2. Context

2.1 Project description

The TRR4 Project, as described in the EPBC Act Referral (AECOM 2012a), involves the construction and operation of a motorway approximately 8.7 km in length between Shaw Road and the Bruce Highway, Townsville (**Figure 1**). This work will complete the broader Townsville Ring Road link which is designed to improve flood immunity, safety and travel efficiency along this section of the National Road Network.

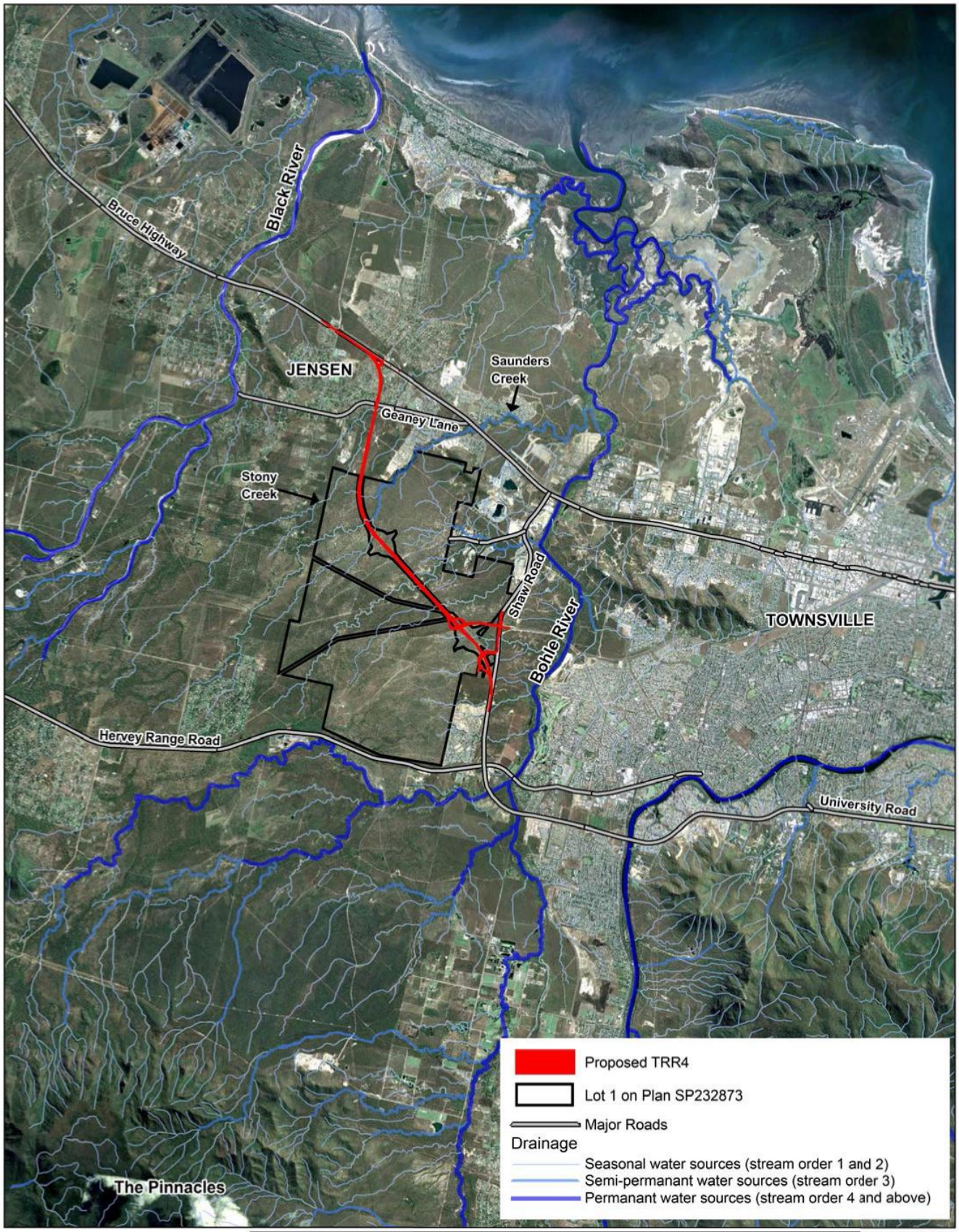
Some of the design parameters for the TRR4 Project have changed from that described in the EPBC Act Referral (AECOM 2012a). Based on information contained in the Referral and more recent advice[3] we understand that the TRR4 Project will broadly involve the following.

- Road alignment as shown on **Figure 1**.
- Four-lane motorway south of Saunders Creek (**Figure 1**) between chainages 19450 and 25550 (*ie* length of 6.1 km). The motorway through this section will comprise two dual-lanes, each 10.4 m wide and separated by a grassed medium strip.
- Vegetation clearing widths between approximately 40 m and 60 m to permit construction and final build. Slightly larger clearing widths are proposed near bridges, some culverts and high embankments to accommodate construction.
- The height of the road embankment for the majority of the alignment is about 2 m.
- Noise barriers are planned adjacent to residential areas near the northern extent of the route.
- All bridging and culverts will be designed for Q50 flooding.

2.2 Environmental setting

The TRR4 Project is on the Bohle Plains, Townsville, part of the Townsville Plains Province of the Brigalow Belt North Bioregion (Sattler & Williams 1999). It is in a relatively flat section of the landscape on older alluvial plain fans and channel infill (Murtha 1975). Streams affected by the route discharge into the Bohle and Black river systems (**Figure 1**). Open eucalypt woodlands and broadleaf tea-tree woodlands dominate the area with thin bands of riparian vegetation occurring along the larger creeks. The majority of proposed route traverses a greenfield area of Unallocated State Land which is currently leased for grazing; mostly cattle though also a few horses. The southern and northern extents pass through or near residential areas.

[3] Notably design information received from AECOM via email 9 August 2013 (shape file data) and 13 August 2013 (description of design change elements).



PROJECT: Townsville Ring Road Section 4 Project Black-throated Finch Supplementary Assessment
TITLE: Geographic context of project area

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Figure 1

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Townsville's climate is characterised by a distinct wet (November to April) and dry season. Due to its geography the region receives less rainfall than other areas in the tropics. Annual rainfall is strongly influenced by storm activity so annual and monthly totals are highly variable. The average annual rainfall is 1,143 mm and the average number of rain days is 91 (http://www.bom.gov.au/qld/townsville/climate_Townsville.shtml).

2.3 Previous studies

AECOM has undertaken two studies relevant to Lot 1 SP232873. The first study[4] occurred in October 2012 (AECOM 2012b) and involved a two-day field survey and habitat assessment. The field survey included morning observations of two water sources over two days. These water sources correspond with stock Dam 7 and the northern-most water trough (2 km north of Dam 3) as shown on **Figure 2**. No BTFs were seen during this study.

The second AECOM study on Lot 1 SP232873 occurred in May 2012 (AECOM 2012c). This study was the initial ecological assessment for the TRR4 Project and involved a five-day field survey between 14 and 25 May 2012. During the survey a pair of adult BTFs was recorded approximately 1 km west of the TRR4 Project alignment. This sighting prompted a more detailed assessment of BTF occurrence in the area by NRA (NRA 2012).

The NRA 2012 study involved a desk-based assessment and four day field survey for BTFs between 5 and 8 June 2012. BTFs were recorded at three general locations, including the area where AECOM 2012c had sighted the species. The results of the field survey and desk-based assessment were used to produce predictive mapping for dry and breeding season habitat for BTFs. Based on the above results and preliminary road design information, the potential impacts of TRR4 Project on BTFs were assessed. The study concluded that significant impacts[5] may occur and recommended that the project be referred to DSEWPaC for assessment under the EPBC Act. Further BTF surveys to inform the assessment were also recommended.

2.4 DSEWPaC Request for Information

As described in **Section 1**, the TRR4 Project was submitted for assessment under the EPBC Act and was deemed a controlled action due to potential impacts on threatened species. DSEWPaC's subsequent Request for Information[6] asked QTMR to provide more details on the potential impacts of the TRR4 Project and the management of those impacts. The sections of the Information Request relevant to the scope of this current study are shown below.

1. Matters of National Environmental Significance

Provide detailed information on the likely presence, distribution, ecology and habitat of listed threatened species, communities or other matters of National Environmental Significance (MNES) likely to and/or potentially occurring at the project site and adjacent areas. Information should be obtained from previous records, fauna databases, scientific literature and other reports. Provide a discussion on all potential direct and indirect impacts of the proposal on the listed threatened species or communities. Types of indirect impacts

[4] This study was not related to the TRR4 Project.

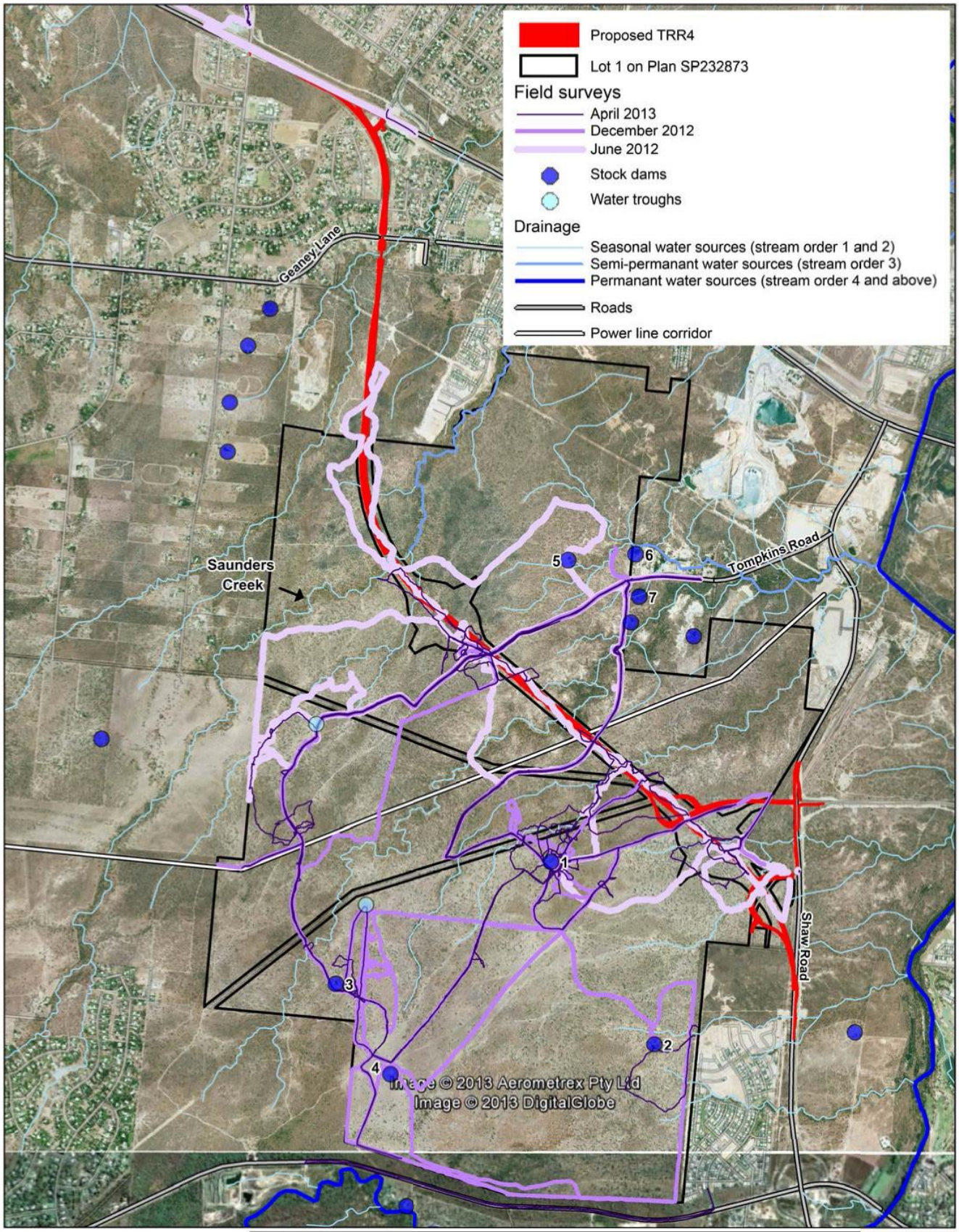
[5] As defined under the EPBC Act.

[6] Dated 8 November 2012.

may include, but are not limited to: changes to water quality, introduction of pathogens and edge effects either during or post construction.

2. Black-throated Finch (Southern) – Poephila cincta cincta

Conduct targeted field surveys of the subject site and surrounding areas to determine the presence, numbers and location of the Black-throated Finch (Southern). The surveys must include both dry and wet season surveys for the species and the survey methodology must be developed in accordance with the "Survey Guidelines" within the Background paper to the EPBC Act policy statement 3.123, available at http://www.environment.gov.au /epbc/publications/black-throated-finch.html.



PROJECT: Townsville Ring Road Section 4 Project Black-throated Finch Supplementary Assessment
TITLE: General field survey areas

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Figure 2

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3. Methods

The study involved a desk-based assessment and targeted dry and wet season[7] field surveys. The results of the desk-based assessment informed the design of the field surveys. The following information sources were reviewed during the desk-based assessment:

- the proposed TRR4 route as supplied by AECOM
- Regional Ecosystem (RE) mapping (1:100,000) Version 6.1 conducted by the Queensland Herbarium (formerly the Queensland Department of Environment and Resource Management, DERM, now the Department of Environment and Heritage, EHP)
- soil mapping (1:100,000) by Murtha 1975
- aerial imagery from Google Earth
- BTF sightings held in a database maintained by NRA
- habitat mapping for the BTF undertaken by NRA (NRA 2006)
- information contained in NRA 2012 and AECOM 2012a, b, c.

The dry season field survey was conducted by NRA's Peter Buosi, Ainslie Langdon and Kate Grundy over five days between 10 and 14 December 2012. The survey involved the following tasks.

- **Water source watching**. Five water sources (stock dams) were chosen for timed observation; shown as stock Dams 1 to 5 on **Figure 2**. These sites were chosen due to their proximity to the TRR4 alignment and likelihood, based on habitat modelling (NRA 2012), of supporting BTFs. Survey effort devoted to each water source is described below. Greater survey effort was devoted to those dams located closer to the proposed alignment. When assigning survey effort consideration was also given to the level of existing information available for each site and the likelihood of those sites supporting BTFs.
  - Stock Dam 1 was watched for three hours after sunrise on two separate days and for three hours prior to sunset on one of those days. The second afternoon of planned observation was abandoned because sufficient information had been collected[8].
  - Stock Dams 2, 3 and 4 were each watched for three hours after sunrise and for three hours prior to sunset.
  - Stock Dam 5 was watched for three hours after sunrise and three hours prior to sunset on two separate days.

[7] The term 'wet season' survey reflects the terminology used by DSEWPaC in their Request for Information (***see* Section 2.4**). The main purpose of this survey is to collect information on BTFs while they are breeding which in the Townsville region usually occurs late in the wet season and/or early dry season.

[8] The effort was re-directed to targeted searches for BTFs and their nests.

- **Targeted searches**. Targeted searches for BTFs and their nests were made around water sources and along sections of the TRR4 alignment where, based on the results of NRA 2012, BTFs were predicted to occur[9]. Whenever BTFs were encountered an attempt was made to follow the birds to collect data on their abundance, behaviour and movements. The areas inspected during the survey, as recorded in the track log of a hand-held GPS[10], are shown on **Figure 2**.
- **Habitat assessment**. Vegetation assessments were made while traversing the site at locations where BTFs were observed and where there were noticeable changes in vegetation type or condition. The format and manner in which information was collected was similar to quaternary level assessments as described by Neldner *et al.* 2012 though adapted to capture specific information relevant to BTFs and the study.

During the course of the survey, stock water troughs were found at two locations (**Figure 2**). These structures are less reliable than the stock dams as water sources for BTFs for the following reasons.

- The troughs are steep-sided and inaccessible to finches unless sticks, or similar perches, are placed in the trough[11].
- The presence of water in the troughs is influenced by livestock management considerations which may not correlate with changes in season, *ie* water availability is unpredictable.

While BTF activity at the troughs was not anticipated, for completeness, the northern trough was observed for three hours of one afternoon and the southern trough was observed on two separate occasions; a 1.5 hour observation and a 15 minute observation. The northern trough occurs along the main access track through the property and as such was observed on numerous occasions (more than twice daily) during the survey period.

The wet season survey was conducted by NRA's Peter Buosi and Ainslie Langdon over five days between 8 and 12 April 2013. The survey involved targeted searches and habitat assessments as described for the above dry season survey. The areas inspected during the survey, as recorded in the track log of a hand-held GPS, are shown on **Figure 2**. Greater focus was devoted to the following areas.

- Areas where BTFs had previously been seen (AECOM 2012c, NRA 2012, dry season survey of current study).
- The southern extent of the TRR4 alignment. Previous NRA survey work suggested that impacts of the TRR4 alignment were more likely to occur in this area.

[9] Locations where BTFs were predicted to occur, as represented by habitat modelling, is discussed in **Section 4.2.3**.

[10] The track log is that of the survey team leader Peter Buosi and is provided as a general indication of the areas inspected during the survey. The other team members surveyed in similar, though not identical, areas.

[11] Some graziers place sticks in water troughs so trapped wildlife can escape.

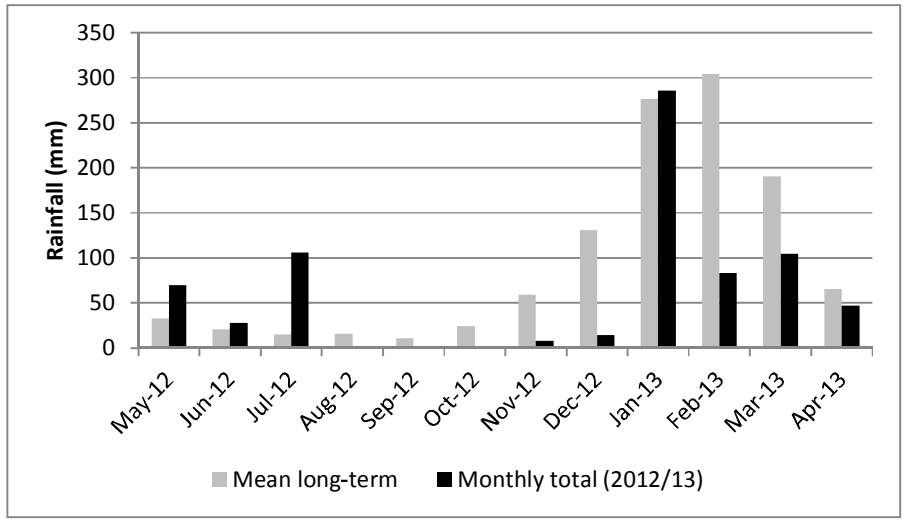
4. Results

4.1 Survey timing and conditions

The weather conditions during each survey event are described below.

- **Dry season survey (December 2012)**. The weather was warm and sunny during the survey period with daytime temperatures between 31.7°C and 32.8°C and overnight temperatures between 21.8°C and 24.2°C. These are normal temperatures for this time of year. There were gentle breezes during most of the survey.
- **Wet season survey (April 2013)**. There were overcast skies and short periods of light rain during the survey which meant temperatures were relatively cool. Daytime temperatures were between 23.1°C and 30°C and overnight temperatures were between 19.3°C and 23.8°C. There were many occasions during the survey period when light breezes and light rain[12] reduced the detectability of BTFs, *eg* wind and rain noise masks the call of BTFs making them harder to find and may discourage them from calling (*pers. obs.* Peter Buosi, NRA.).

Less than 10 mm of rainfall occurred in the three months prior to the December 2012 dry season survey (**Graph 1**) and in the study area water sources were limited to stock Dams 1 to 6 and the water troughs (**Figure 2**). Under these conditions BTF activity was expected to be centred on those dams where conditions, including vegetation types, were suitable for BTFs.



Source: www.bom.gov.au

Graph 1: Monthly total rainfall (May 2012 to April 2013) and long-term average monthly rainfall

The wet season survey took place in April 2013 and although rainfall in the preceding months was below average (**Graph 1**) many seasonal water sources (*eg* ephemeral streams and wetlands) contained water. In Townsville, April is usually the late wet season and within the core breeding period for BTFs (NRA 2007). Generally around this time adult BTFs are either preparing to breed or are caring for eggs, nestlings or attendant young. BTF

[12] Daily rainfall (>0.1 mm) during survey period as recorded by www.bom.gov.au: 10/04/2013 (3.6 mm), 11/04/2013 (22.2 mm) and 12/04/2013 (22.6 mm).

movements are usually restricted with birds remaining in near proximity[13] to their nesting sites (NRA 2007).

There were no extreme weather events (*eg* cyclones, floods or droughts) or other notable disturbances (*eg* fire) in the months before either survey; conditions were generally favourable for BTF searches.

4.2 Field survey results

4.2.1 Black-throated Finch sightings

December 2012 dry season survey

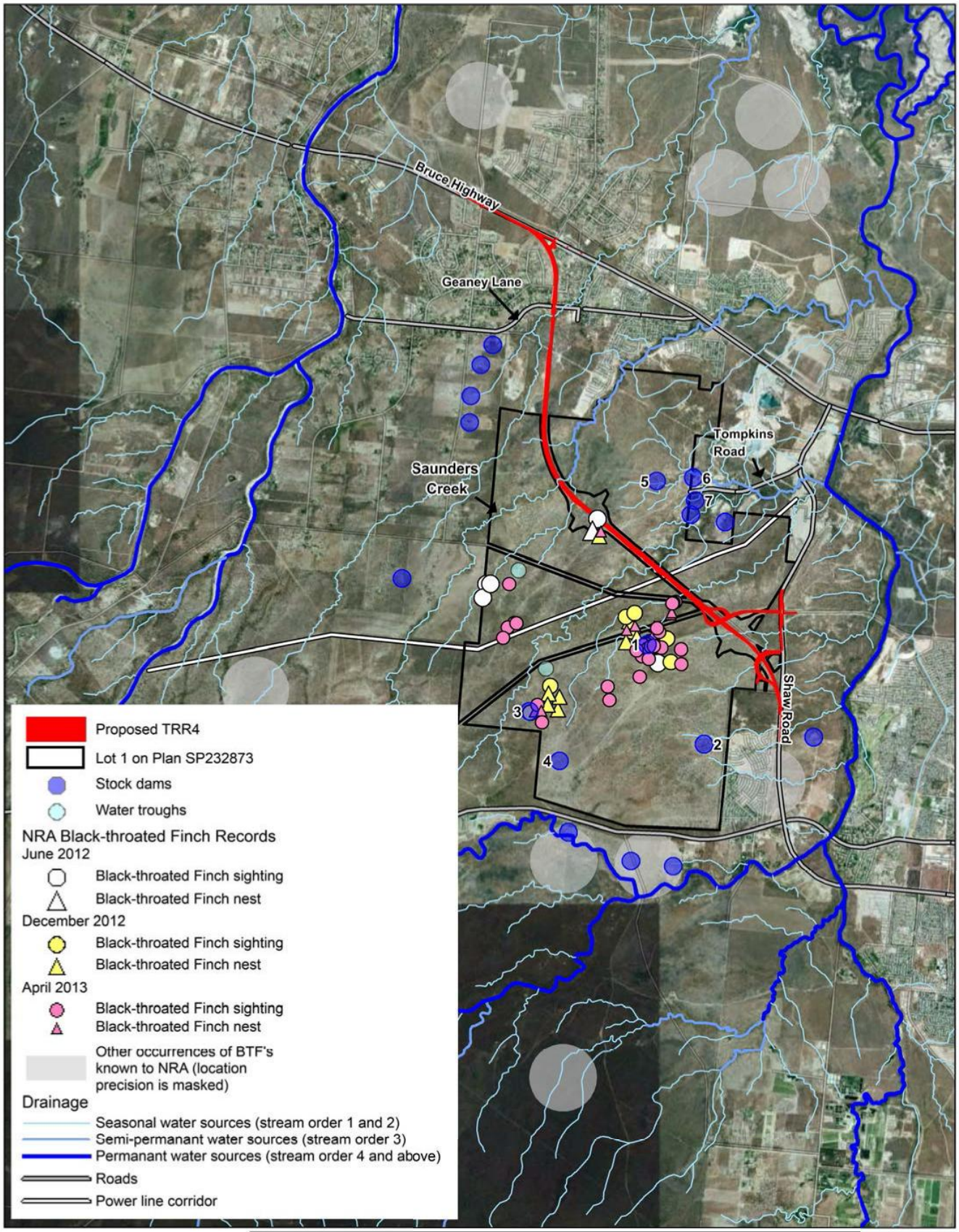
BTFs were sighted at two general locations during the dry season survey; the two locations were separated by about 1.5 km. These sighting locations were approximately 1 km (vicinity of Dam 1) and 2.5 km (vicinity of Dam 3) from the TRR4 route (**Figure 3**) and are summarised below.

- **Dam 1**. BTFs were regularly seen drinking at Dam 1. Adult pairs were mostly seen though small groups of four to seven birds were also commonly encountered. The maximum group size was 15 BTFs which were foraging in a mixed-species flock with Double-bar Finches (*Taeniopygia bichenovii*) about 500 m north-west of Dam 1. About 20 BTFs were thought to be active in the area, nearly all of which were adults. Nests known or thought to be BTF nests were found about 300 m and 430 m north-west of Dam 1. Given the number of BTFs in the area other nesting sites would have been present though they were not found by the survey team.
- **Dam 3**. Twenty BTFs were seen foraging about 470 m north-east of Dam 3. The fact that BTFs were only seen drinking at Dam 3 on one occasion (a group of seven birds) suggests that the birds were using an alternative water source, most likely one of the cattle troughs[14] (**Figure 3**). Four BTF nests were found near to the area where the group of 20 birds were foraging (**Figure 3**). Given the number of BTFs in the area other nesting sites would have been present though they were not found by the survey team.

A BTF nest was also found near the TRR4 route to the west of Tompkins Road (**Figure 3**). This nest is about 180 m from the TRR4 route and was the same nest sighted in May 2012 (NRA 2012) at which time BTFs were active in the area. In December 2012 the nest was in good condition though no BTFs were seen in this area.

[13] Isles 2007 observed three pairs of BTFs during the breeding season and found that they seldom flew more than 350 m from their nest.

[14] The nearest cattle trough had a stick placed in it which BTFs may have utilised as a perch to access the water.



PROJECT: Townsville Ring Road Section 4 Project Black-throated Finch Supplementary Assessment
TITLE: Black-throated Finch sightings recorded by NRA in June 2012, December 2012 and April 2013

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April 2013 wet season survey

During the wet season, BTFs were seen in pairs or small groups, and in comparison to the dry season, the birds were dispersed over a larger area (**Figure 3**). The movement of some birds away from Dams 1 and 3 presumably reflects the wider availability of water in the landscape. Juveniles were often seen in the company of adult birds which confirms that the survey occurred during the breeding season.

There is insufficient data to identify and describe the observed BTFs occurrences according to breeding colonies. However, it is worth noting that other studies have identified breeding colonies as groups of BTFs that have little interaction with each other and are separated by 700 m (Zann 1976) and 500 m (NRA 2006). To provide continuity with the dry season survey results, the wet season BTF sightings are described below with broad reference to Dams 1 and 3.

- **Dam 1**. The following summary takes into account BTF sightings within 1 km of Dam 1.
  - ***Location A*** refers to the group of BTFs (two adult and two juveniles) that were seen near a second order stream approximately 230 m west of the TRR4 route (about 700 m north-east of Dam 1). BTF nests were also found in the vicinity of the sightings. These sighting and nest records are the closest that BTFs have been seen to the TRR4 alignment during recent studies, *ie* AECOM 2012b, c, NRA 2012 and this study. The adjacent creek contained long pools of water which suggests that their wet season activity was centred on these ephemeral water sources as opposed to Dam 1 where other BTFs were active.
  - ***Location B*** refers to the various sightings of BTFs and their nests within 300 m of Dam 1 (the BTF records were between 700 m and 1.1 km of the TRR4 route). This area supported the highest level of BTF activity during the survey with adult pairs and/or small groups (adults ± juveniles) maintaining an almost constant presence in the area. The largest group size seen was 13 birds (adults and juveniles). Nests were found to the north and north-west of Dam 1. Given the number of BTFs in the area other nesting sites would have been present though were not found by the survey team.
  - ***Location C*** refers to the three BTF sightings between 300 m and 500 m of Dam 1. These records are west and south of Dam 1 and between 700 m and 1.5 km of the TRR4 route. Only single adult birds were seen to the west of Dam 1 and a family group (two adults + three juveniles) were seen to the south. The location of the nearest water source to these sightings, and therefore the centre of activity for these birds, is unknown. These birds were either drinking from Dam 1 or from gilgais[15] that are known to occur in that part of the landscape. The presence of a family group, which typically do not range far at this time of year (Isles 2007, NRA 2007), suggests the latter was more likely.
  - ***Location D*** refers to the two sightings between 800 m and 1 km south of Dam 1 which is about 1.2 km north-east of Dam 3 and about 2 km from the TRR4 route. Both sightings were of single birds and they may have been the same individual. The nearest water source to these sightings, and therefore the centre of activity for this/these bird(s), is unknown, though they were probably drinking from gilgais. Given their relative proximity to Dams 1 and 3, it is not clear from which December 2012 dry season population they belonged.

[15] Gilgai are repeated mounds and depressions formed on shrink-swell and cracking clay soils (or vertosols); water can accumulate seasonally in the depressions to form gilgai wetlands (source: http://wetlandinfo.derm.qld.gov.au)

- **Dam 3**. The following summary takes into account those BTF sightings around Dam 3 and those within 2 km to the north.
  - ***Location E*** refers to the two BTF sightings and BTF nests within 200 m of Dam 3 (about 2.7 km from the TRR4 route). One sighting was of an adult pair and the other was of four BTFs (presence of juveniles unknown). Both nests were to the west and within 100 m of the dam. BTF activity near Dam 3 was much lower than that observed in the December 2012 dry season survey.
  - ***Location F*** refers to the four BTFs seen near a vehicle track between 1.1 km and 1.3 km north of Dam 3 (about 2.1 km from the TRR4 route). The birds were only briefly seen and not re-sighted in the area despite repeated searches. No nests were located near to the sighting locations. Water was found pooling nearby in deep wheel ruts and gilgais were present in the general area.
  - ***Location G*** refers to the two adult BTFs seen approximately 1.9 km north of Dam 3 (about 1.6 km of the TRR4 route). These birds were between 600 m and 800 m north of the birds seen at Location F (described above). Given the respective timing of the sightings, the birds at Location G were not the same birds as those seen at Location F though it is possible that they belong to the same general group. Water was present in a small wetland (approximately 4 m diameter). The nearest permanent water source (a stock dam) occurs about 1.6 km to the west on the neighbouring property (*ie* outside the survey area) and habitat modelling done by NRA 2012 suggests suitable habitat occurs around this dam. It is possible that these birds spent the previous dry season at this dam as opposed to Dam 3.

The BTF nest found in May 2012 and re-sighted in December 2012 was still intact in April 2013. As described previously this nest is west of Tompkins Road, about 180 m from the TRR4 route. The continued good condition of the nest suggests that BTFs or Double-bar Finches[16] had used it sometime in early 2013.

4.2.2 Previous field survey results

As described in **Section 2.3** three other studies relevant to the current BTF assessment have been conducted at the site, *ie* AECOM 2012b, c and NRA 2012. BTF sightings from the NRA 2012 study are shown on **Figure 3** (shown as June 2012 records). The AECOM 2012b records are not shown as they were very close to the north-western sightings made by NRA 2012. BTFs were not found during the AECOM 2012b study which included dedicated observations at stock Dam 7 and the northern water trough (**Figure 2**). These results are consistent with the December 2012 survey results from the current study, *ie* BTFs were not frequenting these water points.

4.2.3 Vegetation (habitat) suitability and condition assessments

During field surveys for the current (December 2012 and April 2013) and previous (NRA 2012) study, the potential suitability of vegetation types for BTFs was assessed at specific sites. Assessments involved consideration of plant species composition, vegetation community structure and condition. The suitability of vegetation as BTF habitat was assessed as either 'Likely', 'Possible/Marginal' or 'Unlikely'. The assessment results from all NRA survey events (*ie* NRA 2012 and current study) are shown on **Figures 4** and **5**. As our understanding of BTF habitat requirements is incomplete, the assessments draw on our experience at other sites in Townsville over the last decade. A limitation of this approach is

[16] Although it's not common, Double-bar Finches and BTFs have been known to occupy nests made by the other species (*pers. obs.* Peter Buosi, NRA).

that observations made at a site level do not always reflect the situation in the wider landscape. For example, a site might be assessed as suitable habitat without the assessor knowing that the patch is too small to function as suitable habitat.

Predictive modelling for BTF habitat was conducted as part of the NRA 2012 study. Separate mapping outputs were produced for dry season and breeding/wet season scenarios. The decision rules used for the habitat model were based on a review of the following.

- Habitat modelling previously conducted for the Townsville region (NRA 2006).
- Site-specific information on habitat preferences obtained by plotting BTF records (historical and NRA 2012 study) from the study area and surrounding landscape onto RE (Queensland Herbarium Version 6.1) and soil (Murtha 1975) mapping.

A more detailed description of the decision rules are provided in **Appendix 1**.

To assist the current study, the NRA 2012 BTF habitat mapping was refined using the field vegetation assessment data; the revised maps are shown on **Figures 4** and **5**. The main changes to the NRA 2012 maps are described below. Stippling on **Figures 4** and **5** shows the areas affected by these changes.

- **Reduction in extent of 'higher probability habitat'**. The following general areas were changed from 'higher probability habitat' to 'higher probability supporting habitat'[17].
  - An area south of Dam 7 (**Figure 3**) and around the power line easement. Most of this area contained unsuitable vegetation types for BTFs.
  - An area in the north-east of Lot 1 SP232873. BTFs or their nests were not found in this area and vegetation was at best 'possible/marginal' suitability. The 20 m contour line marks the boundary between 'higher probability habitat' and 'higher probability supporting habitat'.
  - All areas north of Saunders Creek. BTFs or their nests were not found north of Saunders Creek and vegetation in this area was mostly 'possible/marginal' suitability.
- **Reduction in extent of 'higher probability supporting habitat'**. An area in the south-west of Lot 1 SP232873 mapped as 'higher probability supporting habitat' was found to contain dense patches of rat's tail grass (*Sporobolus* sp., probably *S. jacquemontii*) and/or chinee apple (*Ziziphus mauritiana*). This area is unsuitable habitat for BTFs.

The mapping shown on **Figures 4** and **5** broadly indicates the location and extent of BTF habitat along and near the TRR4 route and more generally on Lot 1 SP232873. The different habitat mapping categories and vegetation assessment categories can be used to help identify the higher quality and more suitable (*ie* core) areas of habitat. From a habitat perspective the dry season 'higher probability habitat' areas (**Figure 5**) are the most limiting, and therefore critical, for the species' persistence in the landscape. However, these landscapes are dynamic and the relative importance of specific areas may change over time. The long-term viability of BTF populations in a given area is therefore reliant on large and interconnected areas of core and supporting habitat.

[17] It was determined that these areas were more likely to function as supporting habitat as opposed to core habitat, *eg* BTFs might move into these areas when fire or other disturbances impact on the core parts of their range.

Weed ingress currently poses the greatest threat to BTF habitats on Lot 1 SP232873. The main threats are chinee apple, exotic forbs and exotic grasses. The threats posed by these species and groups are described below.

- **Chinee apple**. While chinee apple is widespread, the largest and most dense stands occur in the southern quarter of the Lot, including the southern end of the TRR4 alignment (in the vicinity of Shaw Road). While the species is quite sparse around Dam 1, dense patches occur to the west and south of Dam 3. The presence of seedlings and young plants suggests that this species is increasing in abundance in these areas. Dense stands of chinee apple negatively impacts on BTF habitat in two ways. Firstly, it reduces the abundance of seeding grasses, and therefore food resources for BTFs. Secondly, it can change the open vegetation community structures that BTF prefer into the more cluttered or dense community structures which BTFs seem to avoid.
- **Exotic forbs**. Snakeweed (*Stachytarpheta jamaicensis*) and stylo (*Stylosanthes* spp.) are the main exotic forbs threatening BTF habitat on the Lot. While these species are widespread they are particularly common along the ephemeral streams. Large patches of snakeweed were also seen on the plains to the east of the northern cattle trough. Dense stands of snakeweed negatively impact on BTF habitat by reducing the abundance of seeding grasses and by reducing accessibility to ground stored seed[18].
- **Exotic grasses**. While numerous exotic grass species occur on the Lot rat's tail grass (probably *S. jacquemontii*) is by far the most abundant and widespread. The largest patches and most dense stands occur in the southern half of the Lot. Vast mono-specific swards of this species occur to the west of Dam 4 and to the south and east of Dam 1 (dam locations shown on **Figures 2** and **3**). Large patches also occur around Dam 3 and along the southern end of the TRR4 alignment. Like snakeweed, dense stands of rat's tail grass negatively impact on BTF habitat by reducing the abundance of other seeding grasses and by reducing accessibility to ground stored seed[19].

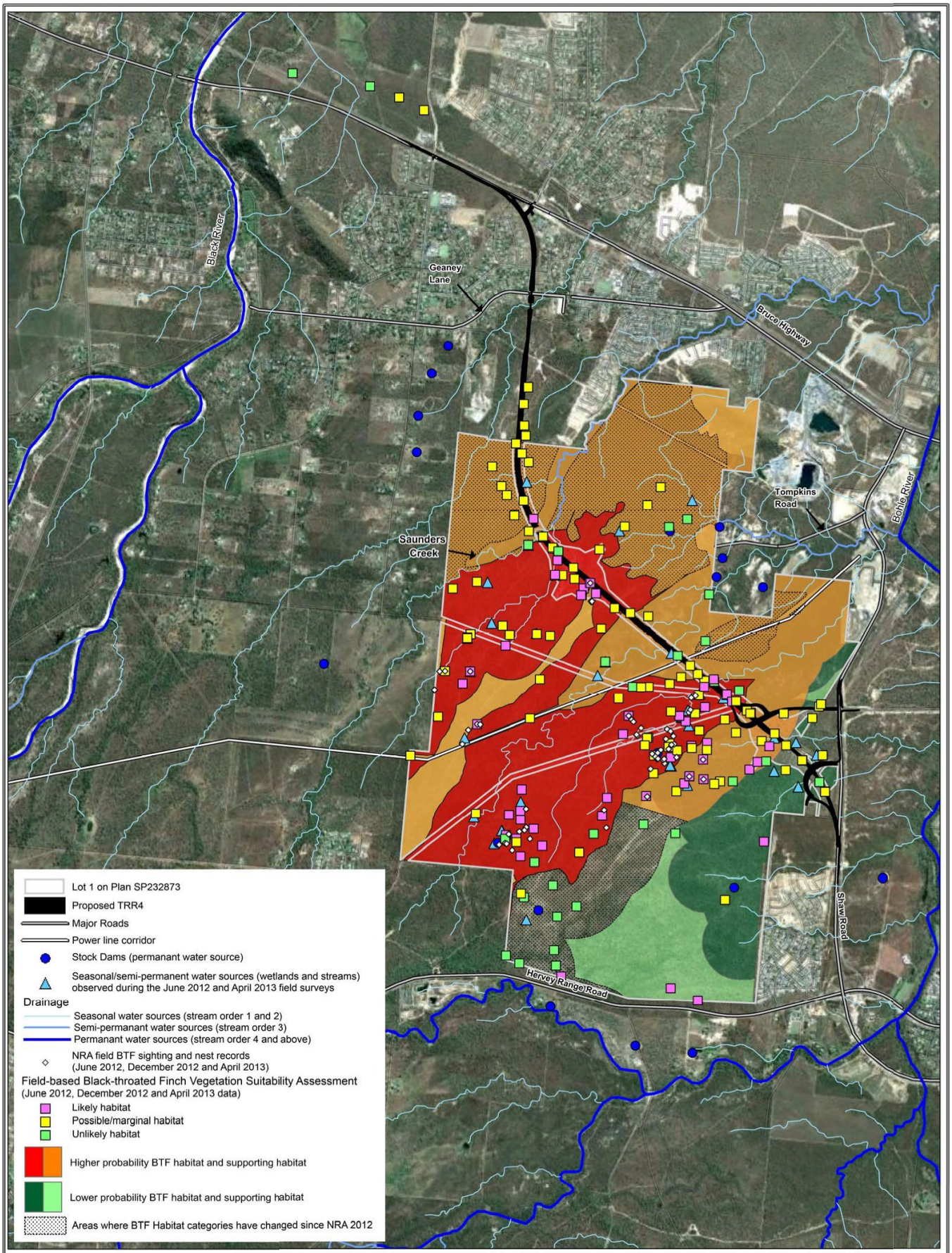
Over-grazing and/or unsuitable fire regimes have probably caused the proliferation of the above weed species. All weed species are well-entrenched in the landscape and unless they are carefully managed they will continue to increase in density and extent. Rat's tail grass is the greatest concern because of the large size of the infestations and their proximity to Dams 1 and 3, *ie* core BTF habitat. Rat's tail grass is relatively unpalatable to stock, and if grazing is not carefully managed, will exacerbate its spread. This was evident in some of the areas inspected during the field survey where cattle were grazing heavily on native grasses while rat's tail grass remained untouched.

4.3 Other findings

The locations of other State or Commonwealth listed Threatened and/or Migratory fauna and flora were recorded during field surveys. The southern subspecies of Squatter Pigeon (*Geophaps scripta scripta*) was the only other State or Commonwealth listed species recorded. This species is listed as Vulnerable under the EPBC Act and Queensland *Nature Conservation Act* 1992. As per the study scope, the raw data (species, abundance and location) was provided to AECOM on 21 May 2013 without analysis or interpretation.

[18] BTFs preferentially forage on the ground between grass clumps and dense ground layers prevent and/or discourage this.

[19] Due to the small size of its seed, rat's tail grass is probably a poor quality food source for BTFs; even when it grows sparsely enough to be accessible for ground foraging. Furthermore, the continuity of food availability for BTFs is less in mono-specific grasslands (like that created by rat's tail grass) because seed production is restricted to a specific time period as opposed to heterogenous grasslands where each grass species produces seed at slightly different times.



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TITLE: Potential distribution of BTF habitat during the breeding season

JOB NO: 248068
DATE: August 2013

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Figure 4

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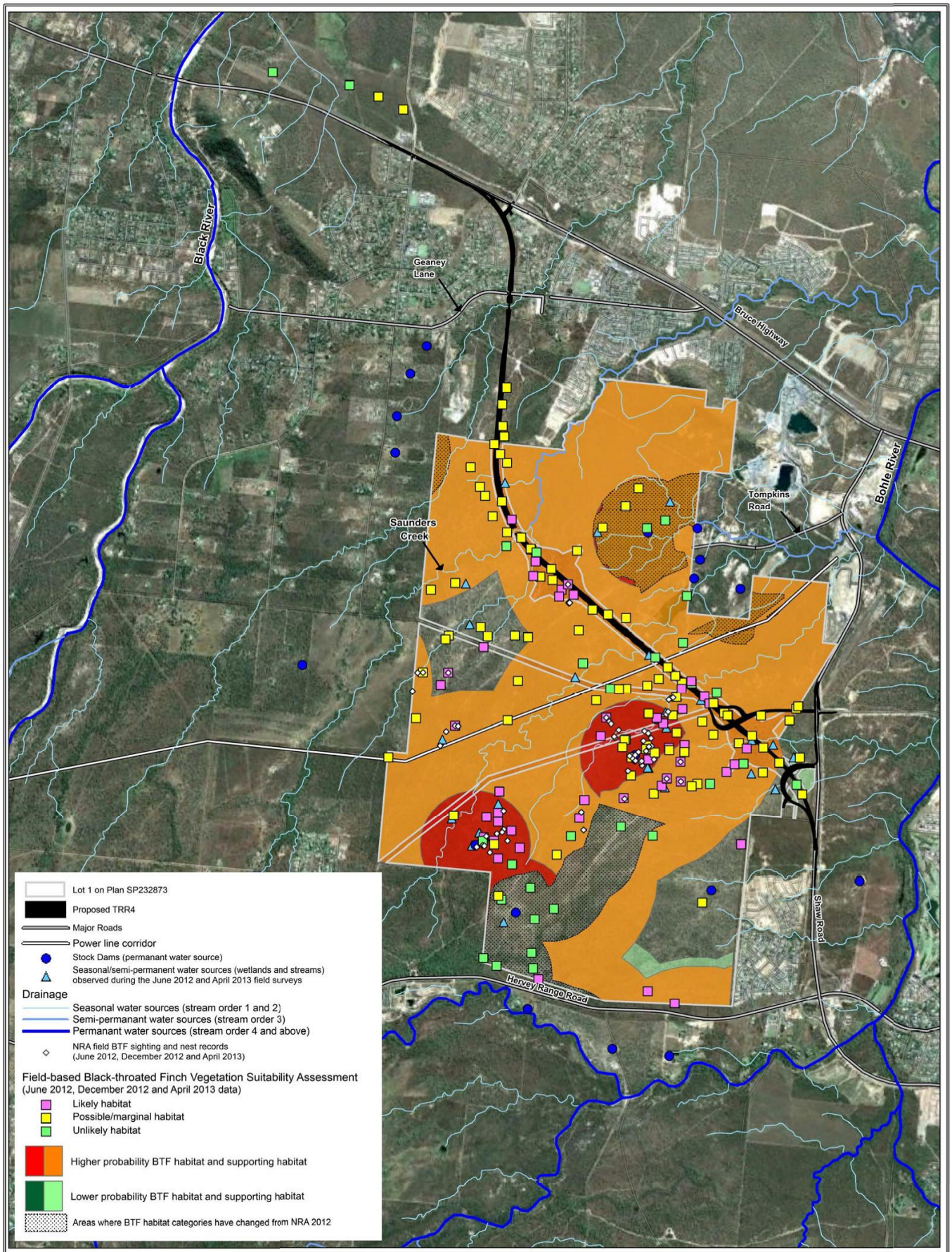

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TITLE: Potential distribution of BTF habitat during the dry season

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Figure 5

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5. Discussion

5.1 Conservation significance of the TRR4 and immediate surrounds for Black-throated Finches

Field surveys found two BTF populations, or colonies, residing on Lot 1 SP232873. These populations are centred on Dams 1 and 3 and in the dry season of 2012 each population comprised about 20 adult birds (**Figure 3**). This number is likely to fluctuate seasonally and annually according to conditions. Based on current knowledge this is at least a medium-sized population for Townsville. Given the dramatic decline in abundance of BTFs over the last decade and their patchy distribution in Townsville, remnant populations of this size are of regional conservation importance. Within and near the TRR4 Project area, breeding habitats and dry season habitats are of greatest importance, particularly the latter given the limited availability of permanent water sources.

The location and connectivity of BTF populations on Lot 1 SP232873 with respect to surrounding populations and habitat is summarised as follows.

- **North of Lot 1 SP232873**. Lot 1 SP232873 has tenuous connectivity via a few small patches of remnant vegetation and riparian forests (Bohle River and Saunders Creek, **Figure 1**) to potential BTF habitats to the north. These habitats to the north are rapidly being cleared for residential development. BTFs are rarely reported north of the Bruce Highway and surveys by NRA in one of the large areas of apparently suitable habitat suggest that BTFs maintain, at best, a sporadic presence in that landscape[20]. BTF persistence north of the Bruce Highway is probably diminishing over time as more sections of the landscape are developed. Recent upgrades and increased traffic volumes along the Bruce Highway in the vicinity of the Bohle River and Saunders Creek has probably reduced north-south connectivity through this area.
- **East of Lot 1 SP232873**. Only a narrow (at most 1.5 km wide) band of remnant vegetation remains to the east of Lot 1 SP232873, *ie* between Shaw Road and the Bohle River (**Figure 1**). Based on observations made from the road during the current study, aerial imagery, vegetation mapping (Queensland Herbarium Version 6.1) and BTF habitat mapping (NRA 2006) BTFs and their habitat are not expected to occur immediately east of the Lot. The Bohle River may, however, function as a movement corridor for BTFs dispersing north and south of the Lot.
- **South of Lot 1 SP232873**. While there are historical records of BTFs immediately south of Lot 1 SP232873, recent surveys (May 2013, *report in prep.)* by NRA in this area indicate that only very small numbers of BTFs remain and the quality of remnant habitats has markedly deteriorated in the last five years.
- **West of Lot 1 SP232873**. BTFs occur to the west of Lot 1 SP232873, however the area is largely unsurveyed and little is known about the birds and quality of habitat in this area.

The above summary points to the increasing isolation of the BTF population(s) residing on Lot 1 SP232873. Suitable habitat no longer occurs to the east and habitats to the south and north are deteriorating; the latter is also being lost to development. BTF populations and

[20] NRA conducted pre-clearing BTF surveys for the North Shore residential development in 2003, 2005 and annually (wet and dry season) between 2007 and 2012. This development is situated on a 929 ha block immediately north of the Bruce Highway and west of the Bohle River.

habitat presumably occur to the west though the extent, quality, and therefore viability, of these habitats are unknown. These findings are slightly different to that reported in NRA 2012 which didn't have access to the same level of information.

The likelihood of BTFs persisting in Lot 1 SP232873 is dependent upon land management practices that are sympathetic to the species' requirements, including the implementation of adequate controls for existing threats, notably weeds and mechanisms facilitating their proliferation, *eg* fire and grazing regimes.

5.2 Potential impacts of the TRR4 Project on Black-throated Finches

5.2.1 Potential threats of the TRR4 Project on Black-throated Finches

As described in NRA 2012 the TRR4 Project poses the following direct and indirect threats to BTFs and their habitat.

- Direct threats:
  - vegetation clearing resulting in the loss of habitat
  - excavation works resulting in the loss of water sources.
- Indirect threats:
  - habitat degradation as a result of weeds introduced or spread during construction and operation
  - exclusion of BTFs from areas near the TRR4 Project area during construction and operation as a result of noise (affecting the ability of birds to communicate) and general activity (BTFs avoid urban environments)
  - sedimentation of creeks, mainly during construction, resulting in the loss or reduction in the availability of suitable water
  - decrease in habitat connectivity as a result of the barrier effect caused by the road.

In addition to the above, the TRR4 Project has the potential to encourage or facilitate:

- the development of other roads in the area (*eg* additional by-passes)
- different land uses in the adjacent areas. The impacts (positive or negative) will depend on what changes in land use occur. A worst case scenario is that the new roads encourage further vegetation clearing and/or urban development.

Other wildlife-related threats sometimes associated with road construction projects include wildlife mortality due to vehicle collisions and pollution (QDMR 2000, Kociolek *et al.* 2011). Within the current context these issues are likely to have minimal impact on BTFs and they are not considered further in this report. The reasons for their exclusion from further discussion are provided below.

- **BTF deaths due to collisions with vehicles**. BTFs are rarely seen along busy roads and there is a very low likelihood of individuals being hit by vehicles.
- **Pollution**. The effects of pollution from roads appear to be rare, even in areas with high traffic volume, and pollution appears to have fewer effects on birds than other road-related effects (Kociolek *et al.* 2011). The main threats are probably associated with large accidental spills, which are generally infrequent, and can be managed by implementing best practice management procedures.

5.2.2 Quantification of potential impacts of the TRR4 Project on Black-throated Finches

Overview

The threats of the TRR4 Project to BTFs are described in **Section 5.2.1**. The following threats, if managed correctly, are likely to have negligible impacts and are not considered further.

- **Weeds and sedimentation**. The impacts resulting from weeds and sedimentation should be minimal if suitably qualified and experienced professionals prepare the management plans (construction and operation) in accordance with current best practice and the plans are effectively implemented.
- **Loss of water sources due to excavation**. Based on current design plans, excavation works are unlikely to result in the loss of any water sources critical to BTFs.

The following discussion therefore focusses on the threats associated with vegetation clearing, habitat fragmentation and the displacement of BTFs from suitable habitat in response to habitat modification caused by the road.

Direct impacts

The TRR4 Project is approximately 9 km long and requires the clearing of a corridor approximately 40 m to 60 m wide to support construction and final build. With respect to Lot 1 SP232873, and based on the BTF field survey results and habitat modelling (**Figures 4** and **5**), this clearing will result in the approximate loss of:

- 36 ha of remnant vegetation
- 0 ha of dry season higher probability BTF habitat and 31 ha of supporting habitat (**Figure 5**)
- 10 ha of breeding season higher probability BTF habitat and 19 ha of supporting habitat (**Figure 4**).

A small patch of supporting BTF habitat occurs along and adjacent to the TRR4 Project route directly north of Lot 1 SP232873, *ie* between the Lot and Geaney Lane (**Figure 1**). Vegetation in this area is at best 'possible/marginal' suitability and is rapidly degrading due to clearing and weed ingress. Due to its small size, it is rapidly decreasing suitability and remoteness from BTF sightings, it is excluded from the impact assessment.

Indirect impacts

Overview

The main indirect threats associated with the proposed motorway relate to the potential barrier effects of the road on BTF movement and the displacement (in the short or longer term) of BTFs from areas near to the road in response to visual pollution (lights and reflections), noise pollution (interfering with avian communication and behaviours) and increased prevalence of predatory birds (*eg* more nestling predators like magpies and butcherbirds being attracted to roadside habitats). With respect to the potential displacement of BTFs, traffic noise is likely to have the largest impact footprint and therefore is the focus of the following discussion.

Roads as barriers to movement

BTFs are known to cross two-lane motorways (*eg* Flinders Highway, south of Townsville) though nothing is known about their willingness to cross four-lane motorways like that proposed for a large section of the TRR4 Project. In our opinion, the proposed width of the road corridor (about 40 m wide) and associated level of disturbance (*eg* noise, reflections, lights, activity, turbulence) might be sufficient to discourage BTF movement across the road in at least the short term and probably longer term. Based on habitat modelling and the observed distribution of BTFs on Lot 1 SP232873 (**Figures 4** and **5**) the TRR4 Project may reduce accessibility to core and supporting/ancillary habitats as described below.

- **Core habitat**. The centre of BTF activity and the majority of core habitat ('higher probability habitat', **Figures 4** and **5**) occurs on the western side of the TRR4 Project route. The TRR4 Project will therefore have minimal impact on access to core habitats.
- **Supporting/ancillary habitat**. Large areas of supporting habitat occur on the eastern side of the TRR4 Project route and the TRR4 Project may reduce BTF access to these areas. Supporting or ancillary habitats are important during times of ecological stress (*eg* after fires in core habitats) and therefore necessary for the long term persistence of BTFs in a landscape. This habitat type is not limiting with alternative areas of supporting/ancillary west of the TRR4 Project route. Access to this habitat type will therefore be reduced though not lost.

Displacement in response to noise-related impacts

There are numerous studies investigating the effects of anthropogenic noise, including traffic noise, on birds (*eg* see reviews by Kociolek *et al.* 2011 and Ortega 2012). Traffic noise has the potential to change a bird's behaviour (*eg* decrease in time spent feeding, Quinn *et al.* 2006), reduce the ability for birds to communicate by masking their calls, impair the ability for a bird to detect predators (and prey for carnivorous birds), decrease hearing sensitivity (temporary or permanent ear damage) and/or increase stress (Dooling & Popper 2007, Kociolek *et al.* 2011). These effects can be broadly categorised into two main impacts, *ie* noise-related hearing damage and behavioural changes.

Dooling and Popper (2007) predict that birds may experience temporary noise-induced hearing damage from continuous noise levels above 93 dB(A) and more permanent damage from continuous noise above 110 dB(A) or impulsive noise (*eg* piling or blasting) levels above 125 dB(A). With respect to the TRR4 Project the loudest activity is likely to be associated with pole driving (approximately 100 dB(A)) during the construction of bridges over Stony and Saunders Creeks (**Figure 1**). Both of these areas are remote from the areas of highest BTF activity and therefore unlikely to harm any BTFs. Some of the other road construction machinery and activities (*eg* scraper, jack hammer, paver) may produce noise levels around 90 dB(A) which is approaching the threshold for temporary noise-induced hearing damage. However, BTFs will probably avoid the areas of highest construction activity and the likelihood of any BTF experiencing temporary hearing damage is very low. While BTFs may temporarily avoid some of the noisier areas during construction, any displacement is likely to be short-term. BTFs are known to live and breed near to noisy areas such as firing ranges, motor-cross tracks and drill rigs (*pers. obs.* Peter Buosi, NRA*)*. In all cases the noise impacts were either short-term (drill rig) or long-term and episodic (firing ranges and motor-cross tracks).

The masking effects of traffic noise are less definitive. Noise in the spectral region of a bird's vocalisation (generally 2 to 4 kHz for birds) has a greater masking affect than noises outside this range (Dooling & Popper 2007). While traffic noise contains energy in this spectral range, most energy occurs in the spectral range below 2 kHz (Parris & Schneider 2009, Bouteloup *et al.* 2011). Some bird species are able to reduce the masking effect of

traffic noise by altering the dominant frequency or amplitude of their song or by altering their behaviours *eg* diurnal singing patterns or altering their position in their habitat when they call (*eg* Slabberkoorn & Peet 2003, Fuller *et al.* 2007, Brumm 2004); however, such adaptions may still impose a cost to the fitness of the affected bird (*eg* Patricelli & Blickley 2001). These circumstances make it difficult to predict the potential masking effects that traffic noise will have on a given bird species and highlights the importance of species-specific information and studies when attempting to quantify potential impacts.

The dominant frequency of a BTF contact call is generally between 3 kHz and 3.5 kHz[21], and as described above, partly falls within the spectral range of traffic noise. While this situation indicates the potential vulnerability of the species to the masking effects of traffic noise, the potential magnitude of impact[22] that may result from the TRR4 Project is unclear. Very few studies have specifically investigated the distance effects of traffic noise, and of those that have, extrapolation of the results is of limited value due to the peculiarities in experimental designs, study locations[23] and apparent variability in the sensitivity of different bird species to traffic noise. Perhaps the most insightful[24] is a study by Forman *et al.* 2002 who assessed the presence of five grassland bird species[25] at varying distances from roads near Boston (United States of America). In summary, they found that traffic volumes between:

- 3,000 and 8,000 vehicles/day had little effect on breeding or bird presence
- 8,000 to 15,000 vehicles/day reduced breeding within 400 m of the road
- 15,000 to 30,000 vehicles/day reduced breeding and bird presence within 700 m of the road
- $\geq$ 30,000 vehicles/day reduced breeding and bird presence within 1,200 m of the road.

Unfortunately, Forman *et al.* 2002 did not provide information on the noise levels for each traffic volume scenario. There are many factors that may influence noise levels for any given traffic volume (*eg* type of road pavement material, presence of natural or man-made noise barriers) and for this reason care should be taken when applying their results to other locations. With this in mind, and for qualitative comparative purposes, projected traffic volumes for the TRR4 Project range from 10,384 vehicles/day in 2016 to 18,937 vehicles/day in 2031 (*pers. comm.* email dated 15 May 2013, from Marjorie Cutting, AECOM, to Peter Buosi, NRA).

Based on available information it appears likely that the traffic noise resulting from the TRR4 Project will decrease the quality of habitats for BTFs within a few hundred metres of the proposed road. The effects will be more pronounced near to the road and impacts may range from partial to complete abandonment of certain areas and/or decreased fitness of BTFs that reside within this zone. It is difficult to define the critical distance from the road

[21] The 'contact', or 'distance', call is used to locate conspecifics over a wide area. Other common call types (*eg* 'alarm', 'begging', 'beep') fall within range of 2 kHz and 6 kHz. *See* Zann 1976 for full descriptions.

[22] Within this context the magnitude of impact is the distance from the proposed road that noise-related impacts on BTFs cease to be notable, or of consequence

[23] Mostly northern hemisphere and adjacent to major highways, *eg* >50, 000 vehicles/day.

[24] Forman *et al.* (2002) was one of the few studies of this type that attempted to isolate the effects of traffic noise from other confounding effects such as patch size, habitat type, adjacent land uses and spatial context.

[25] The Bobolink (*Delichonyx oryzivorus*), Eastern Meadowlark (*Sturnella magna*), Upland Sandpiper (*Bartramia longicauda*), Henslow's Sparrow (*Ammodramus henslowii*), and Grasshopper Sparrow (*A. savannarum*).

wherein traffic noise will cease to impose impacts that are notable, or of consequence; however, based on literature consulted during this study the impact zone could feasibly extend up to 700 m from the road. Whether traffic noise impacts in isolation will cause the complete abandonment of habitats around Dam 1 (approximately 900 m from the proposed road) is not known, though is considered unlikely.

While the discussion of potential mitigation measures is outside the scope of this study it is relevant to note that moving Dam 1, or providing an alternative water source, further removed from TRR4 Project route may reduce the level of impact of traffic noise on birds using Dam 1. This action, however, may have little effect on the overall net loss or degradation of habitat because the action is unlikely to offer the affected BTFs access to new, or previously inaccessible, areas of habitat.

5.3 Potential quantum of impact and offset requirements

5.3.1 Overview

DSEWPaC has developed an EPBC Act Offset Assessment Guide (the OA Guide) to assist in quantifying impacts and determining the potential offset requirements for a project impact. The OA Guide considers the nature and extent of the impacts likely to occur and according to DSEWPaC is designed to provide transparency and equity in decision making. In the following sections the potential impacts of the TRR4 Project on BTFs are quantified with reference to the OA Guide. As per the project scope this assessment is specific to the direct impacts, notably vegetation clearing, that may result from the TRR4 Project.

The 'impact calculator' section of the OA Guide lists a number of 'protected matter attributes' that can be used to assess impacts, and ultimately any offset requirements. The attribute of specific interest is 'area of habitat'. This attribute has two components, *ie* 'habitat area' and 'habitat quality'. With respect to the TRR4 Project, the 'habitat area' refers to the size (in hectares) of BTF habitat that will be impacted. This is taken to mean the amount of habitat that will be lost through vegetation clearing. 'Habitat quality' is ranked 1 (poorest quality) to 10 (highest quality). The OA Guide defines 'habitat quality' as a function of the following.

- **Site condition**. This is the condition of a site in relation to the ecological requirements of the threatened species and including consideration of vegetation condition and structure, the diversity of habitat species present, and the number of relevant habitat features.
- **Site context**. The relative importance of a site in terms of its position in the landscape, taking into account the connectivity needs of a threatened species. It includes considerations such as movement patterns of the species, the proximity of the site in relation to other areas of suitable habitat, and the role of the site in relation to the overall population or extent of a species or community.
- **Species stocking rate**. The usage and/or density of a species at a particular site. It acknowledges that a particular site may have a high value for a particular threatened species, despite appearing to have poor condition and/or context. It includes considerations such as survey data for a site in regards to a particular species population. It also includes consideration of the role of the site population in regards to the overall species' population viability or community extent.

The OA Guide refers to the output resulting from a stated 'habitat area' and 'habitat quality' as the 'total quantum of impact'. The 'total quantum of impact' has a large influence on the size of the offset area likely to be required.

5.3.2 Habitat area

The direct area of impact (*syn.* 'habitat area') of the TRR4 Project is described in **Section 5.2** and forms the basis for calculating the 'total quantum of impact'. In recognition that 'habitat quality' is not uniform, and to assist with the analysis, the potential impact area (*syn.* 'habitat area') of the TRR4 Project was divided into three segments (Segments A to C; **Figure 6**). Segment boundaries reflect broad scale changes in general habitat suitability for BTFs and are based on field observations.

5.3.3 Habitat quality

Site context and species stocking rate

To determine 'habitat quality' consideration was first given to the values associated with 'site context' and 'species stocking rate'.

- **Site context**. Suitable habitat no longer occurs to the east and habitats to the south and north are deteriorating; the latter is also being lost to development. BTF populations and habitat presumably occurs to the west though the extent, quality, and therefore viability, of these habitats are unknown. This circumstance points to the increasing isolation of the BTF population(s) residing on Lot 1 SP232873.
- **Species stocking rate**. Approximately 20 BTFs use habitats within a few hundred metres of the proposed motorway (according to December 2012 survey results). This number is likely to vary annually and seasonally. Based on current knowledge this is at least a medium-sized population for Townsville and is of conservation importance.

It is assumed that medium-sized populations situated in important sections of the landscape (*eg* areas that provide connectivity) and large populations would, 'site condition' permitting, qualify as ranking 10 'habitat quality'. In this context it was decided that habitats on Lot 1 SP232873 and near the TRR4 motorway should have a maximum 'habitat quality' ranking of 9.

Site condition

'Site condition', the third component of 'habitat quality', was considered to be a function of the location of habitat relative to water sources, and vegetation condition/suitability (discussed below). This approach acknowledges that water and vegetation influence the distribution of BTFs in the landscape. With respect to Lot 1 SP232873 (the receiving environment) it appears that water is only limiting during the dry season. During and following the wet season, when most breeding occurs, water is widely dispersed and vegetation condition/suitability presumably has a greater influence on BTF distribution.

Habitat location

From a habitat perspective the dry season habitat areas are the most critical for the species' persistence in the landscape. As a general rule the suitability of habitat decreases with distance from water. Dam 1 is the nearest water point to the proposed TRR4 route and supported a BTF population of about 20 birds in the 2012 dry season. It is assumed that most BTF activity is confined to the area within 1.5 km of this watering point though at times (*eg* when food is scarce) could extend up to 3 km. To help quantify the relationship between water and values (rankings) for 'site condition', 250 m wide band widths were placed around Dam 1 (**Figure 6**). *Habitat location quality* was assumed to be value 9 within 250 m of Dam 1, value 8 between 250 m and 500 m, value 7 between 500 m and 750 m, and so on. The outer band width was set as 1,250 m to 1,500 m (value 4). Beyond this distance band widths of 500 m were applied (**Figure 6**).

The above information formed the basis for calculating the overall *habitat location quality* for each road segment (A to C, **Figure 6**). The process used to derive the values is described below with the results provided in **Appendix 2**, **Table A**.

- The area (in hectares) of each habitat location value (*V*) intersected by the impact area was calculated (= *A*) (the shaded cells in **Appendix 2**, **Table A**).
- The sum of each unit area was calculated, *eg A1 + A2 + A3*, *etc = Total A*.
- Each habitat location value (*V*) was multiplied by its unit area (*A*), *ie V1 x A1 = V1A1*.
- The sum of each value area was calculated, *eg* (*V1A1*) + (*V2A2*), + (*V3A3*), *etc = TotalVA*.
- *TotalVA* / *Total A* = Overall value for *habitat location quality*.

Vegetation suitability/condition

Vegetation suitability/condition within each segment was assessed on a scale of 1 (poor quality) to 9 (best quality). This assessment was based on field observations made by NRA 2012, during the current study and habitat modelling (**Figure 4** and **5**). When assessing condition, the level of weed ingress and grazing pressure was considered. When assessing suitability, the density and composition of all structural layers (though especially the ground layer) was considered. It is acknowledged that the subtleties of what constitutes ideal vegetation for BTFs are not fully understood. The results of this assessment are provided in **Appendix 2, Table B**.

5.3.4 Offset calculations

The vegetation condition/suitability and habitat location values for each segment are provided in **Appendix 2 (Table B)** and were used to assign an overall value for 'habitat quality'. To assist data interpretation the overall value was provided as a fixed value and a range. Values based on averages and opinions are provided separately, acknowledging that these approaches have inherent limitations.

The areas and ranking values determined during the above exercises were then entered into DSEWPaC's offset calculation spread sheet to provide 'quantum of impact' scenarios (**Table 1**).

Table 1: Total quantum of impact calculations[1] based on vegetation clearing (*syn.* habitat loss) for the TRR4 Project

	Quantum of Impact (ha)	
	Low[2]	High[2]
Segment A	5.55	**6.94**
Segment B	4.68	**5.35**
Segment C	**7.15**	8.34
Quantum Range[3]	17.38	20.63
Quantum (segment based)[4]	19.44	
Quantum (overall)[5]	22.74	

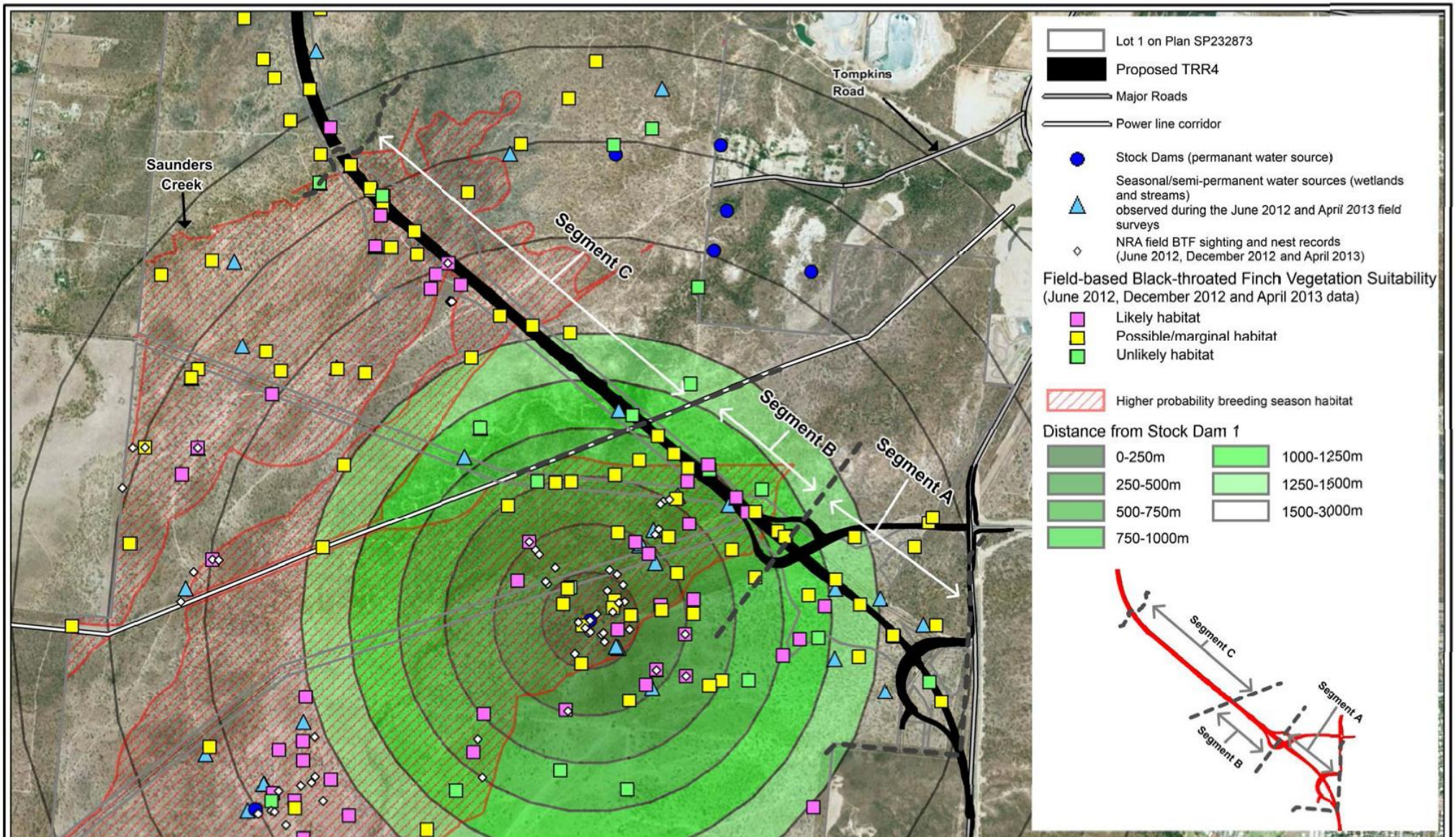
[1] 'Total quantum of impact' was calculated using the offset calculator spread sheet in DSEWPaC's OA Guide. This involves entering values for 'habitat area' and 'habitat quality'. The calculations are based on the direct impacts of vegetation clearing.

[2] 'Total quantum of impact' based on values shown in **Table B** (**Appendix 2**) for *Habitat Quality Value Range* and *Segment Area*. The numbers shown in **bold** font represent the *fixed* value for each segment as shown in *Habitat Quality Value* column of **Table B** (**Appendix 2**).

[3] Sum of each segment value. Provides an upper and lower value based on individual segment results.

[4] The sum of all values in **bold** font, *ie* the sum of *fixed* values as shown in *Habitat Quality Value* column of **Table 1**.

[5] 'Total quantum of impact' based on values shown in **Table B** (**Appendix 2**) for *Habitat Quality Value* (the opinion row) and *Segment Area*.



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TITLE: EPBC Act environmental offset calculation areas

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Figure 6

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6. Salient Findings

Two BTF populations, or colonies, occur on Lot 1 SP232873. These populations are centred on stock Dams 1 and 3 and in the dry season of 2012 each population comprised about 20 adult birds (**Figure 3**). This number is likely to fluctuate seasonally and annually according to conditions. Twenty adult birds is at least a medium-sized population for Townsville and populations of this size are of regional conservation importance. Within and near the TRR4 Project area breeding habitats and dry season habitats are of greatest importance (**Figures 4** and **5**), particularly the latter given the limited availability of permanent water sources. BTFs on Lot 1 SP232873 are becoming increasingly isolated largely due to unsuitable land management practices and development pressures in the surrounding landscape. Weed ingress threatens the quality of habitats on Lot 1 SP232873 and therefore the long term viability of BTF populations reliant on those habitats.

BTFs and their habitat occur along and near the proposed TRR4 Project route. The survey results indicate that those BTFs whose activity is centred on Dam 1 are the most likely to be impacted upon by the proposed TRR4 Project. Impacts include the direct loss of habitat due to vegetation clearing (approximately 36 ha), reduced access to supporting/ancillary habitats due to the potential barrier effect caused by the road and habitat degradation (and possible displacement of birds) due to indirect threats. Of all the project-related threats, traffic noise and its potential to interfere with BTF communication has the largest potential 'unit area of impact'. It is not clear to what degree BTFs will be able to modify their behaviour to accommodate the change in the acoustic environment. Behavioural changes may range from avoiding the impact areas during the noisier parts of the day or the complete abandonment of certain areas. Noise modelling may assist in understanding the potential impacts of traffic noise on BTFs.

The potential direct impact (*ie* vegetation clearing) of the TRR4 Project on BTFs was quantified in accordance with DSEWPaC's EPBC Act Offset Assessment Guide (the OA Guide). Different approaches were applied and indicated that the 'total quantum of impact' ranged from 17.38 ha to 22.74 ha.

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Appendix 1:
Methods used for Black-throated Finch habitat mapping (from NRA 2012)

Review of Historical Records

The TRR4 Project area is in a part of Townsville where few reliable BTF studies have been conducted and consequently the abundance, distribution and detailed habitat requirements of the species in this general area is poorly known. To address this deficiency, BTF records previously collected by NRA in the surrounding landscape were reviewed. The review roughly encompassed the landscape between The Pinnacles Range and coastline, and the Bohle and Black Rivers. NRA recently reviewed all BTF records held by the BTF Recovery Team for a separate project. That review had shown that NRA was the major provider of sighting data for this general section of landscape validating the use of NRA's data[1]. A single BTF sighting recorded by GHD (2005) near the Shaw Road-Hervey Range Road intersection was added to the database.

Distribution of Potential Black-throated Finch Habitat

BTF sightings from the database search area occurred on RE11.3.12, RE11.3.35 and non-remnant vegetation. The REs are described as follows.

- RE11.3.12 - *Melaleuca viridiflora* woodland on alluvial plains.
- RE 11.3.35 - *Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland on alluvial plains.

The six BTF locality records from NRA's June 2012 survey also occurred on RE11.3.12 and RE11.3.35. The suitability of these REs for BTFs has been noted previously (NRA 2006) as have RE11.3.30 and RE 11.3.25 which also occur along and near the TRR4 Project route.

- RE 11.3.30 – *Eucalyptus crebra*, *Corymbia dallachiana* woodland on alluvial plains
- RE 11.3.25 - *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.

Therefore, based on available data from the landscape surrounding the TRR4 Project area BTF habitat is most likely to comprise vegetation communities mapped as RE11.3.12 and RE11.3.35 though may also comprise RE11.3.25 and RE11.3.30 based on observations made elsewhere in Townsville. RE mapping (Queensland Herbarium, Version 6.1) shows that the majority of the TRR4 Project area and immediate surrounds contains vegetation types suitable for BTF habitat.

Water has a major influence on the distribution of BTFs and their habitat. Studies have shown that nesting, including nests used for breeding, occurs in suitable vegetation types in close proximity to water (mean distance of nest to water = 400 m, max. distance = 1 km, n=112 nests; NRA 2006). During and immediately following the wet season BTFs may nest and breed in suitable vegetation types near seasonal/semi-permanent water sources before contracting back to more permanent water sources during the dry. The presence of suitable vegetation near seasonal/semi-permanent and permanent water sources is therefore critical for the survival of BTF populations.

[1] The BTF Recovery Team (BTF RT) maintains a database of BTF records. The records are provided to BTF RT by members of the public and via data sharing arrangements with Birdlife Australia (formerly Birds Australia) and the Department of Environment and Heritage Protection. Due to their conservation status the location data is sensitive information and special permission is required from BTF RT to use their data and permission is not always granted. NRA did not request access to their database during this project.

Field observations suggest that many of the small creeks and wetlands may hold water for many months of the year and provide opportunities for breeding if suitable vegetation occurs. The locations of permanent water sources are thought to be restricted to stock dams and pools along the Bohle and Black Rivers.

As the movement ecology of BTFs is poorly understood it is difficult to determine what amount of foraging habitat around water sources and nesting sites is required to support a population. Daily movements appear to be shorter and more localised during the breeding season (Isles 2007) and greater in the dry and storm seasons (NRA 2005). Mitchell (1996) observed BTFs foraging in areas separated by 1.5 km leading him to conclude that at certain times of the year movements of over 3 km could be part of the species' daily routine. BTF habitats are dynamic, and fire prone, and for birds to persist in a landscape large areas of interconnected habitat are required.

The information above was used to model potential BTF habitat in and near the TRR4 Project area. Our limited understanding of BTF ecology should be considered when using this information as should the scale (1:100,000) of mapping used in the modelling. The decision rules used to map potential BTF habitat are described below.

- Potential BTF habitat during the breeding season (wet to early dry season, *ie* approx. February to June).
  - Higher probability habitat = Sections of RE11.3.12 and RE11.3.35 within 400 m of seasonal/semi-permanent water. Woodland and grassland communities within 600 m of these areas may be important supporting habitat.
  - Lower probability habitat = Sections of RE11.3.12, RE11.3.35, RE11.3.30 and RE11.3.25 within 400 m of seasonal/semi-permanent water. Woodland and grassland communities within 600 m of these areas may be important supporting habitat.
- Potential BTF habitat during the non-breeding season (dry to early wet/storm season, *ie* July to December).
  - Higher probability habitat = Sections of RE11.3.12 and RE11.3.35 within 600 m of permanent water. Woodland and grassland communities within 1,100 m of these areas may be important supporting habitat.
  - Lower probability habitat = Sections of RE11.3.12, RE11.3.35, RE11.3.30 and RE11.3.25 within 600 m of permanent water. Woodland and grassland communities within 1,100 m of these areas may be important supporting habitat.

The relationship between soil mapping (Murtha 1975) and BTF sightings was also investigated when developing the decision rules; however, the results were less informative than that obtained from RE mapping. Decision rules referring to soil mapping were not considered during the 2012/13 study reported here.

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Appendix 2:
Supporting Offset Analysis for Calculating ‘Habitat Quality’

Table A: Analysis used to derive values (scale 1 to 9) for *habitat location quality* for direct impacts of the TRR4 Project on Black-throated Finches[1]

Distance from Dam 1 (m)	0-250	250-500	500-750	750-1000	1000-1250	1250-1500	Total Area (ha)[2]	Total Habitat Quality Area (ha)[3]	Habitat Location Quality[4]
Habitat Location Value	**9**	**8**	**7**	**6**	**5**	**4**			
Segment A				0.06 ha	2.73 ha	2.58 ha	5.37	24.33	4.53
Segment B				3.85 ha	2.84 ha		6.69	37.30	5.58
Segment C					2.11 ha	2.12 ha	4.23	19.03	4.50
Subtotal (Habitat Quality Area)				3.91 ha	7.68 ha	4.7 ha	16.29	80.66	4.95
Proportion (Habitat Quality Area)				24%	47%	29%			

[1] The shaded cells are the area (ha) of each habitat location value (V) intersected by the clearing footprint for the TRR4 Project. The values in the shaded cells were rounded up and are the cause of any apparent anomalies in totals. The impact area for each segment is shown on **Figure 6**.

[2] Total area as described in report text as *Total A* = $A_1 + A_2 + A_3$, *etc*.

[3] Described in report text as *TotalVA* which is a function of $(V_1A_1) + (V_2A_2)$, + (V_3A_3), *etc*.

[4] *Habitat location quality* on a scale of 1 (poorest) to 9 (best).

Table B: Habitat location quality, vegetation suitability/condition and 'habitat quality' rankings[1] for direct impacts of the TRR4 Project on Black-throated Finches

Segment	Segment Area (ha)[2]	Habitat Location Quality[3]	Vegetation Suitability/Condition Value[4]		Habitat Quality Value (Fixed)[5]	Habitat Quality Value (Range)[6]
			Dry Season	Wet Season		
Segment A	13.88	4.53	4	5	5	4 to 5
Segment B	6.69	5.58	6	8	8	7 to 8
Segment C	11.91	4.50	6	7	6	6 to 7
Subtotal	32.48	4.95	n/a	n/a	n/a	n/a
Mean	n/a	4.87	5.33	6.67	6.33	6 to 7
Opinion[7]	n/a	n/a	n/a	n/a	7	

[1] All rankings on a scale of 1 (poorest) to 9 (best).

[2] Total area of segment. This is equivalent to the total impact area (*syn*. 'habitat area').

[3] As derived from **Table 1** and **Figure 6**.

[4] Opinion-based assessments based on field observations made in NRA 2012, during current study and habitat modelling (**Figures 4 and 5**).

[5] Habitat quality value for each segment and for all segments based on the mean (of values for Segments A to C) and opinion-based assessment.

[6] A range is also provided to help provide guidance.

[7] An opinion-based value based on all available information is provided for the entire area.

Appendix C

Bare-rumped Sheathtail Bat Survey and Assessment Reports

Townsville Ring Road, Stage 4

Assessment of Occurrence Threatened Bat Species

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Document Status

Version	Purpose of Document	Orig	Review	Review Date
V1	Ring Road Threatened Bat survey	G. Calvert	L. Liessmann	22/11/2012

Approval for Issue

Name	Signature	Date
Laurence Liessmann		22/11/2012

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1.0 Introduction

The Queensland Department of Traffic and Main Roads (TMR) have commissioned AECOM Australia to undertake an Ecological Assessment of the proposed alignment for Stage 4 of the Townsville Ring Road. AECOM ecologists confirmed the presence of black throated finch and squatter pigeon, and determined that the presence of the bare-rumped sheathtail bat (*Saccolaimus saccolaimus*) was highly likely (AECOM 2012a). Other bat species considered to be potentially present included the Endangered Semon's leaf-nosed bat (*Hipposideros semoni*), Large-eared horseshoe bat (*Rhinolophus philippinensis*), and NC Vulnerable Coastal sheathtail bat (*Taphozous australis*) (AECOM 2012 b).

The presence of the bare-rumped sheathtail bat in the vicinity of the proposed alignment was determined by AECOM ecologists using a recording made with a Song Meter 2 (SM2 BAT+) ultrasonic bat detector on the night of 23 May 2012. The location of the recording was at a small farm dam located approximately 900m to the south west of the proposed alignment, in Area 4 of the survey region (AECOM 2012a).

Following these assessments, it was determined that no suitable roosting habitat was present for the Coastal sheathtail bat and that any records would likely be from foraging individuals (AECOM 2012a). Recommendations were made for additional acoustic monitoring of threatened microchiropteran bat species along the proposed alignment, with particular emphasis on the bare-rumped sheathtail bat (AECOM 2012b).

RPS Australia Pty Ltd (RPS) was commissioned by AECOM to undertake an assessment of threatened bat species within the proposed alignment area, to determine any potential ecological constraints to the proposed development of the site.

A methodology for a passive acoustic monitoring study for threatened bats along the proposed road alignment was developed by AECOM (AECOM 2012b) in consultation with the Queensland Department of Traffic and Main Roads (TMR).

1.1 Threatened Bat Species

A summary of the ecology and habitat requirements of the target threatened bat species is provided in **Table 1** below.

Table 1 Status, Distribution & Ecology of Target Threatened Bat Species

Species	Common Name	Status[1]	Distribution and Habitat
Hipposideros semoni	Semon's leaf-nosed bat	E; E*	The known broad-scale distribution for Semon's Leaf-nosed Bat includes coastal Queensland from Cape York to just south of Cooktown. There is an outlier population at Kroombit Tops, near Gladstone. Semon's Leaf-nosed Bat is found in tropical rainforest, monsoon forest, wet sclerophyll forest and open savannah woodland (Churchill 2008). This species does not have an obligatory requirement for cave roosts. Daytime roost sites include tree hollows, deserted buildings in rainforest, road culverts and shallow caves amongst granite boulders or in fissures (SEWPaC 2012a).
Rhinolophus philippinensis	Greater large-eared horseshoe bat	E; E*	This species occurs only in northern Queensland, from the Iron Range southwards to Townsville and west to the karst regions of Chillagoe and Mitchell-Palmer. The southern limit of its range has not been clarified, and it might be present south of Townsville at Mt Elliott and Cape Cleveland. It has been recorded at Alligator Creek. The species is found in lowland rainforest, along gallery forest-lined creeks within open eucalypt forest, Melaleuca forest with rainforest

Species	Common Name	Status[1]	Distribution and Habitat
			understorey, open savanna woodland and tall riparian woodland of Melaleuca, Forest red gum (E. tereticornis) and Moreton Bay ash (C. tesselaris) (Churchill 2008). It mainly roosts in caves and underground mines located in rainforest, and open eucalypt forest and woodland, however roosts have also been observed in road culverts, and it is suspected that the species also uses basal hollows of large trees, dense vegetation, rockpiles and areas beneath creekbanks (SEWPaC 2012b).
Saccolaimus saccolaimus nudicluniatus	Bare-rumped sheathtail bat	E; CE*	Occasional individuals have been collected from a narrow coastal region (less than 40 km inland) between Ayr and Cooktown, North Queensland, with one isolated specimen from north of Coen on Cape York Peninsula (SEWPaC 2012c). The species inhabits tropical woodland and tall open forests where it roosts in long, wide hollows in the trunks of various Eucalypts. It appears to prefer coastal Eucalypt forests with high annual rainfall (Curtis et al. 2012).
Taphozous australis	Coastal sheathtail bat	V	This species occurs along the Queensland coast from Shoalwater Bay north to the tip of Cape York and appears to remain within a few kilometres of the sea. It occupies habitats close to the coast including coastal dune communities, melaleuca swamps, mangroves, rainforest, and any other habitats within foraging range of roost sites. It roosts in caves, overhangs, boulder fields and anything offering a similar level of shelter (Curtis et al. 2012).

[1] Conservation status as listed under the NCA, where E: Endangered, V: Vulnerable, NT: Near Threatened; and the EPBC Act, where CE*: Critically Endangered, E*: Endangered, V*: Vulnerable.

[2] Previous records exist within 10km of the site (Wildlife Online).

[3] Likelihood of occurrence is based on the known distribution and ecological requirements of the species in the context of the site, where **Low**: No recent records or suitable habitat present on the site; **Moderate**: Recent records and/or suitable/preferred habitat present and/or species that they commonly associated with are present on the site, however, the species was not recorded during the field investigations; and **High**: Known to occur on the site through direct observation within or immediately adjacent to the site.

[4] Assessment of potential level of impact is based on the known distribution and ecological requirements of the species in the context of the site.

1.2 Acoustic Monitoring

Monitoring of threatened bat species was undertaken using several Song Meter 2 (SM2 BAT+) ultrasonic bat detectors. Although it is normally recommended that acoustic recordings are done in association with trapping, the bare-rumped sheathtail bat has not been successfully trapped as they are a high flying species. Churchill (1998) notes “The species performs fast and highly manoeuvrable flight above the canopy resulting in being extremely difficult to capture and there are currently no recognised methods to conduct targeted surveys”.

The survey guidelines for the bare-rumped sheathtail bat (DEWHA 2010) notes “The Bare-rumped sheathtail bat has been very poorly surveyed for a number of reasons":

- Lack of described echolocation call makes it difficult to reliably identify the species in current echolocation surveys;
- Difficulty in trapping this species. In Australia this species has not been trapped in harp trap, mistnets or by using triplines; and it has not been located by systematic cave searches for bats (Schulz & Thomson 2007); and
- Less frequent use of shotguns as a primary technique for sampling fast-flying bats. For example, of the 20 adult specimens of the Bare-rumped Sheathtail Bat in the Queensland Museum at least 12 had been collected using this technique (Schulz & Thomson 2007)”.

As a result of a lack of quality reference calls for the Bare-rumped sheathtail bat, most previous studies on microbats in the Townsville region have tended to lump *Saccolaimus* species together due to call sequences being indistinguishable between species (e.g. Lavery & Johnson 1968, Hourigan *et al* 2006). In particular, their echolocation calls have been virtually indistinguishable from the common Yellow-bellied sheathtail bat (*Saccolaimus flaviventris*) and that of the coastal sheathtail bat (*Taphozous australis*).

The ability to detect Bare-rumped sheathtail bats via analysis of echolocation calls had a critical breakthrough in January 2012, when microbat expert Greg Ford (balance! Environmental) successfully collected good quality Anabat reference calls from the Bare-rumped sheathtail bat from a roost tree in Cairns, which included noting the very distinctive exit calls (when the bats are departing their roost tree) and search-phase calls. While this new discovery provides additional reference calls against which to analyse *Saccolaimus* species calls, it must still be noted that the calls (emergence, foraging and flyover calls) may vary between different geographic locations and populations. As such, on the basis of the new reference calls, it is now possible to conclusively identify the two *Saccolaimus* species from Anabat recordings. In discussions between Greg Ford and AECOM, it was determined that the best quality echolocation recordings would be obtained by utilising Song Meter 2 devices, which provides a 16-bit full spectrum recording.

The use of passive acoustic monitoring to determine the presence of threatened bats was considered to be the best practice approach, as trapping is not effective for Bare-rumped sheathtail bats and non-invasive survey methods are recommended for the Large-eared horseshoe bat and Semon's leaf-nosed bat (DEWHA 2010).

2.0 Methodology

The survey guidelines for the Bare-rumped sheath-tailed bat recommends a survey effort of '16 detector nights' using unattended bat detectors for areas less than 50 hectares in size. As the project area refers to the proposed construction of linear infrastructure, it was decided that placement of the Song Meters would be best done in a targeted approach with recorders strategically placed in areas of most likely roosting habitat, rather than a random or stratified survey approach. Likely areas of roosting habitat was derived from a survey of potential roost trees along the proposed alignment as detailed in AECOM (2012a).

The 16 Detector nights were to be achieved by placement of four detectors for a total of four nights each, with each detector in place at each specific location for two nights. Song Meter 2 acoustic recording devices were initially deployed on 10th September 2012, relocated on 12th September and removed on the 14th September. The timing of the survey is in accordance with the Survey Guidelines for Australia's Threatened bats (DEWHA 2010), which recommends a timing of August to April for Bare-rumped sheath-tailed bat, while there are no recommendations for survey timing for the Large-eared horseshoe bat or Semon's leaf-nosed bat. In accordance with survey guidelines, the bat recordings were not taken on windy, cold or rainy nights.

Locations of Song Meter 2 placements are described in **Table 2** and shown in **Figure 1**. Unfortunately, a 4th Song Meter (SM04) suffered a malfunction that resulted in it failing to record any data, and this malfunction was not detected until after completion of the survey when the data was being analysed. The result of this equipment malfunction is that only 12 survey nights were recorded and no bat echolocation calls were recorded from site 4.

Bat recordings were supplemented with an inspection of potential tree roosts as detailed in AECOM (2012a).

Table 2 Locations of Song Meter 2 Placements

Song Meter Placement						
Detector	SM01		SM02		SM03	
Date	10-11 Sept	12-14 Sept	10-11 Sept	12-14 Sept	10-11 Sept	12-14 Sept
Location	Site 1	Site 7	Site 2	Site 5	Site 3	Site 6

At each location, the Song Meter 2 devices were mounted as high as practicable to reduce interference from surrounding vegetation. The microphone was placed in a vertical position and the device strapped to as narrow a tree as possible to reduce the potential blockage of sound waves from the tree trunk. The recorders were programmed to start recording before dusk and stopped after dawn, so that the entire nights bat activity would be recorded. The location of each deployment was recorded with a hand-held Garmin GPS in GDA94 (MGA55) and a brief description of the vegetation and habitat recorded. Downloaded data was sent to bat echolocation specialist Greg Ford (Balance! Environmental, Toowoomba) for analysis. The analysis of the results is provided in **Appendix 1**.

A description of each of the sites is as follows:

Table 3 Location & Description of Survey Sites

Site No.	Coordinate (Lat / Long)	Site Description
1	-19.294, 146.677	On edge of an open farm dam where Bare-rumped sheath-tailed bat were recorded on 23 May 2012.
2	-19.292,146.690	On the top bank overlooking a dry creek bed between two large *Eucalyptus platyphylla.*
3	-19.287,146.684	On the edge of a dry gully in an open *Melaleuca viridiflora* / *Eucalyptus platyphylla* woodland, some with hollows.
4	-19.283,146.679	On the edge of a small creek with small puddles of water present and

Site No.	Coordinate (Lat / Long)	Site Description
		some large *Eucalyptus platyphylla.*
5	-19.272,146.665	In woodland adjacent to a dry creek bed, with a very large hollow-bearing *Eucalyptus platyphylla* in close proximity. Access via Tompkins Rd.
6	-19.264,146.663	In open woodland area dominated by large old-growth *Eucalyptus platyphylla* with numerous hollows. Access via Millbrae St, Deeragun
7	-19.249,146.664	Along edge of Stoney Creek with large pools of water present – accessed via Geaney Lane, Deeragun

The location of the study sites is shown in **Figure 1**, while a selection of these sites are shown in **Plate 1**, **Plate 2**, and **Plate 3** below.