Flora and Vegetation Management Plan

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Manuwarra Red Dog Highway - Stage 4

Document Version Control

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Rev 0	Initial submission	01/09/2023
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1 EXECUTIVE SUMMARY

Proposal name	Manuwarra Red Dog Highway Project (Significant Amendment)
Proponent Name	Commissioner of Main Roads Western Australia
Ministerial Statement Number	Ministerial Statement No. 1205
Purpose of the EMP	This Flora and Vegetation Management Plan (FVMP) has been prepared to meet Conditions B2-1(4), B2-2, C4-1 and C4-2 of Western Australian Ministerial Statement No. 1205 (Assessment No. 2273), as issued under Part IV of the *Environmental Protection Act 1986* (WA).
Key environmental factors, outcomes and/or objectives	Relevant environmental factors and EPA objectives: • Flora and Vegetation: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. Environmental Outcomes: • No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6. • No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3. • No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3. • No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2. • No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2. • No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.
Condition clauses (if applicable)	This plan addresses conditions B2-1(4), B2-2, C4-1 and C4-2 of Ministerial Statement No. 1205 (Assessment No. 2273) (Table 2-5).
Key components in the EMP (if applicable)	Not applicable. Key requirements of the FVMP have been addressed using the requested formats: • WA Environmental Protection Authority template for environmental management plans (https://www.epa.wa.gov.au/templates-and-forms).
Proposed construction date	November 2023
EMP required pre-construction	Yes ✓ No ☐

2 CONTEXT, SCOPE AND RATIONALE

2.1 Proposal

Main Roads Western Australia (Main Roads) will shortly commence construction of Stage 4 of the Manuwarra Red Dog Highway (MRDH, previously referred to as the Karratha – Tom Price Road). The Revised Proposal was approved as a Revised Proposal by the Western Australian Environment Minister on 03 July 2023.

2.2 Key Elements of Stage 4 of the Revised Proposal

MRDH Stage 4 involves the construction and operation of approximately 112 km of new road from the southern end of the MRDH Stage 3 Road (Wallyinya Pool) to the Nanutarra Munjina Road Figure 1.

All direct disturbance including that for laydown areas, site offices, side tracks, turnaround locations and other construction activities will occur within a 7,142 ha Development Envelope. The disturbance footprint within the Development Envelope is approximately 657 ha in area. Of this area, approximately 557 ha is permanent clearing (e.g. road, drainage infrastructure) and approximately 100 ha is temporary clearing which will be rehabilitated.
Works will include:

- clearing of vegetation and topsoil removal;
- investigative works (geotechnical investigations)
- blasting (required in areas of cut which cannot be excavated by standard earthmoving machinery);
- excavation of material pits to provide construction material;
- water abstraction;
- creation of temporary side-tracks and turnaround locations;
- road drainage;
- accommodation works (i.e., fencing) and potential relocation of services;
- site office and construction compound establishment;
- construction of the road formation, including application of asphalt and bitumen;
- haulage of construction materials and any excess materials generated on site;
- stockpiling and laydown areas (mulch, aggregate, material);
- landscaping and revegetation; and
- ongoing maintenance activities.

Construction will be undertaken using traditional earth-moving, equipment and construction techniques. It is noted that blasting will likely be required in areas of cut which cannot be excavated by standard earthmoving machinery.

The road formation will be built using both imported fill and cut-to-fill materials from within the Development Envelope. The key basic raw materials required for construction of the road include

sand, limestone, clay, lateritic gravel, and crushed rock aggregate. This material will be sourced in accordance with Main Roads standard practise and processes.

Laydown and stockpiling areas (and potential access tracks) for material and equipment will be required during construction, as will areas for facilities such as site offices etc. The location of these will be established by Main Roads. All such areas will be located within the Development Envelope. Clearing for the material pits, laydown areas, stockpiling and facilities is expected to result in up to approximately 100 ha of vegetation clearing, which will be rehabilitated.

MRDH Stage 4 will operate as a two-lane single carriageway (one lane in each direction) road. Traffic modelling indicates a likely maximum of 635 vehicles per day will utilise the road, of which up to around 230 will be heavy vehicles. The road will be operated by Main Roads including standard management and maintenance practices. MRDH Stage 4 will be subject to normal routine, recurrent and periodic maintenance during its operation. The maintenance operations are confined to the road corridor and the road itself, typically including vegetation management, drainage, road markings, signs and the road pavement.

2.3 Purpose of this Flora and Vegetation Management Plan

The Revised Proposal was approved via Ministerial Statement No. 1205 (Assessment No. 2273) on 04 July 2023. Part B2 and C4 of the Ministerial Statement requires Main Roads to prepare a Flora and Vegetation Management Plan (FVMP) and submit this plan to the Minister for approval. This FVMP has been prepared to satisfy this condition. The requirements of these guidelines and where they have been addressed in this FVMP are shown in **Table 2-5**.

This FVMP applies only to Stage 4 of the Revised Proposal. Main Roads will continue to implement the post-construction requirements of the relevant Stage 3 management plans.

The FVMP has been prepared to be consistent with the WA Environmental Protection Authority (EPA) template for environmental management plans (available at https://www.epa.wa.gov.au/templates-and-forms).

2.4 Summary of Potential Impacts

Potential impacts to flora and vegetation may result from the following project activities:

- clearing for construction of the road and ongoing maintenance activities;
- clearing for associated construction activities such as site offices, laydown, side-tracks and so on;
- construction dewatering for the Fortescue River crossing and potentially other watercourse crossings;
- abstraction of water for construction purposes;
- disruption of surface water flow;
- construction of roadside drainage; and
- movement of construction vehicles and machinery around the site, as well as into and out of the site.

Potential direct impacts to flora and vegetation in relation to MRDH Stage 4 have been identified as clearing of vegetation including Threatened Ecological Communities (TECs), Priority Ecological Communities (PECs), potential groundwater dependent vegetation, vegetation of local significance

and threatened and priority flora species. The extent of direct disturbance to vegetation types within the Indicative Disturbance Footprint for MRDH Stage 4 is outlined in **Table 2-1** and are shown in **Figure 2**. The extent of direct disturbance by vegetation condition is shown in **Table 2-2** and **Figure 3**.

Potential indirect impacts to flora and vegetation in relation to the Revised Proposal have been identified as:

- impacts to groundwater dependent vegetation (ie. vegetation condition) as a result of groundwater abstraction;
- impacts to flora and vegetation due to altered fire regimes.
- impacts to flora and vegetation (ie. vegetation condition or species composition) due to changes to surface water flow as a result of the construction and presence of the road (particularly grove-intergrove mulga communities, the Themeda Grasslands TEC; and the Brockman Iron PEC); and
- introduction of new weed species or spread of existing weed species as a result of vehicle movements and earthmoving activities.

Table 2-1 Extent of Direct Disturbance to Vegetation Types

Vegetation Type	Vegetation Unit	Associated Significant Vegetation Type	Vegetation Unit Description	Indicative Disturbance Footprint (ha)	Indicative Temporary Clearing Area (ha)	Total (ha)
Vegetation of Stony Hillslopes, Hillcrests and Foothills	H1	N/A	*Eucalyptus leucophloia* subsp. *leucophloia* scattered low trees over *Triodia wiseana* hummock grassland.	36.7	0.0	36.7
	H2	N/A	*Eucalyptus leucophloia subsp. leucophloia, (Corymbia hamersleyana*) low open woodland over mixed Acacia shrubs over *Triodia wiseana* open hummock	0	0.0	0.0
	H3	N/A	*Eucalyptus leucophloia* subsp. *Leucophloia*, (*Corymbia hamersleyana*) low open woodland over mixed Acacia shrubs over *Triodia wiseana* open hummock grassland	45.5	0.0	45.5
	H4	N/A	*Eucalyptus leucophloia* subsp. *Leucophloia* scattered low trees over *E. gamophylla* scattered low mallees over *Triodia wiseana* open hummock grassland and *Eriachne mucronata* scattered tussock grasses.	0.1	0.0	0.1
Vegetation of Cracking Clays	C1	N/A	*Eriachne benthamii*, *Eragrostis xerophila*, *Astrebla elymoides* very open tussock grassland over *Cynodon convergens* very open bunch grassland.	2.1	0.7	2.8
	C2	Vegetation Communities on Cracking Clays[1] (Vegetation of Local Significance)	*Acacia xiphophylla* low woodland over *Triodia epactia* very open hummock grassland over *Eragrostis xerophila* scattered tussock grasses.	4.6	8.6	13.2
	C3	Brockman Iron cracking clay communities of	Mixed *Astrebla* tussock grassland over *Urochloa occidentalis* var. *occidentalis* bunch grassland.	11.8	0.0	11.8

[1] Vegetation Unit C2, included some grass species that are constituent species of the "Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai" Priority 3 PEC, as described for the Wona Land System. However, the vegetation unit was present on the Hooley Land System rather than the Wona Land System. As such, Vegetation Unit C2 may be considered to be of local conservation significance rather than presenting the PEC.

Vegetation Type	Vegetation Unit	Associated Significant Vegetation Type	Vegetation Unit Description	Indicative Disturbance Footprint (ha)	Indicative Temporary Clearing Area (ha)	Total (ha)
		the Hamersley Range PEC				
	C4	*Themeda* Grasslands on cracking clays TEC	*Themenda sp.*. Hamersley Station (M.E. Trudgen 11431) tussock grassland	11.0	0.0	11.0
	C5		*Eucalyptus victrix* scattered low trees over *Eriachne benthamii*, *Themenda sp.*. Hamersley Station (M.E. Trudgen 11431)) very open tussock grassland over mixed open herbland.	0.6	0.0	0.6
Mulga Vegetation	M1	Grove–intergrove Mulga Community (Vegetation of Local Significance)	*Acacia aptaneura* (*A. pruinocarpa*) low woodland over *Triodia epactia* (*T. melvillei*) very open hummock grassland over *Chrysopogon fallax* scattered tussock grasses.	14.3	3.4	17.7
	M2		*Acacia ?macraneura*, *A. aptaneura* over *Triodia epactia* scattered hummock grasses.	52.3	10.9	63.2
	M3	N/A	*Acacia aneura*/*aptaneura*, (*A ?macraneura*,) low woodland over bunch grasses.	9.1	0.0	9.1
	M4	N/A	*Acacia aptaneura*, *A ?macraneura* (*Hakea lorea* subsp. *Lorea*) low open woodland over mixed tussock grasses, bunch grasses and herbs.	5.3	0.5	5.8
Vegetation of Stony Plains and Sloping Plains	P1	N/A	*Corymbia deserticola* subsp. *Deserticola*, *C. hamersleyana*, *Eucalyptus leucophloia* subsp. *Leucophloia* low open woodland over *Triodia wiseana* open hummock grassland.	36.2	9.9	46.1
	P2	N/A	*Corymbia hamersleyana* low open woodland over mixed Acacia shrubland over *Triodia epactia* hummock grassland.	79.5	21.1	100.6
	P3	N/A	*Hakea lorea* subsp. *Lorea* low open woodland over shrubs over *Triodia epactia* very open hummock grassland with *Themeda sp.* Hamersley Station (M.E. Trudgen 11431) very open tussock grassland.	8.3	0.0	8.3
	P4	N/A	*Corymbia hamersleyana* scattered low trees over *Triodia epactia*, (*T. wiseana*) open hummock grassland and *Eulalia aurea* scattered tussock grasses.	0	0.7	0.7

Vegetation Type	Vegetation Unit	Associated Significant Vegetation Type	Vegetation Unit Description	Indicative Disturbance Footprint (ha)	Indicative Temporary Clearing Area (ha)	Total (ha)
	P5	N/A	*Eucalyptus xerothermica* low open woodland over *Acacia bivenosa* scattered shrubs over *Triodia angusta* open hummock grassland with mixed tussock grasses.	9.4	0.0	9.4
	P6	Themeda Grasslands on cracking clays TEC	*Hakea lorea* subsp. *Lorea* low open woodland over **Vachellia farnesiana* scattered shrubs over *Themeda sp.* Hamersley Station (M.E. Trudgen 11431) tussock grassland.	3.1	0.0	3.1
	P7	Vegetation Communities on Cracking Clays (Vegetation of Local Significance)[2]	*Triodia wiseana hummock* grassland with *Eriachne flaccida* scattered tussock grasses.	0.2	0.0	0.2
	P8	N/A	**Vachellia farnesiana* scattered tall shrubs over *Chrysopogon fallax* very open tussock grassland over mixed annual grassland and herbland.	10.9	0.0	10.9
Vegetation of Drainage Lines	D1	Groundwater Dependent Vegetation (Vegetation of	*Eucalyptus victrix* (*E. camaldulensis* subsp. *Refulgens*) woodland over *Melaleuca glomerata* tall open shrubland over *Triodia epactia* scattered hummock grasses over mixed tussock grasses and sedges.	16.8	0.00	16.8
	D2		*Eucalyptus camaldulensis* subsp. *Refulgens*, *Melaleuca argentea* open forest over mixed scattered tussock grasses with *Cyperus vaginatus* scattered sedges.	0.1	0.0	0.1

[2] One surveyed site within Vegetation Unit P7, included some grass species that are constituent species of the "Mitchell grass and Roebourne Plain grass (*Eragrostis xerophila*) plain on gilgai" Priority 3 PEC, as described for the Wona Land System. However, the vegetation unit was present on the Hooley Land System rather than the Wona Land System. As such, the one site from Vegetation Unit P7 may be considered to be of local conservation significance rather than presenting the PEC.

Vegetation Type	Vegetation Unit	Associated Significant Vegetation Type	Vegetation Unit Description	Indicative Disturbance Footprint (ha)	Indicative Temporary Clearing Area (ha)	Total (ha)
	D3	Local Significance)	*Eucalyptus victrix* low open woodland over **Vachellia farnesiana* scattered tall shrubs over mixed tussock grasses and bunch grasses.	3.2	0.00	3.2
Vegetation of Floodplains	F1	N/A	*Corymbia hamersleyana* low open woodland over *Acacia inaequilatera* tall open shrubland over *Triodia wiseana* (*T. epactia*) open hummock grassland with mixed tussock grasses.	119.4	43.3	162.7
	F2	N/A	*Corymbia hamersleyana* low woodland over mixed Acacia tall open shrubland over *Triodia wiseana*, (*T. epactia*) open hummock grassland.	38.8	0.0	38.8
	F3	N/A	*Corymbia hamersleyana* low open woodland over mixed Acacia open shrubland over *Triodia epactia* very open hummock grassland with *Chrysopogon fallax* very open tussock grassland.	19.9	0.0	19.9
	F4	N/A	*Acacia citrinoviridis* low woodland over *Triodia epactia* open hummock grassland and *Chrysopogon fallax* scattered tussock grasses.	3.5	0.0	3.5
	F5	N/A	*Corymbia hamersleyana* low open woodland over *Acacia bivenosa* tall shrubland over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* tussock grasses.	2.8	0.6	3.4
Other Mapping Units			Cleared/ Disturbed	11.5	0.3	11.8
			Total	557.0	100.0	657.0

Table 2-2 Extent of Direct Disturbance by Vegetation Condition

Vegetation Unit	Revised Indicative Disturbance Footprint (ha)	Temporary Clearing Area (ha)	Total
Excellent	292.0	58.7	350.7
Very Good to Excellent	68.4	15.0	83.4
Very Good	174.0	26.0	200.0
Good to Very Good	7.1	0.00	7.1
Good	4.0	0.00	4.0
Good to Poor	0.0	0.00	0.00
Poor	0.0	0.00	0.00
Completely degraded	3.3	0.2	3.5
Cleared	8.2	0.1	8.3
	557.0	100.0	657.0

2.5 Summary of Mitigation Strategies

The key flora and vegetation mitigation strategies for MRDH Stage 4 as applicable to each environmental outcome are identified in Table 2-3.

Table 2-3 Summary of key mitigation measures

MITIGATION STRATEGY	APPLICABILITY TO ENVIRONMENTAL OUTCOME-BASED CONDITIONS
• A ground disturbance permit process will be developed by the contractor and signed off by the Main Roads Superintendent. The process will include a review of the disturbance area against the approval boundary. • Areas of TEC, PEC, potential groundwater dependent vegetation and locally significant vegetation communities that are not to be cleared, will be demarcated on all relevant project maps. • Areas of TEC, PEC, potential groundwater dependent vegetation and locally significant vegetation communities within 15 m of planned clearing will be delineated onsite by flagging and signage. • All clearing areas will be checked and confirmed post-clearing. • All cleared areas will be identified, mapped, and measured bi-annually through GIS. • All clearing areas will be demarcated and approved by the Main Roads Superintendent prior to clearing commencing. • Weeds within the construction site boundary will be treated according to the weed control management outlined by Weeds Australia with the aim of controlling off-site movement. • A weed register for declared weeds, Weeds of National Significance (WONS) or environmental weed species (if identified) will be developed. The register will include, for each species, details of distribution, abundance, relevant biological information and a history of control methods and their relative success. • All personnel will be inducted prior to their commencement on site. The induction will include weed identification and weed hygiene training. • Vehicle and equipment clean on entry/exit procedures. • Any soil or materials imported onto the worksite will be from weed-free areas.	• Applicable to all sub-conditions associated with Condition B2-1(4).

MITIGATION STRATEGY	APPLICABILITY TO ENVIRONMENTAL OUTCOME-BASED CONDITIONS
• Where roadworks directly impact known areas of environmental weeds, topsoil will be removed separately, heaps delineated, and spoil disposed of as soon as possible through consultation with the Main Roads environmental management representative. • Weed contaminated topsoil stockpiles will be quarantined from uncontaminated / clean topsoil stockpiles, clearly signed in the field and identified on a site plan. • Cleared and exposed areas will be rehabilitated or otherwise stabilised as early as practicable to minimise the potential for wind erosion; • Dust emissions will be controlled through appropriate measures including hydro mulch, water application through water carts and chemical dust suppressants. This applies to the entire construction site and includes, but is not limited to haul roads, cleared areas, batters and stockpiles. • Emergency response drills will include fire response scenarios. • Fire extinguishers and/or barrier will be placed in areas of elevated fire risk. • Use of hot works permits, prior to undertaking any hot works.	
• No water abstraction within the Development Envelope within a 500 m radius of groundwater dependent vegetation. Groundwater monitoring bores will be installed, where new groundwater abstraction bores are required. Groundwater monitoring will be undertaken throughout the period of groundwater abstraction (construction phase only). Monitoring will cover: - Groundwater levels, including subsequent review against modelled potential drawdown - Water quality, including analysis of pH, conductivity, total dissolved solids, metals and Total Residual Hydrocarbons (TRHs).	• Condition B2-1(4)(c) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.
• The road alignment has been specifically selected to generally match the direction of the natural flow where Mulga communities are present, thus minimising flow disruption.	• Condition B2-1(4)(e) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.

MITIGATION STRATEGY	APPLICABILITY TO ENVIRONMENTAL OUTCOME-BASED CONDITIONS
• Road culverts will be installed in sheet flow areas to maintain flows to known areas of grove-intergrove Mulga. • The road and drainage design will be developed to maintain the existing hydrological regime of the area. This will include: - design of major surface water crossing points to ensure that flooding is not exacerbated; - maintain existing flow regimes and water balance of the site as much as possible; - preventing water shadow effects where sheet flow occurs following rains by minimising the dam effect of the road formation; and - designing to mitigate scour. • Best practice in culvert and floodway design as identified in Main Roads Specifications.	• Condition B2-1(4)(a) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6. • Condition B2-1(4)(b) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.

2.6 Key Environmental Factors

A breakdown of the relevant EPA environmental factor is provided within **Table 2-4**, along with a summary of the existing environment, activities that may affect the factor and any relevant site-specific environmental values.

Table 2-4 Overview of key environmental factor, existing environment, and related project activities.

KEY ENVIRONMENTAL FACTOR	EXISTING ENVIRONMENT	RELATED PROJECT ACTIVITIES	SITE-SPECIFIC ENVRIONMENTAL VALUES
Flora and Vegetation	Vegetation: The Development Envelope vegetation is characterised by Fortescue Botanical District (Pilbara Region) as described by Beard (1975). The Fortescue River and Valley predominantly comprises Quaternary alluvial and colluvial deposits. Sand plains areas are mostly vegetated with Acacia shrubs of various species (*Acacia ancistrocarpa*, *Acacia acradenia*, *Acacia inaequilatera* and Acacia *tumida/colei*). Major drainage lines are typically wide and support River Rums (*Eucalyptus camaldulensis*), with smaller drainage channels comprising scattered tress of *Eucalyptus camaldulensis* and/or *Eucalyptus victrix* (Coolibah). The area is also characterised by the Hamersley Ranges and plateau to the intersection with the Nanutarra – Wittenoon Road. This vegetation is characteristically *Eucalyptus leucophloia* (Snappy Gum) and *Corymbia hamersleyana*. Small trees of *Eucalyptus gamophylla* and *Corymbia deserticol*a are also present. The principal shrub species found on these areas are mostly of the Acacia genus, including *Acacia inaequilatera*, *Acacia dictyophleba*, *Acacia monticola*, *Acacia tumida/colei*, *Acacia ancistrocarpa*, *Acacia pachyacra/tenuissima*, *Acacia adoxa*, *Acacia synchronicia* and *Acacia acradenia*. Most of the valley plains support Mulga (*Acacia aneura*) low woodland usually associated with *Acacia pruinocarpa*. Some other small tree and shrub species in this region are *Acacia xiphophylla* (in localised small patches only), *Acacia tetragonophylla*, *Psydrax latifolia*, *Eremophila fraseri, E. latrobei, E. longifolia and Grevillea stenobotrya*. The major and minor drainage lines are vegetated with principally the same species: *Corymbia hamersleyana*, *Eucalyptus camaldulensis* and *E. victrix,* over the shrub species *Gossypium robinsonii*, *G. australe*, *Acacia farnesiana*, and the grass species *Cymbopogon ambiguus and Cenchrus ciliaris* (an introduced pasture grass). Pre-European Vegetation is represented by nine vegetation types, with the dominant vegetation type comprising hummock grasslands (Hamersley 565 and Chichester Plateau 607). These represent 37% and 18% of the Development Envelope. There are 27 vegetation types within the Development Envelope, grouped into seven vegetation types based on species composition, and landscape preference, mostly with vegetation conditions ranging from Excellent to Completely Degraded. One ecological community is listed as a TEC: The '*Themeda* Grasslands on cracking clays (Hamersley station, Pilbara), with vegetation units C4, C5 and P6, representing this TEC (vegetation condition of Good to Very Good) (Figure 3) One PEC occurs within the Development Envelope: 'Brockman Iron cracking clay communities of the Hamersley range (Priority 1) (Figure 4). Two vegetation communities of local significance are also present: • Vegetation Communities on Cracking Clays (Vegetation unit C2 and an area of P7) • Grove-intergrove Mulga community (Vegetation type M1 and M2). Three groundwater dependent vegetation types occur in and surrounding the Development Envelope. These largely comprise Eucalyptus and Melaleuca woodland/forest over tussock and bunch grasses and sedges, that are restricted to the major drainage lines (ie. Fortescue River, Weelumurra Creek and tributaries, and Barnett Creek). Flora: • 590 species native vascular flora from 190 genera and 56 families were recorded within the Development Envelope. • 66 Priority flora species listed by DBCA have previously been recorded in the Development Envelope with 3 'Likely to Occur' and 40 'May Occur'. Biota (2021) recorded 20 priority flora species listed by DBCA in the Development Envelope (Figure 5).	Vegetation clearing for construction of the road and ongoing maintenance activities; clearing for associated construction activities such as site offices, laydown, side-tracks and so on; construction dewatering for the Fortescue River crossing and potentially other watercourse crossings; abstraction of water for construction purposes; disruption of surface water flow; construction of roadside drainage; and movement of construction vehicles and machinery around the site, as well as into and out of the site.	Native vegetation in Good to Excellent condition, priority flora, TEC, PEC, vegetation of local significance and groundwater dependent vegetation.

KEY ENVIRONMENTAL FACTOR	EXISTING ENVIRONMENT	RELATED PROJECT ACTIVITIES	SITE-SPECIFIC ENVRIONMENTAL VALUES
	• 15 introduced flora species was recorded by Biota (2021), however none are listed as WONS or declared pests for the Pilbara region. Buffel Grass, Birdwood Grass, Mimosa Bush and Ruby Dock are considered serious environmental weeds in WA.		

2.7 Condition Requirements

The Flora and Vegetation Management Plan (FVMP) has been developed to satisfy the following conditions within Ministerial Statement No. 1205 (Assessment No. 2273) (03 July 2023), as detailed within Table 2-5.

Table 2-5 Ministerial conditions related to the Flora and Vegetation Management Plan

REFERENCE	CONDITION	CONDITION REQUIREMENT	SECTION REFERENCE	HOW THE FVMP ADDRESSES THE CONDITION REQUIREMENTS
Ministerial Statement No. 1205.	B2-1(3)	The proponent must ensure that the implementation of stage 4 of the proposal achieves the following environmental outcomes: Disturb no more than the following environmental values, as recorded in the baseline biological survey: a) 15 ha of the 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5 and P6; b) 12 ha of the 'Brockman Iron cracking clay communities of the Hamersley Range' priority ecological community, represented by vegetation type C3; c) 20.1 ha of potential groundwater dependent vegetation, represented by vegetation types D1, D2 and D3; d) 13.2 ha of the vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2; e) 80.9 ha of the grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2; and	Section 3 – EMP components	Section 3 details mitigation and monitoring measures to prevent unauthorised clearing impacts to PECs, TECs, groundwater dependent vegetation and significant vegetation communities. This includes the demarcation of clearing extents on design drawings and pegging onsite, site inspections prior to and following clearing, and the review of clearing records and satellite imagery, to monitor clearing against the permitted extents.

REFERENCE	CONDITION	CONDITION REQUIREMENT	SECTION REFERENCE	HOW THE FVMP ADDRESSES THE CONDITION REQUIREMENTS
		f) 0.2 ha of the cracking clays community represented by vegetation type P7.		
	B2-1(4)	The proponent must ensure that the implementation of stage 4 of the proposal achieves the following environmental outcomes: No adverse impacts, beyond the extents identified in condition B2-1(3), to the following environmental values as recorded in the baseline biological survey: a) 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5 and P6; b) 'Brockman Iron cracking clay communities of the Hamersley Range' priority ecological community, represented by vegetation type C3; c) potential groundwater dependent vegetation represented by vegetation types D1, D2 and D3; d) vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2; e) grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2; and f) cracking clays community represented by vegetation type P7.	Section 3 – EMP components	Section 3 details mitigation and monitoring measures to ensure no adverse impacts (beyond permitted clearing areas) to PECs, TECs, groundwater dependent vegetation and significant vegetation communities. This includes the completion of ongoing flora and vegetation monitoring through the establishment of quadrats and photo monitoring points, during the construction and operation phase.
	B2-2	The proponent must prepare an environmental management plan, that satisfies the requirements of condition C4 and demonstrates how achievement of the flora and vegetation environmental outcomes in condition	The FVPM (this document) was prepared to meet the condition criteria B2-2. More information regarding management actions and monitoring/reporting can be found within Section 3.	

REFERENCE	CONDITION	CONDITION REQUIREMENT	SECTION REFERENCE	HOW THE FVMP ADDRESSES THE CONDITION REQUIREMENTS
		B2-1(4), will be monitored and substantiated, and submit it to the CEO, on advice of the DBCA.		
	C4-1	The environmental management plan(s) required under condition B2-2 and condition B4-2, and the environmental management plans required under condition B3-10, condition B5-3 and condition B5-4 must contain provisions which enable the substantiation of whether the relevant outcomes of those conditions are met, and must include:	See further detail below.	
	C4-1(1)	Threshold criteria that provide a limit beyond which the environmental outcomes are not achieved;	Section 3 – EMP components	Corrective action threshold levels are provided for relevant management measures within Table 3-1.
	C4-1(2)	Trigger criteria that will provide an early warning that the environmental outcomes are not likely to be met;	Section 3 – EMP components	Corrective action trigger levels are provided for management measures within Table 3-1.
	C4-1(3)	Monitoring parameters, sites, control/reference sites, methodology, timing and frequencies which will be used to measure threshold criteria and trigger criteria. Include methodology for determining alternate monitoring sites as a contingency if proposed sites are not suitable in the future;	Section 3 – EMP components	Monitoring parameters, including methodology, and frequency are described within Section 4.
	C4-1(4)	Baseline data;	Section 2.8.2 –Survey and Study Findings	Baseline existing environmental information and data for flora and vegetation, is detailed within Table 2-4.
	C4-1(5)	Data collection and analysis methodologies;	Section 3 – EMP components	Monitoring parameters, including data collection and analysis are described within Section 4).
	C4-1(6)	Adaptive management methodology;	Section 6 – Adaptive management and review of the EMP	The FVMP adopts an ‘adaptive management’ approach which seeks to embed a cycle of monitoring, reporting, and implementing change, where required.

REFERENCE	CONDITION	CONDITION REQUIREMENT	SECTION REFERENCE	HOW THE FVMP ADDRESSES THE CONDITION REQUIREMENTS
	C4-1(7)	Contingency measures which will be implemented if threshold criteria or trigger criteria are not met; and	Section 3 –EMP components	Actions in the event of a corrective action trigger being exceeded, are detailed within Section 3.
	C4-1(8)	Reporting requirements.	Section 3 –EMP components Section 7 - Reporting	Applicable reporting aspects are detailed within Section 3 and Table 7-1.
	C4-2	Without limiting condition C3-1, failure to achieve an environmental outcome, or the exceedance of a threshold criteria, regardless of whether threshold contingency measures have been or are being implemented, represents a non-compliance with these conditions.	Section 3 –EMP components Section 7 - Reporting	Contingency actions are included with Section 3. Reporting requirements relating to non-compliances are detailed in Table 7-1.

2.8 Rationale and Approach

This section provides a summary of the rationale and approach to developing the mitigation and management strategies including:

- management objectives and environmental outcomes;
- survey and study findings;
- key assumptions and uncertainties; and
- rationale for choice of indicators and/or management actions.

2.8.1 Environmental Outcomes

This FVMP has been prepared with the objective that potential impacts of MRDH Stage 4 are acceptable, minimised and managed.

The following environmental outcomes have been identified in relation to flora and vegetation and reflect the desired outcomes as listed within Condition B2-1(4) of Ministerial Statement No. 1205 (Assessment No. 2273):

1. No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6.
2. No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.
3. No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.
4. No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2.
5. No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.
6. No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.

2.8.2 Survey and Study Findings

Biota (2021) conducted a detailed and targeted flora survey in accordance with the EPA technical guidance for flora surveys (EPA, 2016b) and the EPA Environmental Factor guidelines for Flora and Vegetation (EPA, 2016a). This study and its key findings are briefly discussed within Table 2-6.

Table 2-6 Overview of flora and vegetation related surveys and studies undertaken within the Project Development area

Reference	Survey/Study Type and Location	Key Findings
Manuwarra Red Dog Highway Stage 4 Biological Survey (Biota 2021a)	Detailed and targeted flora and vegetation survey. Basic and targeted fauna survey. (Including coverage of groundwater dependent vegetation communities) Location: Development Envelope. Fauna survey also extended into adjacent habitats, to inform the use or potential use of habitats within the survey area.	• A total of 590 vascular flora species, from 190 genera and 56 families were recorded. • 20 Priority flora species, as listed by the Department of Biodiversity, Conservation and Attractions (DBCA), was recorded in the Development Envelope. • A total of 27 vegetation units were recorded, the following vegetation types associated with surface water and groundwater: - Vegetation of cracking clays - Mulga vegetation - Vegetation of drainage lines - Vegetation of floodplains • Vegetation condition ranged from excellent to completed degraded. • 15 weed species were recorded within the development footprint. Dense weed infestations were present along drainage lines and within floodplains. • One state-listed threatened ecological community was recorded within the southern end of the Development Envelope – *Themeda* grasslands on cracking clays. • One priority ecological community was recorded within the Development Envelope – Brockman Iron cracking clay communities of the Hammersley Range. • Two vegetation communities of local significance were recorded – vegetation communities on cracking clays, and the grove-intergrove mulga community.

2.8.3 Key Assumptions and Uncertainties

Predicted impacts on key environmental factors have been determined based upon the information obtained from site specific surveys and investigations. This information has been obtained from the Environmental Review Document prepared for the Revised Proposal (Main Roads, 2022).

Main Roads are ultimately responsible for the successful construction and operation of the MRDH Stage 4, to achieve the environmental outcomes outlined within this FVMP. However, there are actions that will be implemented by third parties where relevant (eg. the appointed construction contractor will implement the majority of actions within this FVMP).

2.8.4 Risk Based Approach

A risk-based approach has been used in identifying suitable trigger and threshold criteria within this FVMP, as well as key environmental flora and vegetation elements as detailed within Ministerial Statement No. 1205 (Assessment No. 2273). The risk assessment used within the initial Environmental Referral Document has been used for this purpose. This involves an analysis of potential likelihood and consequence criteria, which were then fed into a risk matrix.

Where proposed construction and operational activities have an elevated likelihood of resulting in a significant adverse environmental impact (ie. potentially severe or irreversible), additional management measures have been assigned to the related environmental outcome that they relate to.

2.8.5 Rationale for Choice of Indicators and/or Management Actions

Main Roads has a long track record of successful implementation of road construction activities in WA. The measures and actions detailed in this plan draw upon that experience and utilise industry-recognised techniques for mitigating environmental impacts and risks.

Trigger and threshold criteria and management actions have been selected which can adequately mitigate the key flora and vegetation related risks during construction and operation of MRDH Stage 4. Where applicable, trigger criteria has been based on the identification of a detectable change and threshold criteria have been based on the whether a statistically significant difference between paired impact and reference sites has been detected by ongoing monitoring.

With reference to the WA EPA's Instructions on Preparing Environmental Management Plans (EPA, 2022), the measures detailed in this EMP have been prepared to detail how the noted environmental outcomes will be achieved. Each outcome notes the state of the environment to be achieved after implementation of MRDH Stage 4 has occurred.

3 EMP COMPONENTS

To comply with relevant environmental legislation and manage impacts to the local environment, Main Roads has defined how the flora and vegetation environmental outcomes will be achieved during the implementation of MRDH Stage 4 (Table 3-1).

Table 3-1 Measures to address the flora and vegetation environmental outcomes

WA EPA Factor: Flora and Vegetation. WA EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained. Outcomes: No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6. No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3. No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3. No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2. No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2. No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7. Key Environmental Values: Native vegetation including the presence of significant vegetation and flora. Key Impacts and Risks: Vegetation and flora loss and degradation through direct and indirect impacts.					
RELATED MANAGEMENT MEASURE	TRIGGER CRITERIA / THRESHOLD CRITERIA	TRIGGER LEVEL ACTIONS / THRESHOLD CONTINGENCY ACTIONS	MONITORING	TIMING/FREQUENCY OF MONITORING	REPORTING
Measures and criteria applicable to all conditions • Condition B2-1(4)(a) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6. • Condition B2-1(4)(b) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3. • Condition B2-1(4)(c) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation (represented by vegetation type D1, D2 and D3). • Condition B2-1(4)(d) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2. • Condition B2-1(4)(e) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, (represented by vegetation types M1 and M2). • Condition B2-1(4)(f) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.					
• A ground disturbance permit process will be developed by the contractor and signed off by the Main Roads Superintendent. The process will include a review of the disturbance area against the approval boundary. • Areas of TEC, PEC, potential groundwater dependent vegetation and locally significant vegetation communities that are not to be cleared, will be demarcated on all relevant project maps. • Areas of TEC, PEC, potential groundwater dependent vegetation and locally significant vegetation communities within 15 m of planned clearing will be delineated onsite by flagging and signage. • All clearing areas will be checked and confirmed post-clearing. • All cleared areas will be identified, mapped, and measured bi-annually through Geographic Information Systems (GIS). • All clearing areas will be demarcated and approved by the Main Roads Superintendent prior to clearing commencing.	Trigger Criterion: • 90% of permitted clearing extent for any specified vegetation type is reached. Threshold Criterion: • Permitted clearing extent (ie. within Condition B2-1(3)) for any specified vegetation type is exceeded.	Trigger level actions: • Undertake review of remaining required clearing to ensure compliance with permitted clearing extents will be achieved. • Communicate extents of clearing (in hectares) for each vegetation type to key personnel (ie. Construction Contractor Site Superintendents, Construction Contractor Environmental Manager, Main Roads Superintendent), noting percentage cleared to date. Threshold contingency actions: • Clearing will cease immediately. • Environmental incident will be recorded, and the cause investigated. • DWER will be notified along with investigation report during annual	• Review of clearing records and GIS satellite/aerial imagery to monitor clearing rates against permitted limits.	• Review of clearing records and GIS imagery to be undertaken bi-annually throughout construction phase.	• Bi-annual clearing audit report (Internal). • Annual DWER compliance report (External).

WA EPA Factor: Flora and Vegetation.

WA EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Outcomes: No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.

Key Environmental Values: Native vegetation including the presence of significant vegetation and flora.

Key Impacts and Risks: Vegetation and flora loss and degradation through direct and indirect impacts.

RELATED MANAGEMENT MEASURE	TRIGGER CRITERIA / THRESHOLD CRITERIA	TRIGGER LEVEL ACTIONS / THRESHOLD CONTINGENCY ACTIONS	MONITORING	TIMING/FREQUENCY OF MONITORING	REPORTING
		compliance reporting if threshold is met and exceeded. • If the investigation shows that the damage to the environmental values is significant, DWER will be notified within five business days. • Within 20 business days of such incidents, DWER will be provided with an investigation report and corrective actions to remediate. • Rehabilitation of any clearing exceedance areas will be undertaken, with any rehabilitation completed in accordance with Main Roads Revegetation Planning and Techniques Guideline.			
• Weeds within the construction site boundary will be treated with the aim of controlling off-site movement. A weed register for declared weeds, WONS, or environmental weed species (if identified) will be developed. The register will include, for each species, details of distribution, abundance, relevant biological information and a history of control methods and their relative success. • All personnel will be inducted prior to their commencement on site. The induction will include weed identification and weed hygiene training. • Vehicle and equipment clean on entry/exit procedures. • Any soil or materials imported onto the worksite will be from weed-free areas. • Where roadworks directly impact known areas of environmental weeds, topsoil will be removed separately,	Trigger Criterion: • Introduction of new environmental weeds to the Themeda Grassland TEC and Brockman Iron PEC areas and vicinities. Monitoring of flora and vegetation detects[3] a change (attributable to the project activities) in vegetation condition (for any noted vegetation unit) within the Development Envelope caused by indirect impacts (ie. weed infestation, edge effects, dust and changes to hydrological processes). Threshold Criterion:	Trigger level actions: • Investigate potential causes, such as changes to hydrological processes, edge effects, dust or weed incursion. • Implement remedial actions. This may include reducing groundwater abstraction rates (L/min), if affected vegetation unit is groundwater dependent vegetation within 500m of an existing utilised Rio Tinto bore, additional weed control, or additional surface water flow mitigation.	• Flora and vegetation monitoring would be undertaken within uncleared areas of the Development Envelope for each vegetation unit and compared against baseline reference sites outside of the Development Envelope (ie. outside the zone of potential indirect impacts). • Establishment of quadrats and photo monitoring points for	• Vegetation condition monitoring to be completed on an annual basis, following a rainfall event (i.e. greater than 50mm), throughout the Project construction phase and five years post construction.	• Annual vegetation monitoring report (Internal). • Annual DWER compliance report (External).

[3] As per MS 1205, a detectable change is the smallest statistically discernible effect size that can be achieved with a monitoring strategy designed to achieve a statistical power of at least 0.8.

WA EPA Factor: Flora and Vegetation.
WA EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Outcomes: No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6.
No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.
No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.
No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2.
No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.
No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.
Key Environmental Values: Native vegetation including the presence of significant vegetation and flora.
Key Impacts and Risks: Vegetation and flora loss and degradation through direct and indirect impacts.

RELATED MANAGEMENT MEASURE	TRIGGER CRITERIA / THRESHOLD CRITERIA	TRIGGER LEVEL ACTIONS / THRESHOLD CONTINGENCY ACTIONS	MONITORING	TIMING/FREQUENCY OF MONITORING	REPORTING
heaps delineated, and spoil disposed of as soon as possible through consultation with the Main Roads environmental management representative. • Weed contaminated topsoil stockpiles will be quarantined from uncontaminated / clean topsoil stockpiles, clearly signed in the field and identified on a site plan. • Cleared and exposed areas will be rehabilitated or otherwise stabilised as early as practicable to minimise the potential for wind erosion. • Dust emissions will be controlled through appropriate measures including hydro mulch, water application through water carts and chemical dust suppressants. This applies to the entire construction site and includes, but is not limited to haul roads, cleared areas, batters and stockpiles. • Fire extinguishers and/or barrier will be placed in areas of elevated fire risk. • Use of hot works permits, prior to undertaking any hot works. • Where monitoring identifies evidence of physical disturbance (i.e., rubbish dumping, fire, access tracks, grazing) or evidence of erosion or flooding attributable to the project activities: - Actions will be taken to remediate the impacted areas (e.g. remove and dispose of rubbish, revegetate affected areas) - Actions will be taken to prevent further occurrences (e.g. installation of temporary signage, temporary fencing, review of procedures, staff education).	• Monitoring of flora and vegetation identifies an adverse impact[4] (attributable to the project activities) in vegetation condition (for each noted vegetation unit) within the Development Envelope caused by indirect impacts (ie. weed infestation, edge effects, dust and changes to hydrological processes), when compared to baseline reference sites.	Threshold contingency actions: • Investigate potential causes, such as changes to hydrological processes, edge effects, dust or weed incursion. • Implement remedial actions once the likely cause is identified. This may include: - Ceasing abstraction of groundwater. - Undertake additional dust mitigation onsite, such as use of water trucks and/or dust surfactants. - Undertake additional revegetation of impacted areas - Undertake additional weed control, including hand removal (small areas) and/or chemical control through foliar spraying (WeedsAustralia, 2021). - Drainage design will be reviewed and revised to incorporate additional surface water flow mitigation (e.g., culverts installation).	evaluating vegetation condition of each vegetation monitoring site. • Monitoring quadrats of 400 m^2 each (ie. 20m x 20m) will be used, recording the following data parameters: - Vegetation composition - Plant density (plants/m^2) - Plant/weed foliage cover (%) - Vegetation condition - Visual observation of plant health of indicator species - Evidence of physical disturbance (i.e., rubbish dumping, fire, access tracks, grazing) - Evidence of erosion or flooding • A photograph will also be taken at each quadrat and compared to subsequent or		

[4] As per MS 1205, an adverse impact is a negative change that is neither trivial nor negligible that could result in a reduction in health, diversity, or abundance of the receptors being impacted or a reduction in environmental value (defined as a beneficial use or ecosystem health condition). For the purpose of this plan, an adverse impact is defined as a statistically significant difference in foliage cover, plant condition and/or plant density between paired impact and reference sites.

WA EPA Factor: Flora and Vegetation.

WA EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Outcomes: No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.

Key Environmental Values: Native vegetation including the presence of significant vegetation and flora.

Key Impacts and Risks: Vegetation and flora loss and degradation through direct and indirect impacts.

RELATED MANAGEMENT MEASURE	TRIGGER CRITERIA / THRESHOLD CRITERIA	TRIGGER LEVEL ACTIONS / THRESHOLD CONTINGENCY ACTIONS	MONITORING	TIMING/FREQUENCY OF MONITORING	REPORTING
			previous photographs. These will utilise the fixed corner points of the monitoring quadrats. • Statistical analysis using Welch's and ANOVA testing will also be completed to assess the significance of quantitative results over each monitoring event (ie. when reviewing plant/weed cover and foliage cover).		
Measures and criteria applicable to specific conditions					
Condition B2-1(4)(c) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.					
No water abstraction within the Development Envelope within a 500 m radius of groundwater dependent vegetation.	Trigger Criterion: • Drawings do not show 500 m radius buffer, from groundwater abstraction point to identified groundwater dependent vegetation. Threshold Criterion: • Groundwater abstraction occurs within the Development Envelope within a 500 m radius of groundwater dependent vegetation.	Trigger level actions: • Groundwater abstraction not to commence until drawings are reviewed and revised to show required buffer zone. Threshold contingency actions: • Abstraction of groundwater to cease at all bores within 500m of groundwater dependent vegetation. • Environmental incident will be recorded, and the cause investigated.	• Review of drawings which show buffer zone. • Visual inspection during site inspection.	• Review of drawings completed prior to installation of any new groundwater abstraction bores. • Site inspections to be completed on fortnightly basis, during construction.	• Record of drawings which show buffer zone (Internal). • Site inspection reports, provided on fortnightly basis (Internal).

WA EPA Factor: Flora and Vegetation.

WA EPA Objective: To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

Outcomes: No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to potential groundwater dependent vegetation represented by vegetation type D1, D2 and D3.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to vegetation on cracking clays locally significant vegetation community, represented by vegetation type C2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2.

No adverse impacts, beyond the extents identified in Condition B2-1(3), to cracking clays community represented by vegetation type P7.

Key Environmental Values: Native vegetation including the presence of significant vegetation and flora.

Key Impacts and Risks: Vegetation and flora loss and degradation through direct and indirect impacts.

RELATED MANAGEMENT MEASURE	TRIGGER CRITERIA / THRESHOLD CRITERIA	TRIGGER LEVEL ACTIONS / THRESHOLD CONTINGENCY ACTIONS	MONITORING	TIMING/FREQUENCY OF MONITORING	REPORTING
Condition B2-1(4)(e) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to grove-intergrove mulga locally significant vegetation community, represented by vegetation types M1 and M2. Condition B2-1(4)(a) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Themeda grasslands on cracking clays (Hamersley Station, Pilbara)' threatened ecological community, represented by vegetation types C4, C5, and P6. Condition B2-1(4)(b) – No adverse impacts, beyond the extents identified in Condition B2-1(3), to 'Brockman Iron cracking clay communities of the Hamersley, represented by vegetation type C3.					
• The road and drainage design will be developed to maintain the existing hydrological regime of the area. This will include: - design of major surface water crossing points to ensure that flooding is not exacerbated. - maintain existing flow regimes and water balance of the site as much as possible. - preventing water shadow effects where sheet flow occurs following rains by minimising the dam effect of the road formation. - designing to mitigate scour. - using the baseline modelling of surface water flows as a point of reference for drainage design. • Best practice in culvert and floodway design as identified in Main Roads specifications will be implemented. • Road alignment to be designed to generally match the direction of the natural flow where Mulga communities, Themeda Grassland TEC and the Brockman Iron PEC are present, thus minimising flow disruption. • Culverts will be installed in sheet flow areas to maintain adequate flows to mulga vegetation (surface water dependent) and Themeda Grasslands TEC and Brockman Iron PEC (sensitive to altered surface water flows) avoiding adverse impact.	Trigger Criterion: No trigger criterion identified due to nature of monitoring. Threshold Criterion: • Road design does not include measures to maintain natural sheet flow.	Trigger level actions: Not applicable Threshold contingency actions: • Road and drainage design will be reviewed and revised to incorporate additional surface water flow mitigation (for example culvert design, road alignment) • Road formation earthworks not to commence until design drawings have been updated to incorporate additional surface wate flow mitigation.	• Pre-construction review of road formation design.	• Pre-construction	• Design review (internal)

4 VEGETATION MONITORING AND INSPECTION

Ongoing monitoring of vegetation will be undertaken across MRDH Stage 4 to measure vegetation condition against the trigger and threshold criteria. Monitoring is intended to identify if any change in vegetation condition has occurred and whether that change is due to the construction activities or external factors.

4.1 Monitoring Sites

Monitoring 'impact' and 'reference' sites will be established within the Development Envelope. Impact sites will be located within 50 m of the disturbance footprint. Each reference site will be located at sufficient distance from the 'impact' monitoring sites, to avoid the influence of any potential MRDH Stage 4 impacts (ie. Dust, weeds ect).

Monitoring of impact sites will occur in locations where vegetation types C2, C3, C4, C5, D1, D2, D3, M1, M2, P6 and P7 occur along the disturbance footprint. The location along the route of each of the monitoring locations depends on the vegetation types present. Final locations of the monitoring sites will be determined prior to the construction of each stage of the road. The monitoring sites will be established in areas where there is the potential for impacts to occur. The establishment of monitoring sites will be undertaken in stages in conjunction with the phases of the road construction. Indicative monitoring locations are provided in Figure 4.

4.2 Monitoring Methodology

Vegetation monitoring sites will be established and marked by recording locations with a GPS unit. Each impact and reference sites will consist of one 400 m^2 (ie. 20 m x 20 m) quadrat. The number of quadrats used at each location will be determined by the ecology contractor during establishment of the monitoring sites. A sufficient number of quadrats will be established to ensure the monitoring program has sufficient statistical power to detect changes.

The following parameters will be monitored within each quadrat

- Vegetation composition – all species identified, count of total stems (where possible)
- Plant density (plants/m2)
- Plant/weed foliage cover (%)
- Vegetation condition – as per Trudgen (1988)
- Visual observation of plant health of indicator species
- Evidence of physical disturbance attributable to the project activities (i.e., rubbish dumping, fire, unauthorised access tracks)
- Evidence of erosion or flooding

Photo monitoring points will also be established to enable comparison with previous or subsequent monitoring events. These will utilise fixed corner points of monitoring quadrats (ie. Photos taken from the southwest corner to the northeast cover of each quadrat). All monitoring will be recorded using field monitoring sheets. Statistical analysis to assess the significance of quantitative results across the different monitoring events will be undertaken, using Welch's and ANOVA testing protocols. This significance testing analysis will be used to identify if any of the

monitoring parameters result in significant changes over time, between the 'impact' sites and reference sites. This will be used to determine if any changes observed at the impacts sites (when compared to the reference sites) are attributable to the project activities.

4.3 Monitoring Timing

The monitoring of vegetation will be undertaken on an annual basis, approximately 6-8 weeks following a significant rainfall event (i.e. greater than 50mm), throughout the construction period and five years post construction or until the environmental outcomes identified in this plan have been met.

The exception to the above is during construction activities within 1 km of the TEC and PEC in the southern section, where monitoring will occur semi-annually.

4.4 Vegetation Inspections

The site inspections will be undertaken prior to and following clearing, during construction phase and scheduled to occur on a fortnightly basis. The environmental personnel will inspect parameters such as visual evidence of erosion, increase of dust, rubbish, grazing, unauthorised access track, grazing, fire, weeds, flooding and drying to identify compliance with this FVMP.

5 DETERMINING THE EXTENT OF CLEARING

On a bi-annual basis a spatial assessment will be undertaken to confirm the extent of vegetation that was cleared. A spatial analysis will be used to compare the state of each vegetation type with the 'baseline' state which existed prior to the clearing activities occurring. The spatial assessment will be ground truthed by the digital ground survey data that will be collected after completion of vegetation clearing via a digital ground survey in accordance with Main Roads Digital Ground Survey Standard 67-08-43 to capture the As Constructed Vegetation Clearing Area data.

6 ADAPTIVE MANAGEMENT AND REVIEW OF THE EMP

This FVMP adopts an 'adaptive management' approach which seeks to embed a cycle of monitoring, reporting, and implementing change, where required. Accordingly, it is intended that this FVMP may be updated (as required) over the life of MRHD Stage 4 to reflect changes in the monitoring and management practices, subject to the results of the monitoring to identify that the environmental outcomes are being achieved. The FVMP may also be revised to address learnings from the implementation of corrective actions, should this occur.

In addition, auditing and review schedules are necessary to embed a formal process to identify and consider any need to update the FVMP in order to achieve improved environmental performance (which may not otherwise be triggered by management or monitoring outcomes).

6.1 Environmental Auditing

This FVMP will be audited annually by Main Roads during construction to ensure the implementation of the management and monitoring measures, and to confirm the management measures specified are achieving the environmental outcomes.

The proposed auditing schedule for this FVMP is identified in Table 6-1.

Table 6-1 Environmental audit schedule

TIMING	ACTION	SCHEDULE
Pre-construction	Review of construction procedures to ensure FVMP management / monitoring actions are incorporated within works procedures	Prior to construction (single event)
Construction	Inspections by site environmental personnel to identify compliance with FVMP	Periodic (Fortnightly)
	Independent 'third-party' audit for assessment of compliance with FVMP	Annually (once per calendar year)
Post construction	Independent 'third-party' audit for assessment of compliance with FVMP	Yearly until rehabilitated area successfully established

6.2 Management Review Program

Main Roads proposes to review this FVMP annually in order to consider:

- management and monitoring actions;
- opportunities for improvement in environmental performance (for example, changes to construction methodology or timing);
- identify a need to update this FVMP to capture changes to the management and/or monitoring actions; and
- identify any general need to update this FVMP.

Main Roads acknowledge that a revision to this FVMP may trigger a need for additional approval by DWER prior to implementing major changes to the specified management or monitoring actions.

The proposed FVMP review schedule is identified in Table 6-2. The proposed reviews will be undertaken by a suitably qualified ecologist or relevant specialist.

Table 6-2 FVMP Review schedule

TIMING	ACTION	SCHEDULE
Pre-construction Construction	• Review of FVMP management and monitoring actions. • Review of opportunities for an improvement in environmental performance. • Address learnings from corrective actions. • Revise FVMP (if appropriate) and seek approval of DWER for revised FVMP.	Annually (once per calendar year).

7 REPORTING

Main Roads will report to DWER on the implementation of this FVMP as part of annual compliance reporting under the conditions of approval.

Where compliance audits undertaken by Main Roads identify that the environmental management actions and/or the environmental objectives are not being achieved (i.e. non-compliance or an environmental incident), Main Roads will notify DWER as soon as reasonably practicable. Consistent with standard document control procedures, Main Roads will maintain copies of all reports submitted to DWER. The reporting requirements for this FVMP are identified in Table 7-1.

Table 7-1 Reporting Requirements

Aspect	Report from	Report to	Reporting frequency
Non-compliance Reporting	Manager Environment	CEO*	Within seven (7) days after aware of the potential non-compliance.
Compliance reporting	Manager Environment	CEO*	Annually. The first report within fifteen (15) months of the date of commencement of Ministerial Statement No. 677 (Assessment No. 2273).
Compliance Assessment Plan	Manager Environment	CEO*	At least six (6) months prior to the first Compliance Assessment Report.

*CEO: The Chief Executive Officer of the Department of the Public Service of the State.

In the event of a threshold criteria being exceeded, Main Roads will implement the corrective actions outlined within Table 3-1 within seven business days. An environmental incident investigation will then be completed to determine the root cause, contributing factors and the extent of any impacts to vegetation or flora species. A finalised copy of the incident would then be provided to DWER.

The format and content of reporting of a non-compliance event or an environmental incident will be subject to the nature of the non-compliance/incident and will include all requested information from DWER. In consideration of this, specific templates for reporting these are not provided as part of this FVMP.

The format and content of annual reporting will be in accordance with the requirements of the annual reporting conditions.

8 COMPLETION CRITERIA

To determine if the Proposal has met the environmental outcomes identified in condition B2-1, the following subsequent hierarchy of assessment will be undertaken at the end of the monitoring period (five years post construction):

- A comparison of results against the relevant triggers outlined in this FVMP will be conducted to identify any potential exceedance. Where there are no exceedances of trigger criterion, it will be deemed to meet the environmental objectives.
- Where exceedances to the triggers were noted, comparison will be made against data from the reference sites. Where exceedances are comparable to reference site, it will be deemed to meet the environmental objectives.
- Where there are exceedances of the triggers that are not comparable with the reference site, statistical analysis will be used to determine if there is a significant difference between

the ‘impact’ and reference sites. If there is no statistical difference between the ‘impact’ and reference sites, it will be considered that the environmental objectives have been met.

- If there is a statistical difference between ‘impact’ and reference sites, further analysis is to be undertaken to determine if any changes over time are significant and/or project attributable.

9 STAKEHOLDER CONSULTATION

Stakeholder consultation was undertaken throughout the environmental assessment of MRDH Stage 4, including with State and Commonwealth government departments, local government, Aboriginal groups landowners and committees and reference groups. An overview of the main stakeholder consultation, including type date and outcome is provided within the Environmental Review Document.

10 REFERENCES

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11 GLOSSARY OF TERMS

Term/Abbreviation/Acronym	Definition
Adverse Impact	A negative change that is neither trivial nor negligible that could result in a reduction in health, diversity, or abundance of the receptors being impacted or a reduction in environmental value. For the purpose of this plan, an adverse impact is defined as a statistically significant difference in foliage cover, plant condition and/or plant density between paired impact and reference sites.
DBCA	Department of Biodiversity, Conservation and Attractions
Development Envelope	The maximum area within which the footprint for Stage 4 of the Revised Proposal will be located
Detectable	The smallest statistically discernible effect size that can be achieved with a monitoring strategy designed to achieve a statistical power of at least 0.8.
DWER	Department of Water and Environmental Regulation
Environmental Value	A beneficial use or ecosystem health condition
FVMP	Flora and Vegetation management plan
GIS	Geographic Information System
ha	Hectares
Indicative disturbance footprint	The indicative location where ground disturbance for the physical elements of Stage 4 of the Revised Proposal will occur. The extent of this footprint is used to determine impacts. The spatial location of this footprint may vary as the design is refined.
m BGL	Metres Below Ground Level
Main Roads	Main Roads Western Australia
MRDH	Manuwarra Red Dog Highway
MSE	Mechanically Stabilised Earth
N/A	Not applicable
PEC	Priority Ecological Communities
Environmental Weeds	Any plant declared under section 22(2) of the *Biosecurity and Agriculture Management Act 2007*, any plant listed on the Weeds of National Significance List and any weeds listed on the Department of Biodiversity, Conservation and Attractions' Pilbara Impact and Invasiveness Ratings list, as amended or replaced from time to time.
TEC	Threatened Ecological Communities
TRH	Total Residual Hydrocarbons
WA	Western Australia
WONS	Weed of National Significance

12 FIGURES

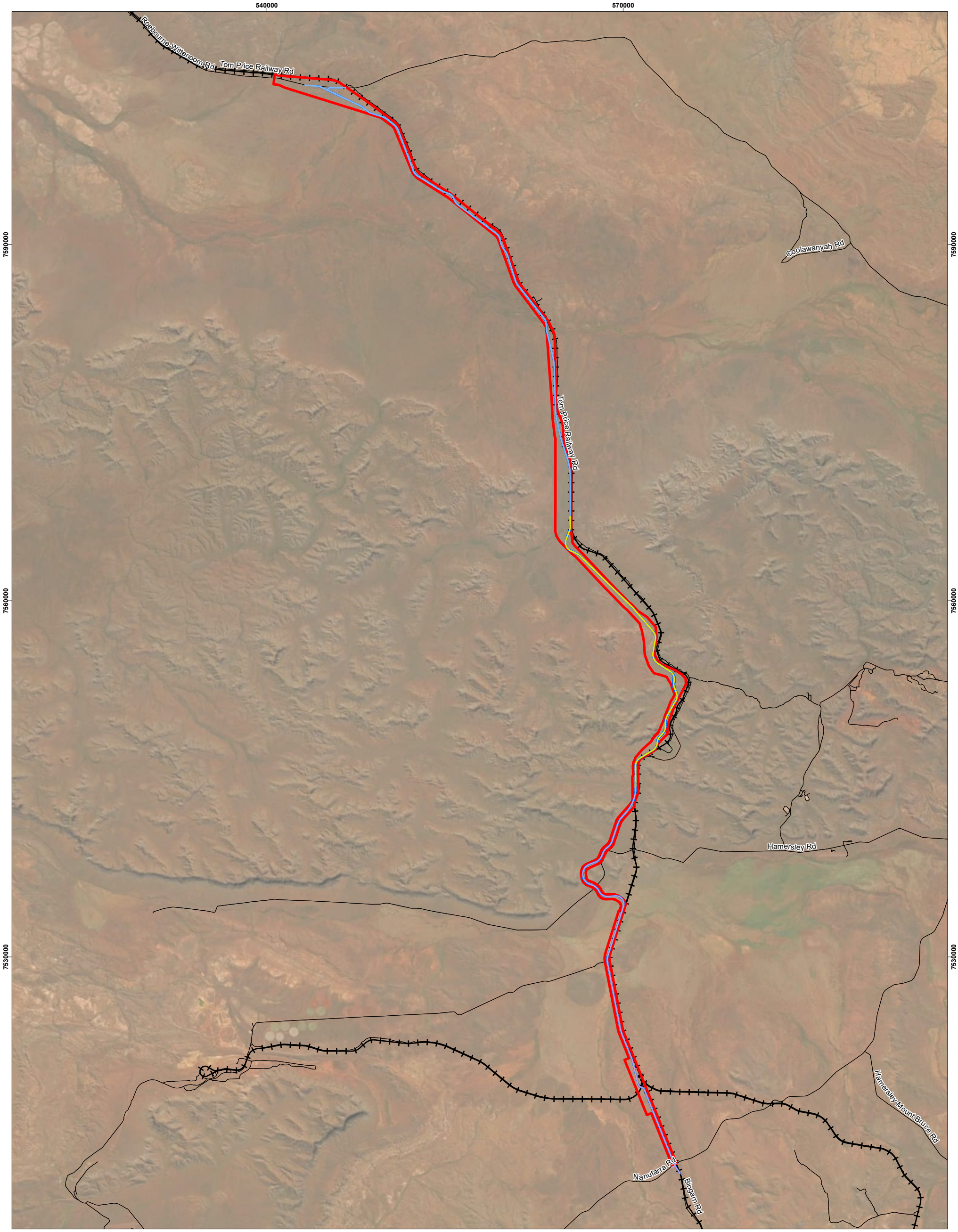

Figure 1 - Location and Layout Plan

Legend

- Coolawanyah Section
- Hamersley Section
- Tom Price Section
- Roads
- Railways
- Disturbance Footprint
- Development Envelope

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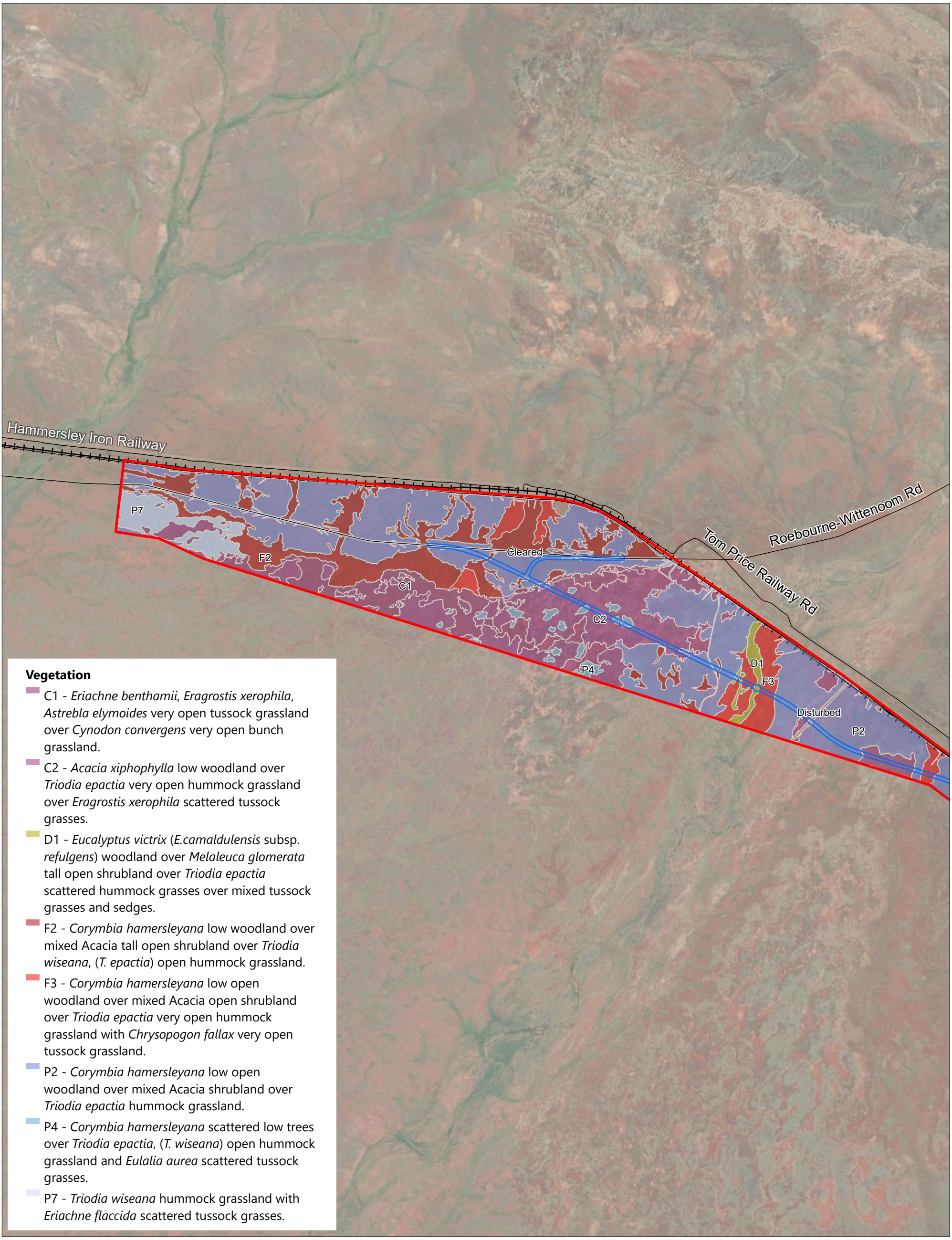
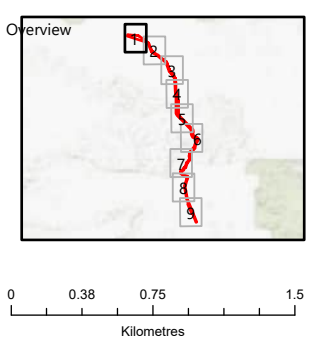


Figure 2.1 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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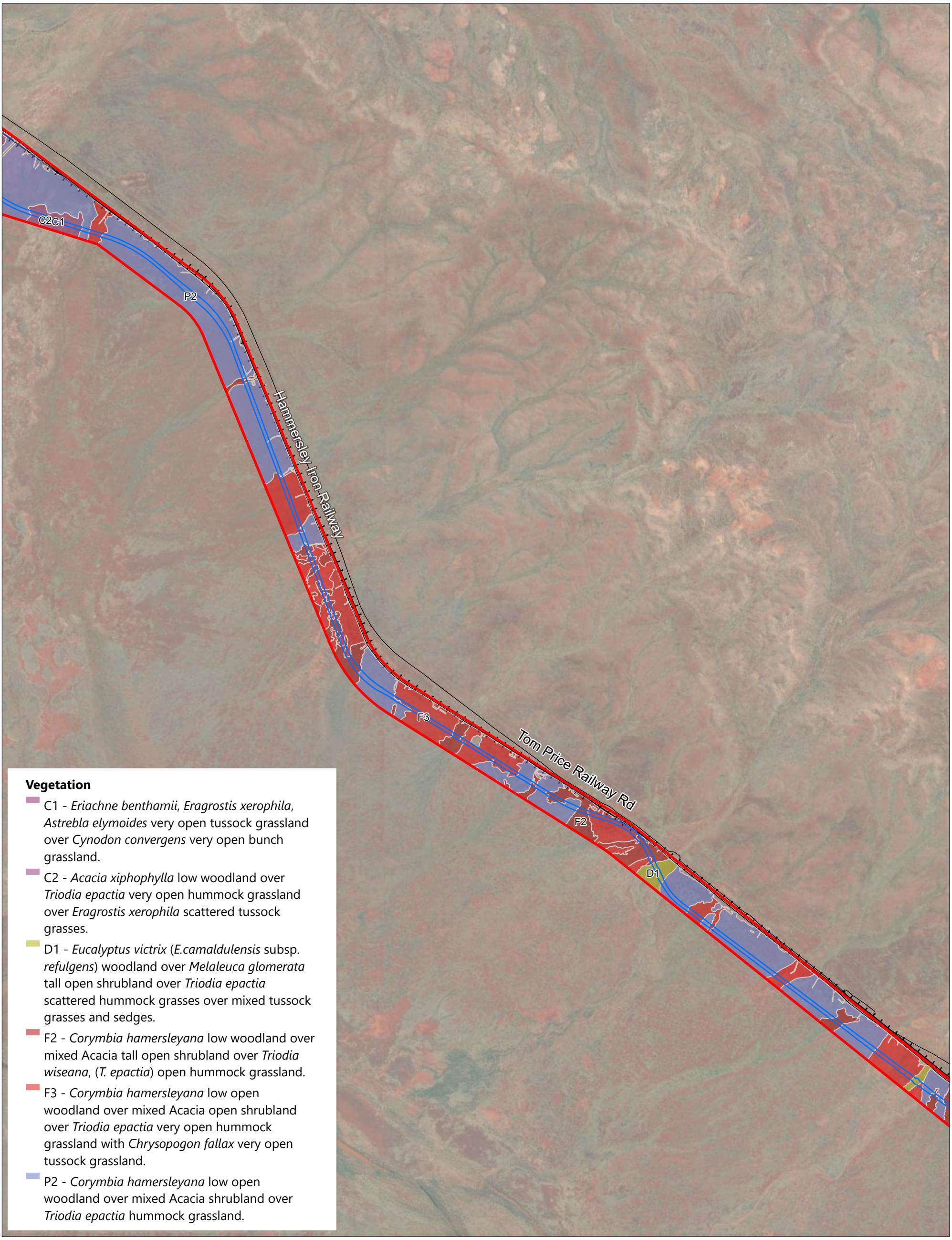
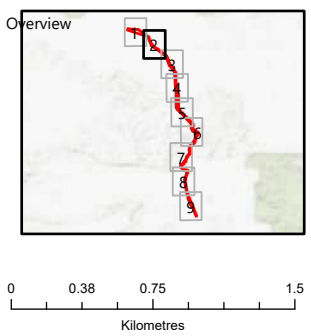


Figure 2.2 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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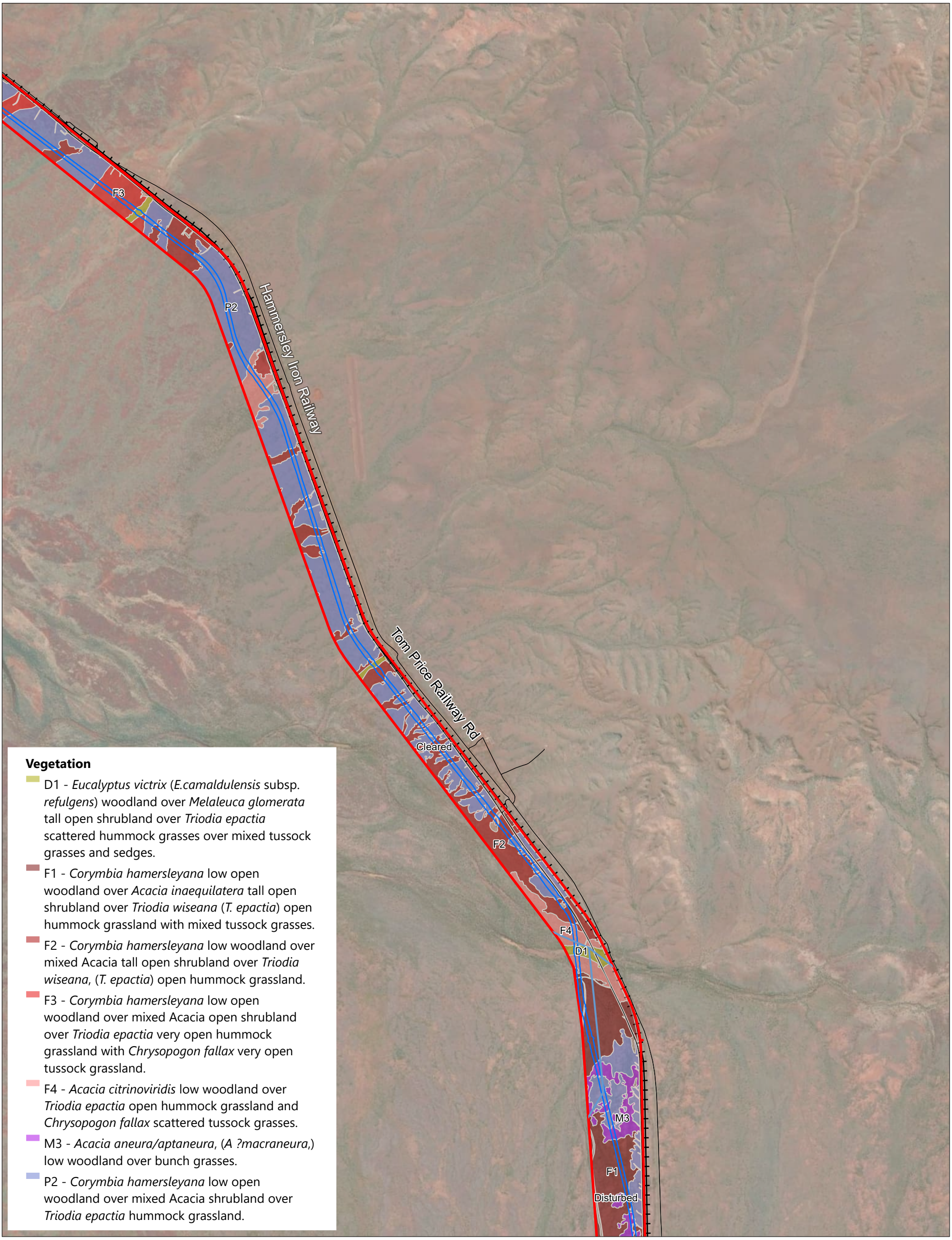
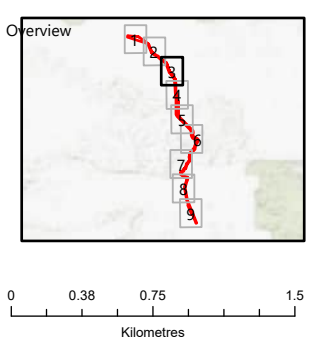


Figure 2.3 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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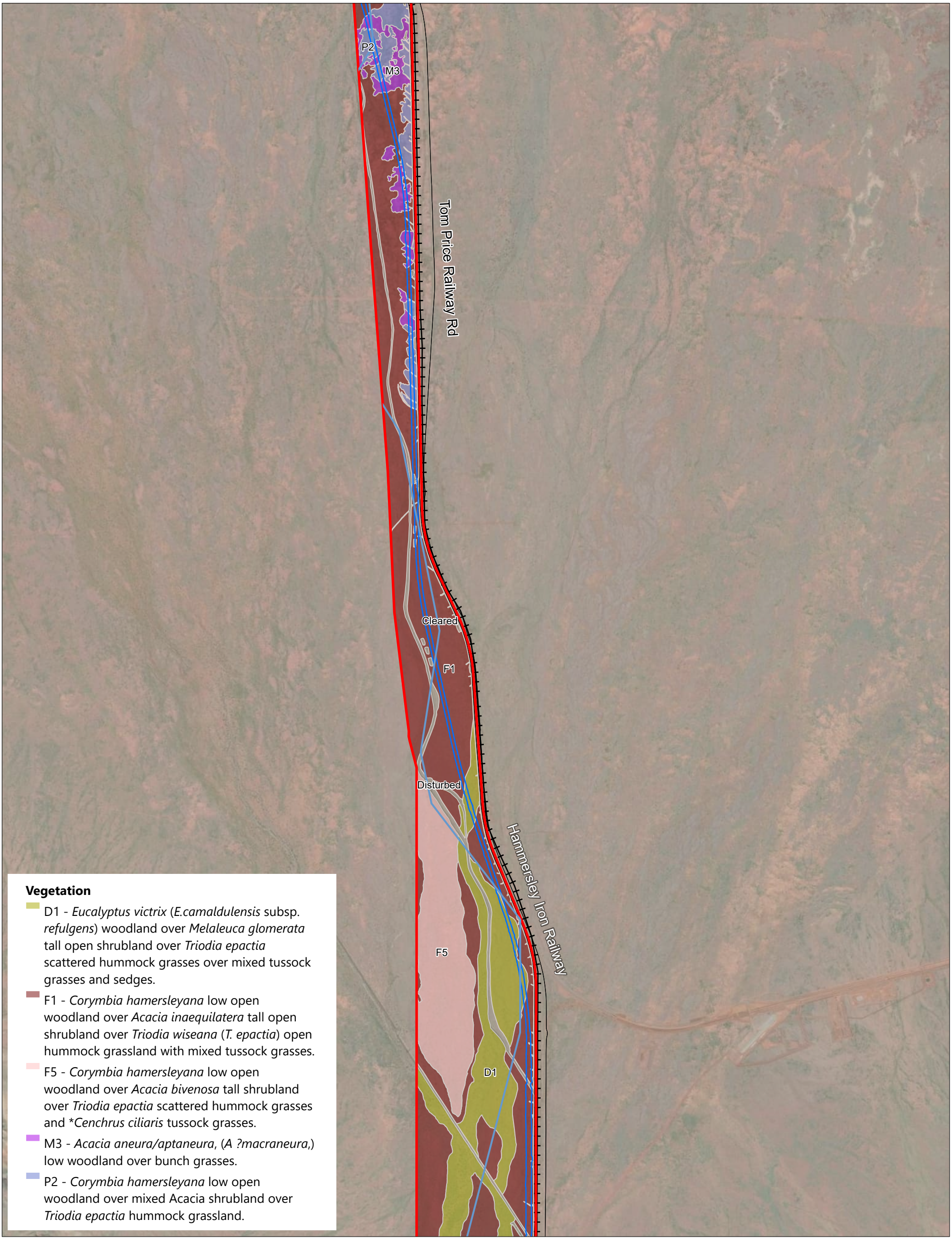
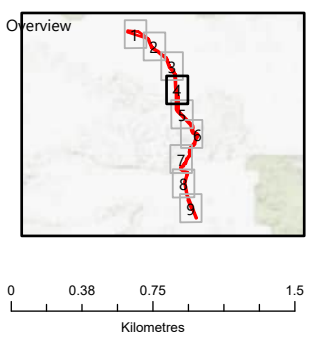


Figure 2.4 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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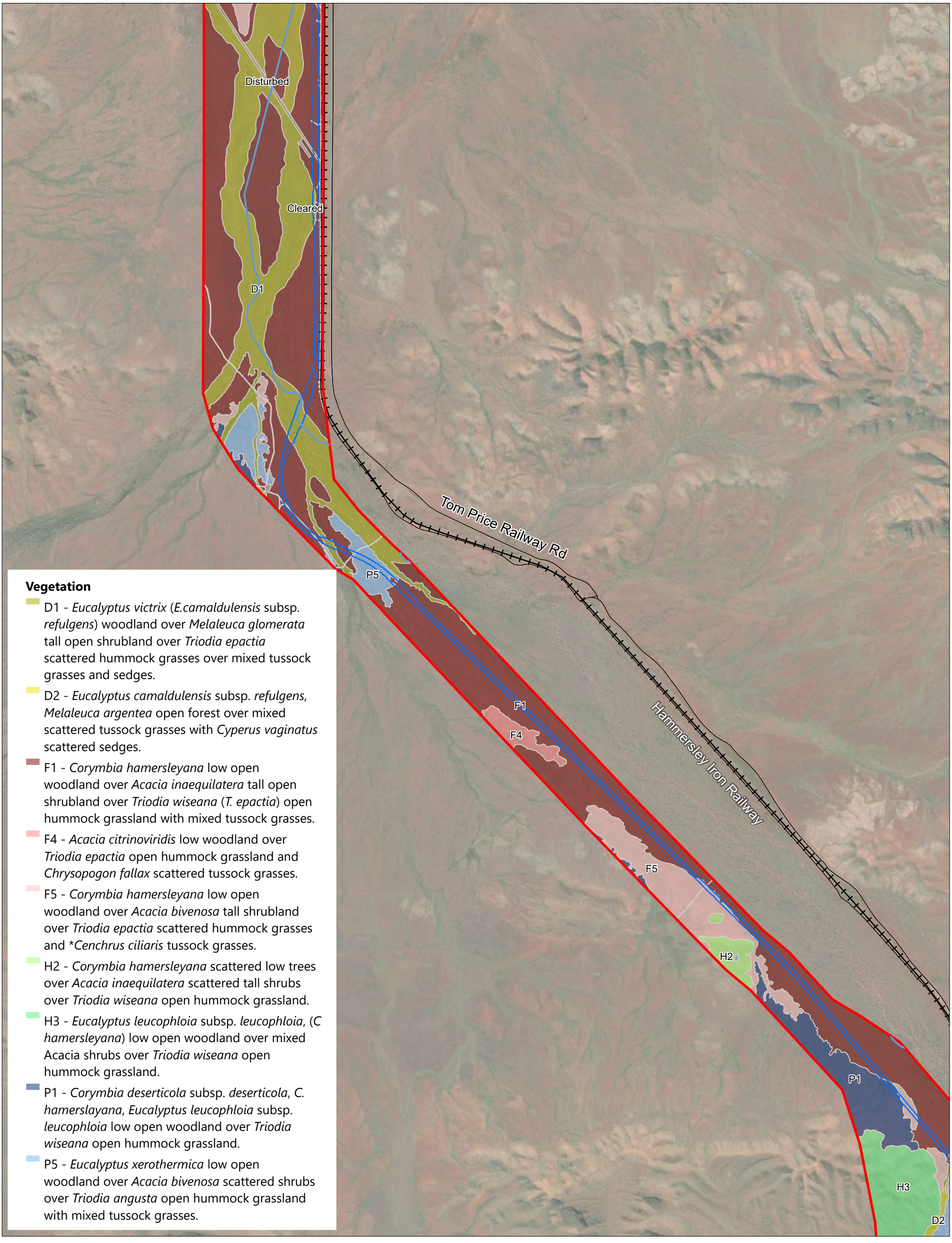
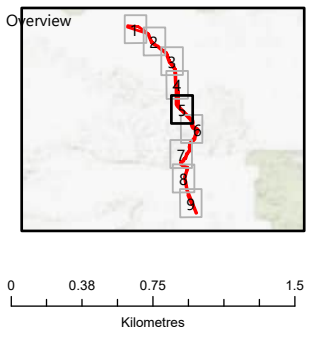


Figure 2.5 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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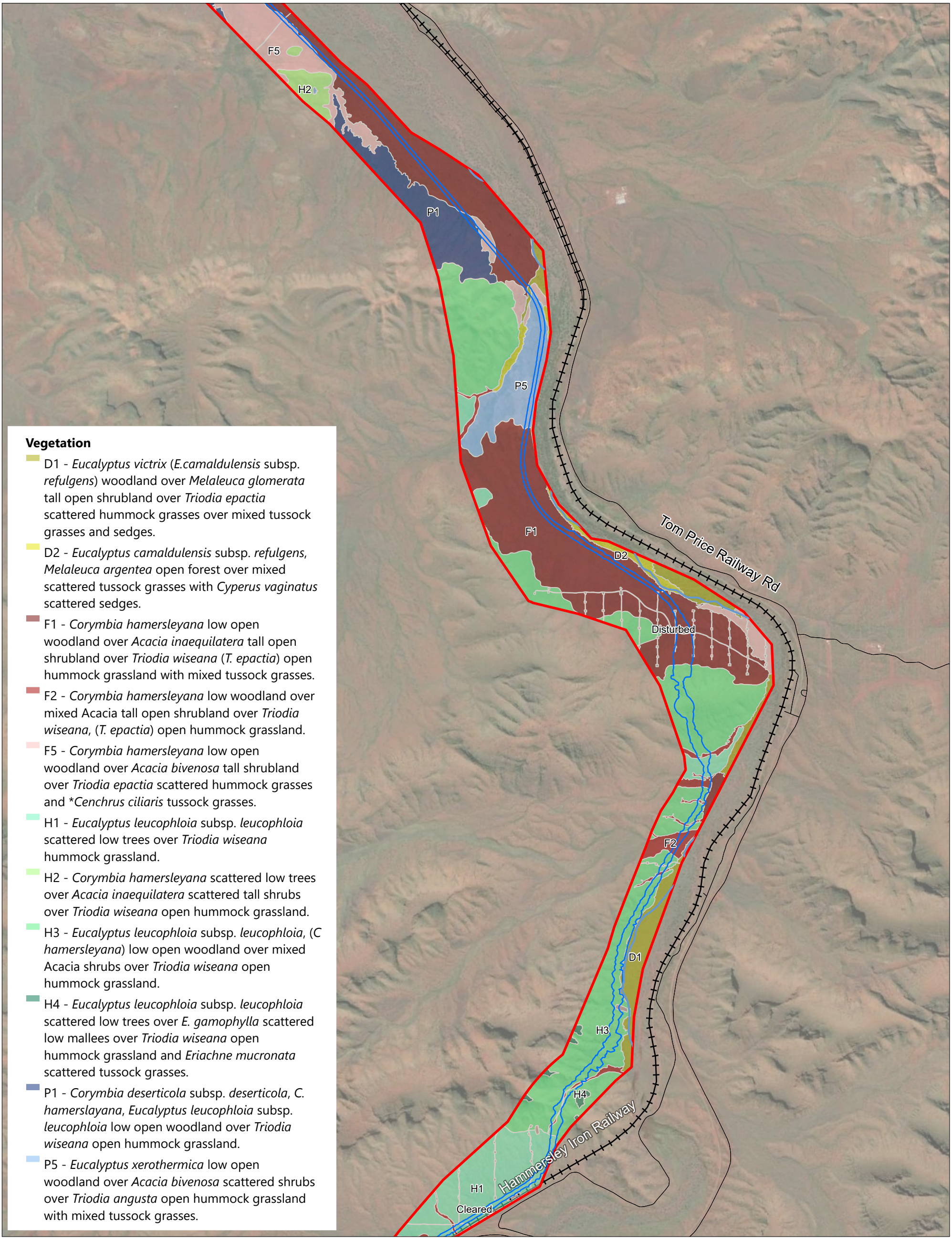
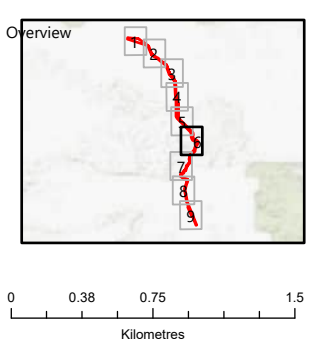


Figure 2.6 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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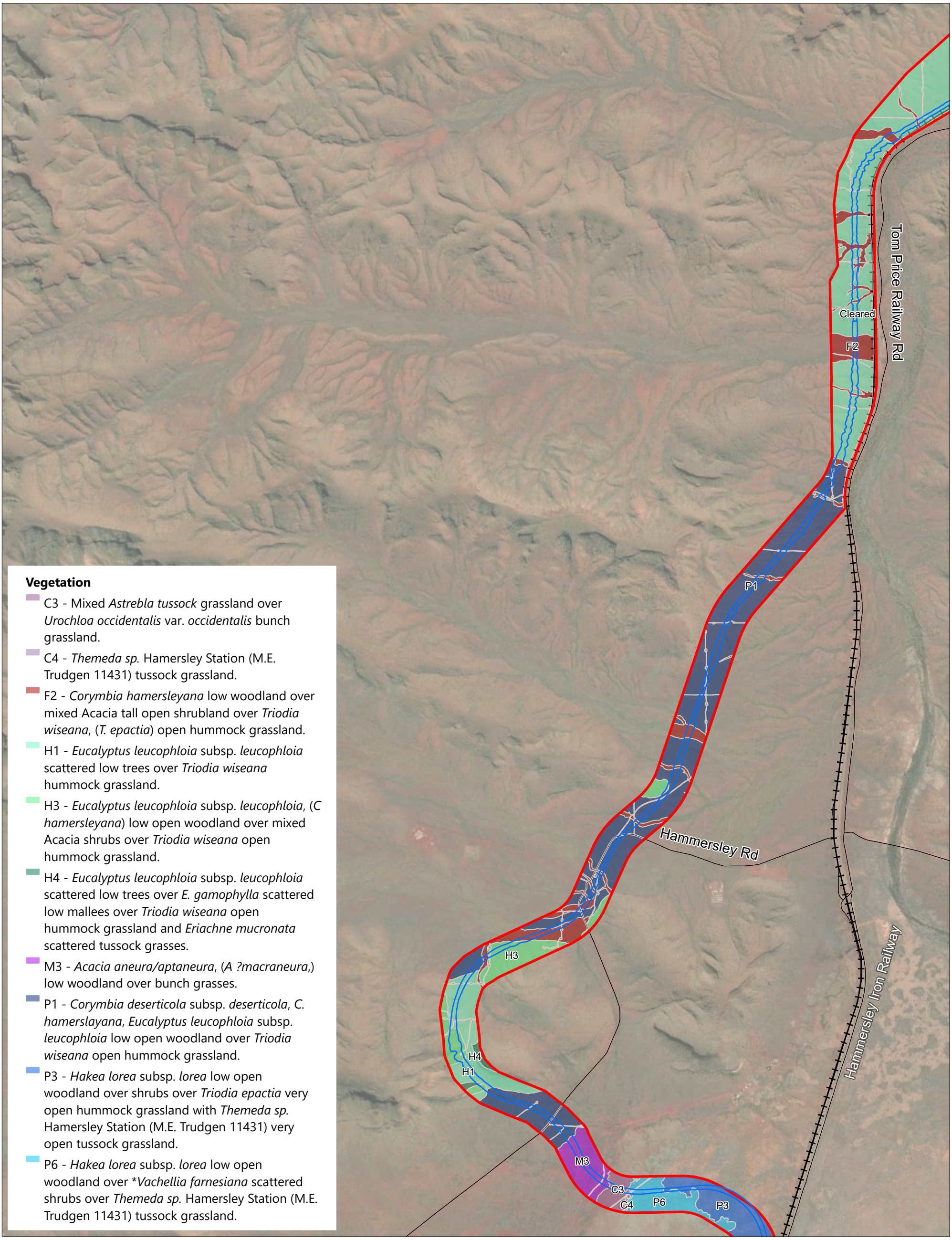
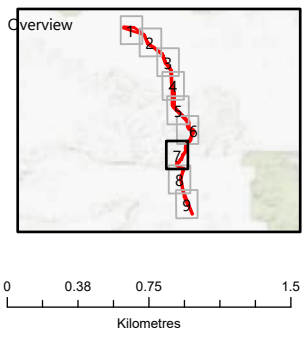


Figure 2.7 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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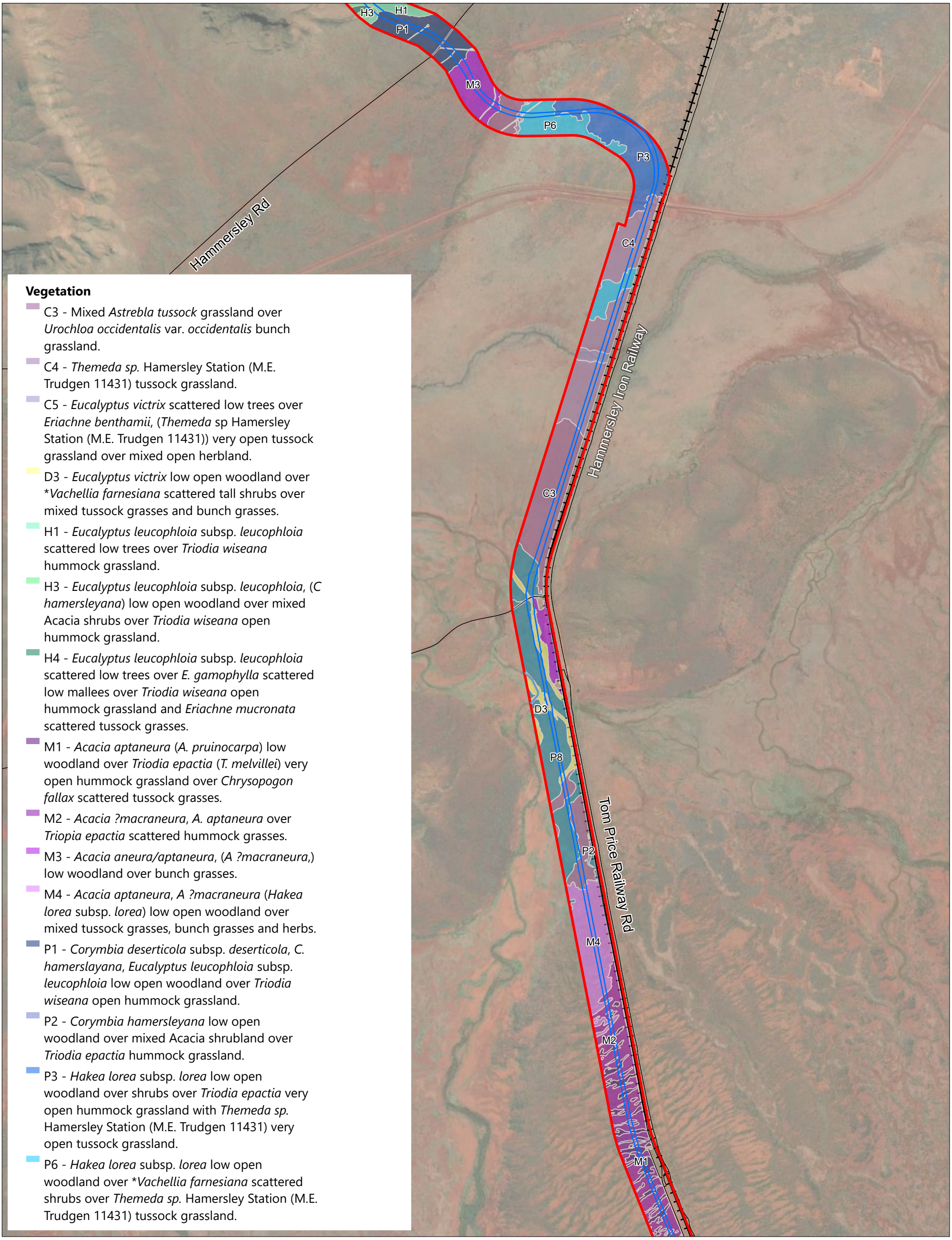
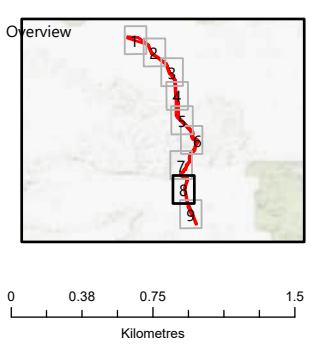


Figure 2.8 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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Hammersley Iron Railway
Cleared
M1
Hammersley Iron Railway
Hammersley Iron Railway
M2
Tom Price Railway Rd
Nanutarra Rd

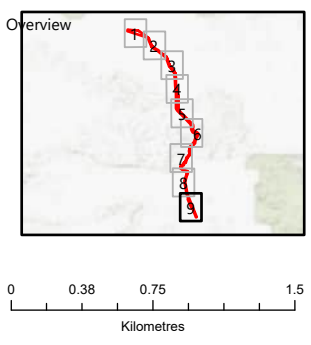
Vegetation

- M1 - *Acacia aptaneura* (*A. pruinocarpa*) low woodland over *Triodia epactia* (*T. melvillei*) very open hummock grassland over *Chrysopogon fallax* scattered tussock grasses.
- M2 - *Acacia ?macraneura*, *A. aptaneura* over *Triopia epactia* scattered hummock grasses.

Figure 2.9 **Vegetation units**

Legend

- Roads
- Railways
- Rivers and Creeks
- Disturbance Footprint
- Development Envelope



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541800 546000 550200

7606200 7602000 7597800

Hammersley Iron Railway

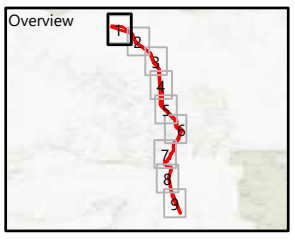
Roebourne-Wittenoom Rd

Tom Price Railway Rd

Vegetation Condition
- Excellent
- Very Good
- Good
- Poor
- Cleared

Figure 3.1 **Vegetation Condition**

Legend
- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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7593600
7589400
ebourne-Wittenoom Rd
ay Rd
Hammersley Iron Railway
Tom Price Railway Rd

Vegetation Condition
- Excellent
- Excellent to Very Good
- Very Good
- Good
- Good to Poor
- Poor
- Cleared

Figure 3.2 Vegetation Condition

Legend
- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks

Overview

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Tel: +61 8 9469 4400 Fax: +61 8 9469 4488

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7585200
7581000
Hammersley Iron Railway
Tom Price Railway Rd
Tom Pric
Vegetation Condition
Excellent
Very Good
Good
Good to Poor
Poor
Cleared

Figure 3.3 **Vegetation Condition**

Legend

- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks

Overview

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Kilometres

N

KARRATHA
TOM PRICE
PERTH

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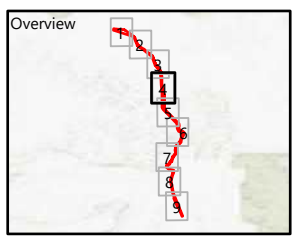
562800
567000
7581000
7576800
7572600
7568400
Tom Price Railway Rd
Hammersley Iron Railway

Vegetation Condition
- Excellent
- Very Good
- Good
- Cleared

Figure 3.4 Vegetation Condition

Legend
- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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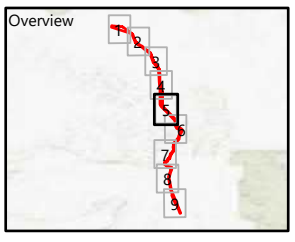
562800
567000
571200
7568400
7564200
7560000
7555800
Tom Price Railway Rd
Hammersley Iron Railway

Vegetation Condition
- Excellent
- Excellent to Very Good
- Very Good
- Very Good to Good
- Good
- Poor
- Cleared

Figure 3.5 **Vegetation Condition**

Legend
- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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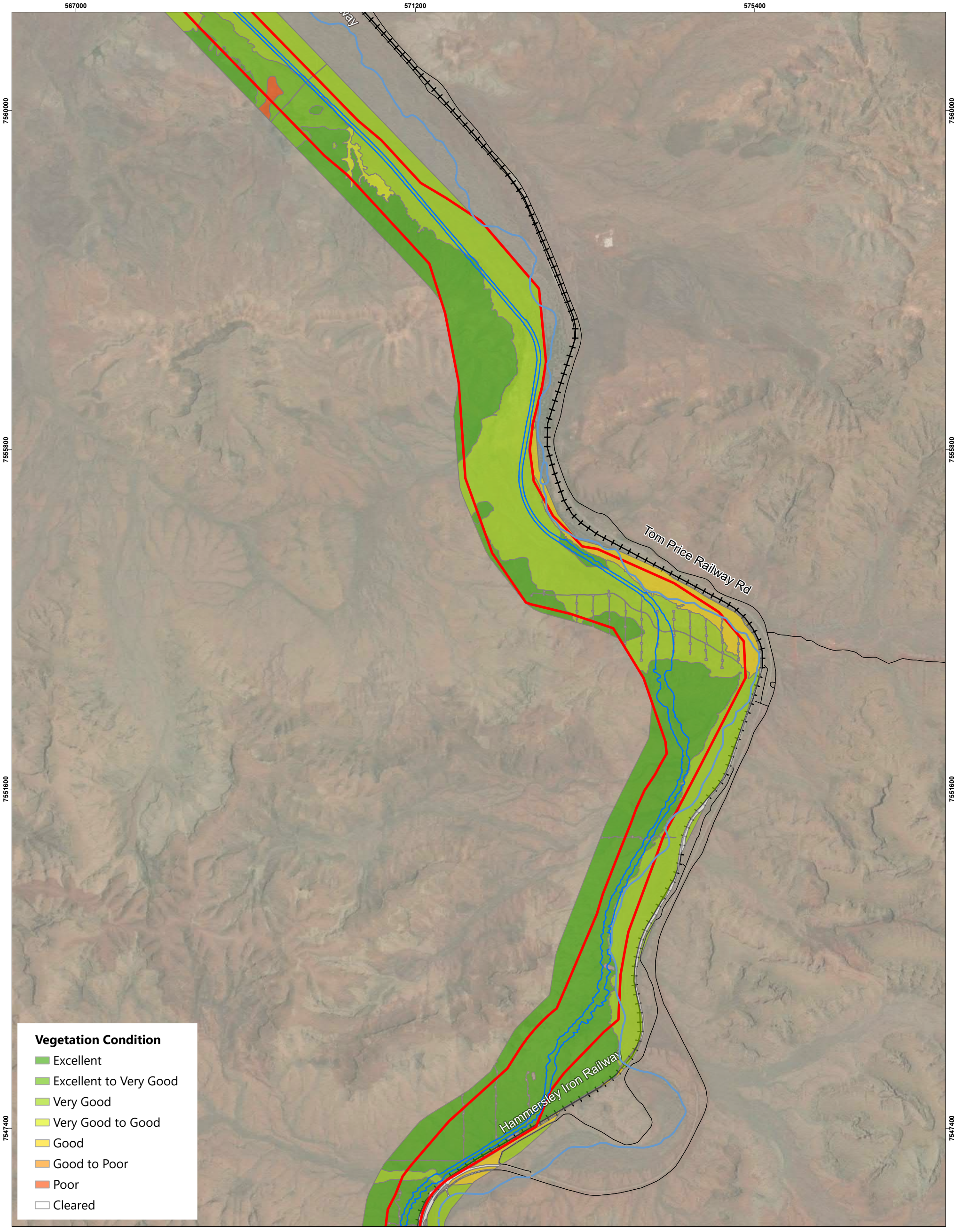
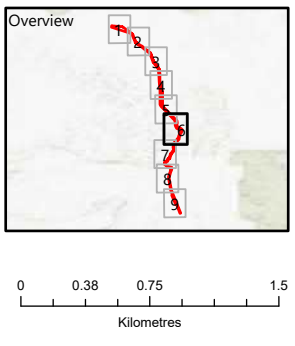


Figure 3.6 **Vegetation Condition**

Legend

- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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562800
567000
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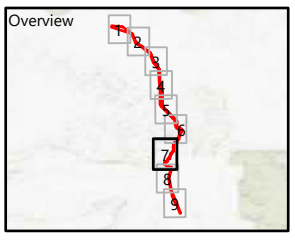
7539000
7534800
Tom Price Railway Rd
Hammersley Rd
Hammersley Iron Railway
Vegetation Condition
Excellent
Very Good
Very Good to Good
Good
Good to Poor
Cleared

Figure 3.7 Vegetation Condition

Legend

- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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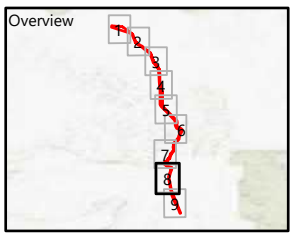
562800
567000
571200
7534800
7530600
7526400
7522200

Hammersley Rd
Hammersley Iron Railway
Tom Price Railway Rd

Vegetation Condition
- Excellent
- Excellent to Very Good
- Very Good
- Very Good to Good
- Good
- Good to Poor
- Cleared

Figure 3.8 Vegetation Condition

Legend
- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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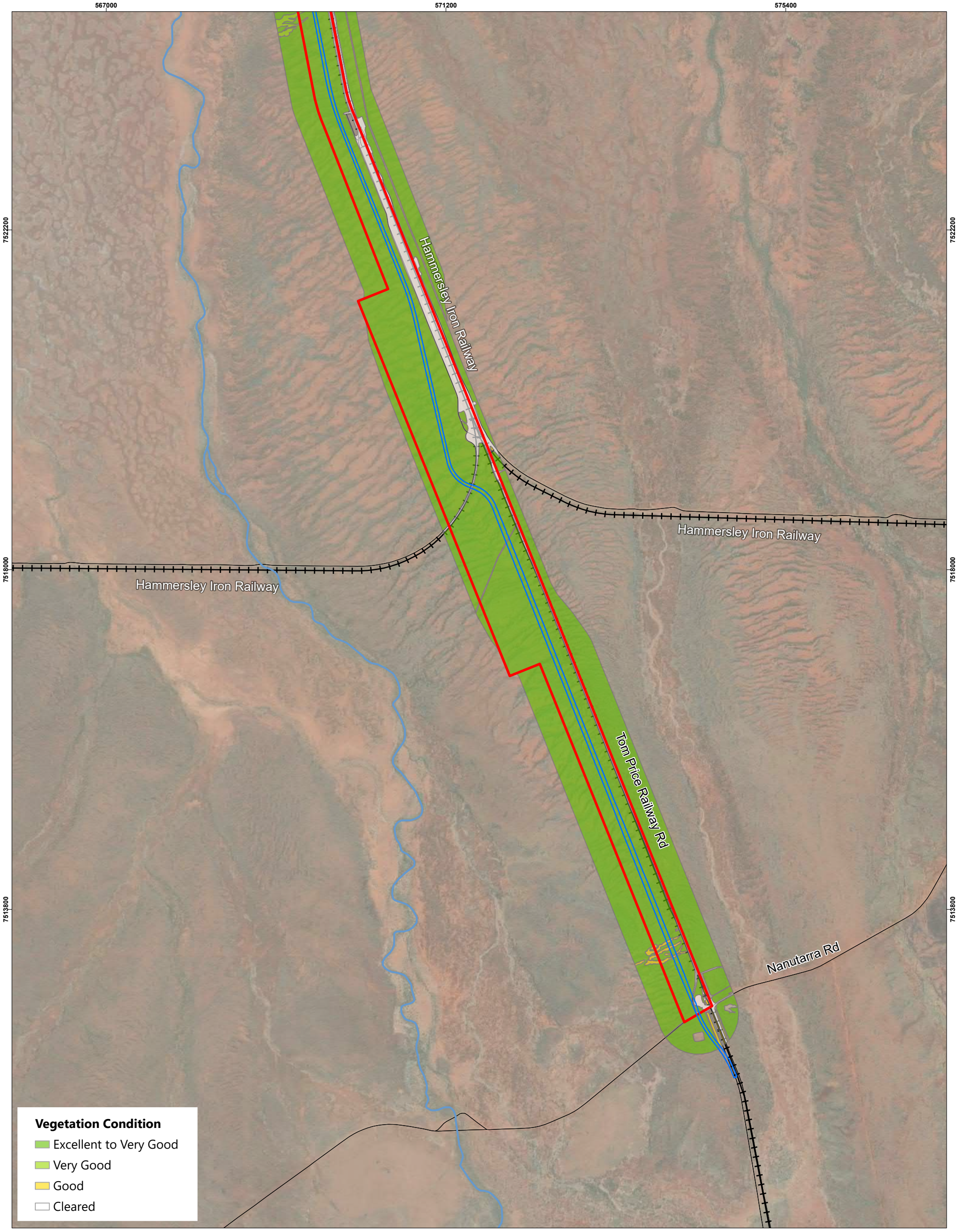
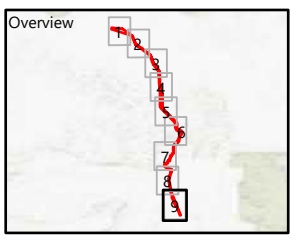


Figure 3.9 Vegetation Condition

Legend

- Roads
- Railways
- Disturbance Footprint
- Development Envelope
- Rivers and Creeks



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7600000

7600000

Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

C2 - Acacia xiphophylla low woodland over Triodia epactia very open hummock grassland over Eragrostis xerophila scattered tussock grasses.

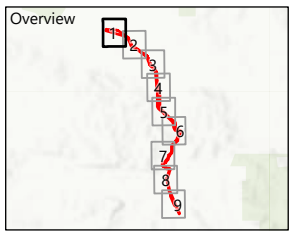
D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

P7 - Triodia wiseana hummock grassland with Eriachne flaccida scattered tussock grasses.

Figure 4.1 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

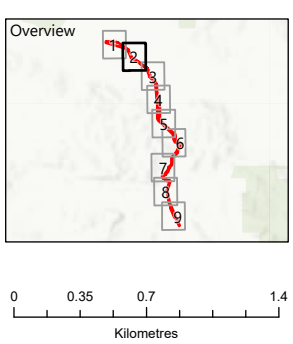
C2 - Acacia xiphophylla low woodland over Triodia epactia very open hummock grassland over Eragrostis xerophila scattered tussock grasses.

D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

Figure 4.2 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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560000

Indicative Flora and Vegetation Impact Monitoring Site
Indicative Flora and Vegetation Reference Monitoring Site

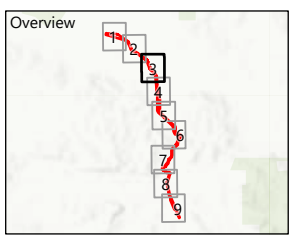
Vegetation

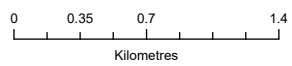
D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

Figure 4.3 Vegetation Monitoring Sitess

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint





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560000

Indicative Flora and Vegetation Impact Monitoring Site
Indicative Flora and Vegetation Reference Monitoring Site

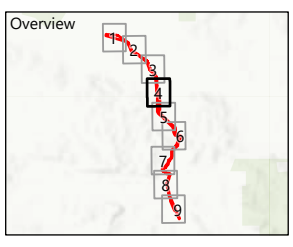
Vegetation

D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

Figure 4.4 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



0 0.35 0.7 1.4

Kilometres

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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

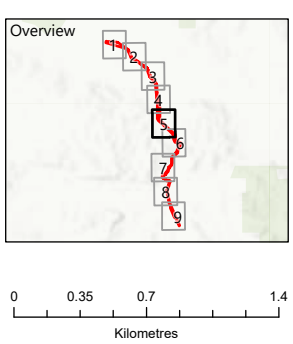
D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

D2 - Eucalyptus camaldulensis subsp. refulgens, Melaleuca argentea open forest over mixed scattered tussock grasses with Cyperus vaginatus scattered sedges.

Figure 4.5 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

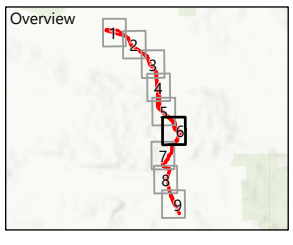
D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

D2 - Eucalyptus camaldulensis subsp. refulgens, Melaleuca argentea open forest over mixed scattered tussock grasses with Cyperus vaginatus scattered sedges.

Figure 4.6 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

C3 - Brockman Iron PEC

C4 - Themeda sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.

D1 - Eucalyptus victrix (E.camaldulensis subsp. refulgens) woodland over Melaleuca glomerata tall open shrubland over Triodia epactia scattered hummock grasses over mixed tussock grasses and sedges.

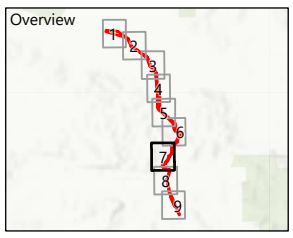
M2 - Acacia ?macraneura, A. aptaneura over Triopia epactia scattered hummock grasses.

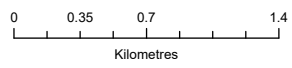
P6 - Hakea lorea subsp. lorea low open woodland over *Vachellia farnesiana scattered shrubs over Themeda sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.

Figure 4.7 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint





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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

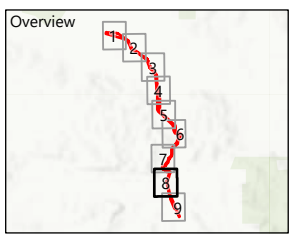
Vegetation

- C3 - Brockman Iron PEC
- C4 - Themeda sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.
- C5 - Eucalyptus victrix scattered low trees over Eriachne benthamii, (Themed sp Hamersley Station (M.E. Trudgen 11431)) very open tussock grassland over mixed open herbland.
- D3 - Eucalyptus victrix low open woodland over *Vachellia farnesiana scattered tall shrubs over mixed tussock grasses and bunch grasses.
- M1 - Acacia aptaneura (A. pruinocarpa) low woodland over Triodia epactia (T. melvillei) very open hummock grassland over Chrysopogon fallax scattered tussock grasses.
- M2 - Acacia ?macraneura, A. aptaneura over Triopia epactia scattered hummock grasses.
- P6 - Hakea lorea subsp. lorea low open woodland over *Vachellia farnesiana scattered shrubs over Themeda sp. Hamersley Station (M.E. Trudgen 11431) tussock grassland.

Figure 4.8 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Kilometres

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Indicative Flora and Vegetation Impact Monitoring Site

Indicative Flora and Vegetation Reference Monitoring Site

Vegetation

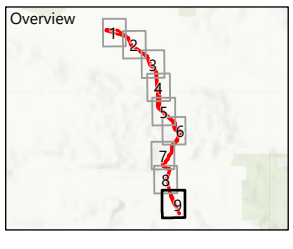
M1 - Acacia aptaneura (A. pruinocarpa) low woodland over Triodia epactia (T. melvillei) very open hummock grassland over Chrysopogon fallax scattered tussock grasses.

M2 - Acacia ?macraneura, A. aptaneura over Triopia epactia scattered hummock grasses.

Figure 4.9 Vegetation Monitoring Sites

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Kilometres

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541800 546000 550200

7606200 7602000 7597800

Inset Map

Hammersley Iron Railway

Roebourne-Wittenoom Rd

Tom Price Railway Rd

Flora Recorded

- P2 - *Euphorbia inappendiculata* var. *inappendiculata*
- P2 - *Euphorbia inappendiculata* var. *queenslandica*
- P3 - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- P3 - *Euphorbia australis* var. *glabra*
- P3 - *Gymnanthera cunninghamii*
- P3 - *Swainsona thompsoniana*
- P3 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- P4 - *Goodenia berringbinensis*

Figure 5.1 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint

Overview

0 0.38 0.75 1.5

Kilometres

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TOM PRICE

PERTH

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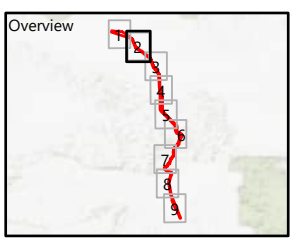
550200
554400
558600
7602000
7597800
7593600
7589400

ay Rd
Hammersley Iron Railway
Tom Price Railway Rd

Figure 5.2 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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Kilometres

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558600
562800
567000
7593600
7589400
7585200
7581000
Hammersley Iron Railway
Tom Price Railway Rd
Tom Price
Flora Recorded
P3 - *Euphorbia australis* var. *glabra*

Figure 5.3 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint

Overview

0 0.38 0.75 1.5
Kilometres

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562800
567000
7581000
7576800
7572600
7568400
Tom Price Railway Rd
Hammersley Iron Railway

Flora Recorded

P1 - *Josephinia* sp. Woodstock (A.A. Mitchell PRP 989) PN

Figure 5.4 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint

Overview

0 0.38 0.75 1.5
Kilometres

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TOM PRICE
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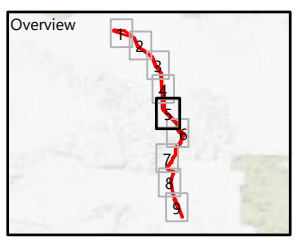
562800
567000
571200
7568400
7564200
7560000
7555800
Tom Price Railway Rd
Hammersley Iron Railway

Figure 5.5 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



0 0.38 0.75 1.5
Kilometres

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Tel: +61 8 9469 4400 Fax: +61 8 9469 4488

567000
571200
575400
7560000
7555800
7551600
7547400

Tom Price Railway Rd

Hammersley Iron Railway

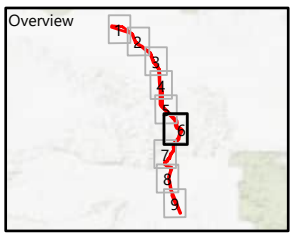
Flora Recorded

- P1 - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- P3 - *Triodia basitricha*

Figure 5.6 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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562800
567000
571200
7547400
7543200
7539000
7534800
Tom Price Railway Rd
Hammersley Rd
Hammersley Iron Railway
Flora Recorded
P1 - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
P2 - *Aristida lazaridis*
P3 - *Glycine falcata*
P3 - *Sida* sp. Hamersley Range (K. Newbey 10692)
P3 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
P4 - *Eremophila magnifica* subsp. *magnifica*
T - *Seringia exastia*

Figure 5.7 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint

Overview

0 0.38 0.75 1.5
Kilometres

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TOM PRICE
PERTH

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Tel: +61 8 9469 4400 Fax: +61 8 9469 4488

562800 567000 571200

7534800 7530600 7526400 7522200

Hammersley Rd

Hammersley Iron Railway

Tom Price Railway Rd

Flora Recorded

- P1 - *Hibiscus* sp. Mt Brockman (E. Thoma ET 1354)
- P2 - *Aristida lazaridis*
- P2 - *Euphorbia inappendiculata* var. *queenslandica*
- P3 - *Aristida jerichoensis* var. *subspinulifera*
- P3 - *Astrebla lappacea*
- P3 - *Dolichocarpa* sp. Hamersley Station (A.A. Mitchell PRP 1479)
- P3 - *Euphorbia australis* var. *glabra*
- P3 - *Glycine falcata*
- P3 - *Rhagodia* sp. Hamersley (M. Trudgen 17794)
- P3 - *Sida* sp. Hamersley Range (K. Newbey 10692)
- P3 - *Themeda* sp. Hamersley Station (M.E. Trudgen 11431)
- P4 - *Eremophila magnifica* subsp. *magnifica*
- T - *Seringia exastia*

Figure 5.8 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint

Overview

0 0.38 0.75 1.5

Kilometres

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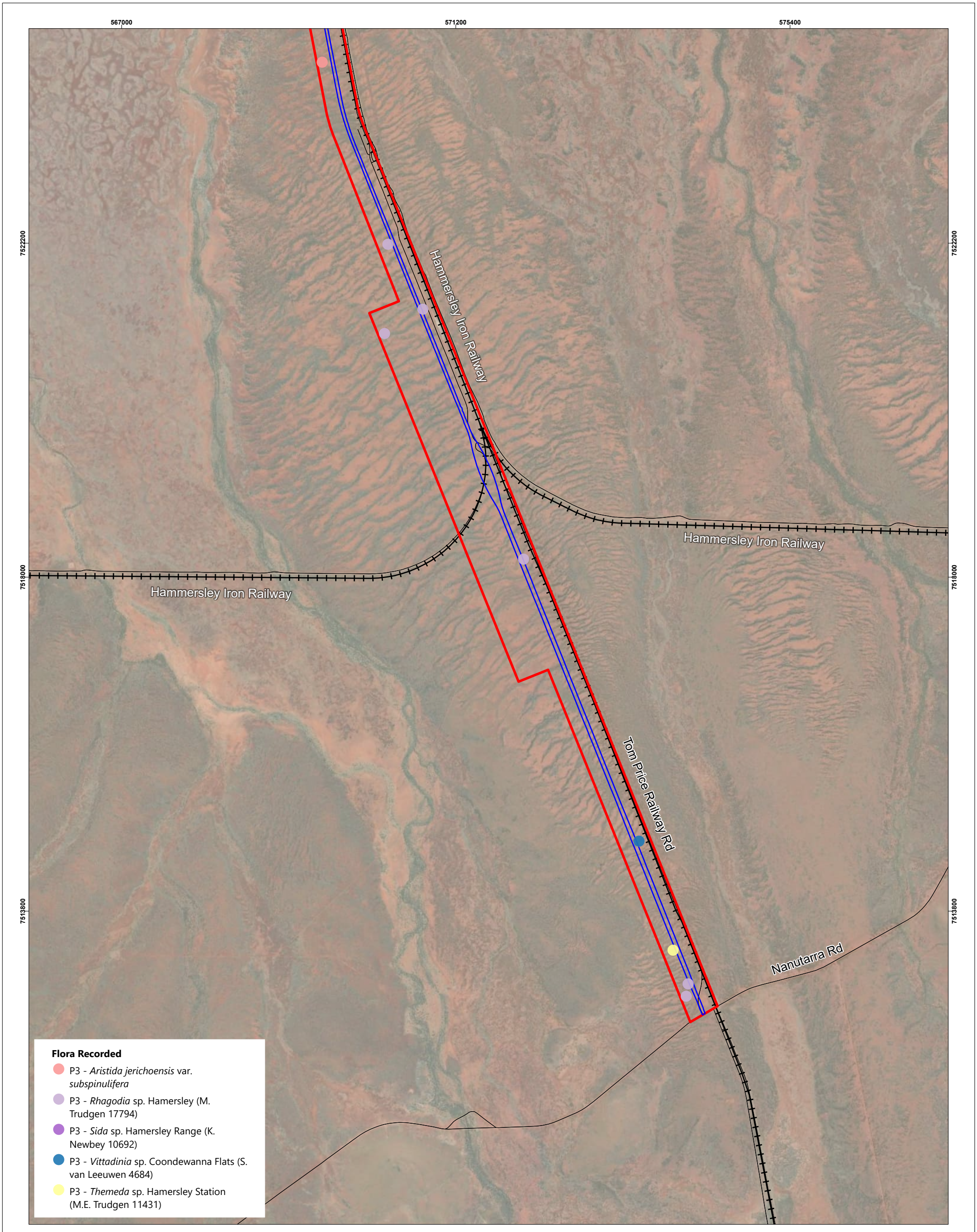
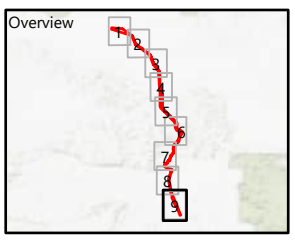


Figure 5.9 Conservation Significant Flora

Legend

- Roads
- Railways
- Development Envelope
- Indicative Disturbance Footprint



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