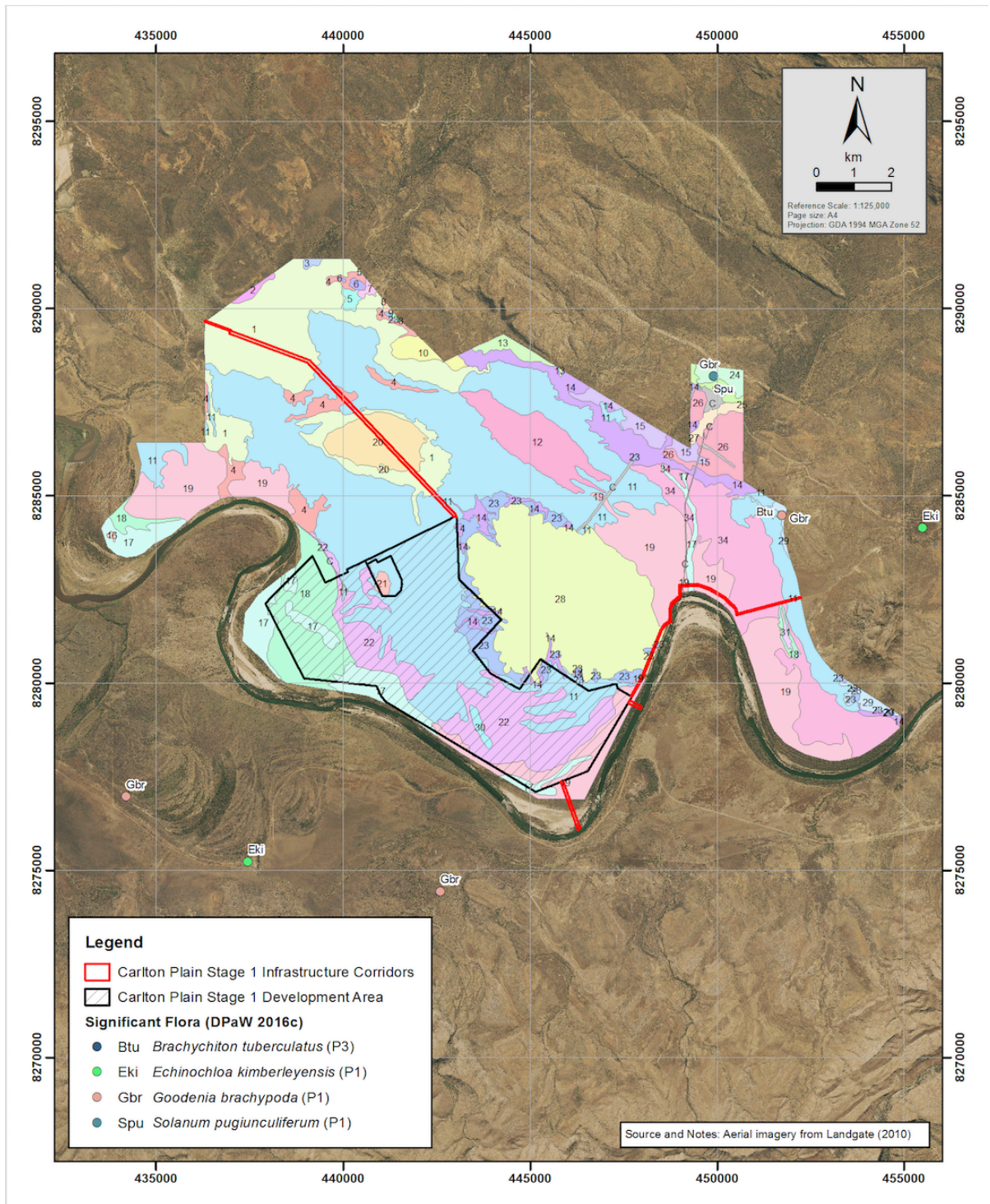


Figure 11 - Carlton Plain Stage 1 Vegetation Types and known priority taxa locations



(Source: Woodman Environmental Consulting (2017), based on 2016 survey)

Table 10 - Vegetation Type descriptions: Carlton Plain Stage 1

**Vegetation Types**

- 1 Low open to low woodland of mixed tree species including *Excoecaria parvifolia*, *Eucalyptus microtheca*, *Adansonia gregorii* and *Terminalia hadleyana* over low open to low closed sedgeland of *Cyperus* spp. over low isolated grasses to low closed grassland of mixed species including *Ophiuros exaltatus*, *Eulalia aurea* and *Chrysopogon fallax* over mixed low isolated forbs to open forbland flats, plains, floodplains and minor drainage lines on grey or brown cracking clay or loamy clay.
- 2 Low open woodland of *Adansonia gregorii* and *Bauhinia cunninghamii* over tall isolated clumps of shrubs of *Carissa lanceolata*, *Ehretia saligna* var. *saligna* and *Terminalia canescens* over low to mid grassland of mixed species including *Chrysopogon fallax*, *Cynodon convergens*, *Eriachne ?sulcata* and *Themeda triandra* over low isolated clumps of forbs of *Corchorus aestuans* and *Heliotropium euodes* on gentle slopes of low hillocks on grey-brown clay loam, with surface stones.
- 3 Mid isolated clumps of trees of *Adansonia gregorii* and *Eucalyptus microtheca* over low woodland of *Bauhinia cunninghamii* and *Excoecaria parvifolia* over tall sparse shrubland of *Flueggea virosa* subsp. *melanthesoides* over low open shrubland of *\*Sida cordifolia*, *Tribulopsis pentandra* and *Waltheria indica* on plains with drainage lines and sinkholes on brown sandy clay.
- 4 Low open woodland to low woodland of *Eucalyptus microtheca* over tall isolated clumps of shrubs of *Melaleuca ?nervosa* occasionally with mid isolated grassland to grassland of mixed species including *Chrysopogon fallax*, *Heteropogon contortus* and *Dichanthium fecundum* occasionally with low isolated clumps of trees of *Excoecaria parvifolia* on plains and floodplains on brown sandy clay.
- 5 Low woodland of *Eucalyptus microtheca* and *Excoecaria parvifolia* over mid isolated clumps of shrubs of *Carissa lanceolata* over low open grassland of *Chrysopogon fallax*, *Cynodon convergens* and *Aristida holathera* var. *holathera* on plains on orange clayey sand.
- 6 Mid open woodland to woodland of *Corymbia bella* and *Corymbia polycarpa* over low open woodland to woodland of *Acacia neurocarpa* and *Melaleuca ?nervosa* over low to mid sparse shrubland to shrubland of *\*Hyptis suaveolens* over low to mid grassland of mixed species including *Cynodon convergens* and *Setaria apiculata* on plains and drainage lines on brown sandy clay.
- 7 Low woodland of *Bauhinia cunninghamii* and *Grevillea striata* over tall isolated clumps of shrubs of *Carissa lanceolata* over low open grassland of *Chrysopogon fallax* and *Eriachne* sp. on plains on orange clayey sand.
- 8 Low isolated clumps of trees of *Corymbia ?grandifolia* over tall sparse shrubland of *Calytrix exstipulata* over tall isolated clumps of grasses of *Sorghum ?stipoides* over low isolated clumps of forbs of *Spermacoce ?brachystema* on low hillocks on brown loamy sand, with sandstone outcropping and surface stones.
- 9 Low open woodland of *Melaleuca minutifolia* over mixed grassland dominated by species including *Chrysopogon fallax* and *Eriachne obtusa* often with *Triodia bitextura* on stony plains and low rises on light brown clay.
- 10 Low open woodland of *Terminalia platyptera* over mid isolated shrubs of *Bauhinia cunninghamii* and *Carissa lanceolata* over mid closed grassland of *Aristida holathera* var. *holathera* and *Sorghum ?stipoides* on low hillocks on brown sandy clay, with surface stones.
- 11 Mid grassland of mixed species dominated by *Chrysopogon fallax*, *Iseilema* spp. and *Themeda triandra* on plains with red, grey and brown sandy clay and loamy clay.
- 12 Tall open to tall closed grassland of *Sorghum stipoides* and *Ophiuros exaltatus* over mid isolated clumps of grasses to tall closed grassland of *Chrysopogon fallax*, *Heteropogon contortus* and *Themeda triandra* on plains on red or brown medium or loamy cracking clay.
- 13 Tall isolated clumps of shrubs of *Cochlospermum fraseri* and *Grevillea striata* over tall open grassland of *Sorghum stipoides* over low closed grassland of mixed species including *Sorghum stipoides* and *Triodia bitextura* on gentle slopes on brown sandy clay, between patches of low open woodland of *Corymbia ?grandifolia* and *Erythrophleum chlorostachys*.
- 14 Mid woodland of *Adansonia gregorii*, *Bauhinia cunninghamii* and *Terminalia* spp. over tall isolated clumps of shrubs of *Flueggea virosa* subsp. *melanthesoides* over tall closed grassland of mixed species including *Heteropogon contortus*, *Chrysopogon fallax*, *Dichanthium fecundum* and *Panicum decompositum* on flats, in drainage lines and on adjacent floodplains on brown-grey sandy to loamy clay and clay.
- 15 Mid isolated clumps of trees of *Corymbia bella* over low open woodland of *Bauhinia cunninghamii*, *Corymbia polycarpa* and *Eucalyptus microtheca* over mid isolated clumps of shrubs of *Carissa lanceolata* over mid grassland of *Themeda triandra* on plains on brown sandy clay.
- 16 Mid forest of *\*Moringa oleifera* in closed depressions of brown clay.
- 17 Low isolated clumps of trees of *Erythrina vespertilio* and *Gyrocarpus americanus* subsp. *pachyphyllus* over tall isolated clumps of shrubs to tall shrubland of *\*Calotropis procera*, *Ficus aculeata* var. *indecora* and *Flueggea virosa* subsp. *melanthesoides* over mid isolated clumps of shrubs to mid sparse shrubland of *Heliotropium muelleri* over low isolated clumps of forbs of *\*Hyptis suaveolens* occasionally with open woodland of *Eucalyptus camaldulensis* subsp. *obtusa* on floodplains on brown clay to clayey sand.
- 18 Mid woodland of *Eucalyptus camaldulensis* subsp. *obtusa* over tall sparse shrubland to shrubland of *Flueggea virosa* subsp. *melanthesoides* on drainage lines/floodplains on brown sandy clay to loamy clay.
- 19 Low to mid isolated clumps of trees to mid woodland of mixed trees dominated by *Corymbia bella*, often with *Ficus aculeata* var. *indecora* over tall isolated clumps of shrubs to tall open shrubland of *\*Calotropis procera* and *Flueggea virosa* subsp. *melanthesoides* over low to mid open shrubland of *\*Hyptis suaveolens*, between bands of bare soil or low isolated clumps to sparse grassland of mixed species on flats and plains on brown clay or loamy clay.
- 20 Tall open shrubland of *\*Parkinsonia aculeata* over low sparse to open chenopod shrubland of *Chenopodium auricomum* over sparse grassland of *Panicum decompositum* and *?Dichanthium fecundum* fringed by tall sparse grassland of *Ophiuros exaltatus* and low open woodland of *Excoecaria parvifolia* on flats on grey clay.

### Vegetation Types (continued)

- 21 Low woodland of *Barringtonia acutangula* subsp. *acutangula* over mid sedge-land of *Eleocharis dulcis* over low sparse forbland of *Glinus lotoides* and *Heliotropium* sp. on closed depressions on grey clay.
- 22 Mid woodland to open forest of *Corymbia bella* and *Eucalyptus microtheca* over tall sparse to open shrubland of *Ficus aculeata* var. *indecora* and *Flueggea virosa* subsp. *melanthesoides* over low to mid open grassland to grassland of mixed species including and *Cynodon convergens* and *Urochloa mosambicensis* or occasionally with low isolated clumps to mid open forbland of *Hyptis suaveolens* on plains on brown clay and loamy clay.
- 23 Low open grassland of *Eriachne pulchella* subsp. *dominii* on outwash stony plains on brown
- 24 Mid isolated clumps of trees of *Eucalyptus miniata* over low isolated clumps of trees of *Corymbia ?collina*, *Erythrophleum chlorostachys*, *?Gardenia* sp. and *Owenia vernicosa* over tall isolated clumps of shrubs of *Calytrix exstipulata* over mid isolated clumps of shrubs of *Tephrosia* sp. over tall open grassland of *Sorghum stipoides* on steep ridges and gullies with sandstone outcrops on brown clayey sand.
- 25 Low isolated clumps of trees of *Erythrophleum chlorostachys* and *Eucalyptus obconica* over tall isolated clumps of shrubs of *Calytrix exstipulata* and *Cochlospermum fraseri* over tall isolated clumps of grasses of *Sorghum ?stipoides* over *Triodia bitextura* and *Triodia stenostachya* on midslopes with sandstone outcrops on light brown clay.
- 26 Low woodland to open forest of *Corymbia bella*, *C. polycarpa* and *C. confertiflora* over tall shrubland of mixed species including *Acacia neurocarpa*, *Melaleuca ?nervosa* and *Hyptis suaveolens* over mixed open grassland of Poaceae spp. on flats, plains and drainage lines on light brown sandy clay.
- 27 Mid open forest of mixed species dominated by *Corymbia bella*, *Melaleuca leucadendra* and *Terminalia hadleyana* over tall shrubland of *Flueggea virosa* subsp. *melanthesoides* and *Pandanus spiralis* var. *thermalis* over mid open forbland of *Hyptis suaveolens* and mid isolated clumps of grasses of *Setaria apiculata* on drainage lines on light brown silty sand.
- 28 Low woodland to open forest of species including *Adansonia gregorii*, *Bauhinia cunninghamii*, *Erythrophleum chlorostachys* and *Terminalia canescens* over tall open shrubland of *Calytrix exstipulata*, *Cochlospermum fraseri* and *Melaleuca minutifolia* over mixed open grassland on lower to upperslopes and hill top on light brown clay with metamorphic sandstone.
- 29 Low open woodland of *Bauhinia cunninghamii*, *Terminalia platyptera* and *Grevillea striata* over mid isolated clumps of shrubs of *Carissa lanceolata* over low grassland of mixed species including *Aristida holathera* var. *holathera*, *Eriachne obtusa* and *Sorghum ?stipoides* with *Heliotropium euodes* on floodplains to outwash areas on light brown clay.
- 30 Low woodland of *Eucalyptus pruinosa* subsp. *?pruinosa* and *Bauhinia cunninghamii* over mid isolated shrubs including *Carissa lanceolata* over grassland dominated by *?Dichanthium fecundum* and *Heteropogon contortus* on drainage lines on brown clay.
- 31 Mid sparse to closed sedgeland of *Eleocharis dulcis* and occasionally *Cyperus macrostachyos* over low forbland of *Glinus lotoides* with occasional tall sparse shrubland dominated by *Ludwigia perennis* and *Excoecaria parvifolia* on closed depressions on brown clay.
- 34 Low woodland of *Melaleuca argentea* and *Acacia neurocarpa* over tall shrubland of *Hyptis suaveolens* over low grassland dominated by *Cynodon convergens* on floodplains on brown clay.
- C Cleared Land

Table 11 - Carlton Plain Stage 1 Vegetation Type Extent

Vegetation Type	Area (ha)	% of Carlton Plain Stage 1 Development Area
1	30.9	1.00%
4	4.1	0.13%
11	1230.3	39.87%
14	27.6	0.89%
17	228.8	7.41%
18	371.2	12.03%
19	189	6.12%
20	16.4	0.53%
21	2.6	0.08%
22	827	26.80%
23	98.8	3.20%
28	15.6	0.51%
30	24	0.78%
34	7	0.23%
C	1.6	0.05%
Outside of mapped area	11.1	0.36%
<b>TOTAL (ha)</b>	<b>3,086</b>	<b>100.00%</b>

(Source: Woodman Environmental Consulting (2017), based on 2016 survey)

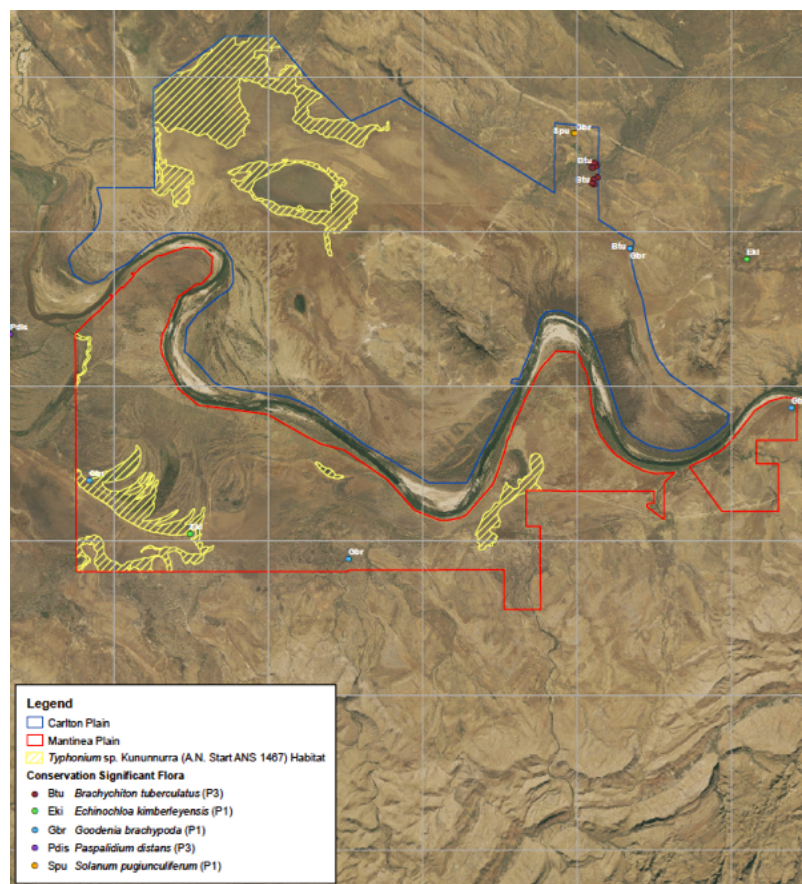
### 4.3.1 Significant Vegetation

No vegetation taxa as listed under the EPBC Act 1999 or Wildlife Conservation Act 1950 were recorded within the project area during the Level 1 dry season survey undertaken by Woodman Environmental Consulting in 2016, or are otherwise historically known within the survey area.

Woodman (2016a) identified that No Threatened Ecological Communities (TECs) will be impacted by the proposal however Carlton Plain Stage 1 forms part of the (Priority 3) Priority Ecological Community (PEC) *Ivanhoe Land System*. Woodman (2016) describes this land system as being listed as a PEC due to the threat posed by agriculture expansion into this specific soil type, which is mainly gently sloping alluvial black soil plains. There are no alluvial black soil plains in the Carlton Plain Stage 1 area.

Special consideration has been given to potential habitat for threatened flora taxa *Typhonium* sp. Kununurra (A.N. Start ANS 1467), given the priority status of this species (P1) and that it is used as an indicator of the Ivanhoe PEC habitat. Figure 12, below, illustrates the known locations of priority species, and potential *Typhonium* sp. habitat within the broader Carlton Plain and Mantinea development areas (which were subsequently surveyed for *Typhonium* sp. during the 2017 wet season, under methodological guidance from DPaW). It should be noted that no suitable habitat for *Typhonium* sp. has been identified within the Carlton Plain Stage 1 area.

Figure 12 - Potential *Typhonium* habitat and priority species locations



(Source: Woodman, 2016b).

Habitats potentially supporting four other Priority flora species have been surveyed across the broader Carlton Plain and Mantinea development area. Figure 12 also includes known records of the following:

- *Brachychiton tuberculatus* (P3)
- *Echinochloa kimberleyensis* (P1)
- *Goodenia brachypoda* (P1)
- *Solanum pugiunculiferum* (P1)

It is noted that none of these taxa have been located within the Carlton Plain Stage 1 development envelope.

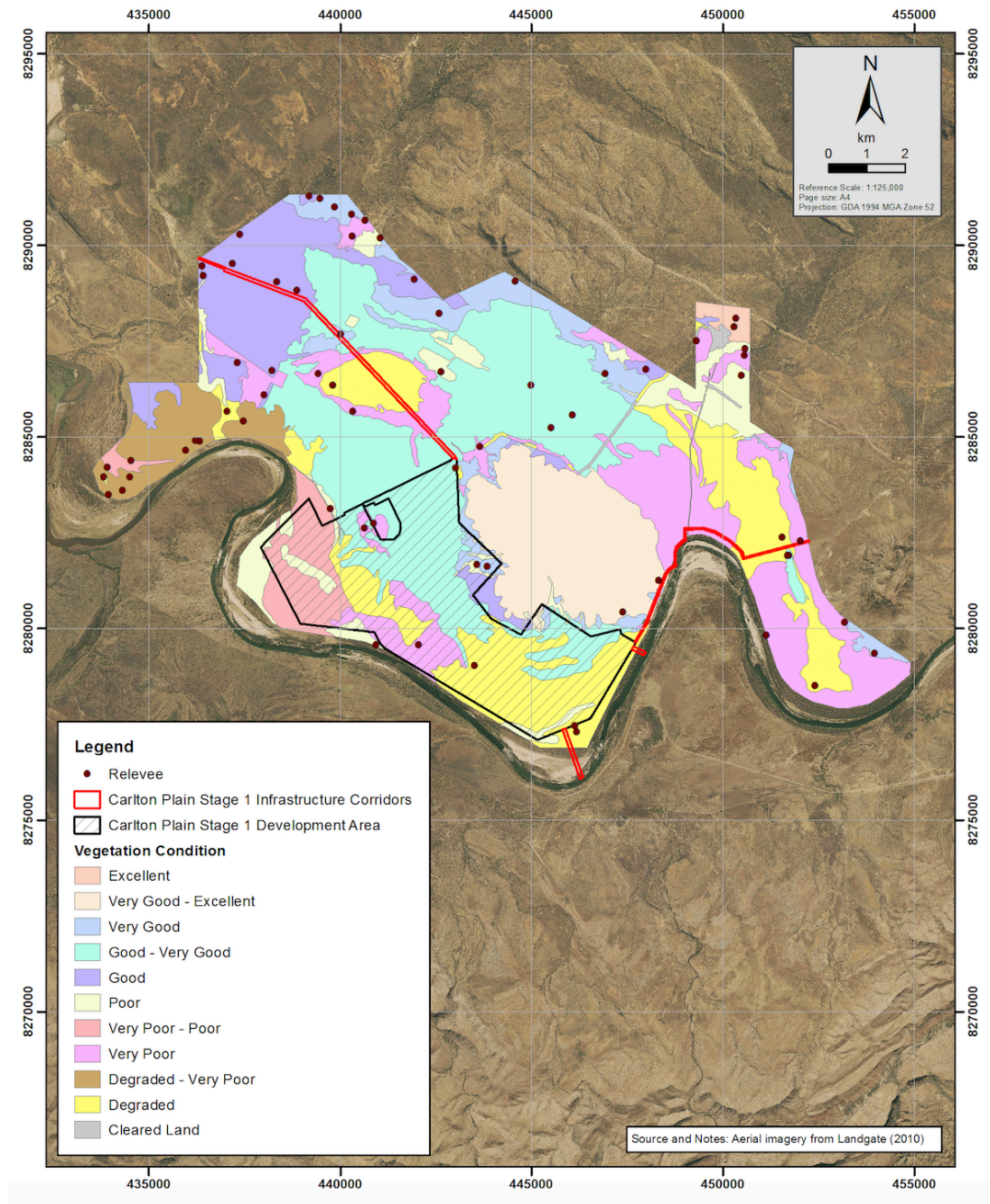
#### 4.3.2 Vegetation Condition

Figure 13 illustrates vegetation condition across Carlton Plain, as determined by Woodman (2016a) following dry season survey. As summarised in Table 12, over 60% of the Stage 1 development envelope is classified as being in poor, very poor, degraded or cleared condition.

Table 12 - Vegetation condition assessment: Carlton Plain Stage 1

Vegetation Condition Rating	Area (ha)	% of total
Cleared	1.6	0.1%
Degraded	1023.2	33.2%
Poor	151.8	4.9%
Very Poor	322.2	10.4%
Very Poor-Poor	371.1	12.0%
Good	57	1.8%
Good-Very Good	1063.5	34.5%
Very Good	69.2	2.2%
Very Good-Excellent	15.2	0.5%
Outside of mapped area	11	0.4%
<b>TOTAL</b>	<b>3086</b>	<b>100.0%</b>
<u>Cleared/Degraded/Very Poor/Poor</u>	<u>1869.9</u>	<u>60.6%</u>

Figure 13 - Vegetation Condition: Carlton Plain Stage 1



### 4.3.3 Weed Class

The search by Woodman (2016a) of the Department of Environment and Energy (DoEE) database identified that 9 significant invasive flora taxa, or habitat for the taxa, are likely to occur or may occur within Carlton Plain and surrounds, including *Andropogon gayanus*, *Cenchrus ciliaris*, *Jatropha gossypifolia*, *Lantana camara*, *Mimosa pigra*, *Parkinsonia aculeata*, *Salvinia molesta*, *Urochloa mutica* and *Vachellia nilotica*. Of these taxa, 7 are listed as Declared Pests in Western Australia under the *Biosecurity and Agriculture Management Act 2007* (BAM Act) and are Weeds of National Significance (WoNS).

Woodman (2016a) mapped weed cover class across the Carlton Plain and Mantinea proposed development areas, including Carlton Plain Stage 1. Figure 14 illustrates weed class assessment prepared as a result of the survey undertaken in 2016. As summarised in Table 13, approximately 40% of Carlton Plain Stage 1 has been assessed to have 20 to 80% weed coverage.

Figure 14 - Weed Cover: Carlton Plain Stage 1

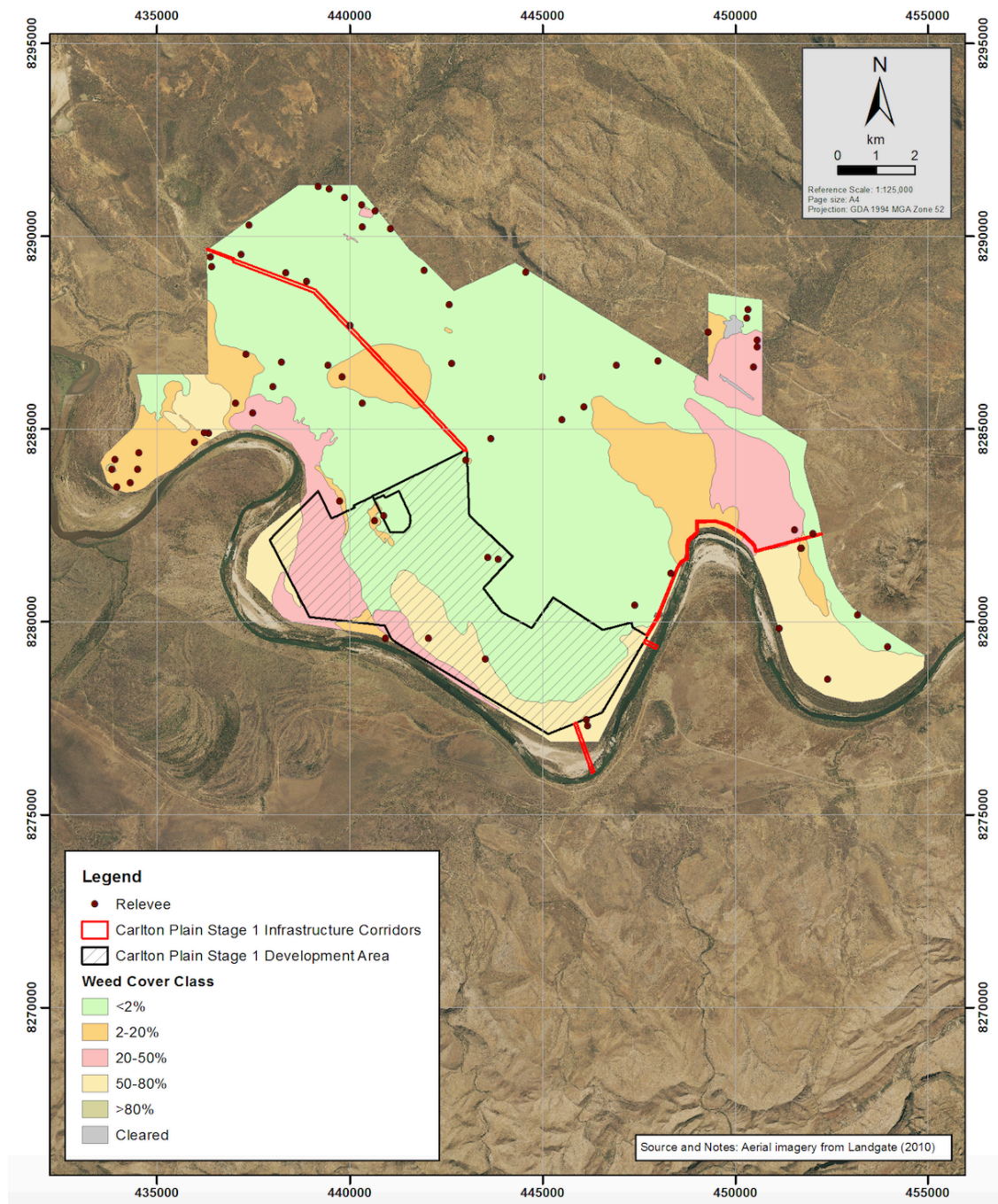


Table 13 - Weed Cover Class by area: Carlton Plain Stage 1

Weed Cover Class	Area (ha)	% of Carlton Plain Stage 1
<2	1,817	58.9%
2-20	68	2.2%
20-50	519	16.8%
50-80	671	21.7%
Outside of mapped area	11	0.4%
<b>TOTAL</b>	<b>3,086</b>	<b>100%</b>

#### 4.4 Potential impacts, predicted outcome and mitigation

This section has demonstrated that the type and condition of vegetation on the clearing footprint described as 'Carlton Plain Stage 1' is expected to have minimal impact on listed priority flora and Matters of National Environmental Significance.

In summary, the vegetation values and associated impacts can be considered thus:

- There are no Threatened Ecological Communities on Carlton Plain Stage 1.
- No priority flora taxa have been recorded on Carlton Plain Stage 1.
- The Priority Ecological Community *Ivanhoe Land System* which has been identified as a PEC due to the alluvial black soil plains which characterise the System, yet no black soil plains and associated vegetation (eg *Typhonium* sp.) can be found on Carlton Plain Stage 1.
- Over 60% of the 3,086ha identified for clearing for agriculture and associated infrastructure has been assessed as being in a degraded, poor, very poor or cleared condition.
- Approximately 40% of the 3,086ha Carlton Plain Stage 1 has been assessed as exhibiting 20-80% weed coverage.

Furthermore, while the Stage 1 development proposes to develop up to 3,086ha for irrigated agriculture and associated infrastructure, over 6,000ha of vegetation across Carlton Plain will be retained in its current state under the proposed full development scenario shown in Figure 5, ensuring that the total landscape will not be cleared under the proposed development arrangements.



## 5.0 Key Environmental Factor 2– Landforms

### 5.1 EPA objective

To maintain the variety and integrity of distinctive physical landforms so that environmental values are protected (EPA 2016c).

### 5.2 Policy and guidance

EPA considerations for Landforms as an environmental factor include the following:

- Application of the mitigation hierarchy to avoid and minimise impacts to distinctive landforms, where possible;
- The landform’s environmental values which are potentially impacted, and their significance;
- The scale of potential impact to the landform and its environmental values;
- The extent of impacts on the landform from previous activities or development;
- The impact of the proposal on the stability and integrity of the landform; and
- The current state of knowledge of the environmental values supported by the landform.

(EPA 2016c)

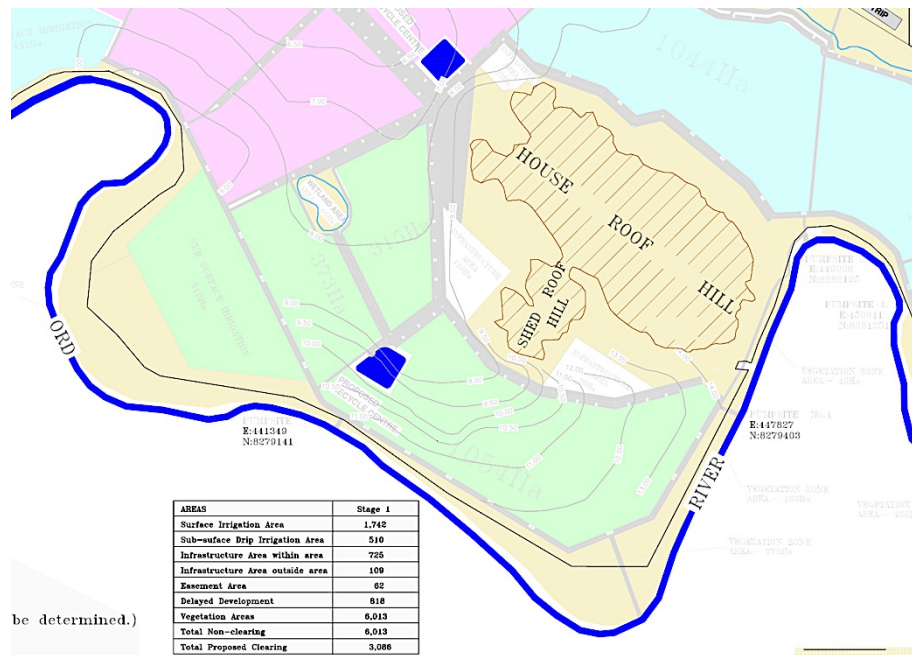
### 5.3 Receiving environment

Carlton Hill Stage 1 is located between House Roof Hill and the Ord River. The proposed area includes the alluvial plains, which are addressed as an environmental factor in further detail in Section 6.0. These plains exhibit a low grade topography, for which contouring for irrigation development will occur to ensure required water distribution and drainage can be achieved.

Figure 15, derived from Figure 4, illustrates the topography of the proposed development area. From the eastern edge of Stage 1, levels at 14mAHD (Australian Height Datum) grade to 8mAHD on the western, downstream side of the development.

Detailed farm planning has been undertaken, with natural contours underpinning the irrigation proposal.

Figure 15 - Carlton Plain Stage 1 Topography



In contrast to the alluvial plains, House Roof Hill extends relatively steeply to approximately 400mAHD. Plate 7 and Plate 8 respectively show the rise of House Roof Hill from the Carlton Plain, and the condition and topography of the proposed infrastructure zone at the base of the hill.



Plate 7 - House Roof Hill (view to east across Stage 1 area).