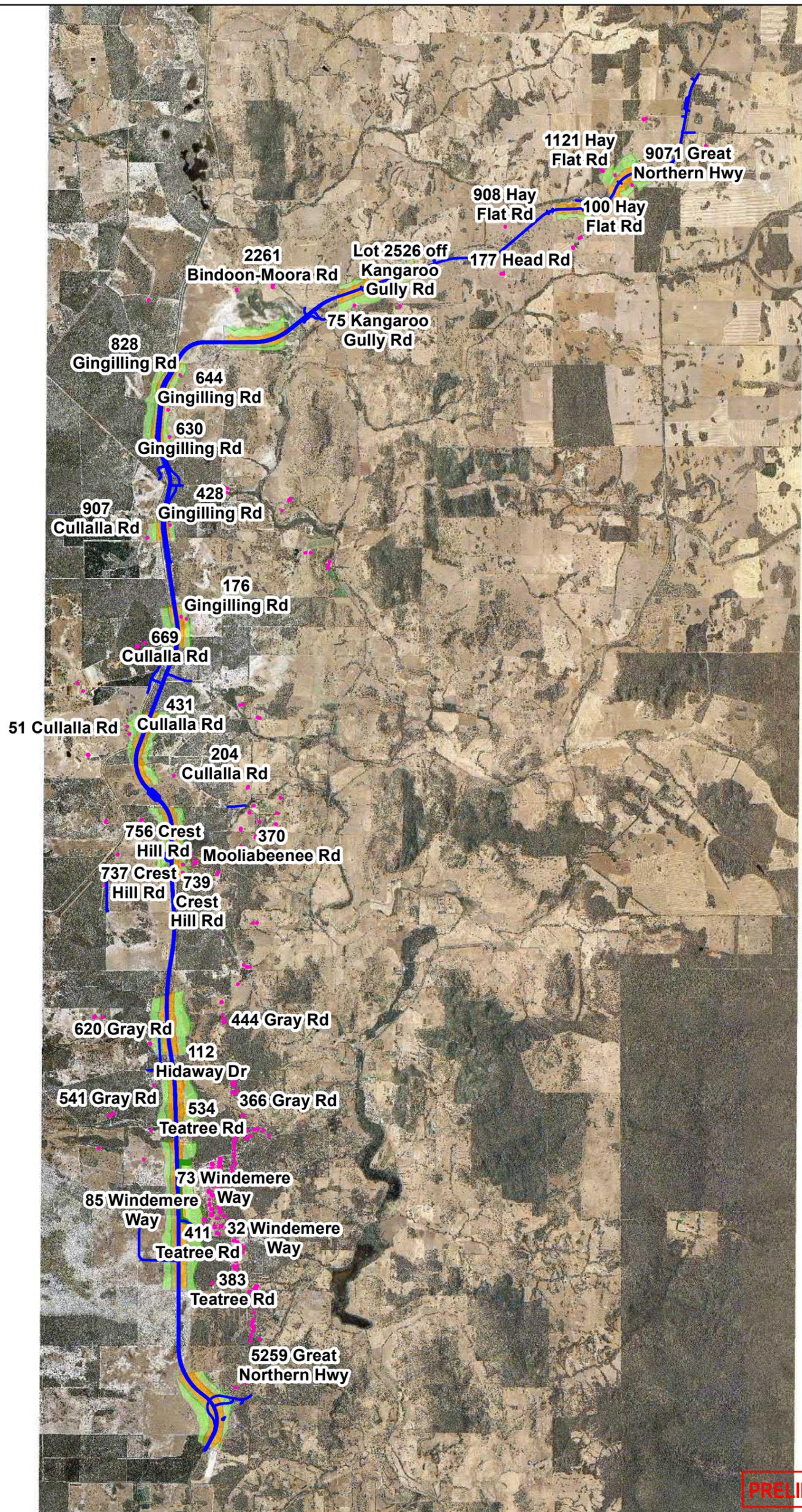
- predict the year 2038 (and 2051) traffic noise levels adjacent to the GNH
- assess the predicted noise levels with respect to State planning policy 5.4, and identify noise sensitive receivers where mitigation will be required to meet the project noise limits

The full noise assessment report is provided in **Appendix I** and the predicted noise contours for the entire Proposal are shown on **Figure 4-32**.

Assessment of the predicted noise levels against State planning policy 5.4 (WAPC 2009) found that there are a number of residences where noise targets may be exceeded, and one further residence on the threshold of noise limits. These results are shown in **Table 4-52** and **Table 4-53**.

**Table 4-52: Predicted Noise Levels at Noise Sensitive Receivers Exceeding State Planning Policy 5.4 Targets**

Location	Complies with Daytime Noise Target (55 L <sub>Aeq</sub> dB)	Predicted Daytime Noise Level (L <sub>Aeq</sub> dB)	Complies with Night-time Noise Target (50 L <sub>Aeq</sub> dB)	Predicted Night-time Noise Level (L <sub>Aeq</sub> dB)
Lot 3281 (no. 9071) GNH, Wannamal	x	60	x	54
Lot 36 (no. 620) Gray Road, Bindoon	x	56	✓	50
Lot 502 (no. 737) Crest Hill Road, Mooliabeenee	x	58	x	53
739 Crest Hill Rd, Mooliabeenee	x	58	x	53
431 Cullalla Rd, Moondah	x	58	x	52
630 Gingilling Rd, Wannamal	x	56	x	50
Lot 53 (no. 644) Gingilling Road, Wannamal	x	58	x	53
828 Gingilling Rd, Wannamal	x	57	x	52
907 Cullalla Rd, Cullalla	x	57	x	51
1121 Hay Flat Rd, Wannamal	x	58	x	52
Lot 2917 (no. 75) Kangaroo Gully Road, Wannamal	x	57	x	51



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers
- Noise protection wall

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

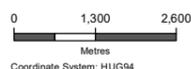


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Coordinate System: HUG94



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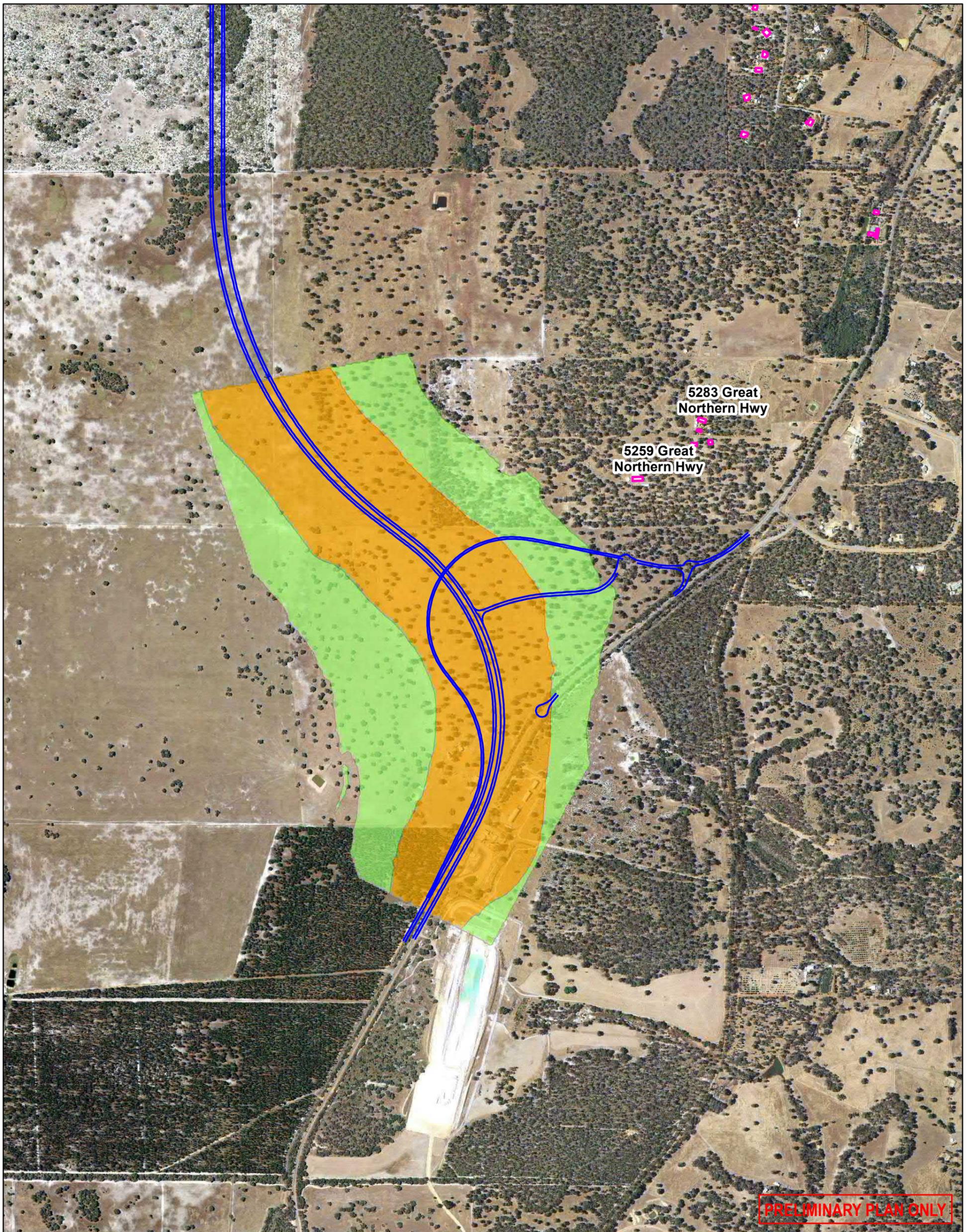
Client Project  
Great Northern Highway  
Muecha to Wubin Upgrade Stage 2

**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9101 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

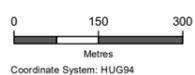


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Great Northern Highway  
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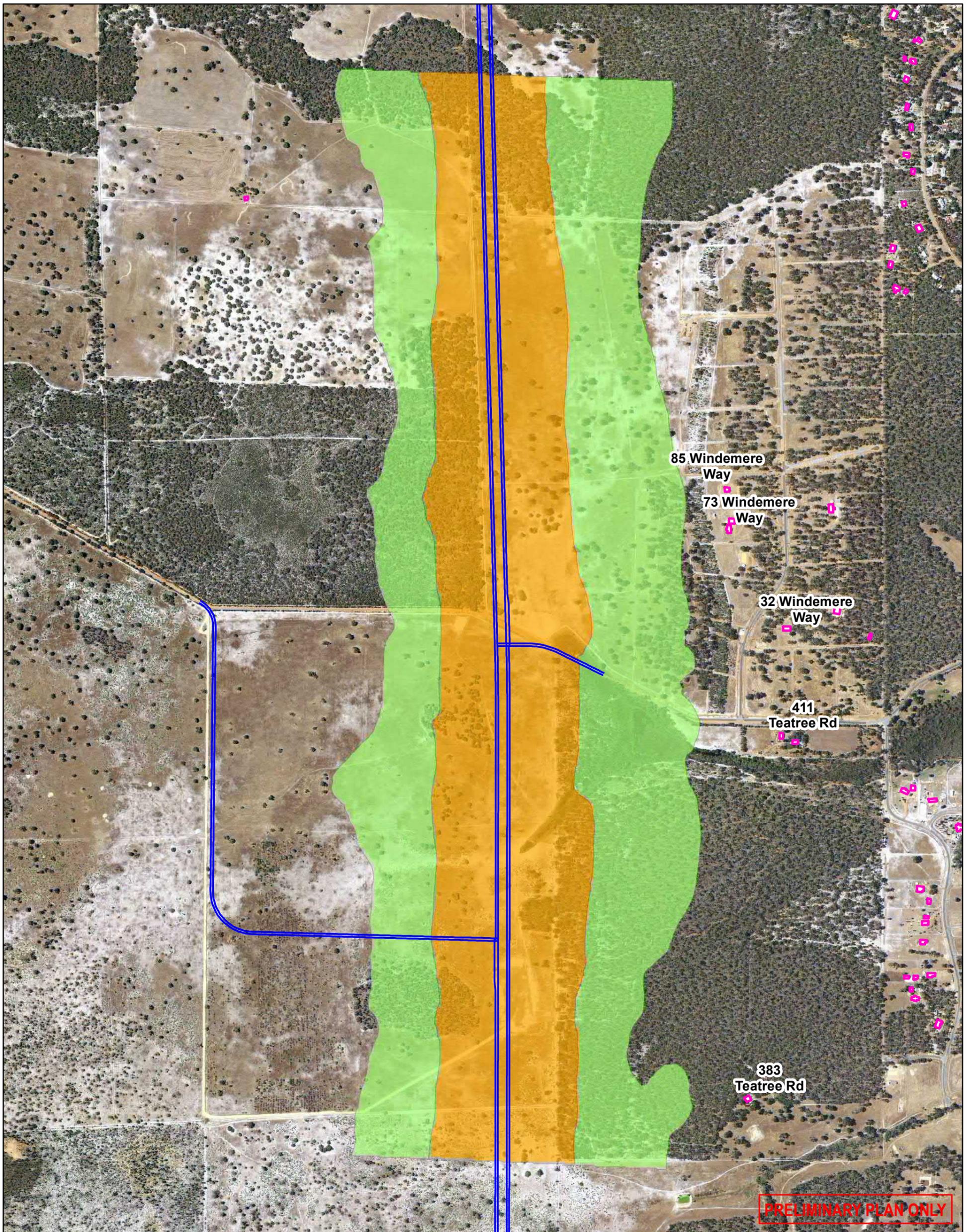
**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9102 Issue: A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

PRELIMINARY PLAN ONLY



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

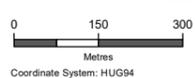


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Scale at A3  
Project  
1:12,580

Coordinate System: HUG94



Main Roads Western Australia

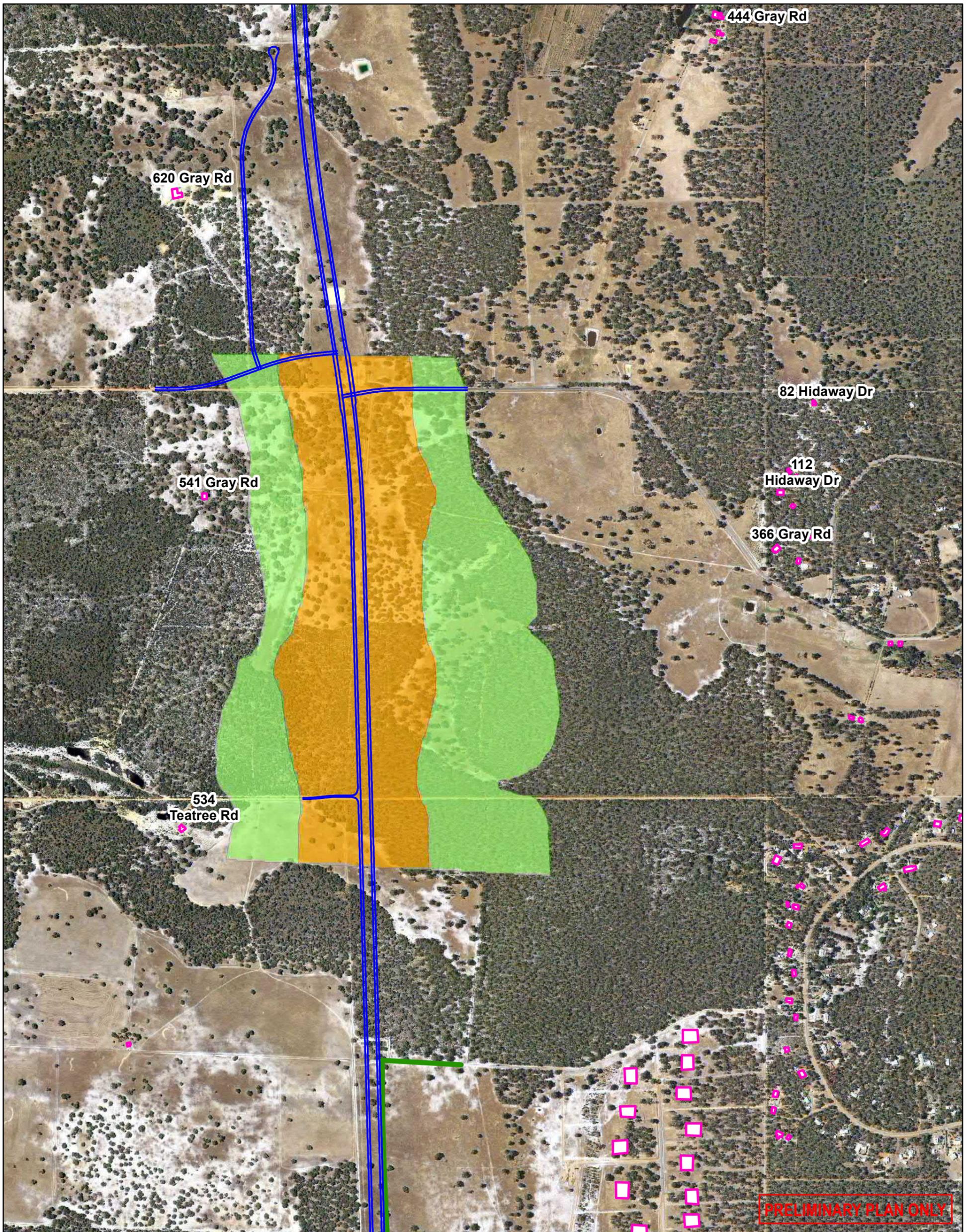
Client  
Project  
**Great Northern Highway  
Muchea to Wubin Upgrade Stage 2**

**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9103** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
20/08/2018	MFR	FB	LMB



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers
- Noise protection wall

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

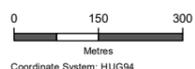
Data Source: Main Roads WA, Landgate



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Scale at A3  
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Coordinate System: HUG94



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Great Northern Highway  
 Muchea to Wubin Upgrade Stage 2

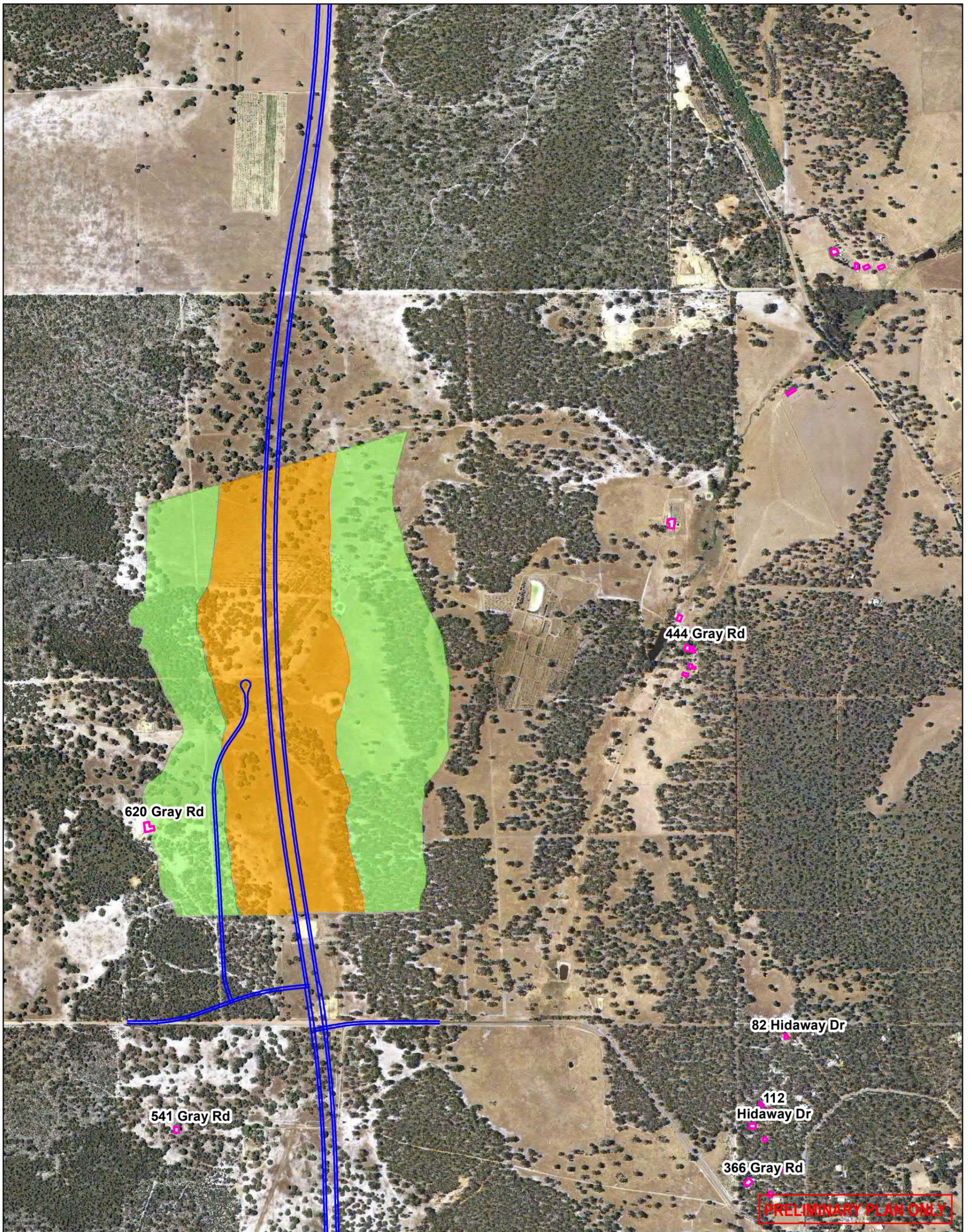
**Predicted Day Time Traffic  
 Noise Level along  
 Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9104 Issue A

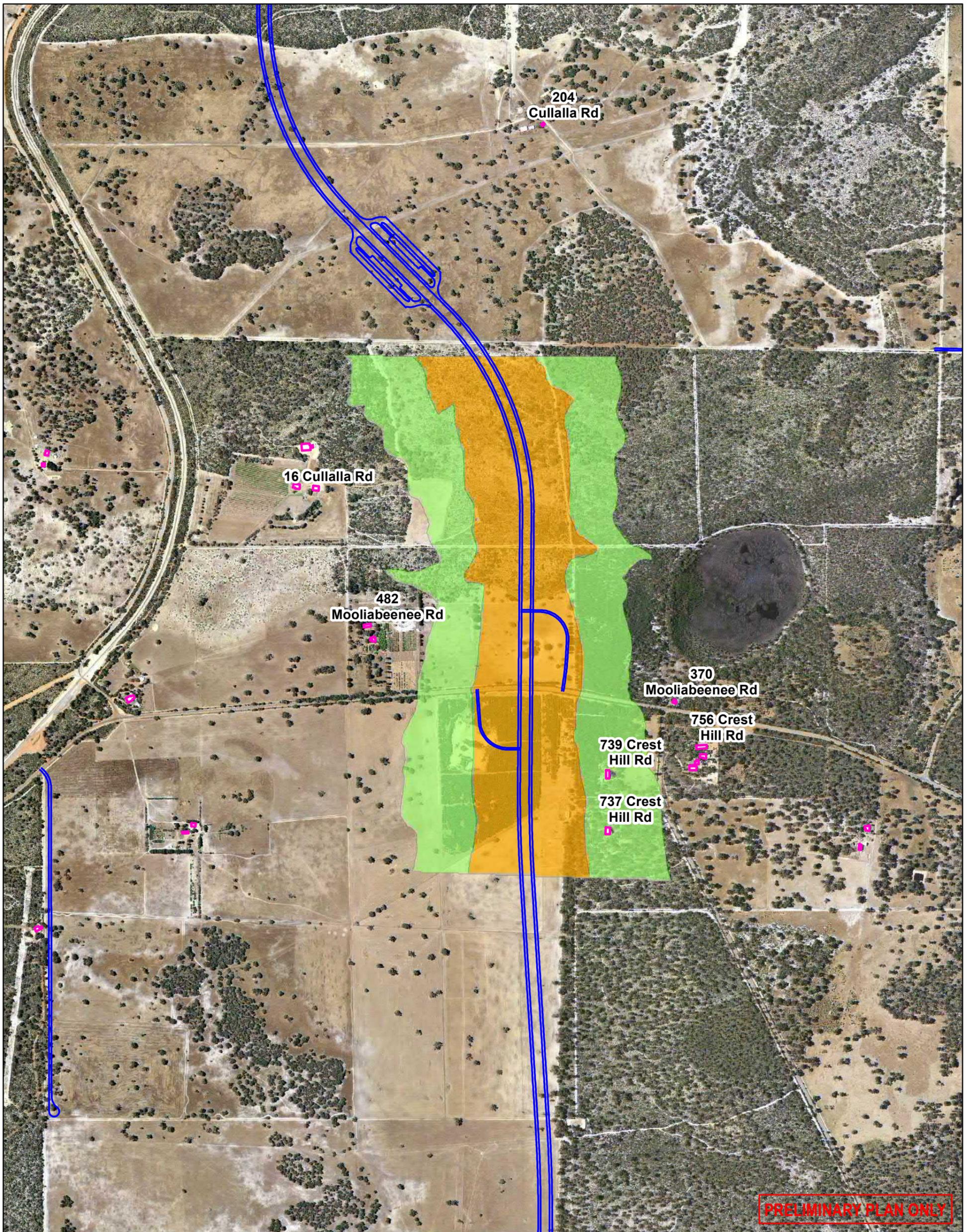
Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

PRELIMINARY PLAN ONLY



<p><b>Legend</b></p> <p>— Proposed Bindoon Bypass Centreline</p> <p>□ Noise Sensitive Receivers</p> <p><b>Predicted Day Time Noise Level including Facade Correction</b></p> <p>&lt;55 dBA</p> <p>55-60 dBA</p> <p>&gt;60 dBA</p> <p><small>Data Source: Main Roads WA, Landgate</small></p>	<p>Joint Venture Partners:</p> <p>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</p> <p>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</p> <p>© Main Roads Western Australia</p> <p>0 150 300 Metres</p> <p>Scale at A3 1:12,563</p> <p>Coordinate System: HUG94</p>	<p>mainroads WESTERN AUSTRALIA</p> <p>ARUP TRADING AS, ASJV</p> <p>JACOBS</p> <p><b>Main Roads Western Australia</b></p> <p>Client Project</p> <p><b>Great Northern Highway Muchea to Wubin Upgrade Stage 2</b></p>	<p><b>Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass</b></p> <p>Drawing No: GNH-CN12-EN01-DRG-9105 Issue: A</p> <p>Task No: Noise Assessment Drawing Status / Other: Draft / Other Info</p> <table border="1"> <tr> <td>Date: 10/08/2018</td> <td>By: MFR</td> <td>Chkd: FB</td> <td>Appd: LMB</td> </tr> </table>	Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB				



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

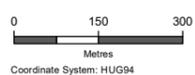


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Coordinate System: HUG94



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Client  
Project  
Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

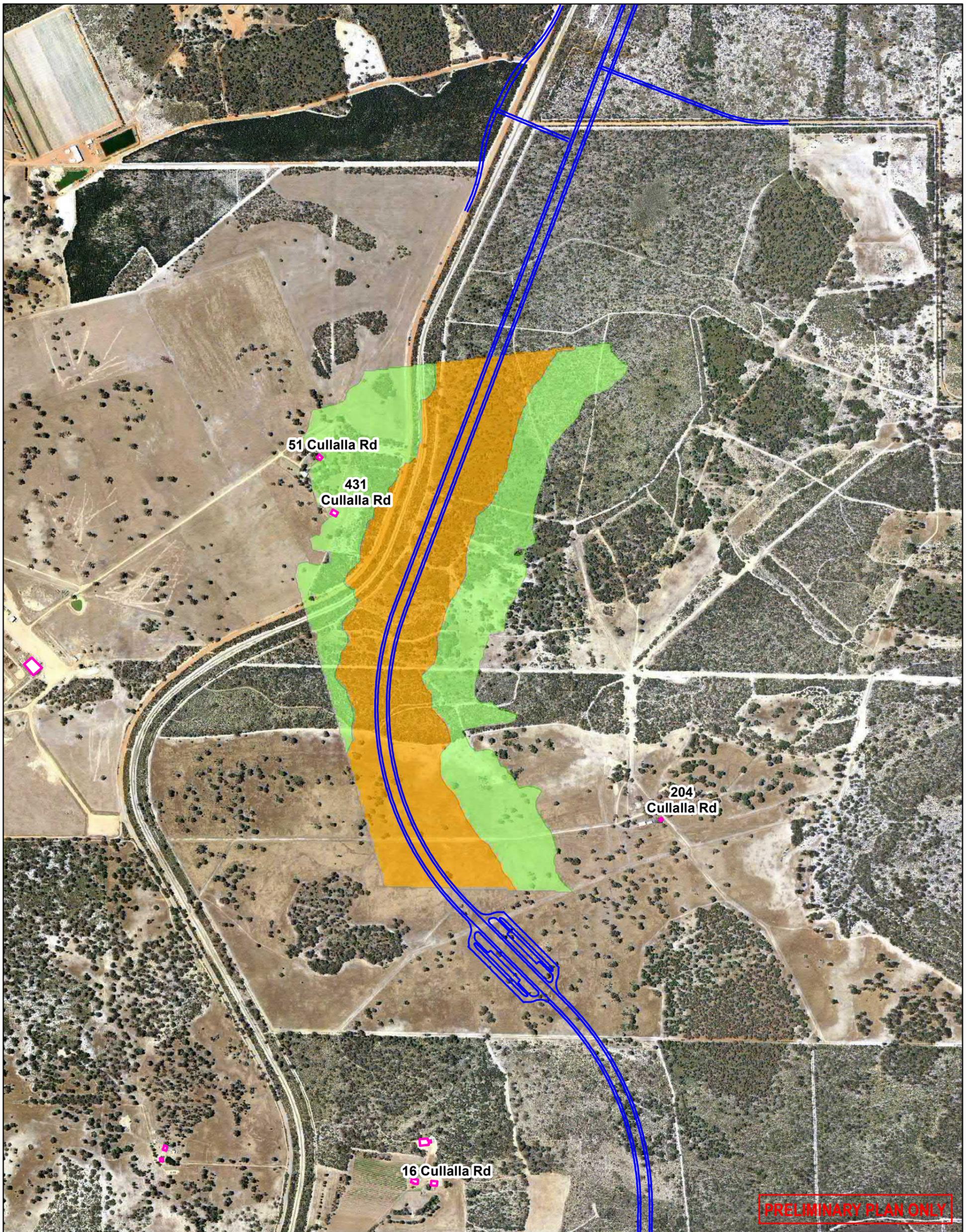
**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9106 Issue: A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

PRELIMINARY PLAN ONLY



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate



0 150 300  
Metres  
Scale at A3  
1:12,563  
Coordinate System: HUG94

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Client  
Project  
Great Northern Highway  
Muchoa to Wubin Upgrade Stage 2

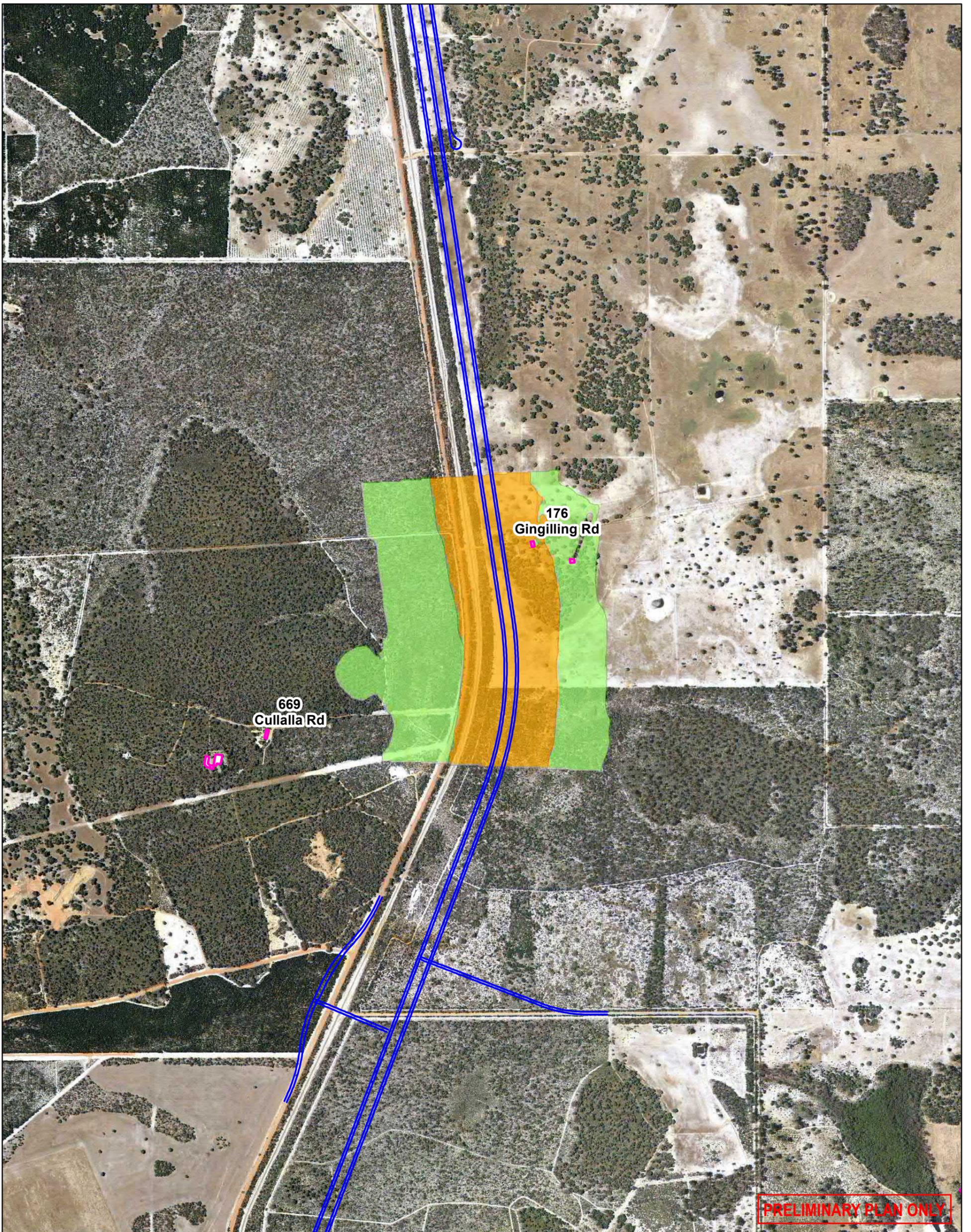
**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9107 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

PRELIMINARY PLAN ONLY



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

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WESTERN AUSTRALIA

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**JACOBS**

**GNH** BLACKBURN

**Main Roads Western Australia** Client  
Project

**Great Northern Highway**  
Muchoa to Wubin Upgrade Stage 2

**Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9108 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

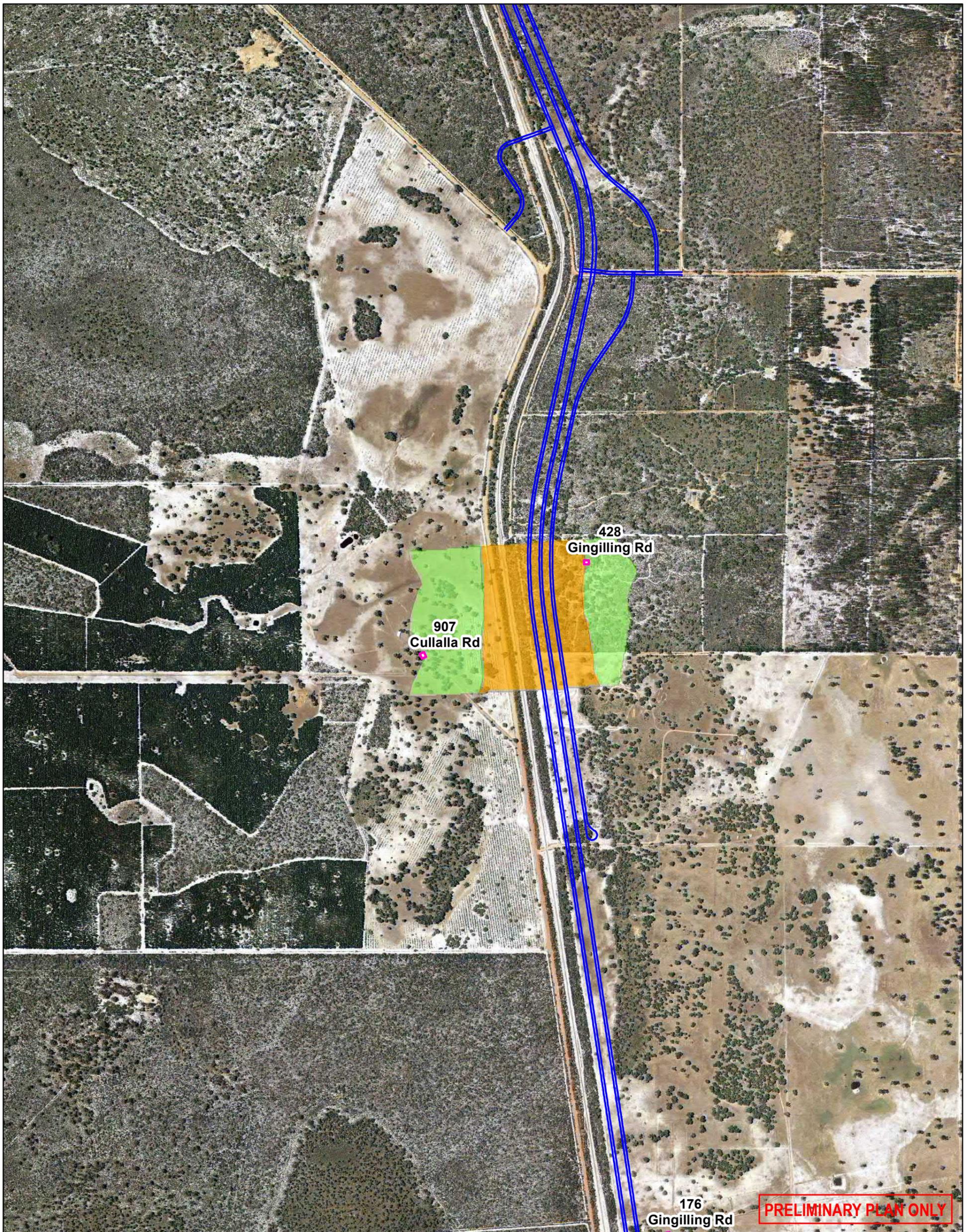
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0 150 300 Metres

Coordinate System: HUG94

Data Source: Main Roads WA, Landgate



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate



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0 150 300  
Metres

Coordinate System: HUG94

**Client**  
Project

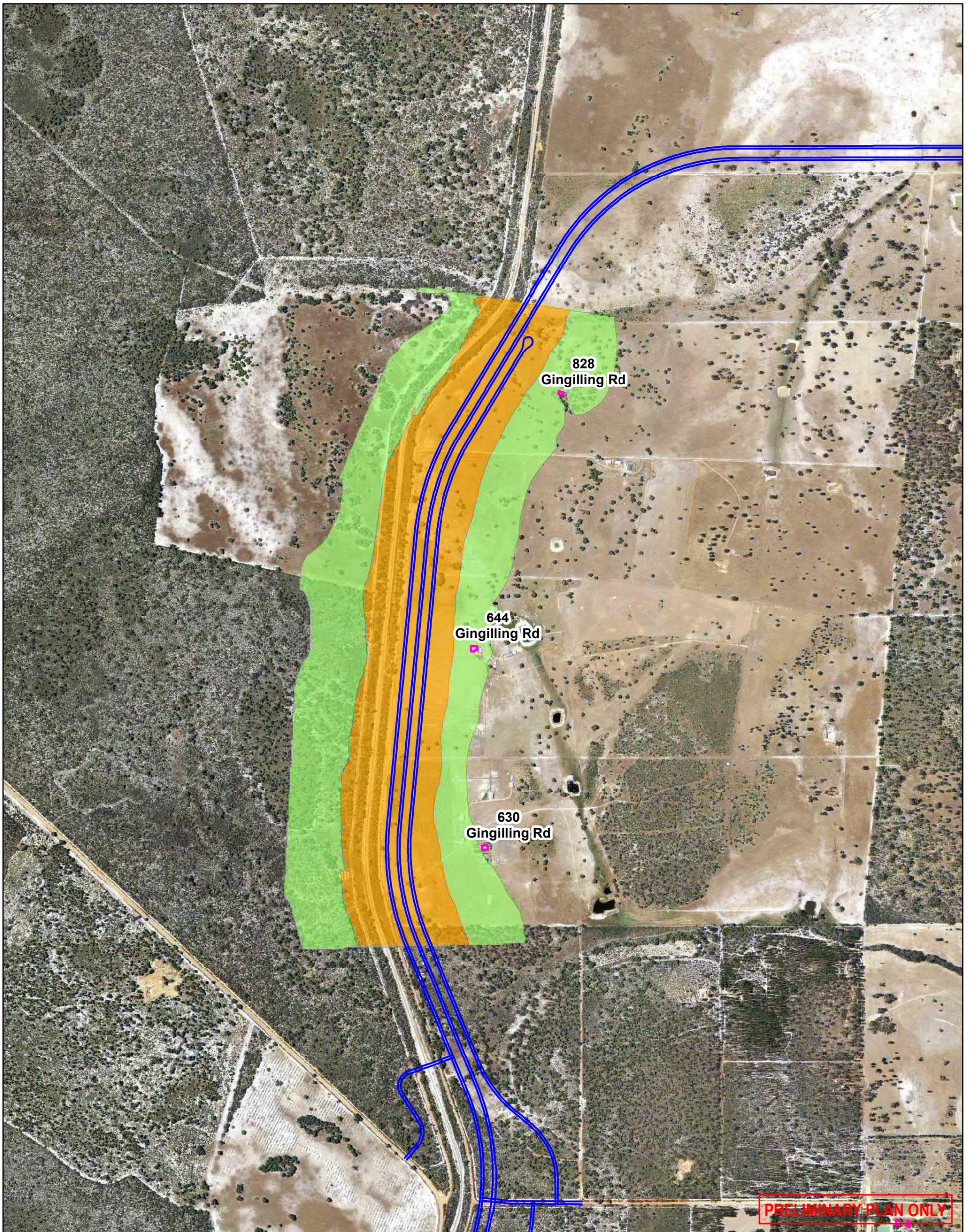
**Main Roads Western Australia**

**Great Northern Highway  
Muchea to Wubin Upgrade Stage 2**

**Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No	Issue		
GNH-CN12-EN01-DRG-9109	A		
Task No	Drawing Status / Other		
Noise Assessment	Draft / Other Info		
Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

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**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

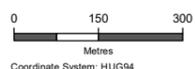


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Coordinate System: HUG94



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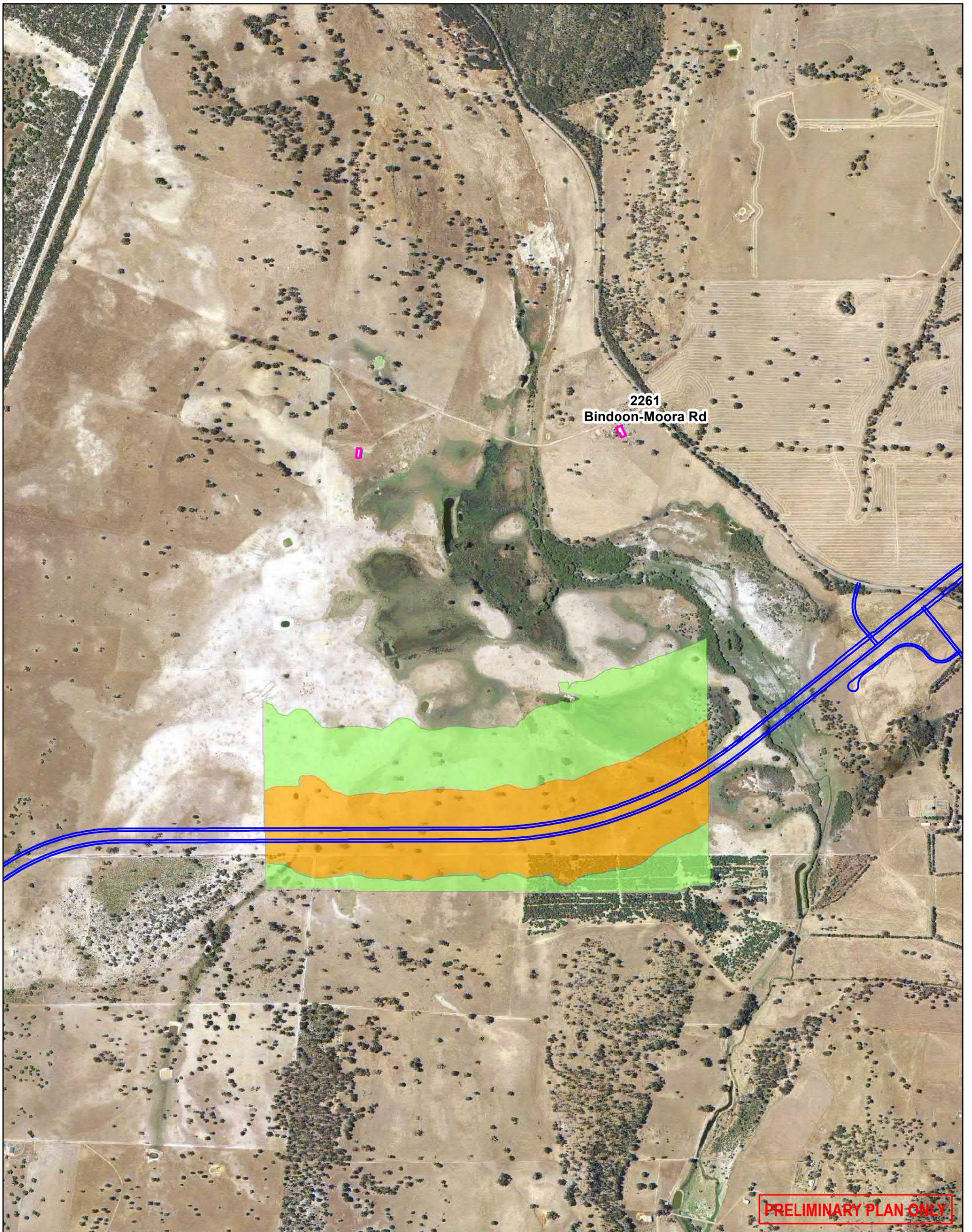
Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9110 Issue: A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

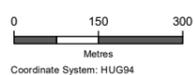


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Coordinate System: HUG94



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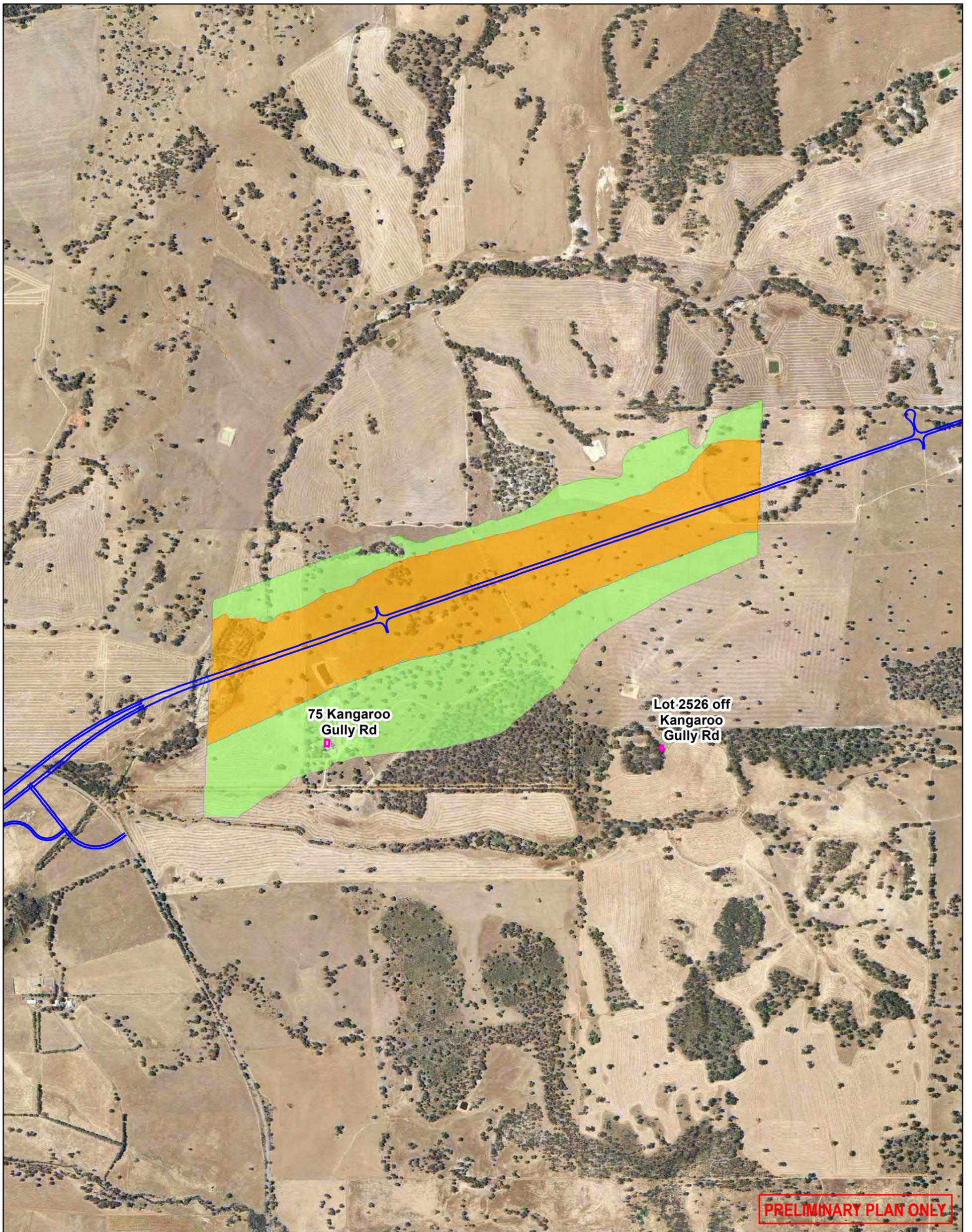
Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

**Predicted Day Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9111 Issue: A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

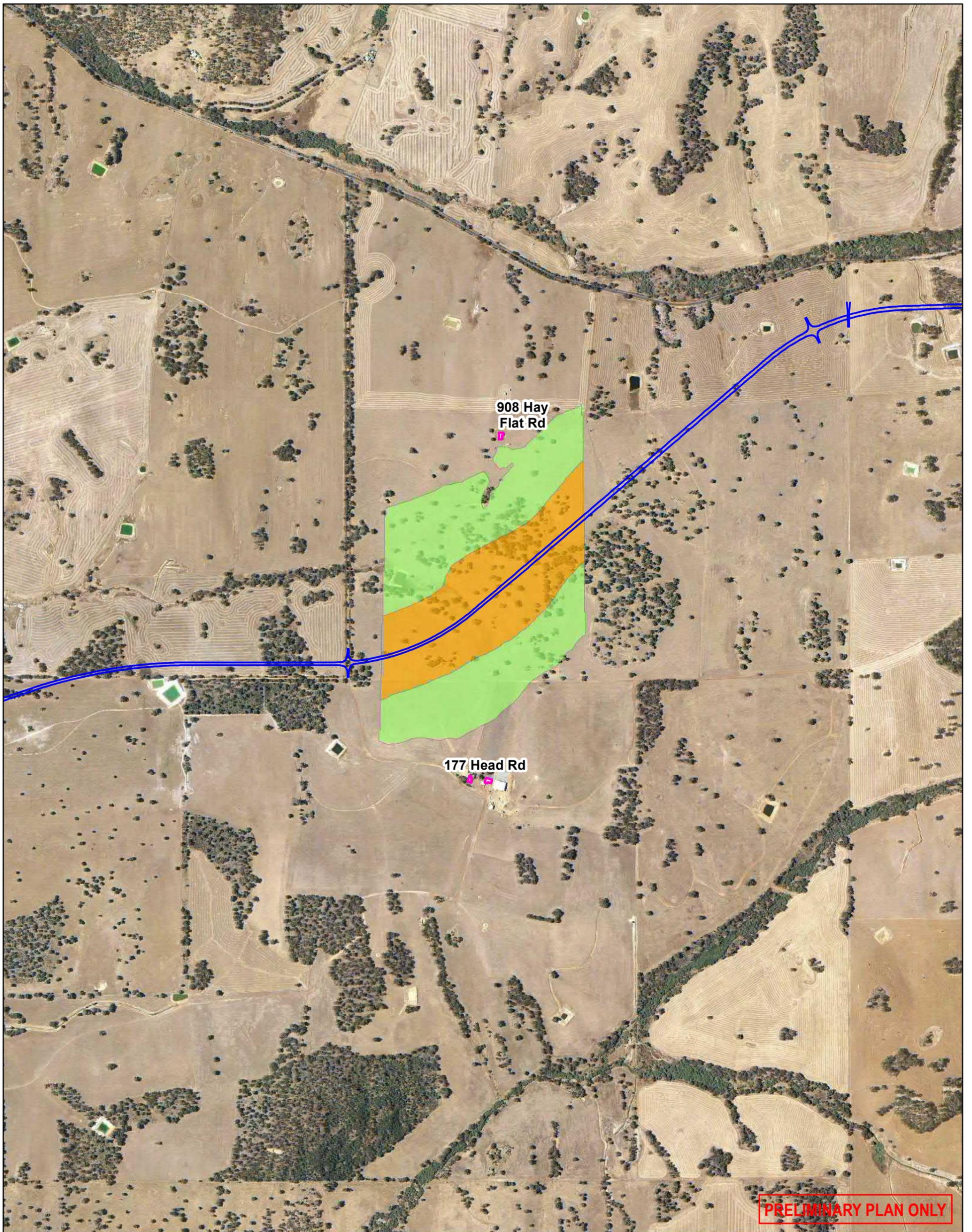
Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**PRELIMINARY PLAN ONLY**

<p><b>Legend</b></p> <p>— Proposed Bindoon Bypass Centreline</p> <p>□ Noise Sensitive Receivers</p> <p><b>Predicted Day Time Noise Level including Facade Correction</b></p> <p>&lt;55 dBA</p> <p>55-60 dBA</p> <p>&gt;60 dBA</p>	<p>North Arrow</p> <p>Scale at A3 1:12,563</p> <p>0 150 300 Metres</p> <p>Coordinate System: HUG94</p>	<p>Joint Venture Partners:</p> <p>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</p> <p>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</p> <p>© Main Roads Western Australia</p>		<p><b>Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass</b></p> <p>Drawing No: GNH-CN12-EN01-DRG-9112   Issue A</p> <p>Task No: Noise Assessment   Drawing Status / Other: Draft / Other Info</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Date: 10/08/2018</td> <td>By: MFR</td> <td>Chkd: FB</td> <td>Appd: LMB</td> </tr> </table>	Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
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<p>Data Source: Main Roads WA, Landgate</p>								

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**PRELIMINARY PLAN ONLY**

**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

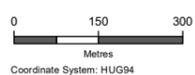


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Coordinate System: HUG94



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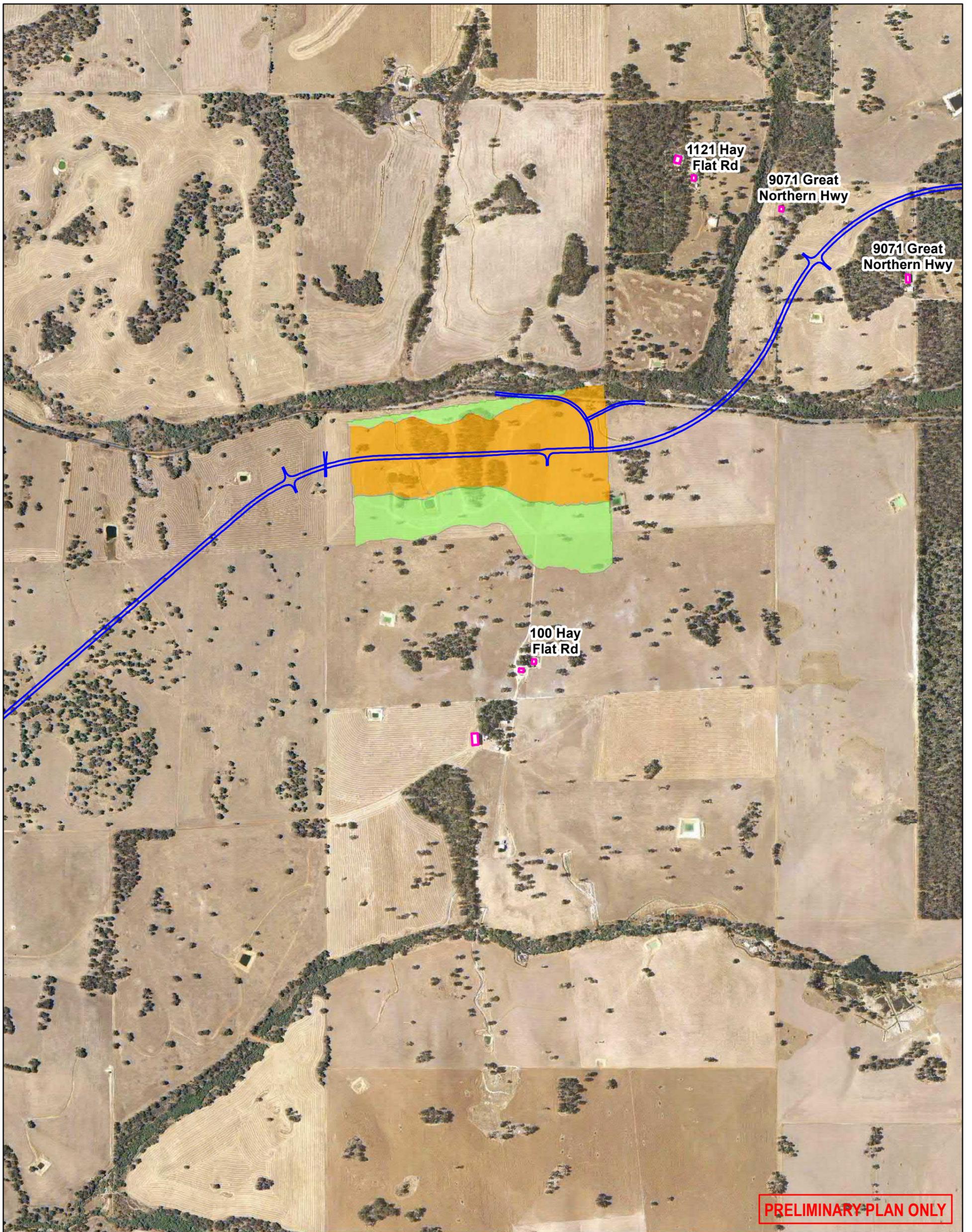
Great Northern Highway  
Muchoa to Wubin Upgrade Stage 2

**Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9113** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**PRELIMINARY PLAN ONLY**

**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

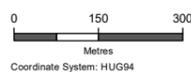


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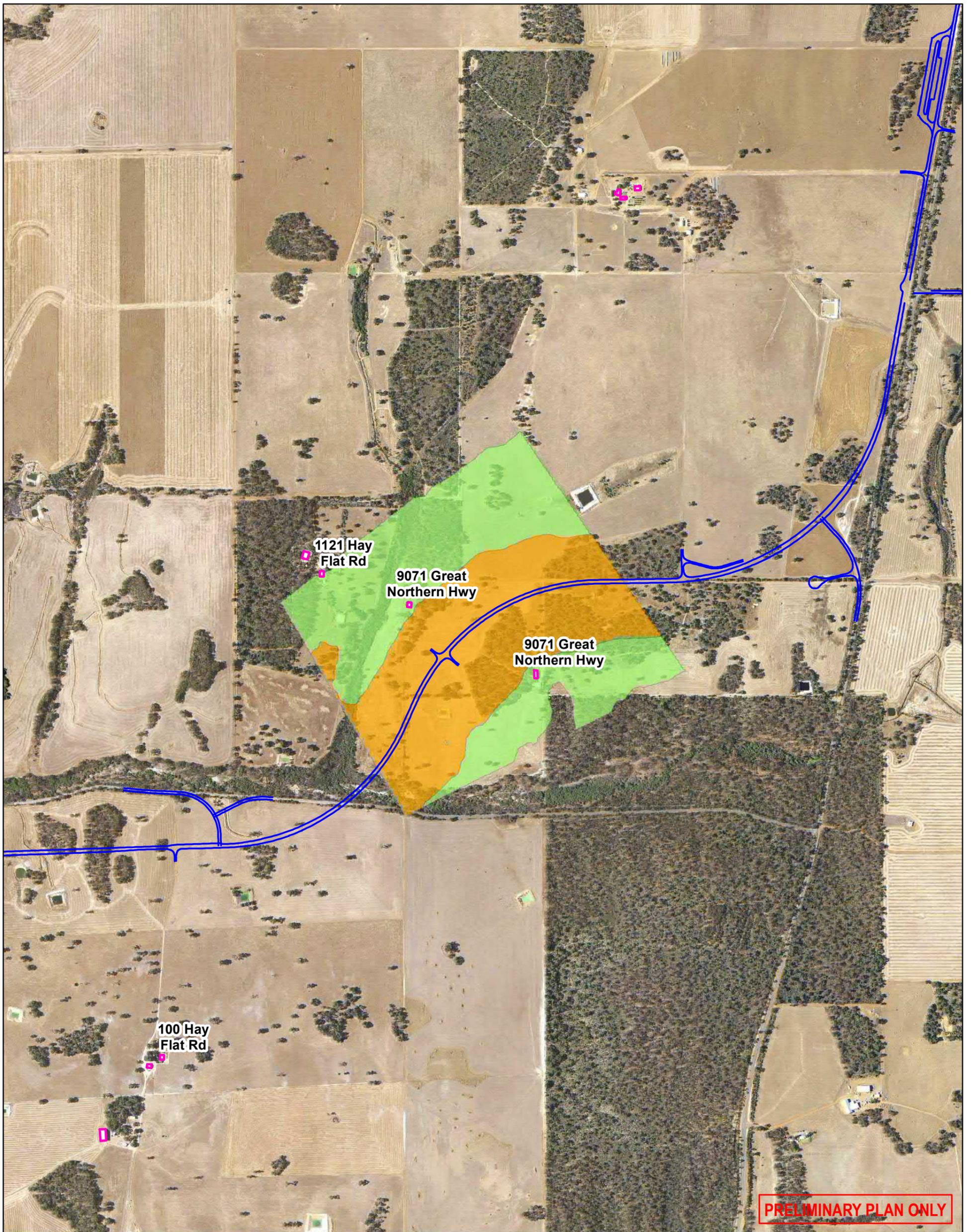
Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

**Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9114 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**PRELIMINARY PLAN ONLY**

**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Day Time Noise Level including Facade Correction**

- <55 dBA
- 55-60 dBA
- >60 dBA

Data Source: Main Roads WA, Landgate

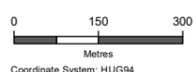


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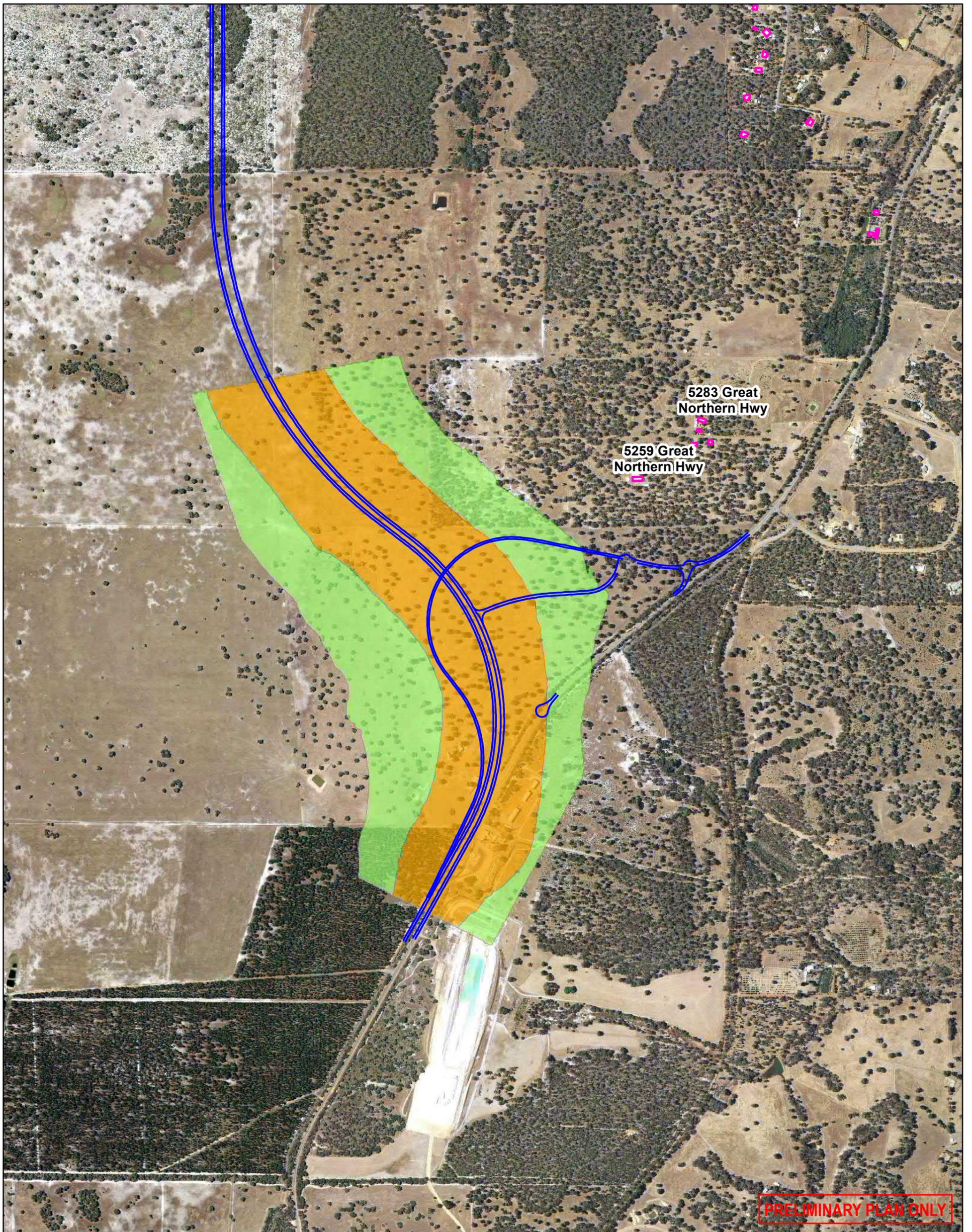
Great Northern Highway  
Muchea to Wubin Upgrade Stage 2

**Predicted Day Time Traffic Noise Level along Proposed Bindoon Bypass**

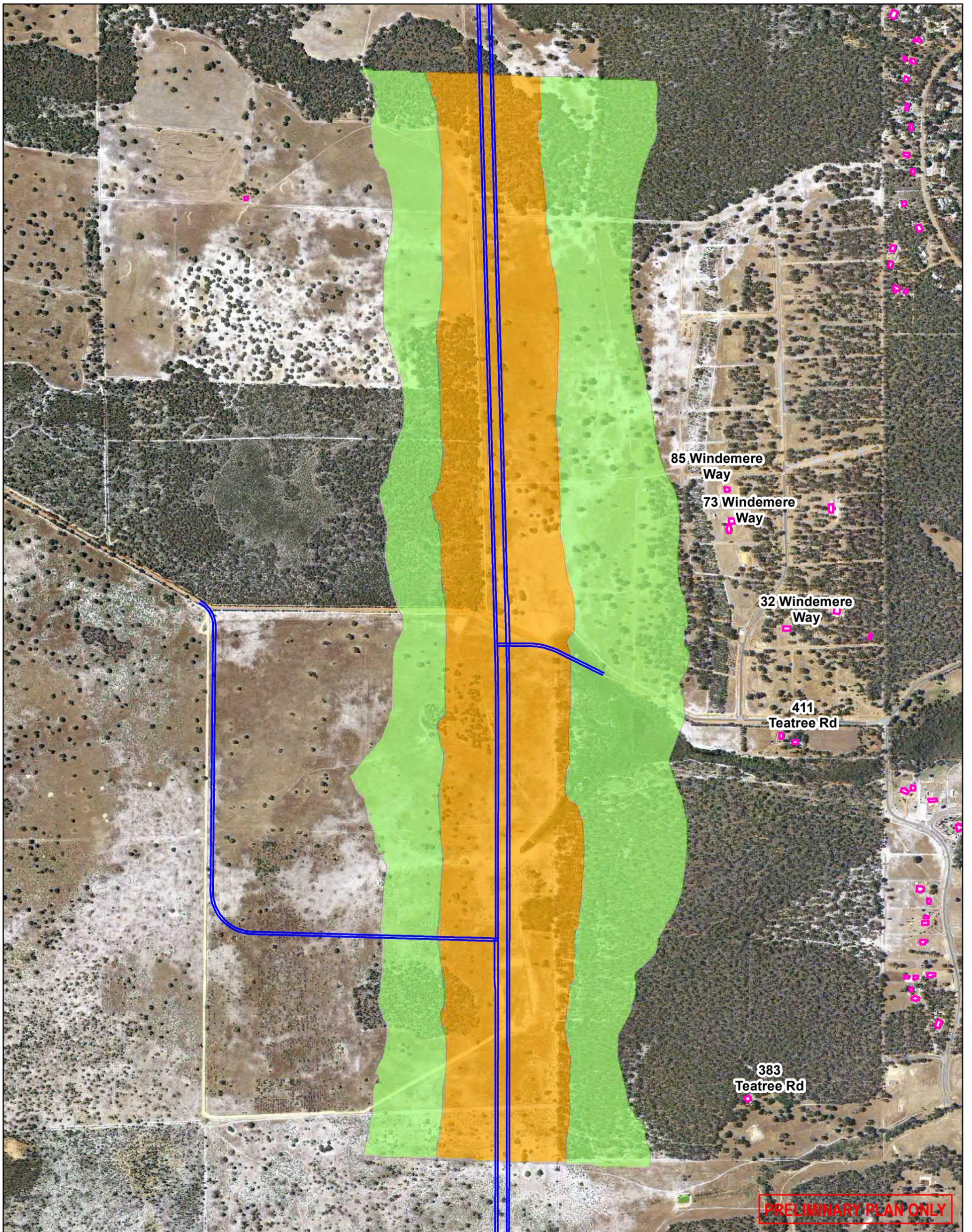
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Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



<p><b>Legend</b></p> <p>— Proposed Bindoon Bypass Centreline</p> <p>□ Noise Sensitive Receivers</p> <p><b>Predicted Night Time Noise Level including Facade Correction</b></p> <p>&lt;50 dBA</p> <p>50-55 dBA</p> <p>&gt;55 dBA</p> <p>Data Source: Main Roads WA, Landgate</p>	<p>0 150 300 Metres</p> <p>Scale at A3 1:12,563</p> <p>Coordinate System: HUG94</p>	<p>Joint Venture Partners:</p> <p>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</p> <p>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</p> <p>© Main Roads Western Australia</p>	<p><b>mainroads</b> WESTERN AUSTRALIA</p> <p><b>ARUP</b> TRADING AS ASJV <b>JACOBS</b></p> <p><b>GNH</b> BLACKBURN</p> <p><b>Main Roads Western Australia</b></p> <p><b>Great Northern Highway Muchea to Wubin Upgrade Stage 2</b></p>	<p><b>Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass</b></p> <p>Drawing No: GNH-CN12-EN01-DRG-9116 Issue: A</p> <p>Task No: Noise Assessment Drawing Status / Other: Draft / Other Info</p> <table border="1"> <tr> <td>Date: 10/08/2018</td> <td>By: MFR</td> <td>Chkd: FB</td> <td>Appd: LMB</td> </tr> </table>	Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB					



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate



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Scale at A3  
1:12,580  
Coordinate System: HUG94



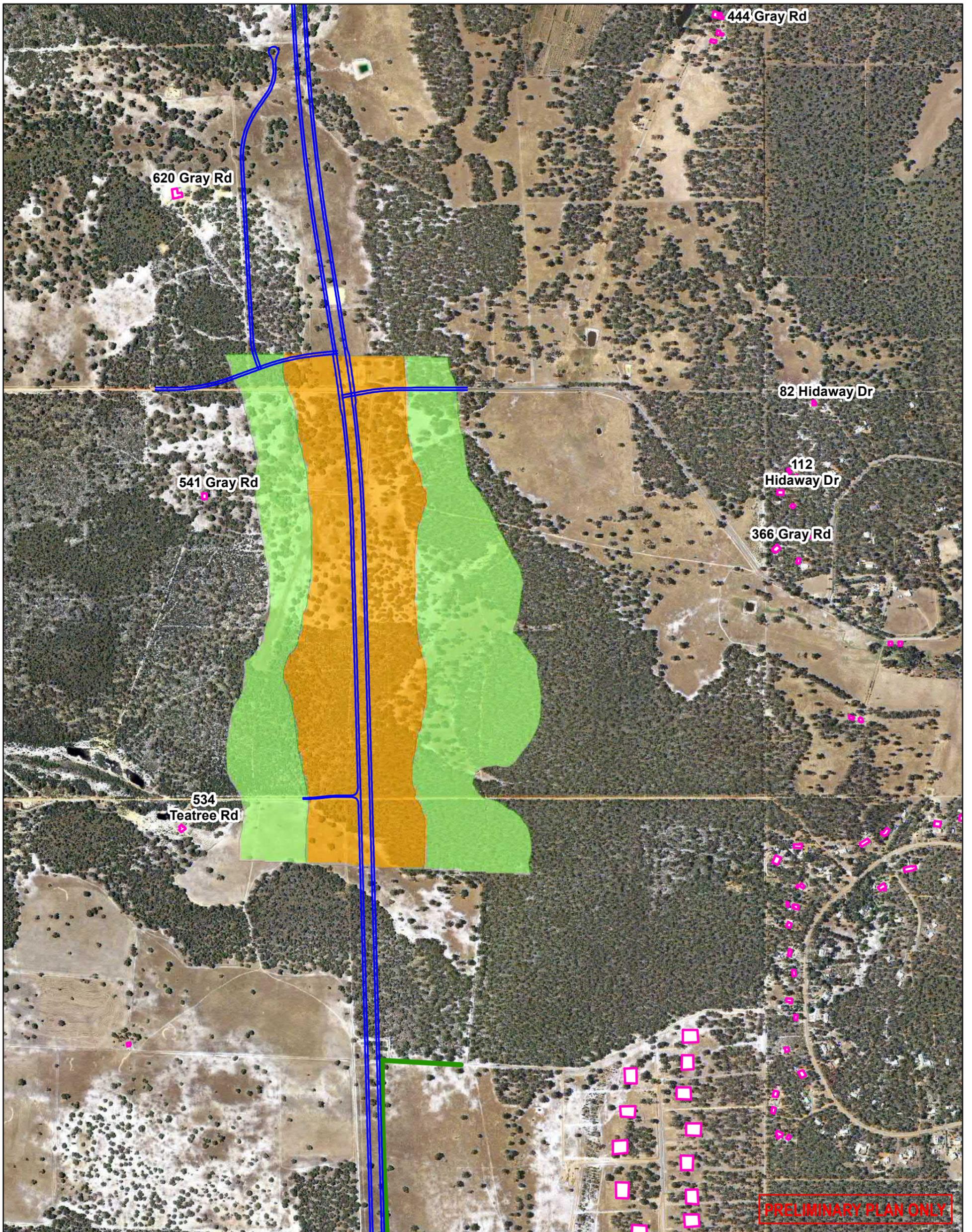
**Main Roads Western Australia**  
Client  
Project  
**Great Northern Highway  
Muecha to Wubin Upgrade Stage 2**

**Predicted Night Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9117** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
20/08/2018	MFR	FB	LMB



- Legend**
- Proposed Bindoon Bypass Centreline
  - Noise Sensitive Receivers
  - Noise protection wall

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

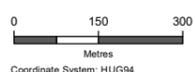
Data Source: Main Roads WA, Landgate



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Scale at A3  
 1:12,563

Coordinate System: HUG94



Main Roads Western Australia

Great Northern Highway  
 Muchea to Wubin Upgrade Stage 2

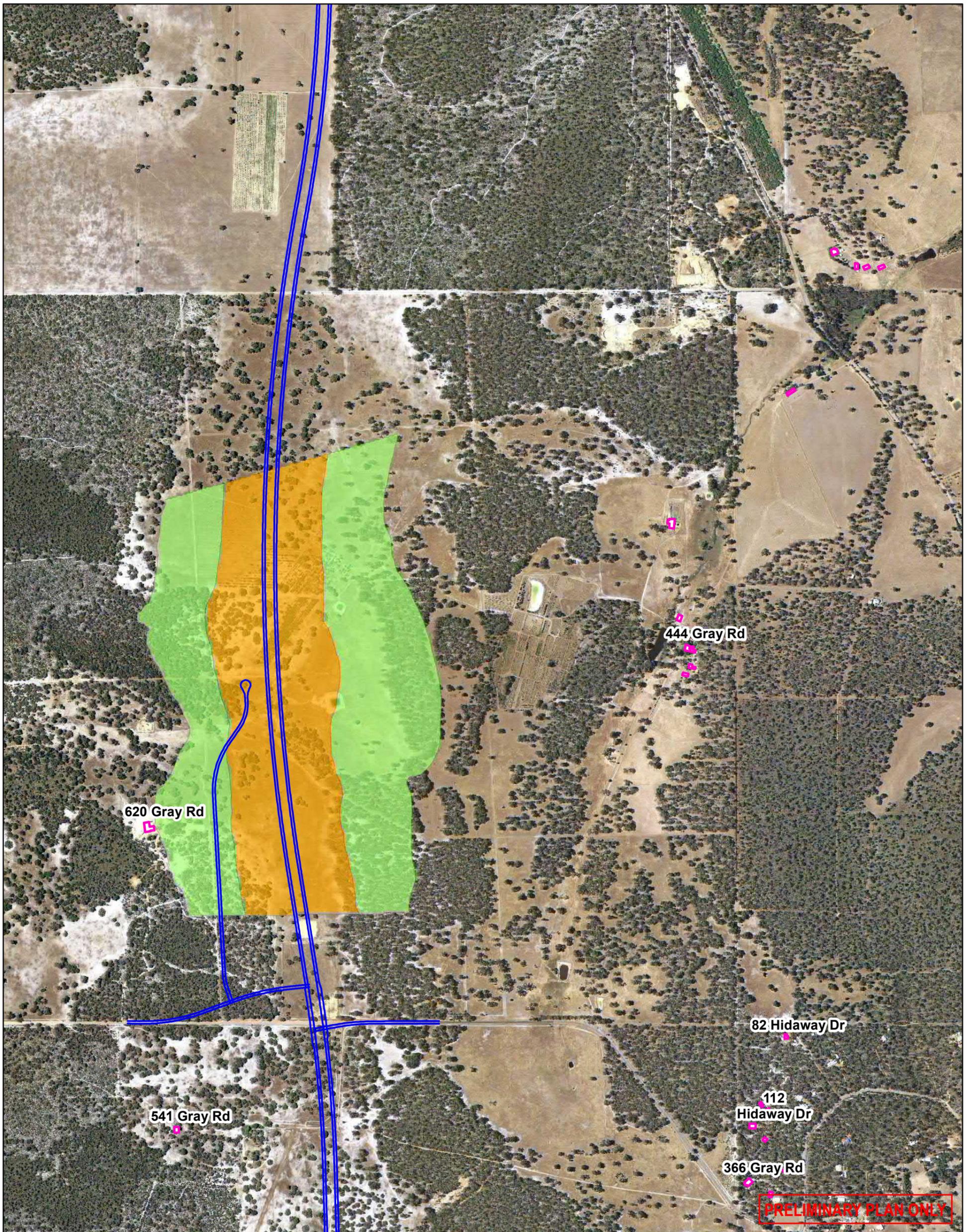
**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9118 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

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**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers
- Noise protection wall

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

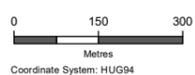


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Coordinate System: HUG94



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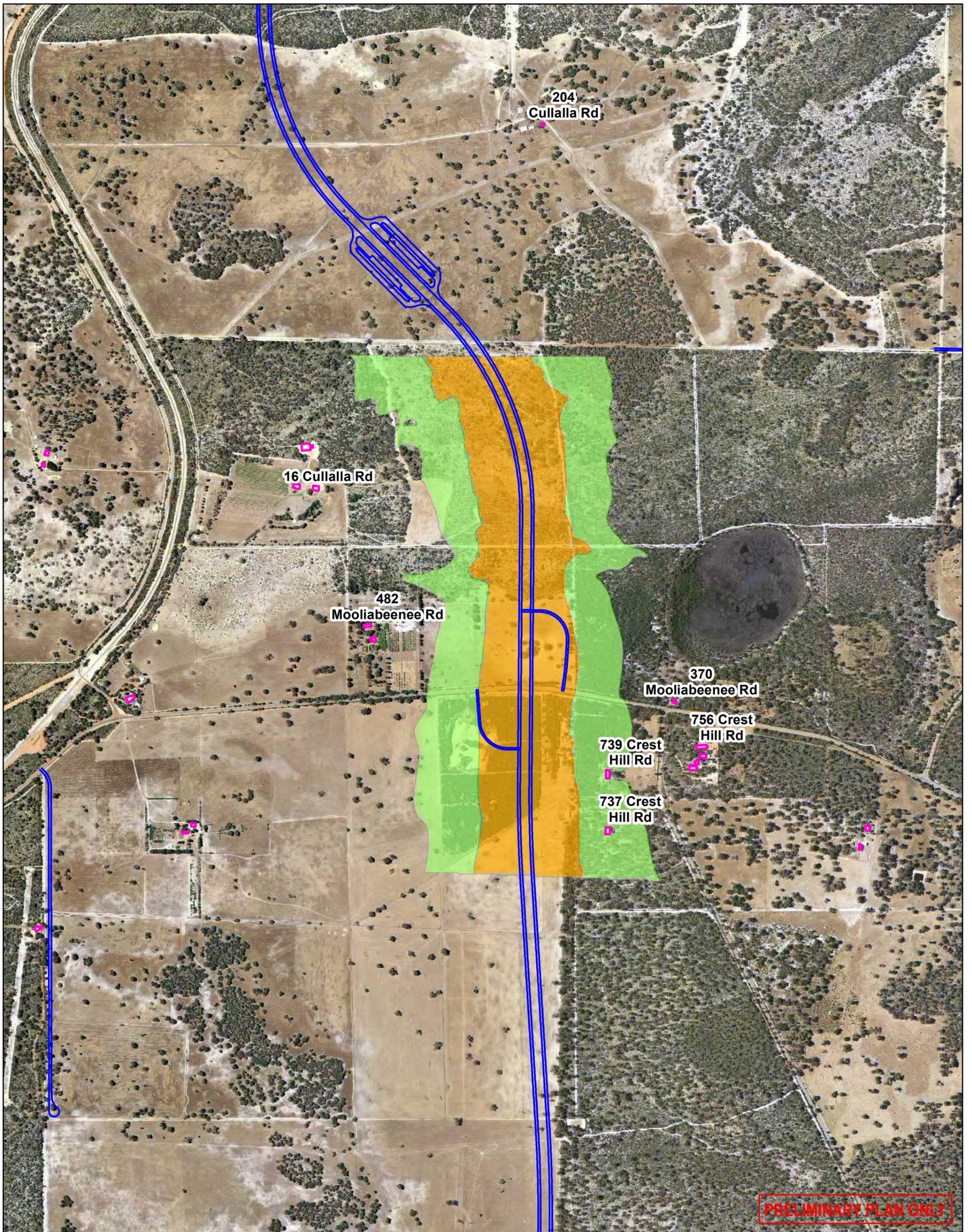
Client  
 Project  
**Great Northern Highway  
 Muchea to Wubin Upgrade Stage 2**

**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9119 Issue: A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



- Legend**
- Proposed Bindoon Bypass Centreline
  - Noise Sensitive Receivers
  - Noise protection wall

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

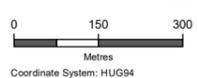


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Muchea to Wubin Upgrade Stage 2

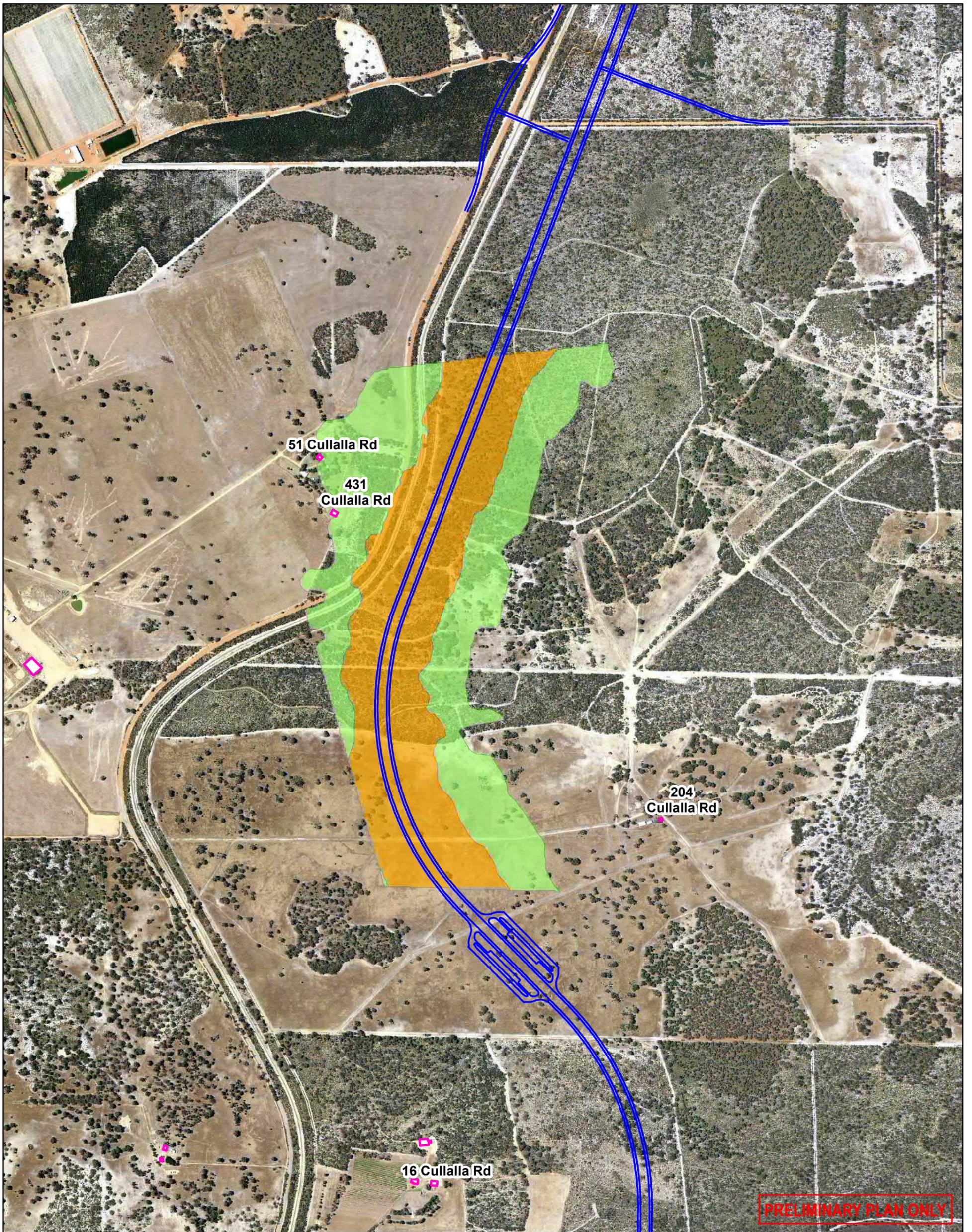
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Drawing No: GNH-CN12-EN01-DRG-9120 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

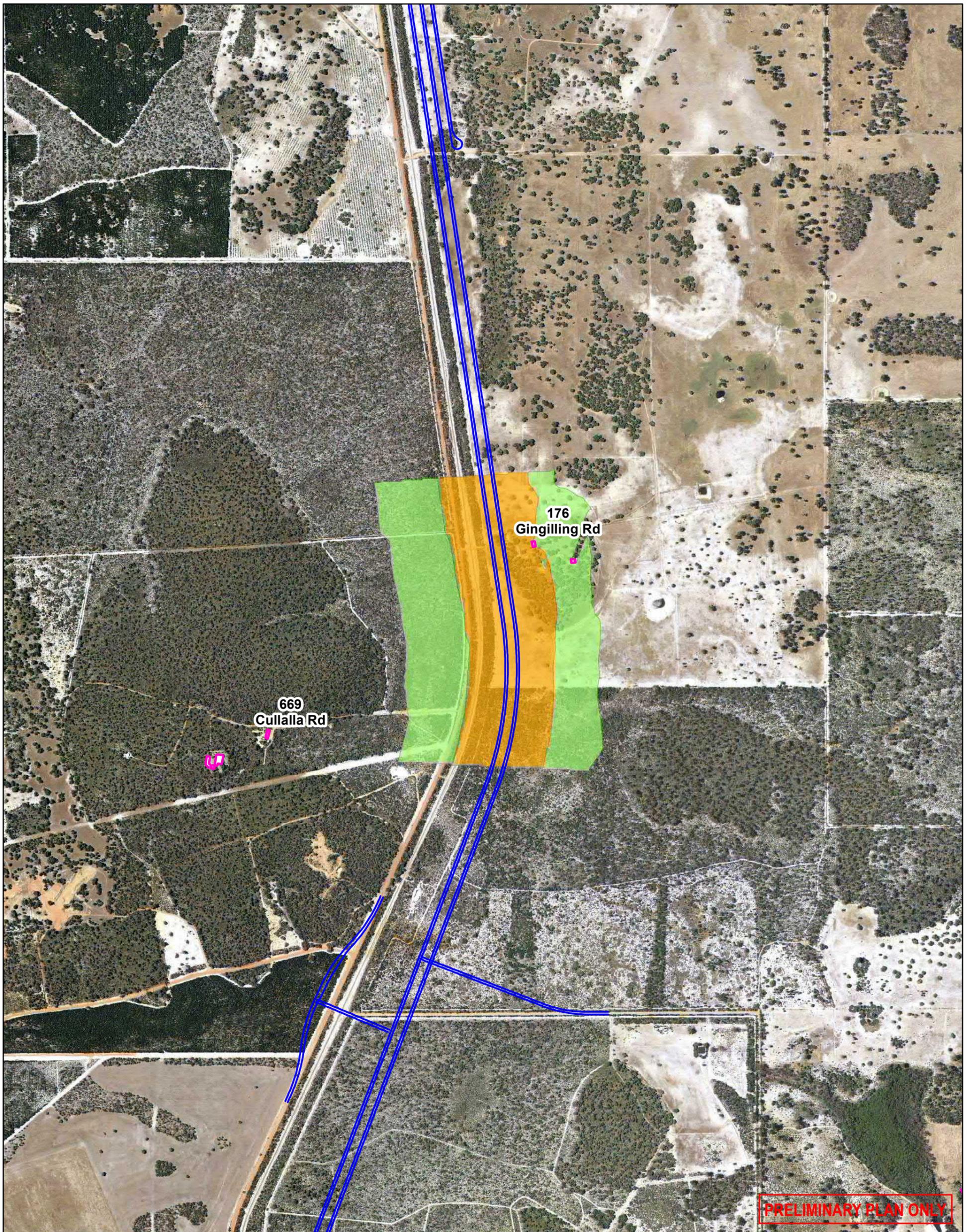
Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

PRELIMINARY PLAN ONLY



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<small>Task No</small> Noise Assessment	<small>Drawing Status / Other</small> Draft / Other Info											
<small>Date</small> 10/08/2018	<small>By</small> MFR											
<small>Chkd</small> FB	<small>Appd</small> LMB											

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**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

**Legend**

- North Arrow
- Scale: 0, 150, 300 Metres
- Scale at A3: 1:12,563
- Coordinate System: HUG94

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Main Roads Western Australia

**Project**  
Great Northern Highway  
Muchoa to Wubin Upgrade Stage 2

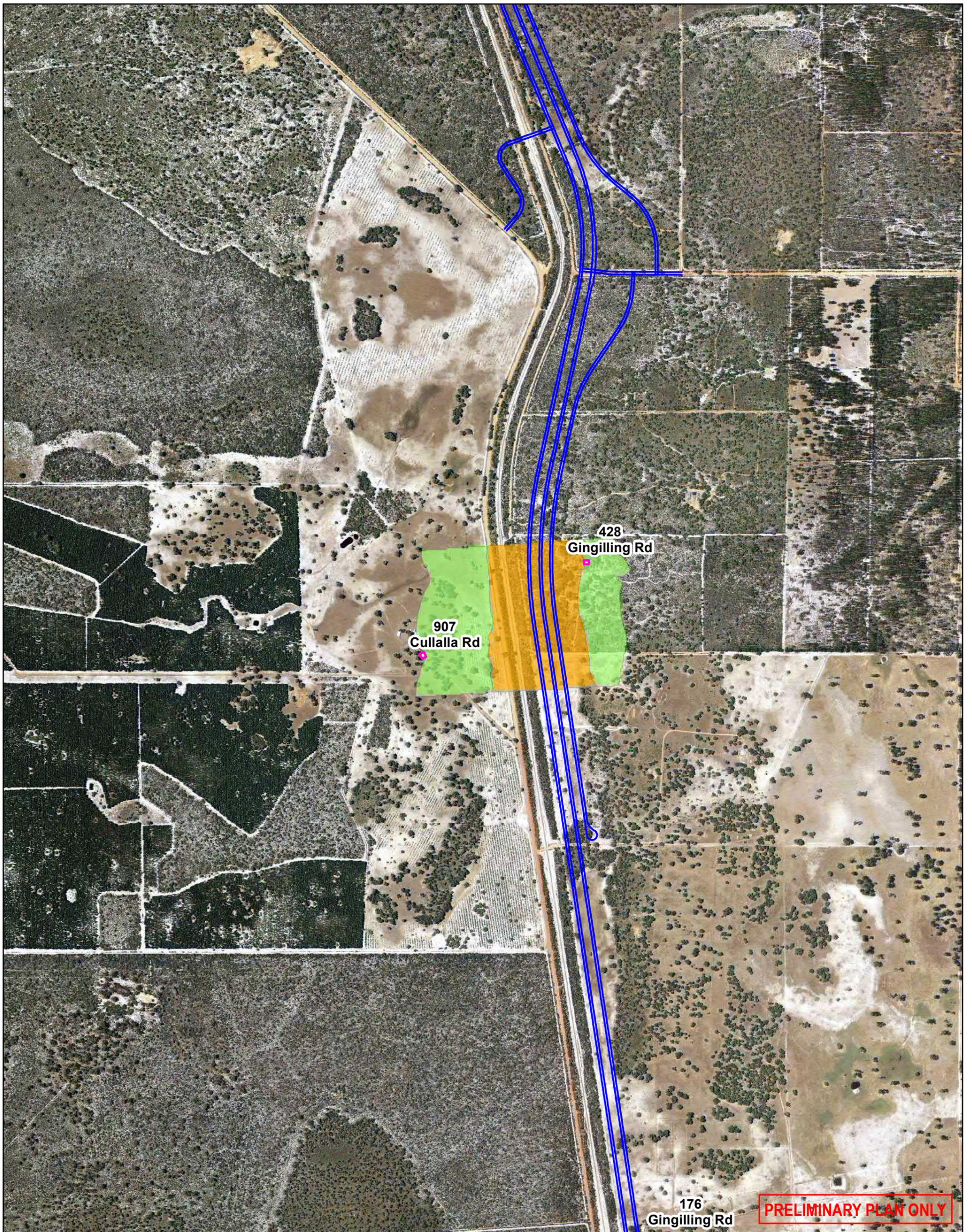
**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9122 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
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Data Source: Main Roads WA, Landgate



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

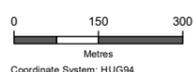


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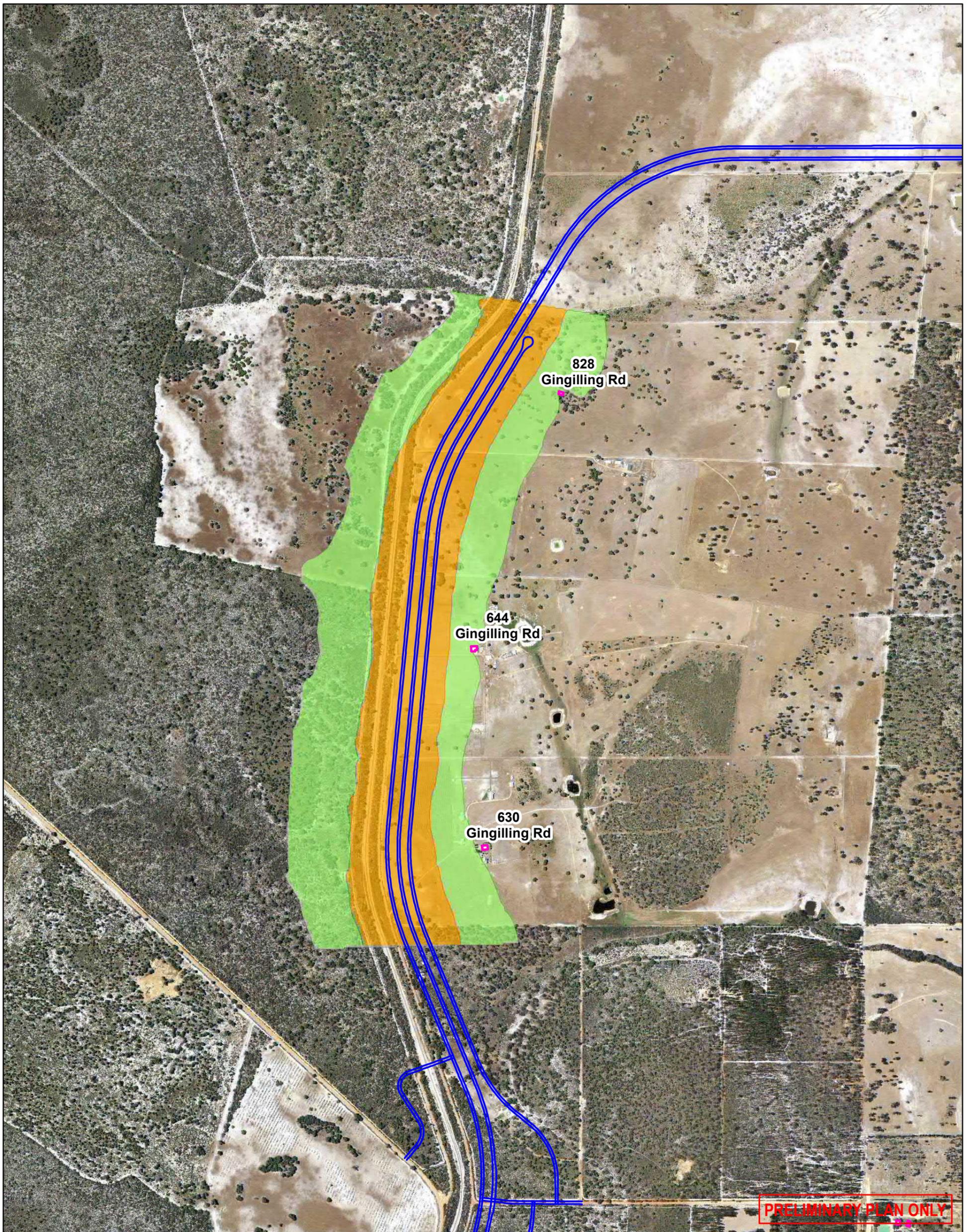
Client Project  
**Great Northern Highway  
Muchea to Wubin Upgrade Stage 2**

**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9123** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

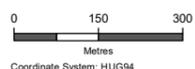


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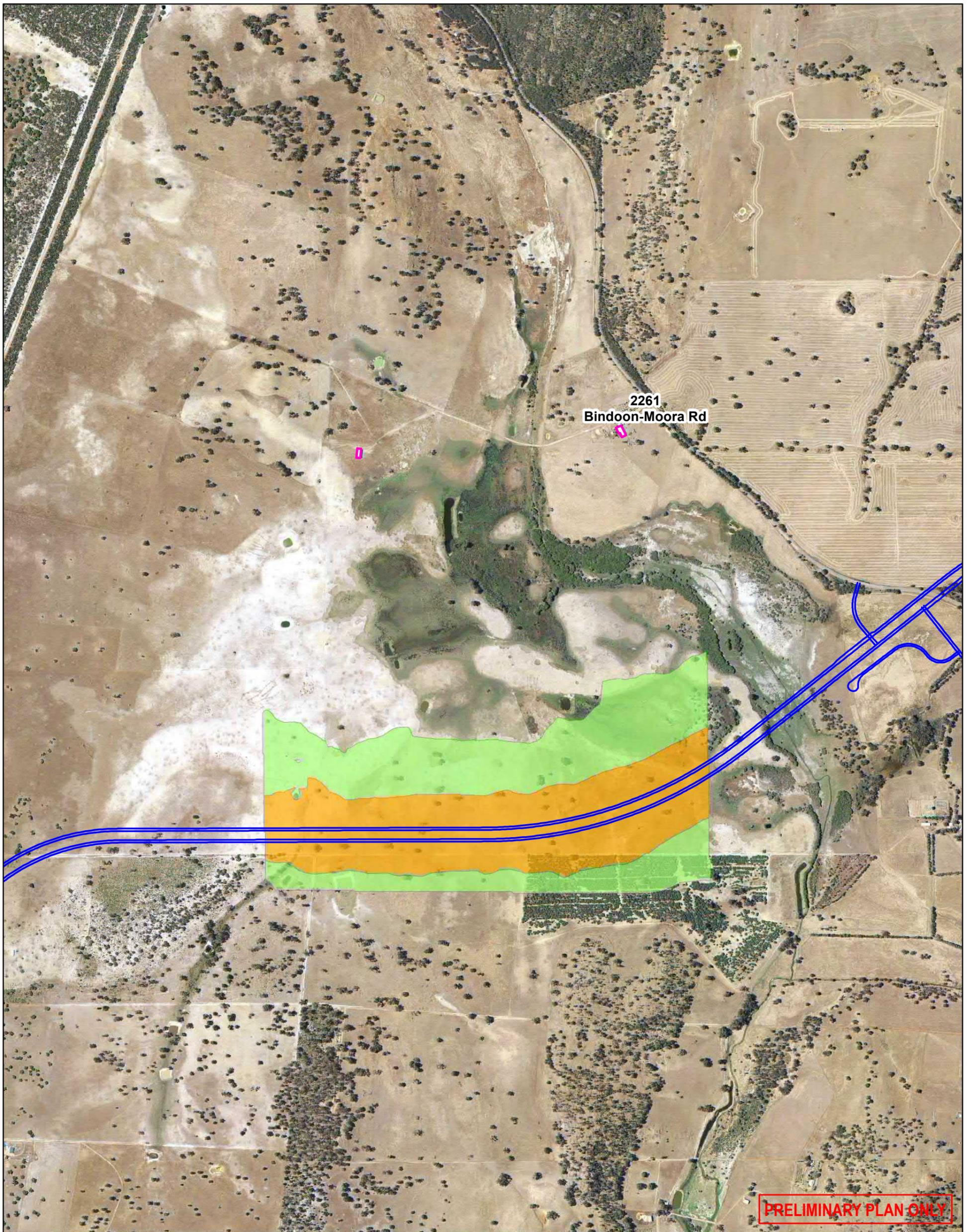
Client  
 Project  
**Great Northern Highway  
 Muchea to Wubin Upgrade Stage 2**

**Predicted Night Time Traffic  
 Noise Level along  
 Proposed Bindoon Bypass**

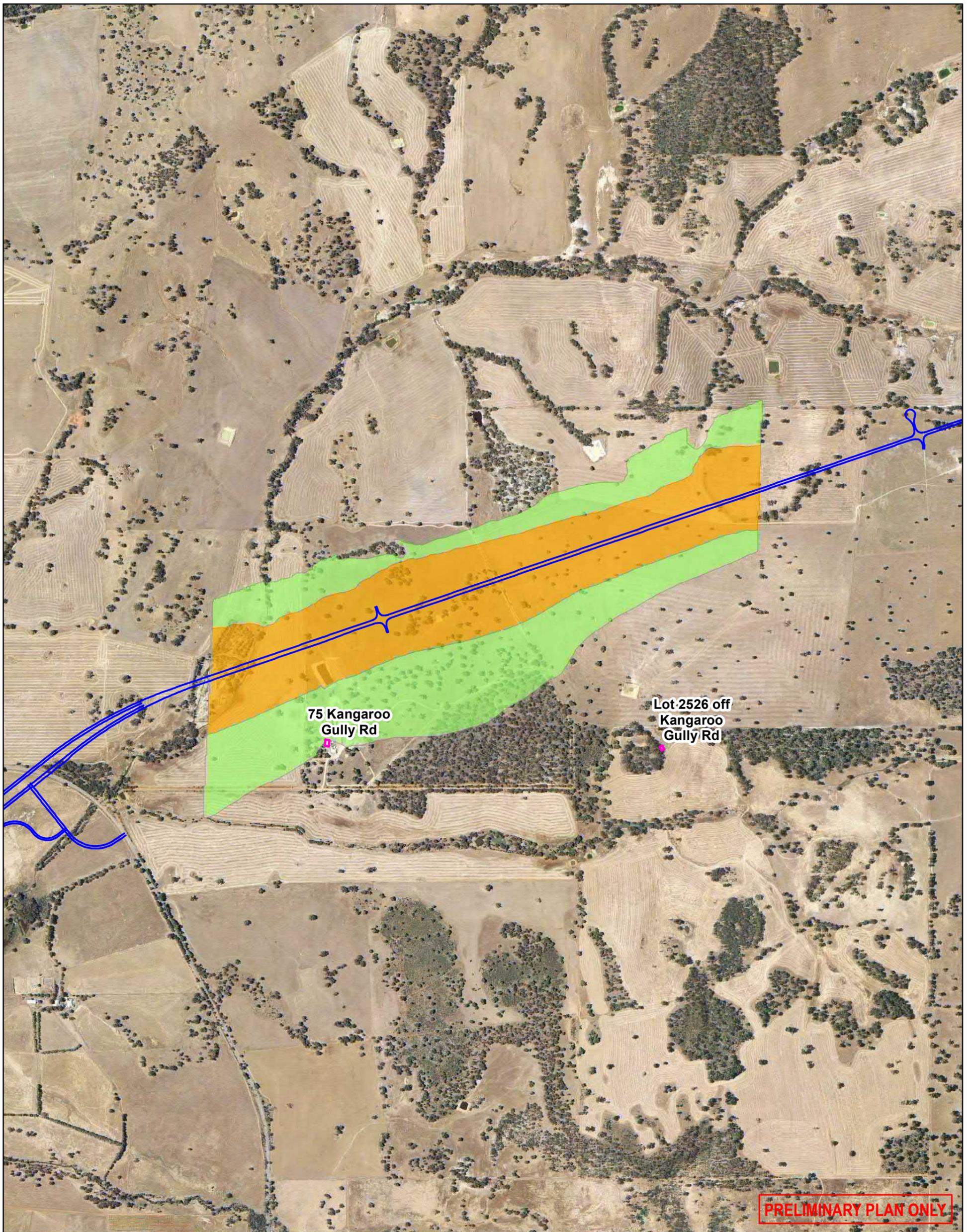
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Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



<p><b>Legend</b></p> <p>— Proposed Bindoon Bypass Centreline</p> <p>□ Noise Sensitive Receivers</p> <p><b>Predicted Night Time Noise Level including Facade Correction</b></p> <p>&lt;50 dBA</p> <p>50-55 dBA</p> <p>&gt;55 dBA</p> <p><small>Data Source: Main Roads WA, Landgate</small></p>	<p>0 150 300 Metres</p> <p>Scale at A3: 1:12,563</p> <p>Coordinate System: HUG94</p>	<p>Joint Venture Partners:</p> <p>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</p> <p>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</p> <p>© Main Roads Western Australia</p>	<p><b>Client</b> Project</p> <p><b>Great Northern Highway Muchea to Wubin Upgrade Stage 2</b></p>	<p><b>Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass</b></p> <p>Drawing No: GNH-CN12-EN01-DRG-9125 Issue: A</p> <p>Task No: Noise Assessment Drawing Status / Other: Draft / Other Info</p> <table border="1"> <tr> <td>Date: 10/08/2018</td> <td>By: MFR</td> <td>Chkd: FB</td> <td>Appd: LMB</td> </tr> </table>	Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB					



**PRELIMINARY PLAN ONLY**

**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

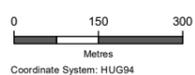


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Project  
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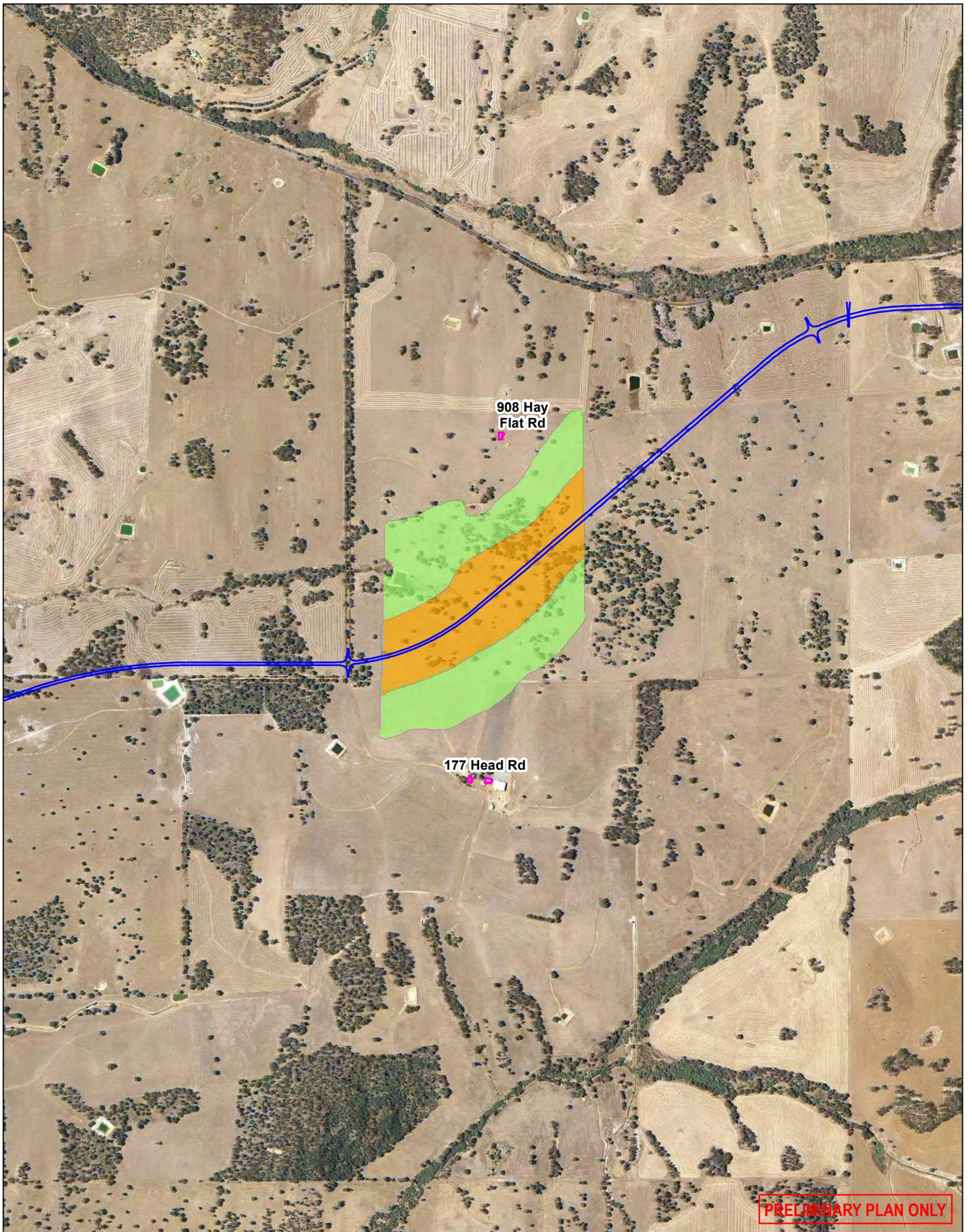
Great Northern Highway  
Muecha to Wubin Upgrade Stage 2

**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9126** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

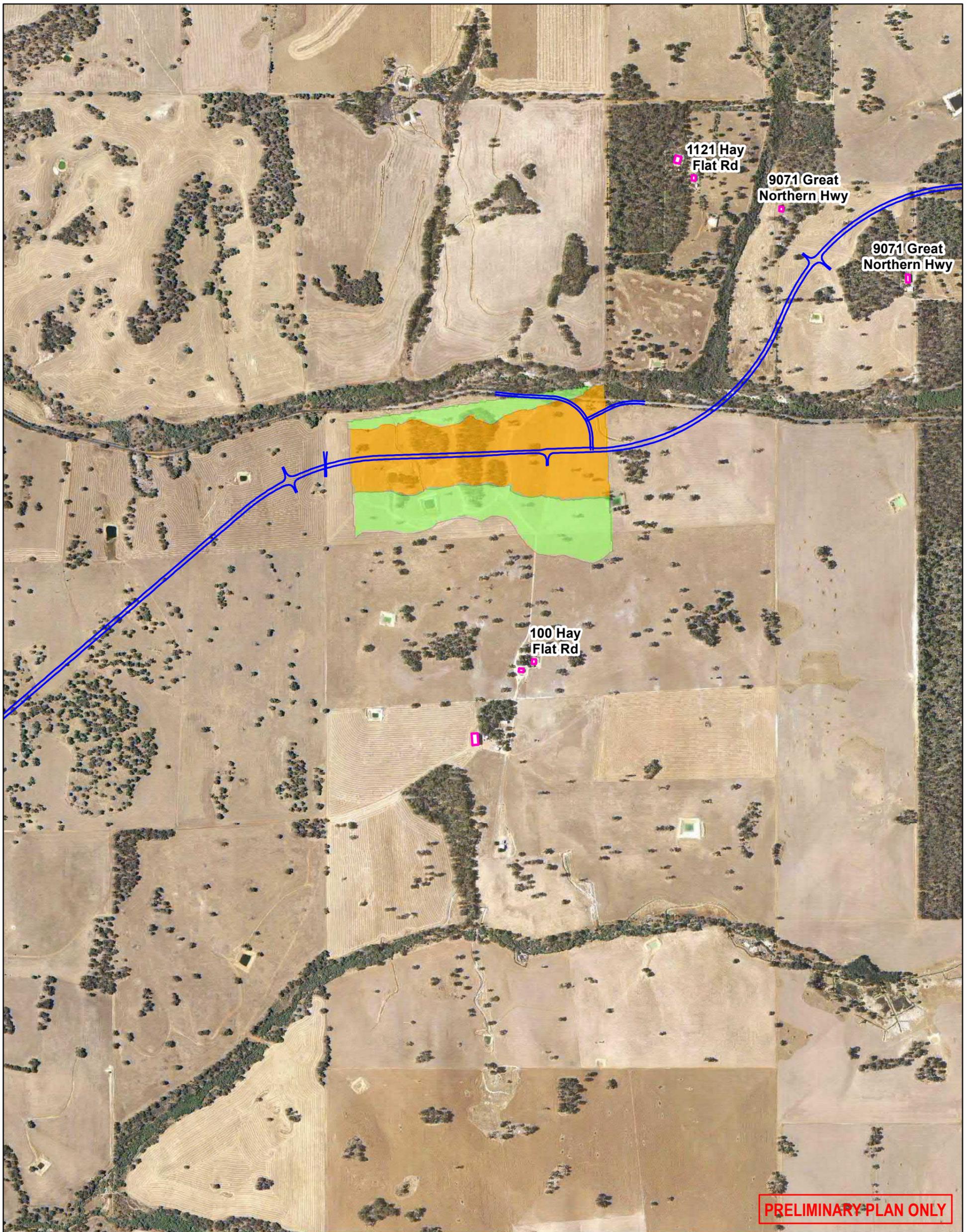
Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



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<p><b>Legend</b></p> <p>— Proposed Bindoon Bypass Centreline</p> <p>□ Noise Sensitive Receivers</p> <p><b>Predicted Night Time Noise Level including Facade Correction</b></p> <p>&lt;50 dBA</p> <p>50-55 dBA</p> <p>&gt;55 dBA</p>	 <p>Joint Venture Partners:</p> <p>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</p> <p>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</p> <p>© Main Roads Western Australia</p>	  	<p><b>Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass</b></p> <p>Drawing No: GNH-CN12-EN01-DRG-9127 Issue: A</p> <p>Task No: Noise Assessment Drawing Status / Other: Draft / Other Info</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Date: 10/08/2018</td> <td style="width: 25%;">By: MFR</td> <td style="width: 25%;">Chkd: FB</td> <td style="width: 25%;">Appd: LMB</td> </tr> </table>	Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB
Date: 10/08/2018	By: MFR	Chkd: FB	Appd: LMB				
Data Source: Main Roads WA, Landgate	<p>0 150 300 Metres</p> <p>Scale at A3: 1:12,563</p> <p>Coordinate System: HUG94</p>	<p>Client: Main Roads Western Australia</p> <p>Project: Great Northern Highway Muchea to Wubin Upgrade Stage 2</p>					

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**PRELIMINARY PLAN ONLY**

**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

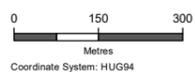


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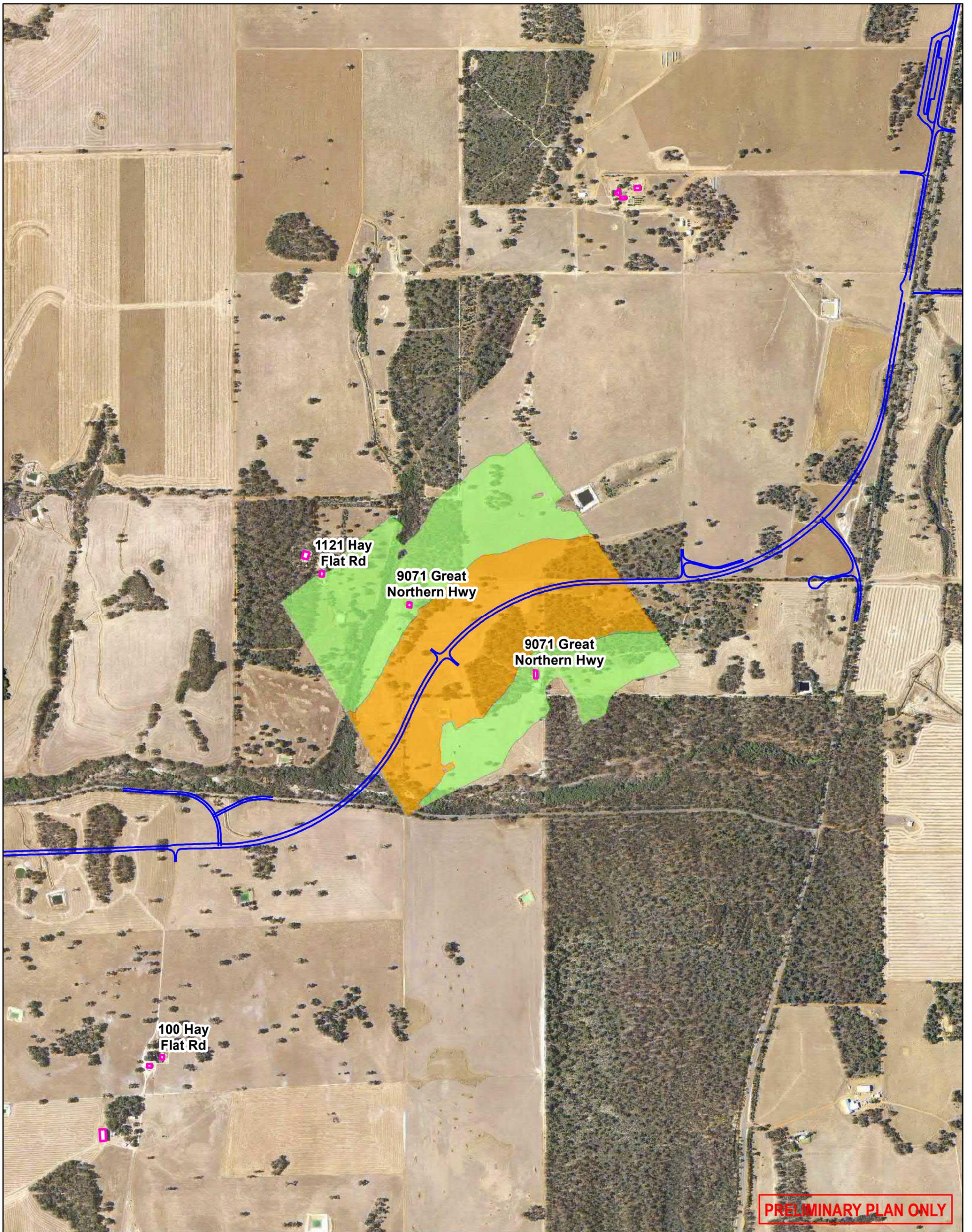
**Great Northern Highway  
Muchea to Wubin Upgrade Stage 2**

**Predicted Night Time Traffic  
Noise Level along  
Proposed Bindoon Bypass**

Drawing No: **GNH-CN12-EN01-DRG-9128** Issue: **A**

Task No: **Noise Assessment** Drawing Status / Other: **Draft / Other Info**

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB



**Legend**

- Proposed Bindoon Bypass Centreline
- Noise Sensitive Receivers

**Predicted Night Time Noise Level including Facade Correction**

- <50 dBA
- 50-55 dBA
- >55 dBA

Data Source: Main Roads WA, Landgate

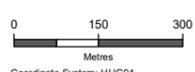


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Muchea to Wubin Upgrade Stage 2

**Predicted Night Time Traffic Noise Level along Proposed Bindoon Bypass**

Drawing No: GNH-CN12-EN01-DRG-9129 Issue A

Task No: Noise Assessment Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
10/08/2018	MFR	FB	LMB

**Table 4-53: Noise Sensitive Receivers Exceeding State Planning Policy 5.4 Noise Limits**

Location	Complies with Daytime Noise Limit (60 L <sub>Aeq</sub> dB)	Predicted Daytime Noise Level (L <sub>Aeq</sub> dB)	Complies with Night-time Noise Limit (55 L <sub>Aeq</sub> dB)	Predicted Night-time Noise Level (L <sub>Aeq</sub> dB)
Lot 1 (no. 428) Gingilling Road, Mooliabeenee	✘	61	✔	55

#### 4.6.5.2 Visual Amenity, Dust and Light Spill

##### Visual Amenity

To determine the potential impacts of the Bindoon Bypass to visual amenity, a Viewshed analysis using ArcGIS was undertaken as outlined in *Visual landscape planning in WA; a manual for evaluation, assessment, siting and design* (WAPC & Department for Planning and Infrastructure 2007). From this, 24 viewpoints were selected to be assessed for visual amenity impacts. These viewpoints were selected for assessment based on their sensitivity and proximity to the Disturbance Footprint, with the majority of these viewpoints representing occupied houses (local residents). The Viewshed output and selected viewpoints are shown on **Figure 4-33**.

Each viewpoint has been assessed in terms of the existing character, level of sensitivity and extent to which the Bindoon Bypass will change the views (magnitude of change) (**Table 4-54**). Impacts range from Negligible to High, and in most instances where impacts have been assessed as High-Moderate or High, photomontages have been developed to better understand what the impact may look like. Detailed information in relation to the visual impact assessment is contained in **Appendix J**.

**Table 4-54: Potential Visual Impacts by Viewpoint**

Viewpoint (VP)	Sensitivity	Magnitude	Impact
VP 1 Chittering Roadhouse	Low	Moderate	Low-moderate
VP 2 Great Northern Highway Stockyard	Moderate	High	High-moderate
VP 3 Kings Property	Low	Negligible	Negligible
VP 4 Windermere Way	High	Moderate	High-moderate
VP 5 Teatree North Access Road	Moderate	Negligible	Negligible
VP 6 Gray Road	Moderate	Low	Low-moderate
VP 7 Crest Hill Road	High	High	High
VP 8 Mooliabeenee Road (east)	Moderate	Low	Low-moderate
VP 9 Mooliabeenee Road (west)	Moderate	Moderate	Moderate
VP 10 Cullala Road (1)	Moderate	Negligible	Negligible
VP 11 Cullala Road (2)	Moderate	Negligible	Negligible
VP 12 Gingilling Road (1)	Moderate	High	High-moderate
VP 13 Gingilling Road (2)	Moderate	Negligible	Negligible
VP 14 Gingilling Road (3)	Moderate	High	High-moderate
VP 15 Gingilling Road (4)	Moderate	Negligible	Negligible
VP 16 Bindoon-Moora Road (1)	High	Moderate	High-moderate
VP 17 Bindoon-Moora Road (2)	High	High	High
VP 18 Kangaroo Gully Road (1)	High	High	High

Viewpoint (VP)	Sensitivity	Magnitude	Impact
VP 19 Kangaroo Gully Road (2)	Moderate	Negligible	Negligible
VP 20 Head Road (south)	High	High	High
VP 21 Hay Flat Road (1)	High	Moderate	High-moderate
VP 22 Great Northern Highway (west 1)	High	High	High
VP 23 Hay Flat Road (2)	High	Moderate	High-moderate
VP 24 Great Northern Highway (west 2)	Moderate	Negligible	Negligible

*Viewpoint 2 Great Northern Highway Stockyard*

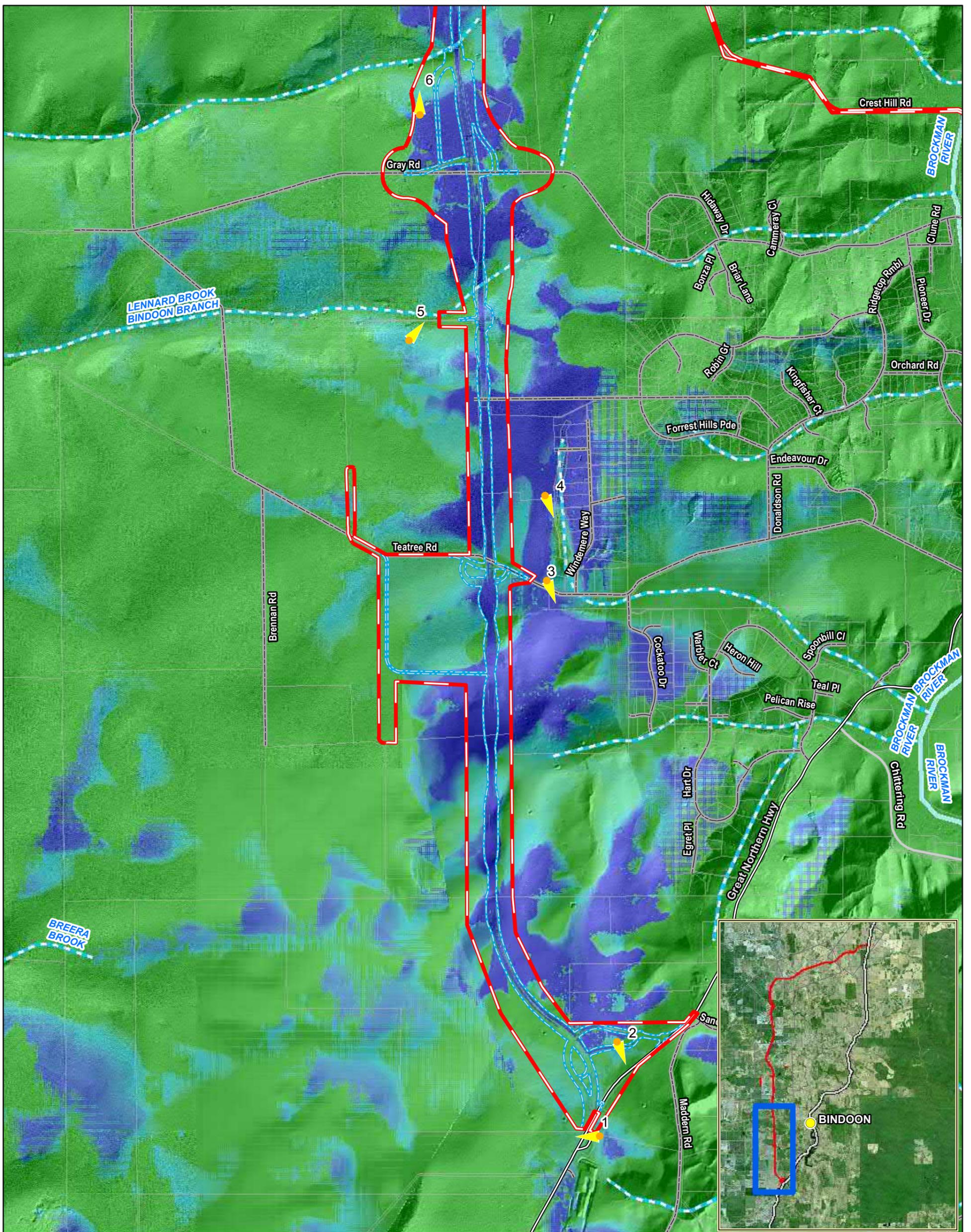
Viewpoint 2 looks toward stockyards and agricultural buildings west of the existing GNH. To the east of the viewpoint is the existing GNH corridor, with views to the west and north filtered by stands of intermittent trees. There is also an unclassified residential premises at Viewpoint 2, which is considered to have moderate sensitivity given its proximity to the existing GNH corridor. The magnitude of the change is considered high, as that the Bindoon Bypass will sever the existing field pattern, require removal of a large stand of trees, and the aesthetic qualities of the landscape would be altered. This results in an impact at Viewpoint 2 of High-Moderate. However, the construction of the Bindoon Bypass is likely to require the removal of the buildings at this viewpoint.

*Viewpoint 4 Windermere Way*

Viewpoint 4 is the view west from Windermere Way. This viewpoint has established elevated properties to the east and more recent property development on lower slopes to the west. The properties at this viewpoint generally experience elevated views of agriculture land filtered by mature vegetation. To the west there is a band of vegetation that marks the boundary of recent development, and this filters views to adjoining agricultural land. Due to the elevation of the properties at this viewpoint, and the scenic and remote nature of the view, the sensitivity is considered high. It is also considered that the composition of the view and sense of rural amenity will cause change of a moderate magnitude. Therefore, the overall impact is High-Moderate. Given the nature of the potential impact, photomontages were developed for Viewpoint 4, which indicate that the view of the Bindoon Bypass is obscured by nearby vegetation, and therefore the impact would be lower than the impact assessment framework indicates.

*Viewpoint 7 Crest Hill Road*

Viewpoint 7 is on the edge of mature bushland south of Moolibeenee Road. The west facing views towards cleared agricultural fields are filtered by mature vegetation with a range of texture, form and colour. The sensitivity of this viewpoint is considered high due to the remote, scenic nature of the view. The magnitude of the change is also considered high due to the rural agricultural context, and new filtered view towards the Bindoon Bypass on the embankment approaching Moolibeenee grade-separated interchange. Due to the high sensitivity and magnitude of the change, the overall impact is considered to be potentially High. However, given the nature of vegetation close to the viewpoint and the fact that this vegetation is proposed to remain undisturbed by the Bindoon Bypass, the actual visual impact would be lower than the impact assessment framework indicates.



**Legend**

- Development Envelope
- Development Footprint
- Highway
- Major Road
- Minor Road
- Cadastral Boundary
- View Points
- Major Watercourse
- Minor Watercourse
- High : Visibility
- Low : Visibility

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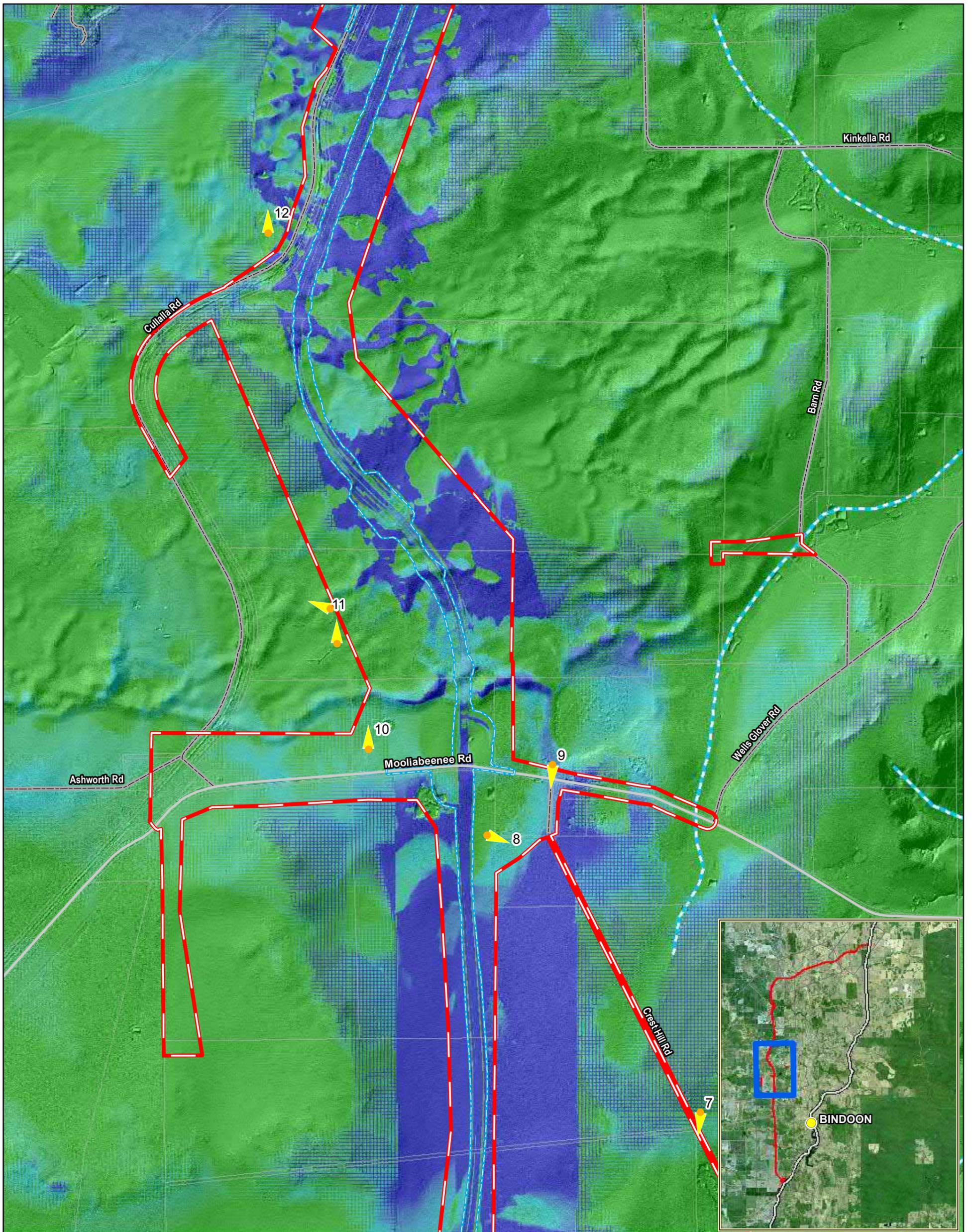
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Viewshed Analysis and Selected Viewpoints

Figure: 4-33 Page 1 of 5

Drawing No <b>GNH-CN12-EA-PER-00001 - F4-33</b>	Issue <b>1</b>
Task No <b>ERD</b>	Drawing Status / Other <b>Draft</b>
Date <b>9/08/2019</b>	By <b>BG</b>
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**Legend**

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- Minor Road
- Cadastral Boundary
- ▶ View Points
- Minor Watercourse
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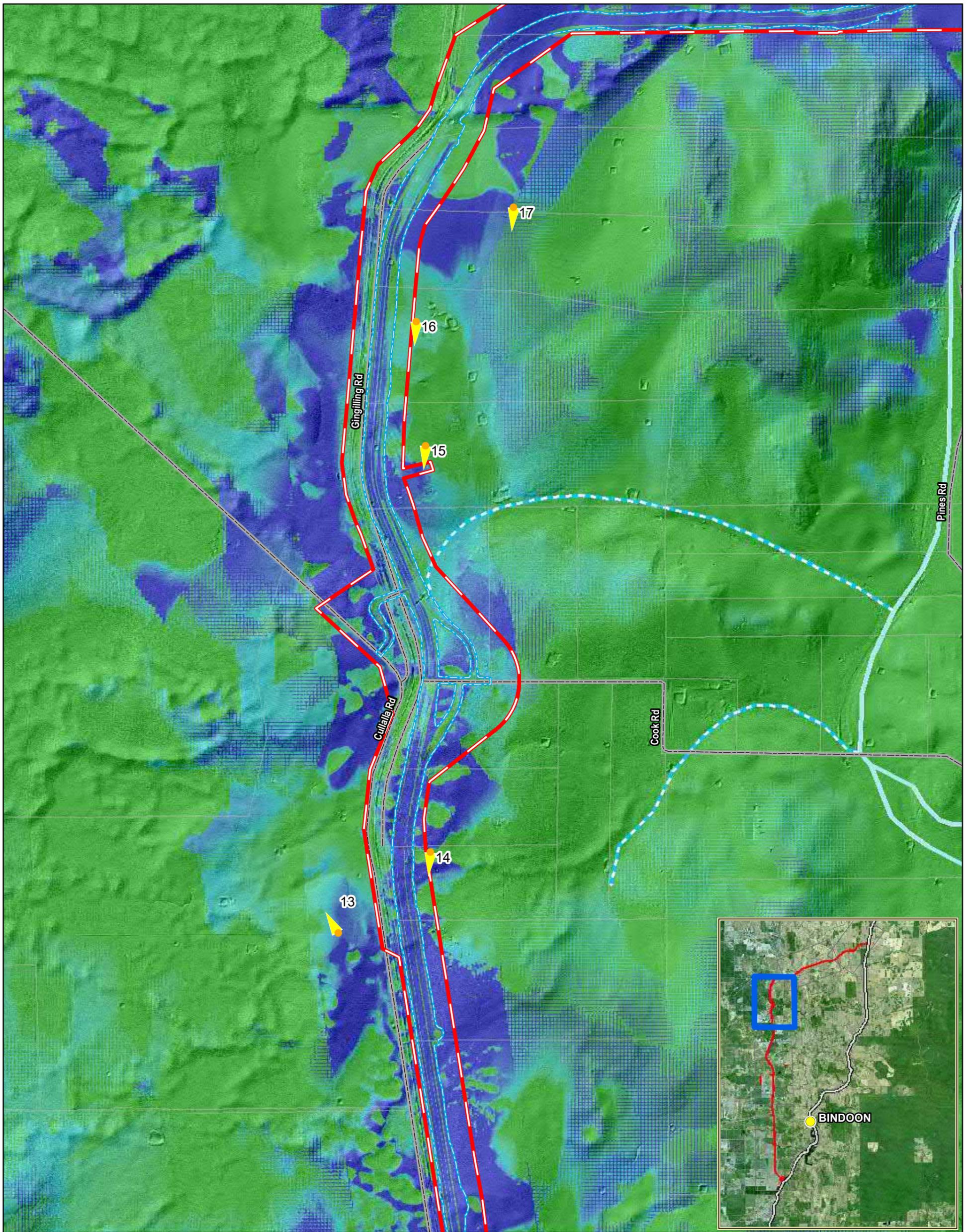
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**Viewshed Analysis and Selected Viewpoints**  
 Figure: 4-33 Page 2 of 5  
 Drawing No: **GNH-CN12-EA-PER-00001 - F4-33** Issue: **1**  
 Task No: **ERD** Drawing Status / Other: **Draft**  

Date	By	Chkd	Appd
9/08/2019	BG	LB	TJ

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**Legend**

- Development Envelope
- Development Footprint
- Minor Road
- Major Watercourse
- Minor Watercourse
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- Low : Visibility

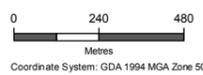


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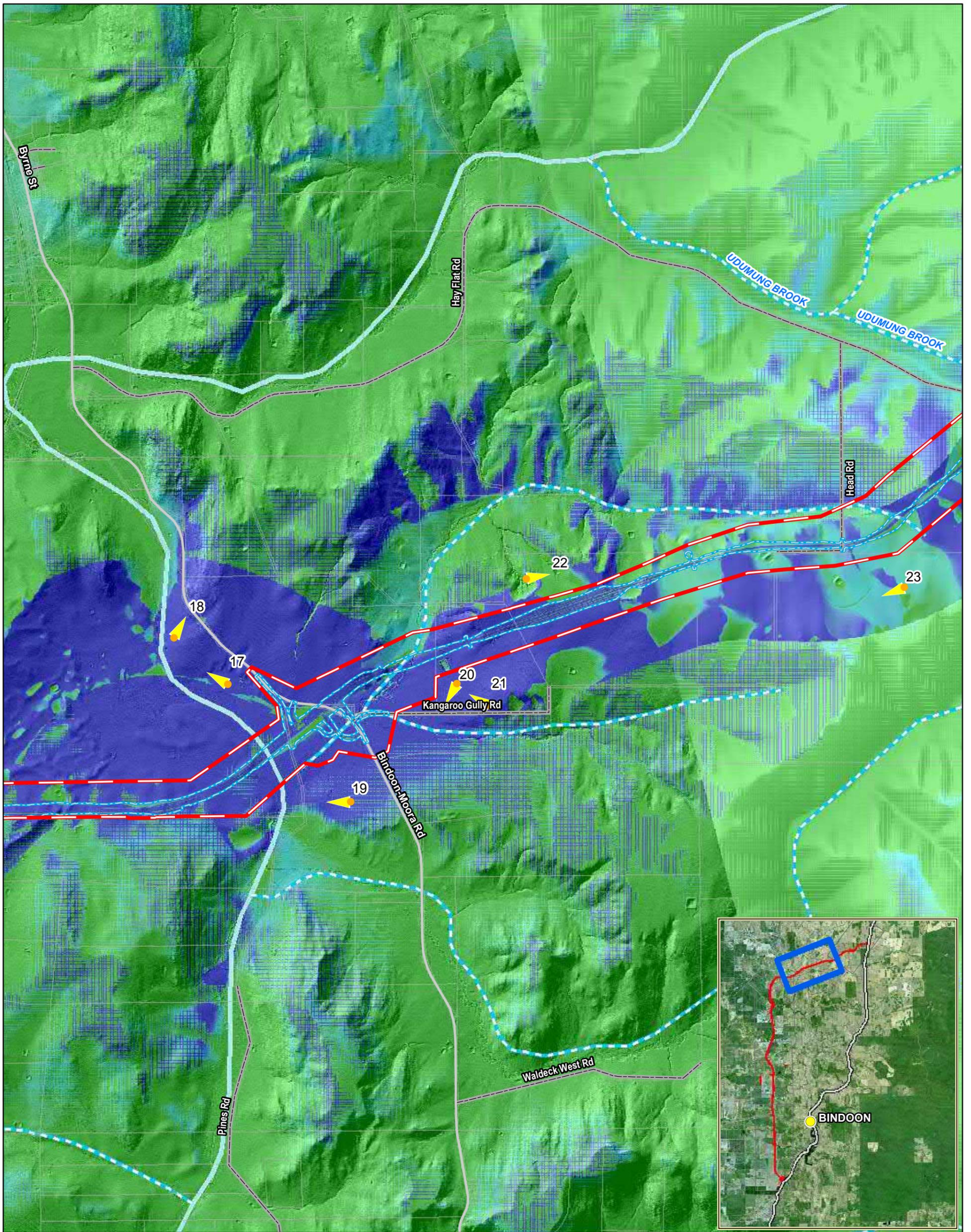
**Viewshed Analysis and Selected Viewpoints**

Figure: 4-33 Page 3 of 5

Drawing No: GNH-CN12-EA-PER-00001 - F4-33 Issue: 1

Task No: ERD Drawing Status / Other: Draft

Date	By	Chkd	Appd
9/08/2019	BG	LB	TJ



**Legend**

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- Development Footprint
- Major Road
- Minor Road
- Cadastral Boundary
- ▶ View Points
- Major Watercourse
- Minor Watercourse
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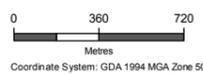


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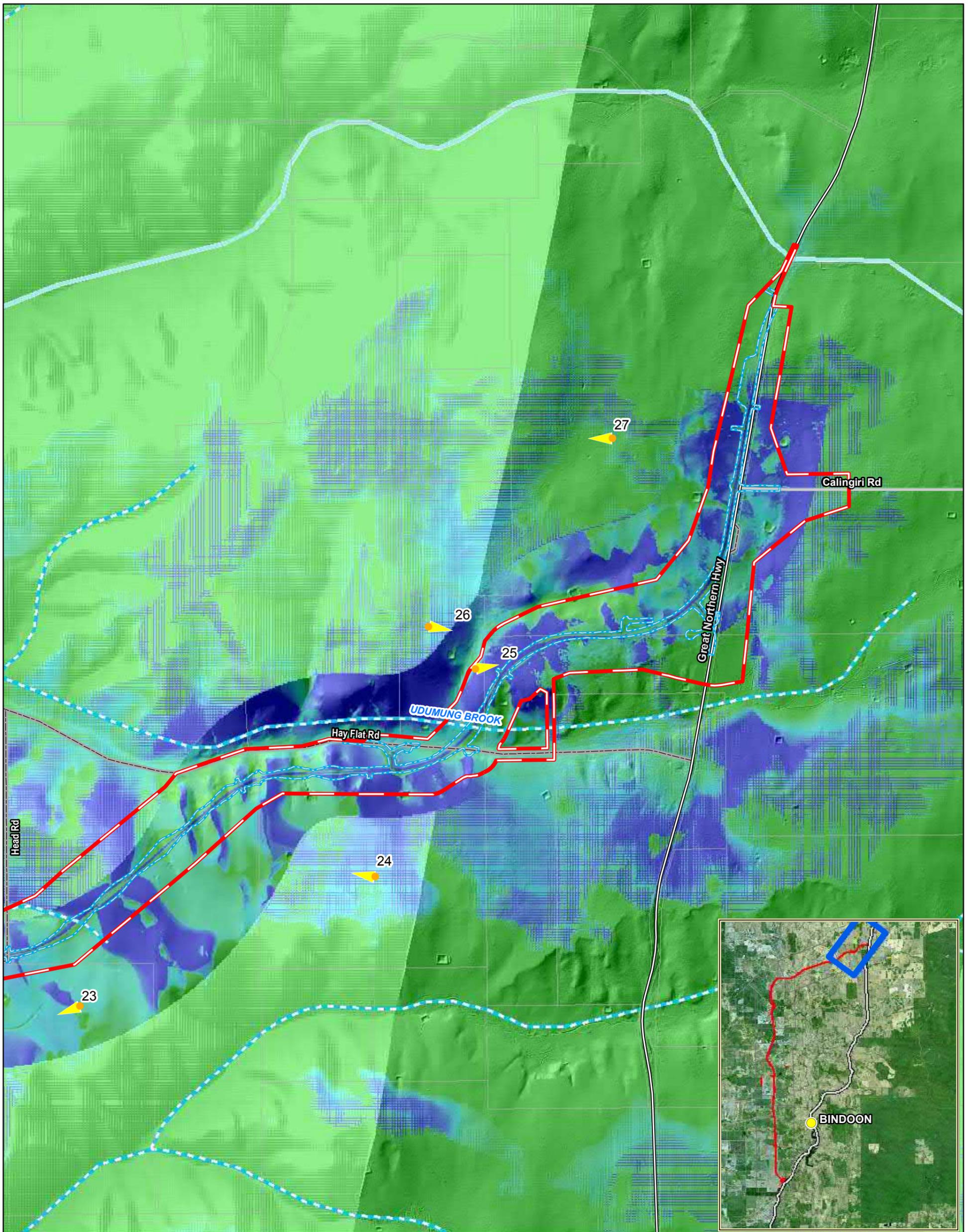
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Figure: 4-33 Page 4 of 5

Drawing No: GNH-CN12-EA-PER-00001 - F4-33 Issue: 1

Task No: ERD Drawing Status / Other: Draft

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**Legend**

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 Figure: 4-33      Page 5 of 5

Drawing No <b>GNH-CN12-EA-PER-00001 - F4-33</b>		Issue <b>1</b>	
Task No <b>ERD</b>	Drawing Status / Other <b>Draft</b>		
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#### *Viewpoint 12 Gingilling Road (1)*

Viewpoint 12 is located within mature bushland to the west of Crest Hill Road. The residential property at the viewpoint is surrounded by mature to semi-mature vegetation, planted during commercial nursery operations with limited continued operation. This vegetation offers enclosed views from the viewpoint with a variety of texture and colour. The sensitivity of this viewpoint is moderate due to the remote nature of the view and sense of enclosure and tranquillity offered by the boundary vegetation. The magnitude of the change arising from the Bindoon Bypass is considered high due to the extent of the vegetation clearance near the viewpoint. Therefore, the impact of the Bindoon Bypass at Viewpoint 12 is High-Moderate. Although vegetation will be removed near this viewpoint, the established nature of vegetation around the viewpoint will limit the impacts at the viewpoint.

Furthermore, the Bindoon Bypass near this viewpoint will be at ground level or in cut, and therefore the elevation of the alignment will not be above vegetation at the property.

#### *Viewpoint 14 Gingilling Road (3)*

Viewpoint 14 is characterised by an access gate to private property, Gingilling Road and the rail corridor. The rail corridor is enclosed by mature vegetation which restricts views of the trains. The area is predominantly pasture land with scattered tree canopy. The sensitivity of this viewpoint is moderate due to its rural nature, but also its proximity to the road and rail corridors. The magnitude of impact arising from the project is considered high as the alignment will be clearly visible from this viewpoint. The topography is reasonably flat with little vegetation to filter views, and therefore the impact has potential to be High-Moderate.

#### *Viewpoint 16 Bindoon-Moora Road (1)*

Viewpoint 16 has a view of rolling topography with mature vegetation. Hills in the foreground are used for agricultural purposes, are cleared with intermittent stands of vegetation, and Bindoon-Moora Road is located to the east. The sensitivity of this viewpoint is high due to the current scenic nature of the viewpoint and sense of remoteness. The magnitude of the change is also considered to be moderate, as there will be intermittent views of the Bindoon Bypass and change in the continuity of the broad rural landscape patterns. The impact is therefore High-Moderate, and photomontages show that the Bindoon Bypass will be visible from this viewpoint.

#### *Viewpoint 17 Bindoon-Moora Road (2)*

Viewpoint 17 looks towards the mature trees that line Bindoon-Moora Road. The terrain rises to the north and agricultural fields are visible with mature vegetation along the boundaries. The view from this viewpoint is panoramic with cleared pasture dominating the landscape. The sensitivity of this receptor is considered high due to the rural nature of the surrounding area, and the current sense of remoteness at the viewpoint. The magnitude of the change is considered to be high as the intersection of the Bindoon Bypass with Bindoon-Moora Road would be visible from this viewpoint. Trees visible from this viewpoint are also proposed to be removed and their absence will further alter the landscape as viewed from this viewpoint. The impact is potentially High, and photomontages show that the Bindoon Bypass will be visible from this viewpoint.

#### *Viewpoint 18 Kangaroo Gully Road (1)*

Viewpoint 18 is located on flat agricultural land with the topography rising in the north, south and west. In the foreground of Viewpoint 18 are intermittent large mature trees, with the majority of the surrounding area being pastoral land. The sensitivity of the viewpoint is high due to the sense of remoteness and rural character of the area. The magnitude of the impact is expected to be high as the Bindoon Bypass will traverse east-west in close proximity to the property. The overall impact is considered to be High, and photomontages show that the Bindoon Bypass will be visible from the viewpoint.

#### *Viewpoint 20 Head Road (south)*

Viewpoint 20 is enclosed by a stand of vegetation to the northern boundary and hedge to the west. The viewpoint has oblique extended views to the north and northwest towards rolling terrain with mature vegetation lining Head Road. The sensitivity of this view point is considered to be high due to the scenic, rural and remote

nature of the view. The magnitude of the change is also likely to be high, due to the changes that would be experienced in the long vistas of natural forms that can be seen from the viewpoint. Overall the impact is High, and the photomontages show that the Bindoon Bypass will be visible from the viewpoint.

#### *Viewpoint 21 Hay Flat Road (1)*

Viewpoint 21 is located to the south of Hay Flat Road and to the west of Udumung Nature Reserve, which can be seen as consistent green forest from the viewpoint. The topography is rolling and there are intermittent mature trees throughout the view. The sensitivity of the area is high due to the panoramic, scenic, rural and remote nature of the view. The magnitude of the change is moderate due to the Bindoon Bypass traversing lower slopes limiting views from Viewpoint 17. The impact is expected to be High-Moderate; however, the topography of the site would indicate that the impact will be lower than this.

#### *Viewpoint 22 Great Northern Highway (west 1)*

Viewpoint 22 is located on rolling terrain with intermittent mature trees; in particular, one mature tree which is in the foreground at this viewpoint and forms a feature of this view. The sensitivity of the viewpoint is high due to the panoramic, scenic, rural and remote nature of the view. The magnitude of the change is also expected to be high due to the close proximity of the Bindoon Bypass to the viewpoint. The impact is therefore High, with photomontages illustrating how close the Bindoon Bypass will be to the viewpoint

#### *Viewpoint 23 Hay Flat Road (2)*

Viewpoint 23 is located on the east facing slopes of undulating topography. The site looks towards a slight valley whereby there is increased vegetation associated with a small creek. The sensitivity of the area is considered to be high due to the panoramic, scenic, rural and remote nature of the view. The magnitude of the change is considered to be moderate due to some vegetation being required to be removed and the Bindoon Bypass being visible from the viewpoint. The impact is High-Moderate; however, photomontages show that vegetation close to the viewpoint screens the majority of the road, and therefore the impact may be less than the impact assessment framework indicates.

### **Light Spill and Headlight Glare**

Potential visual impacts may also come from lighting associated with the construction and operation of the road.

During construction, activities are planned to be conducted during daylight hours; therefore, no light spill impacts are expected during construction. There may be exceptions to this where Main Roads may provide approval for night works. Any instances of night works would be over a short duration, and any light impacts would be temporary in nature.

The lighting design for the Proposal has the potential to impact on local residences through light spill into occupied houses. Lighting will be installed at intersections, with the type of lighting based on the expected traffic volumes in accordance with the requirements of AS/NZS 1158:2005 (lighting for roads and public spaces), as follows:

- V3 Category lighting:
  - ▶ Southern Interchange
  - ▶ Mooliabeenee Interchange
  - ▶ Bindoon – Moora Road Interchange.
- Flag lighting:
  - ▶ Calingiri Road
  - ▶ Gray Road
  - ▶ Teatree Road

- ▶ Barn Road
- ▶ Cook Road
- ▶ Hay Flat Road.

An assessment of the proposed lighting was undertaken against the AS/NZS 4282 Control of the Obtrusive Effects of Outdoor Lighting (Arup 2018b). The standard recommends that the illuminance on windows of habitable dwelling is no more than one lumen when in dark surrounds. The assessment found that no residences would be impacted by light level higher than one lumen as a result of the Proposal (**Appendix K**).

Headlights from road traffic have the potential to impact occupied houses through glare cast into windows. To determine the potential level of impact, residences in close proximity to the Development Footprint were identified, and their occupation status determined. Impacts to occupied premises, or premises with unverified occupation status, have been determined based on their distance from the Development Footprint. A similar approach has been taken for unliveable residences; however, in these instances the occupation status has also been taken into consideration. Impacts based on distances have been applied as follows:

- possible high impact: residences located 200 m from the vehicle in the direction of the high beam emitted light
- moderate impact: residences located between 200 m and 300 m from the vehicle in the direction of the high beam emitted light;
- low impact: residences located between 300 m and 400 m from the vehicle in the direction of the high beam emitted light;
- negligible impact: residences located greater than 400 m from the vehicle in the direction of the high beam emitted light.

The residences considered for impacts from light spill and headlight glare are shown on **Figure 4-34**. **Table 4-55** analyses the potential impacts from headlight glare at each of the residences. Impacts to all residences (whether they are of unverified, unliveable or occupied status) had negligible or low light spill impact.



### Legend

- Occupied House
- Unverified House
- Unverified Structure
- Design - CN12
- Freeway / Highway
- Major Road
- Minor Road
- Cadastral Boundary

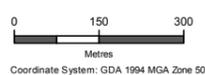


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### Bindoon Bypass Buildings and Structures Figure: 1 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
2/07/2018	BG	XX	XX



### Legend

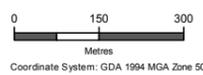
- Occupied House
- Verified Shed - Workshop
- Unverified Structure
- Design - CN12
- Freeway / Highway
- Major Road
- Minor Road
- Cadastral Boundary



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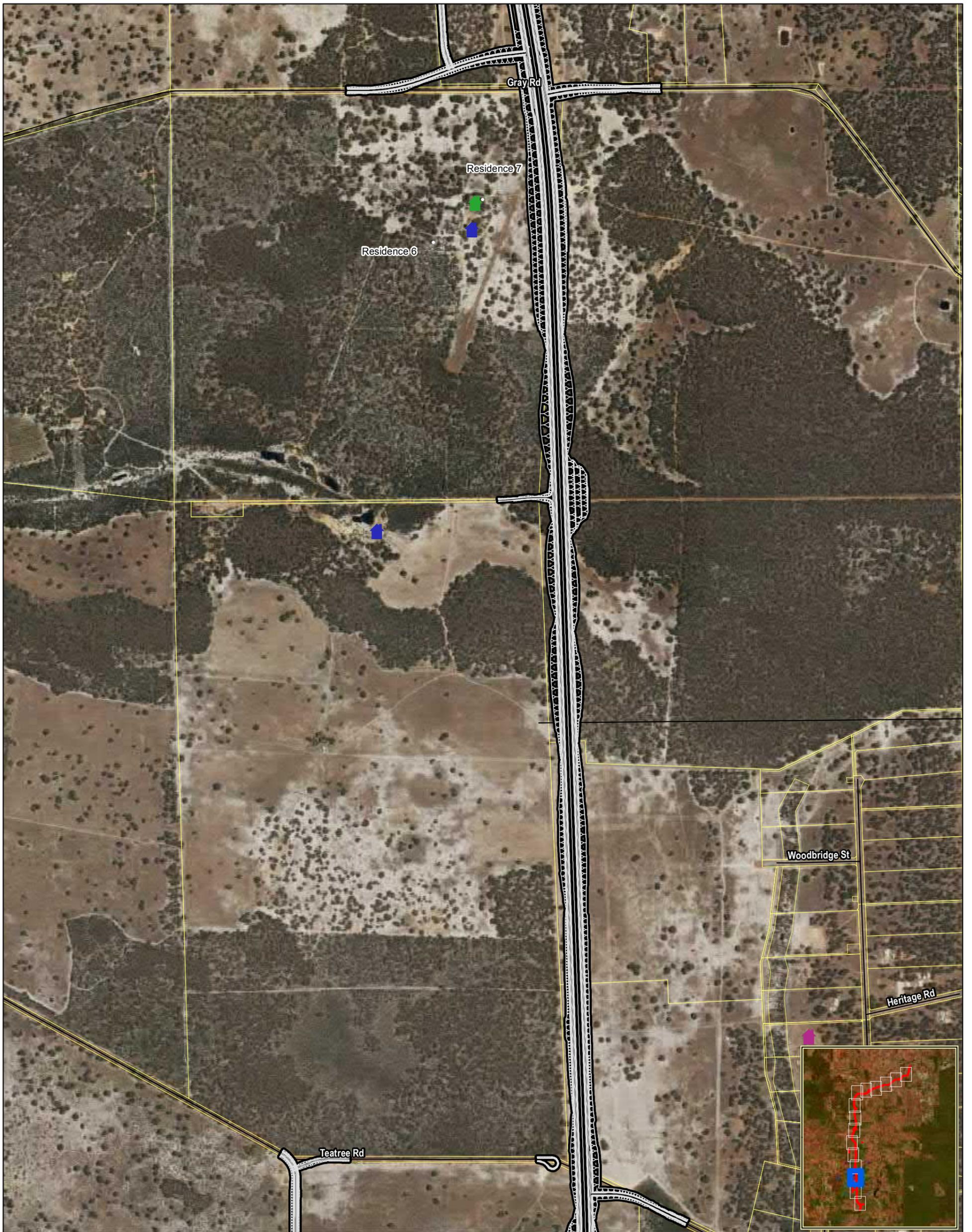
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### Bindoon Bypass Buildings and Structures Figure: 2 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
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### Legend

-  Occupied House
-  Unliveable House
-  Unverified Structure
-  Design - CN12
-  Freeway / Highway
-  Major Road
-  Minor Road
-  Cadastral Boundary

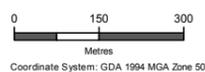


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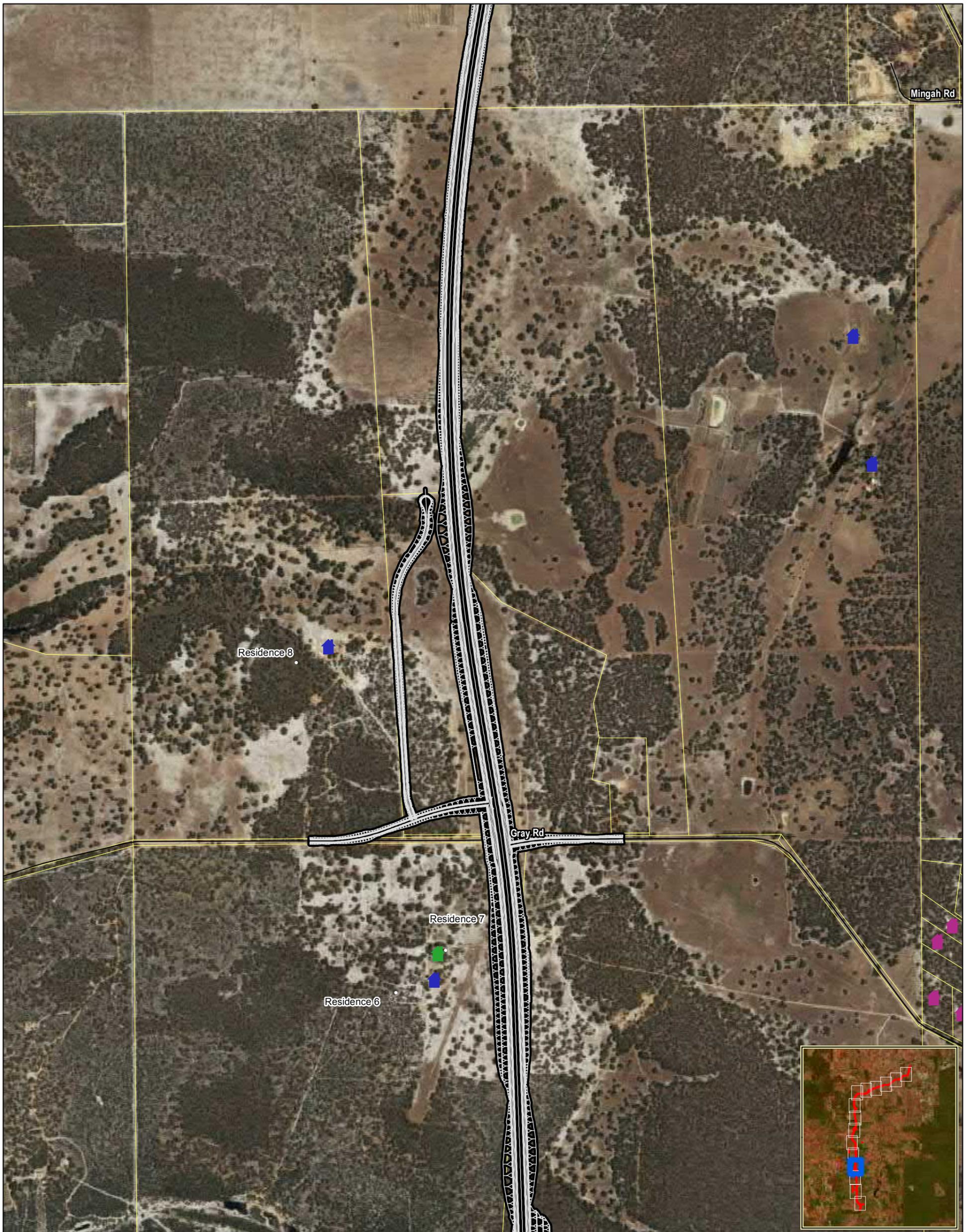
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### Bindoon Bypass Buildings and Structures Figure: 3 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

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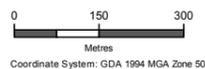
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-  Unliveable House
-  Unverified Structure
-  Design - CN12
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### Bindoon Bypass Buildings and Structures Figure: 4 of 15

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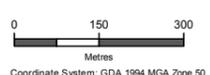
-  Occupied House
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-  Design - CN12
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### Legend

- Occupied House
- Unverified House
- Design - CN12
- Freeway / Highway
- Major Road
- Minor Road
- Cadastral Boundary

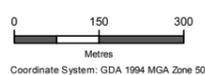


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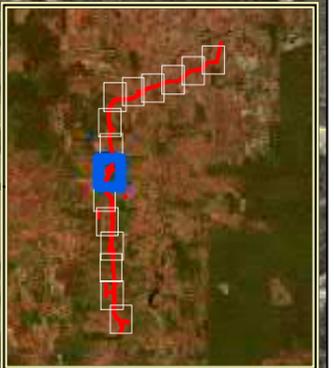
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### Bindoon Bypass Buildings and Structures Figure: 6 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

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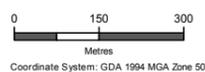
-  Occupied House
-  Design - CN12
-  Freeway / Highway
-  Major Road
-  Minor Road
-  Cadastral Boundary



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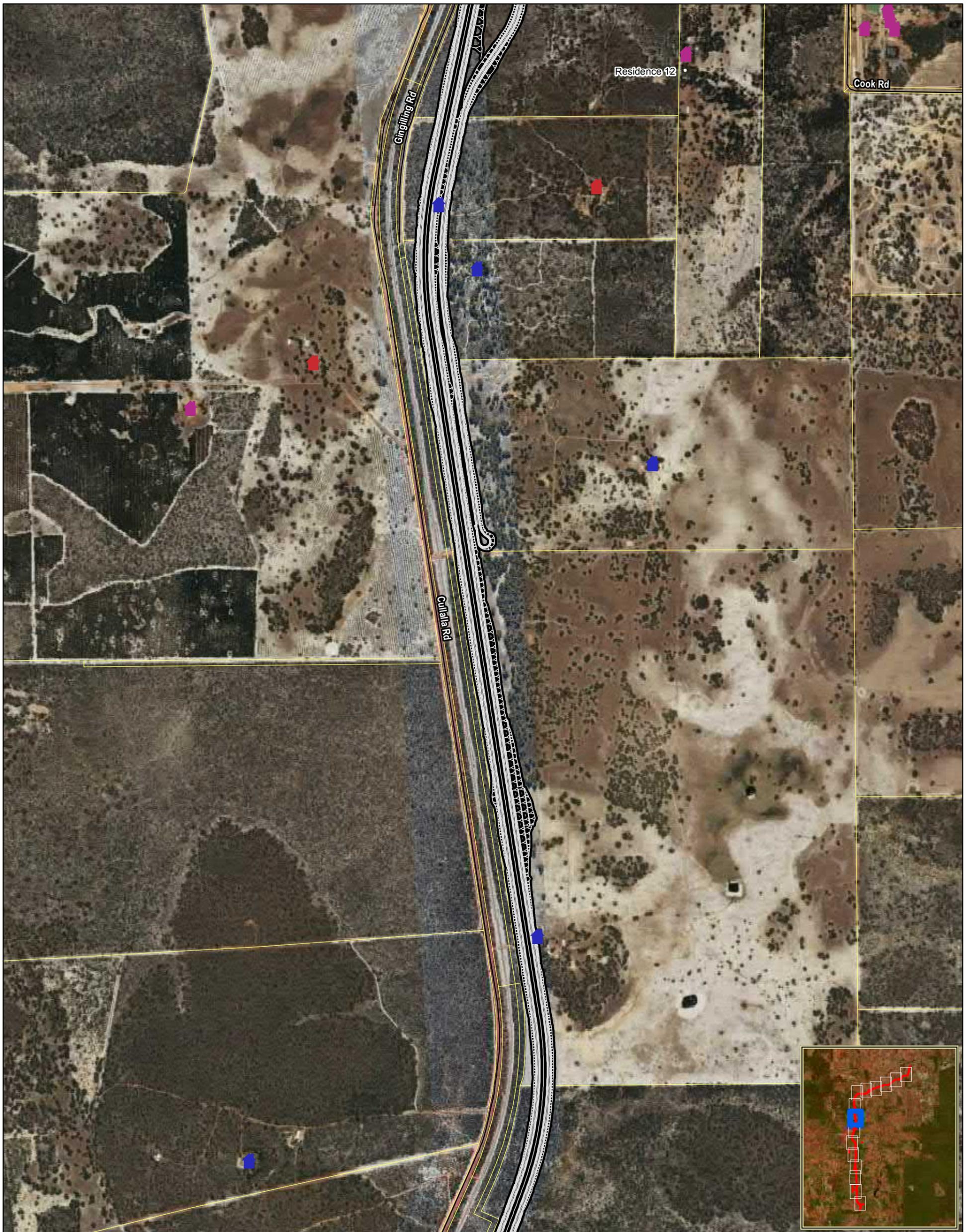
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 Bindoon Bypass

### Bindoon Bypass Buildings and Structures Figure: 7 of 15

Drawing No: **GNH-CN12-RW01-GIS-0039** Issue: **A**

Task No: **GNH-CN12** Drawing Status / Other: **Draft / Other Info**

Date: **2/07/2018** By: **BG** Chkd: **XX** Appd: **XX**



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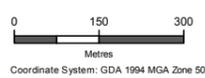
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-  Unverified Structure
-  Design - CN12
-  Freeway / Highway
-  Major Road
-  Minor Road
-  Cadastral Boundary



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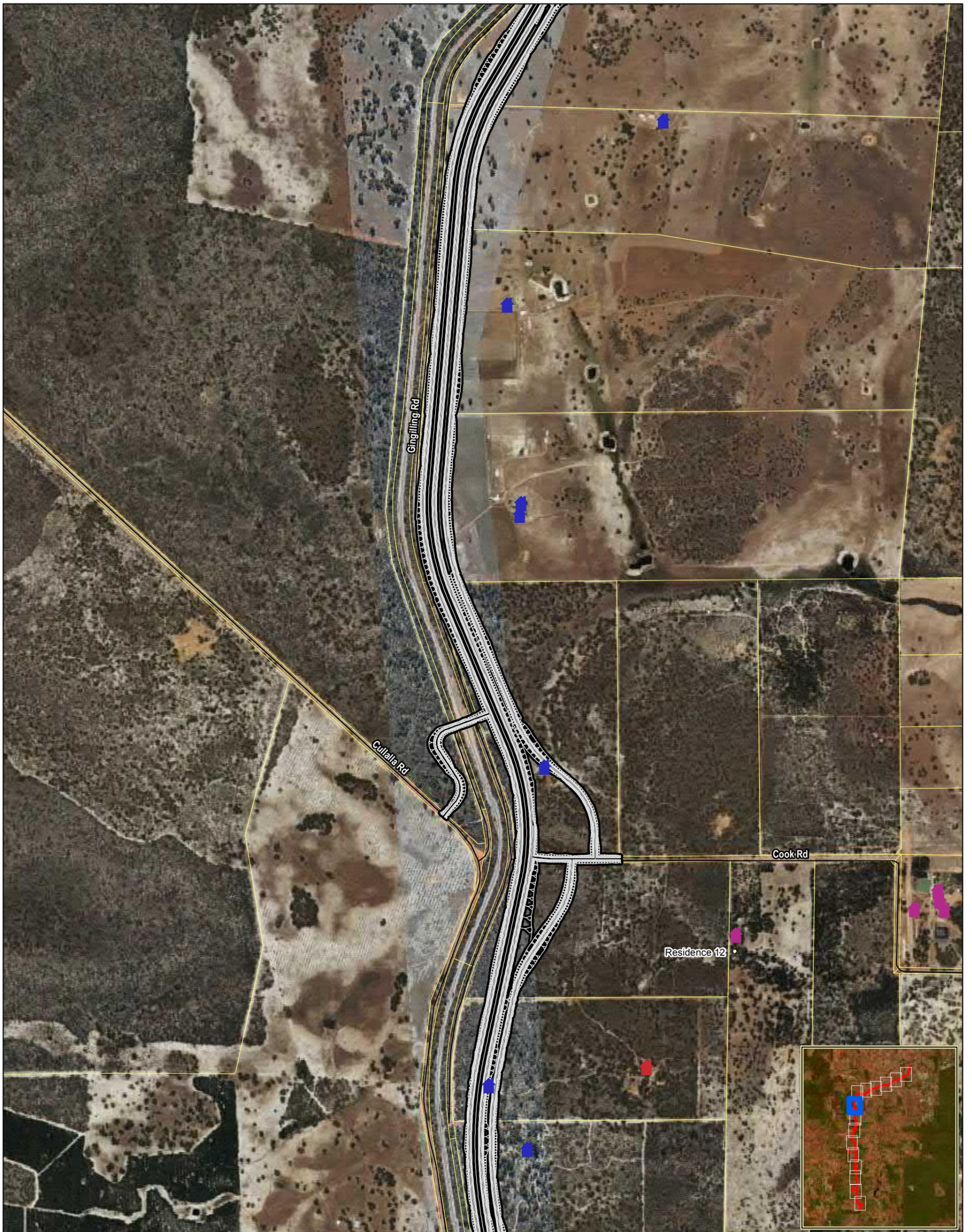
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### Bindoon Bypass Buildings and Structures Figure: 8 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

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-  Occupied House
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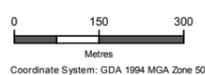


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### Bindoon Bypass Buildings and Structures Figure: 9 of 15

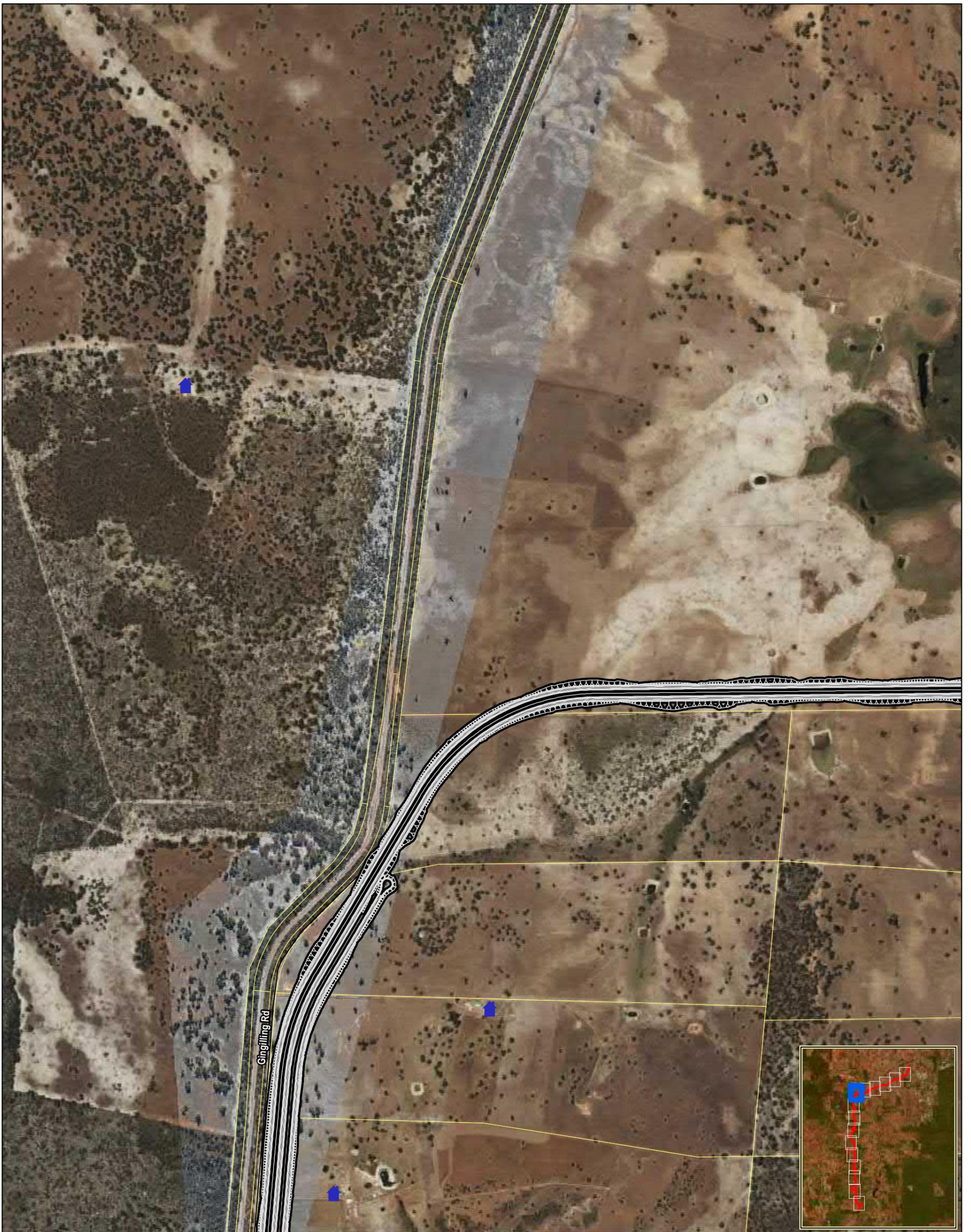
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Task No  
GNH-CN12

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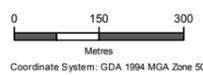
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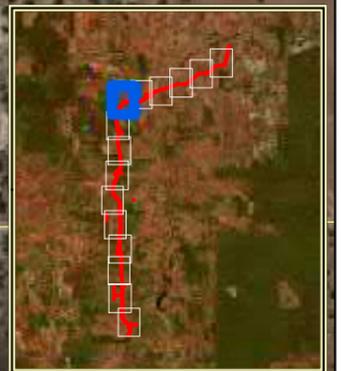
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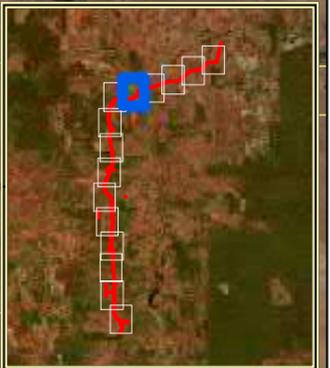
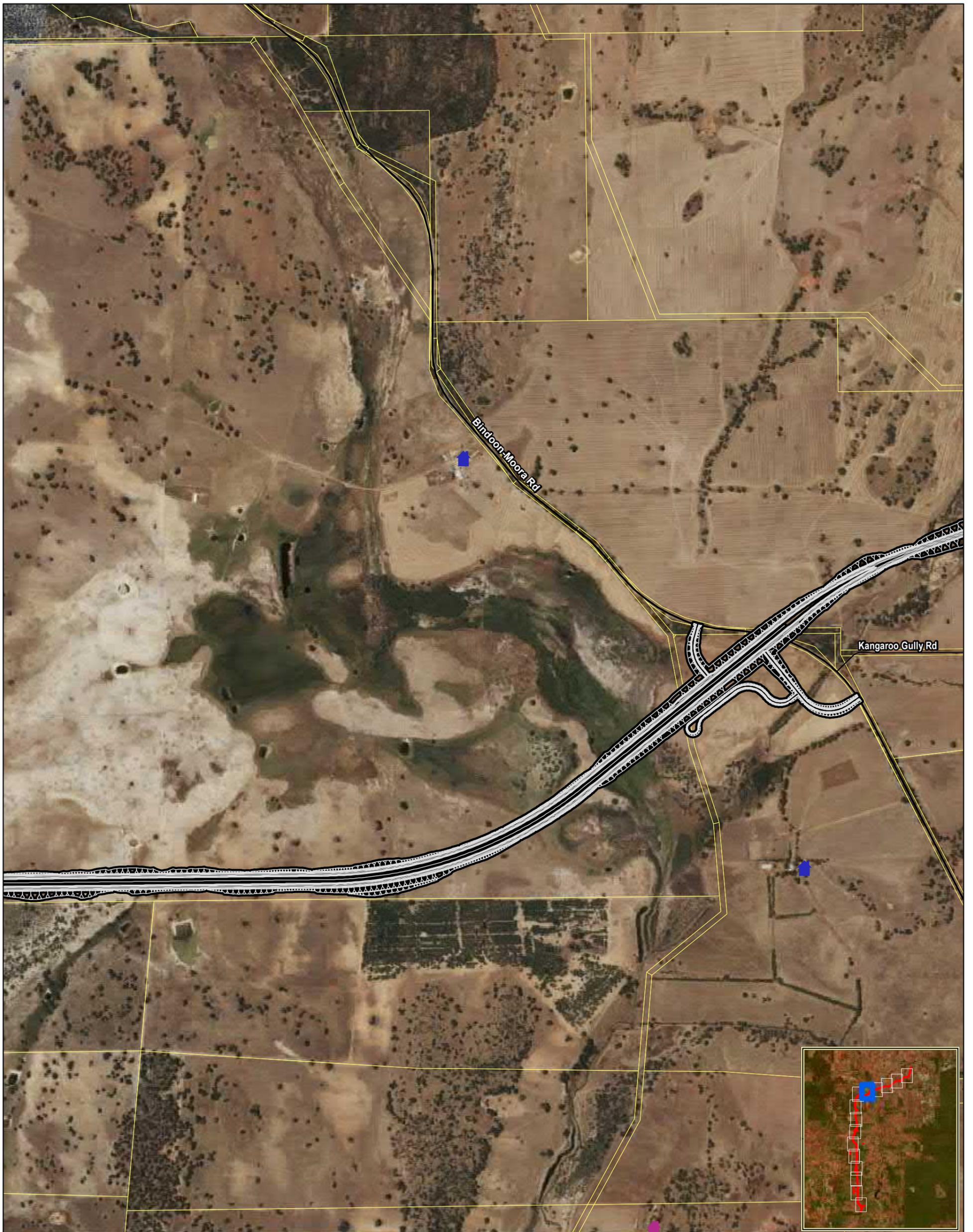
**Bindoon Bypass  
 Buildings and Structures**  
 Figure: 10 of 15

Drawing No: **GNH-CN12-RW01-GIS-0039** Issue: **A**

Task No: **GNH-CN12** Drawing Status / Other: **Draft / Other Info**

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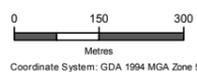
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### Bindoon Bypass Buildings and Structures Figure: 11 of 15

Drawing No  
 GNH-CN12-RW01-GIS-0039

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Task No  
 GNH-CN12

Drawing Status / Other  
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Date	By	Chkd	Appd
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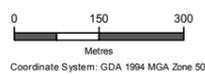
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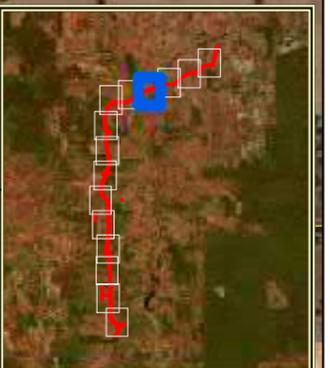
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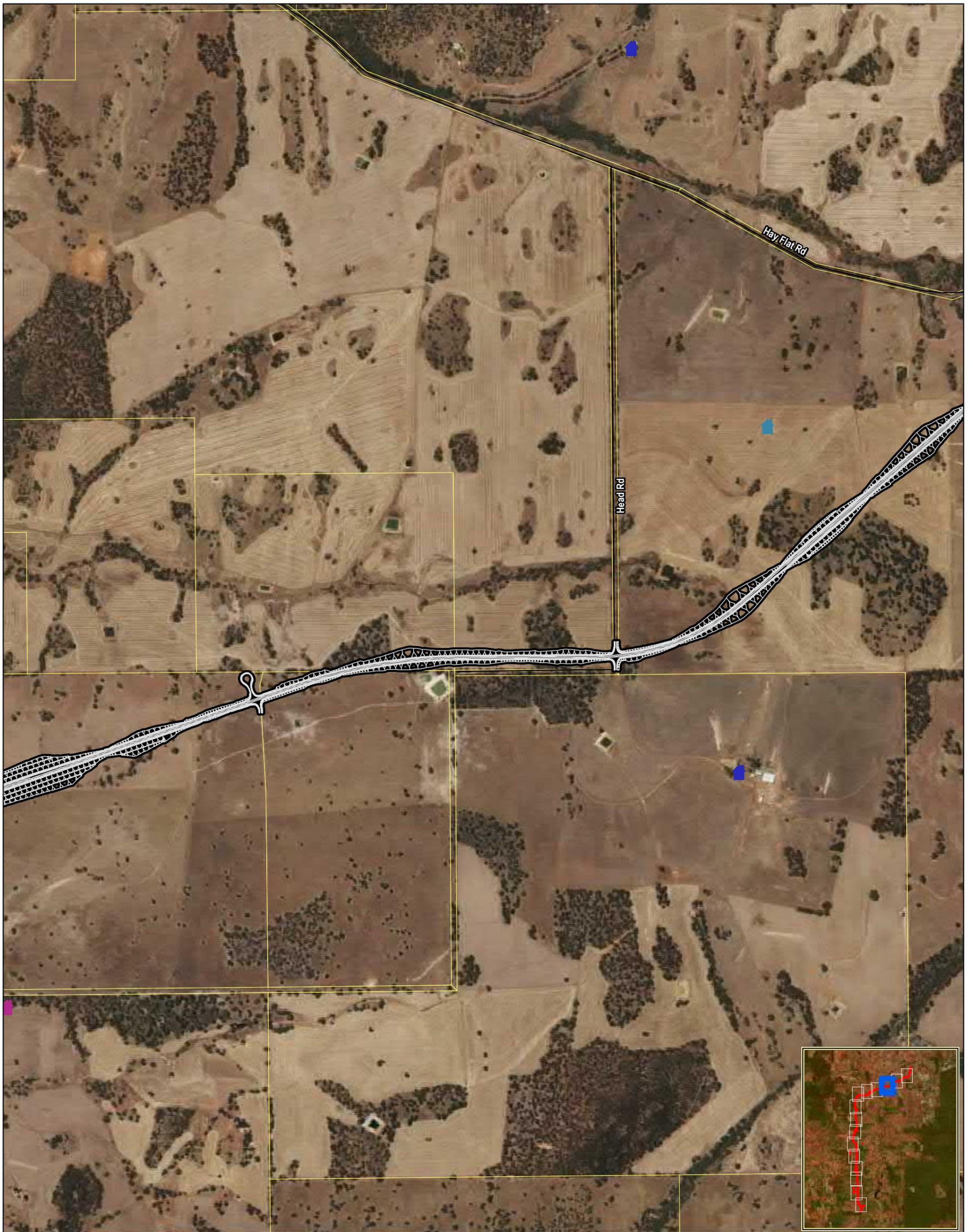
### Bindoon Bypass Buildings and Structures Figure: 12 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
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**Great Northern Highway  
Bindoon Bypass**

### Bindoon Bypass Buildings and Structures Figure: 13 of 15

Drawing No <b>GNH-CN12-RW01-GIS-0039</b>		Issue <b>A</b>	
Task No <b>GNH-CN12</b>		Drawing Status / Other <b>Draft / Other Info</b>	
Date <b>2/07/2018</b>	By <b>BG</b>	Chkd <b>XX</b>	Appd <b>XX</b>

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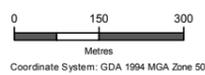
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Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

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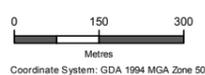
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### Bindoon Bypass Buildings and Structures Figure: 15 of 15

Drawing No: GNH-CN12-RW01-GIS-0039 Issue: A

Task No: GNH-CN12 Drawing Status / Other: Draft / Other Info

Date	By	Chkd	Appd
2/07/2018	BG	XX	XX

**Table 4-55: Light Spill Impact Assessment**

Residence ID	Distance and Impact Criteria	Residence Status	Analysis
1	363 m – Low impact	Unverified	The low impact on Residence 1 is further minimised, due to proposed V3 sub-category lighting on the ramp nearby, therefore less apparent glare.
2	601 m – Negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source.
3	493 m – Negligible impact	Unverified	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source.
4	510 m – Negligible impact	Unverified	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source.
5	386 m – Low impact	Occupied	The low impact will be further minimised as this residence is not in the direction of the headlight. Moreover, this residence is not adjacent to the highway, but to a side road with lower traffic volume. Hence, the impact on this residence can be considered negligible.
6	662 m – Negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light coming from a property access road with fairly low traffic volume.
7	559 m – Negligible impact	Unliveable	Based on the survey, this residence is uninhabitable. Should it be made habitable in the future, the residence 6 analysis will apply to it.
8	350 m – Low impact	Occupied	The low impact will be further minimised as this residence is not in the direction of the headlight. Moreover, this residence is not adjacent to the highway, but to a property access road with low traffic volume.
9	402 m – negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light not coming from the highway, but from a local road with lower traffic volume.
10	538 m –Negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light not coming from the highway, but from a local road with lower traffic volume.
11	524 m – Negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light not coming from the highway, but from a local road with lower traffic volume.

Residence ID	Distance and Impact Criteria	Residence Status	Analysis
12	790 m – Negligible impact	Unverified	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light not coming from the highway, but from a property access road with low traffic volume.
13	440 m – Negligible impact	Occupied	It is not considered that headlight glare will have an impact on this residence, due to distance from the light source.
14	529 m – Negligible impact	Unverified	It not considered that headlight glare will have an impact on this residence, due to distance from the light source.
15	682 m – Negligible impact	Occupied	It not considered that headlight glare will have an impact on this residence, due to distance from the light source, as well as the source of light coming from the vehicles turning onto a side road with low traffic volume.

## Dust

Dust impacts are only likely to occur during the construction phase. During operations, the Bindoon Bypass will be completely sealed and no dust will be generated. The extent and nature of dust generating activities during construction will be minor, short term and temporary, particularly in relation to other dust generating activities that regularly occur in the study area (i.e. cropping). Construction activities with the potential to generate the most dust are clearing and earth moving activities. However, due to the dry environment in the study area, dust plumes may also be generated from other construction activities including movement of light vehicles. Dust generated by the Proposal may cause nuisance to those living near the construction site.

### 4.6.6 Mitigation

#### 4.6.6.1 Noise

Noise generated during construction of the Bindoon Bypass will be managed in accordance with the *Environmental Protection (Noise) Regulations 1997* (Noise Regulations). Noise Regulations require that the following management occurs during construction:

- the construction work will be carried out in accordance with control of environmental noise practices set out in section 4 of Australian Standard (AS) 2436-2010 *Guide to noise and vibration control on construction, maintenance and demolition sites*
- the equipment used on the premises will be the quietest reasonably available
- if Main Roads is required to prepare a construction noise management plan in respect of the construction site:
  - ▶ the noise management plan will be prepared and given in accordance with the requirement, and approved by the Local Government
  - ▶ the construction work will be carried out in accordance with the noise management plan, excluding any ancillary measures
- if out-of-hours works are required, a noise management plan will be developed and approved by the local government (in accordance with the local government’s delegated authority from the DWER):
  - ▶ plan will be submitted to the local government not later than 7 days before proposed works commence

- ▶ all nearby sensitive receivers will be consulted on the noise management plan prior to its submission to local government
- ▶ all nearby noise sensitive receivers will be notified in writing at least 24 hours prior to the works commencing.

Further mitigation measures have been proposed to reduce ongoing (operational) noise impacts as a result of the Proposal, including preparation of a Noise Management Plan in line with the requirements of State planning policy 5.4. Mitigation measures will be employed along the alignment as required, with particular attention to areas near the residences that have been identified as likely to experience noise levels above the targets and limits set out in State planning policy 5.4 (**Table 4-56**). Noise mitigation measures employed by Main Roads in rural settings generally includes:

- consider a low-noise pavement for sections of the alignment
- building modifications and improvements (such as double glazing, installation of air conditioning units) to reduce noise inside residences where State planning policy 5.4 targets or limits are exceeded.

Construction of noise walls or earthen bunds is generally not considered in rural settings, due to their negative impacts on other factors such as amenity.

Noise complaints during operation will be managed by MRWA through a specific procedure that includes:

- A framework for receiving and responding to noise-related complaints (e.g., free call number, online form).
- A noise complaint register where details of the complainant and nature of the complaint are recorded.
- Timeframes and protocols for MRWA to contact and liaise with the complainant to establish gather further information and to identify the nature and source of the complaint.
- The process for further investigation of the complaint (if required).
- Details of how the results of the investigation will be recorded and communicated to the complainant.
- Details of how any changes in mitigation measures will be identified and implemented as a result of the investigation.

**Table 4-56: Proposed noise mitigation measures**

Location	Mitigation Measure
428 Gingilling Road, Wannamal	A noise management plan as required by State Planning Policy 5.4 (SPP 5.4) will be prepared for the proposal. Noise mitigation, as set out in the Implementation Guidelines for SPP 5.4, will be offered to these properties. The mitigation to be applied will be discussed and agreed with by Main Roads and each affected property owner, prior to the construction of the proposal.
Lot 3281 (no. 9071) GNH, Wannamal	
Lot 36 (no. 620) Gray Road, Bindoon	
Lot 502 (no. 737) Crest Hill Road, Mooliabeenee	
739 Crest Hill Rd, Mooliabeenee	
431 Cullalla Rd, Moondah	
630 Gingilling Rd, Wannamal	
Lot 53 (no. 644) Gingilling Road, Wannamal	
828 Gingilling Rd, Wannamal	
907 Cullalla Rd, Cullalla	
1121 Hay Flat Rd, Wannamal	
Lot 2917 (no. 75) Kangaroo Gully Road, Wannamal	

#### 4.6.6.2 Visual Amenity, Dust and Light Spill

##### Visual Amenity

In order to minimise or mitigate the impacts to visual amenity the Proposal, the following measures and practices will be put in place:

- Landowners will be consulted to identify suitable types of planting/landscaping (for example, trees and tall shrubs, rather than low shrubs and groundcovers), and to investigate opportunities for early planting of screening vegetation prior to commencement of construction.
- The detailed design phase will assess the viability of alignment adjustments and design criteria such as steepening of cut/fill batter slopes, median width, or provision of barriers to minimise the amount of existing native vegetation to be cleared.
- The road reserve will be revegetated to reflect the existing vegetation patterns and structure.

Additional mitigation measures for specific viewpoint locations are detailed in **Table 4-57**. The particular environmental conditions (for example the distinctive character of the vegetation or landscape at the location), proximity of the Proposal, or type of earthworks required at these viewpoints were considered to warrant additional management measures to those detailed above.

**Table 4-57: Proposed visual amenity mitigation measures by viewpoint.**

Viewpoint (VP)	Mitigation Measures (Source: Arup 2018a)
VP 7 Crest Hill Road	Retention of <i>Xanthorrhoea</i> spp. outside the Development Footprint
VP 11 Cullala Road (2)	Planting along the road reserve with a focus on covering exposed earthworks
VP 16 Bindoon-Moora Road (1)	Planting with linear canopy planting and intermittent planting to mirror existing open wooded landscape
VP 17 Bindoon-Moora Road (2)	Planting along road corridor with gaps that mirror the existing open woodland
VP 21 Hay Flat Road (1)	Intermittent planting of shrubs along the road reserve away from viewpoint to achieve vegetation consistent with the surrounding area.

##### Light Spill and Headlight Glare

To reduce light spill from intersection lighting the following mitigation measures will be incorporated into the design:

- review of best practice lighting during detailed design to confirm high-pressure sodium light remains appropriate
- luminaire photometry selection which provides sufficient illumination of the road surface with minimal light spill beyond the road
- zero-degree tilt for luminaires for minimal light spill
- use of aeroscreen (flat glass) luminaires wherever possible for minimal glare and light spill
- lighting will be installed at intersections only: no lighting will be installed along the remainder of the alignment.

Where required to reduce impacts to residences from headlights of vehicles travelling on the Bindoon Bypass, planting will be undertaken around the outside of curves, including intersections, near those residences that may be impacted.

## Dust

To reduce dust during construction, the following mitigation measures will be implemented:

- wetting of cleared areas as required (water trucks or similar will be available during construction)
- should visible dust plumes be observed, works will be reduced or stopped until either conditions become less favourable for dust lift-off or additional measures (wetting of cleared areas) are undertaken to reduce dust lift-off
- reduced vehicle speed limits (e.g. 40km/hr) on site to reduce the potential for dust to be generated by vehicle movements
- progressive revegetation of cleared areas to reduce the amount of time these remain bare and susceptible to wind erosion
- investigation and trialling of dust suppressants and soil stabilisation treatments (e.g. Dustex, gluon, hydro-mulch) for exposed areas.

### 4.6.7 Predicted Outcome

#### 4.6.7.1 Noise

The traffic noise assessment conducted by the GNH IPT in 2018 (GNH IPT 2018b) found that up to 11 noise sensitive receivers have potential to experience noise levels above State planning policy 5.4 targets, and one sensitive receiver with potential to experience noise levels above the limits. These results were determined by noise modelling. Main Roads will work with impacted landowners and residents to reduce impacts from road noise to as low as reasonably practicable through noise mitigation measures to be agreed with each land owner.

#### 4.6.7.2 Visual Amenity, Dust and Light-spill

A number of potential landscape and visual amenity impacts may be caused by the Bindoon Bypass. The existing rural character of the area will be compromised by the presence of the highway, and this will be experienced at a range of magnitudes from various viewpoints. The mitigation measures proposed will reduce impacts to visual amenity, with the reduction become more pronounced over time as vegetation matures and establishes. Planting along the road reserve will mirror existing landscape character along the Development Envelope, and therefore it is expected that visual impacts will not be significant.

The proposed intersection lighting for the Proposal is not anticipated to result in light spill impacts to residences. As such, light spill impacts are negligible. Impacts due to headlight glare may occur, particularly where vehicles turn off the Bindoon Bypass and onto local roads. The mitigation proposed in these areas will reduce potential impacts to residents, thus residual impacts are expected to be negligible.

Dust impacts from the construction and operation of the Bindoon Bypass will not be significant. The operation of the road will not generate dust due to it being sealed. During construction, a range of mitigation measures will be available to be employed by site construction teams. Dust levels are therefore not expected to increase beyond those levels already generated by surrounding agricultural land uses.

## 5. Other Environmental Factors or Matters

An Agreement to Reserve (AtR) and Conservation Covenant is in place on Lot 2138 Hay Flat Road, Wannamal (**Figure 5-1**). This AtR and Conservation Covenant was established under the *Soil and Land Conservation Act 1945* and pertains to the vegetated portion of the property. In order to avoid impacting the nearby Udumung Nature Reserve, the Proposal crosses Hay Flat Road and Udumung Brook in the south east corner of this property. The AtR is not associated with any EPBC Act offsets.

A total of 1.4 ha of vegetation subject to the AtR and Conservation Covenant is within the Development Footprint, of which 0.5 ha is mapped as *Eucalyptus wandoo* and *Casuarina obesa* sparse woodland (EwBeNa) and 0.9 ha is mapped as *Eucalyptus wandoo*, *Melaleuca raphiophylla* and *Casuarina obesa* over pasture (P EwMrCo) (FVC 2018a). All vegetation was mapped as being Degraded (FVC 2018a). Approximately 11 ha of similar vegetation exists on the property.

Given the degraded condition of the vegetation, the implementation of the proposal is unlikely to degrade the environmental values present and no significant impacts are anticipated. Further consultation will be undertaken with the land owner, DPIRD and DPLH in relation to this AtR and Conservation Covenant through the land acquisition process.



### Legend

- Development Envelope
- Development Footprint
- Covenant Vegetation (DPI&RD)
- Minor Road
- Lot 2138
- Cadastral Boundary
- Water Line

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Client Project

**Great Northern Highway  
 Bindoon Bypass South  
 Environmental Review Document**

Agreement to Reserve and Conservation  
 Covenant on Lot 2138 Hay Flat Road  
 Wannamal  
**Figure: 5-1**

Drawing No <b>GNH-CN12-EA-PER-00001</b>		Issue <b>1</b>	
Task <b>EDR</b>	Drawing Status / Other <b>Draft</b>		
Date <b>30/05/2019</b>	By <b>BG</b>	Chkd <b>LB</b>	Appd <b>TJ</b>