



global environmental solutions

Culburra West Urban Development Project

Ecological & Riparian Issues & Assessment Report

Appendix D Dedicated Flora and Fauna Field Surveys at Culburra

22 March 2013

1 INTRODUCTION

This Appendix provides details of the flora and fauna surveys undertaken on the subject land at Culburra and on Long Bow Point over the last two decades. It includes details of the survey effort for the 2011 to 2013 investigation period.

Field surveys for flora within the Subject Land at Culburra have included:

- previous detailed floristic analysis of the vegetation on the subject land (refer to the *InSites 2011 Report*);
- targeted searches for threatened orchids and other threatened plant species since October 2012 (Figure A3);
- detailed vegetation cross-sections along seven locations along the Crookhaven River foreshore during March 2013; and
- searches for orchids were also a focus of all time spent on the subject land during the 2011 to 2013 fauna surveys (detailed below), including searches while walking between traps site *etc.*

Dedicated field surveys for fauna within the subject land and adjoining lands at Culburra have been conducted during the following survey periods (Table 1):

- November 23 to December 16, 1993 (Daly & Leonard)
- October 20 to 24, 1996 (Hoye)
- September 4 to 19, 1996 (Daly & Leonard)
- July 16 to 21, 1997 and August 11 to 15, 1997 (Gunninah, 1999)
- January 13 to March 13, 2001 (Gunninah, 2001)
- December 16-17, 2002 (Gunninah 2003)
- October 15-19, 2007 (Insites/ Andrews.Neil, 2007)
- December 13-17, 2010 (LesryK Environmental Consulting)
- January 4-6, 14-19, February 15-17, May 7-11, August 28-31, September 18-21, October 16-18 and December 19-20 2012 (SLR Consulting); and
- January 14-19, March 13-14 and 18-20 March 2013 (SLR Consulting)

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

Table A1 – Fauna Field Survey Summary

| Year | Dates | Technique | Location | Effort | Reference |
|-------------|-----------------|---------------------------------------|----------------|--|----------------|
| 1993 | 23-30 Nov | Trapping | Long Bow Point | 70 TN – Pitfall | Daly & Leonard |
| | 13-16 Dec | Trapping | | 75 TN Arboreal Elliott | |
| | 13-17 Dec | Trapping | | 40 TN – Pitfall | |
| | 1993 - 1996 | Spotlighting | Long Bow Point | 11 hrs 30mins | Daly & Leonard |
| 1996 | 4-15 Sept | Trapping | Long Bow Point | 550 TN Ground Elliott | Daly & Leonard |
| | 4-19 Sept | Hair Tube | | 240 TN | Hoye |
| | 20-24 Oct | Anabat | | 4 nights | |
| | 20-24 Oct | Spotlight Transects | | 8 hrs | |
| | 20-24 Oct | Harp Trap | | 16 TN | Daly & Leonard |
| | 23 Nov – 13 Dec | Hair Tube | | 140 TN | |
| 1997 | 16-21 Jul | Spotlighting | Long Bow Point | 62 hrs 30mins | Gunninah |
| | 11-15 Aug | Call Playback (Owls) | | 1hr 30 mins | |
| | | Anabat | | 18 nights | |
| | | Harp Trap | | 16 TN | |
| | | Amphibian | | 62 hrs 30 mins | |
| | 21 Jul -14 Aug | Hair Tube | | 425 TN | |
| 2001 | 12-21 Jan | Trapping | Subject Land | 45 TN Ground Elliot; 45 TN Cage; 45 TN Pitfall | Gunninah |
| | 15 Jan | Amphibian | | 1 hr | |
| | 16 Jan | Avifauna | | 30mins | |
| | 19-21 Jan | Anabat | | 5 nights | |
| | 20-22 Jan | Harp Trap | | 5 TN | |
| | 20-21 Jan | Avifauna | | 30 mins | |
| | 22 Jan - 7 Mar | Hair Tube | | 1100 TN | |
| | 28 Feb | Anabat | | 1 night | |
| | 28 Feb – 5 Mar | Trapping | | 400 TN Ground Elliott; 30 TN Cage; 75 TN Pitfall | |
| | 1-2 Mar | Amphibian | | 3 hrs | |
| | 1-7 Mar | Trapping | | 60 TN, Ground Elliot; 6 TN Cage | |
| | 1-6 Mar | Trapping | | 100 TN Ground Elliott; 25 TN Pitfall; 100 TN Arboreal Elliot | |
| | 1-3 Mar | Call playback (Owls, Gliders & Koala) | Subject Land | 3 hr 55 mins | Gunninah |

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| Year | Dates | Technique | Location | Effort | Reference |
|-------------|--|--|--|--|----------------------|
| | 1-6 Mar 2-11 Mar 3-6 Mar 4 Mar 4-7 Mar 4-14 Mar 5-6 Mar 6-12 Mar 7-8 Mar 9-10 Mar 9-10 Mar 10 Mar 11 Mar 12 Mar 12 Mar 12 Mar 1-12 Mar | Anabat Harp Trap Spotlight Call playback (Black Bittern) Avifauna Hairtubes Call playback (Owls, Gliders, & Koala) Trapping Amphibian Call playback (Owls, Gliders, & Koala) Anabat Amphibian Amphibian Call playback (Black Bittern) Spotlight Amphibian Spotlighting | Long Bow Point | 6 nights 20 TN 4 hrs 50 mins 10mins 4 hrs 600 TN 4 hrs 43 mins 200 TN Ground Elliot; 20 TN Cage; 25 TN Pitfall; 50 TN Arboreal Elliot 5 hrs 1 hr 52 mins 2 nights 2hrs 50 mins 40mins 10 mins 40 mins 30 mins 22 hrs 40mins | |
| 2002 | 16-17 Dec | Spotlighting Call playback Owls, Gliders & Koala Anabat Amphibian Reptile surveys Avifauna | STP | 4 hrs 3 hrs 2 nights 6 hrs 6 hrs 12 hours | Gunninah |
| 2007 | 15-19 Oct | Spotlighting Anabat Avifauna Call Playback (Owls & Gliders) | UEA north | 11 hrs (3hrs from car, 8hrs on foot) 4 nights 4 hours 1 hr | Insites |
| 2010 | 13-17 Dec | Spotlighting Call playback (Owls & Gliders) Anabat Infrared Avifauna Reptile Surveys | Subject Land | 12 hours 3 hrs 4 nights 4 nights/days 5 hrs 3 hrs | LesryK LesryK |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

| Year | Dates | Technique | Location | Effort | Reference |
|-------------|--|--|----------------|---|----------------|
| | | Cage Trapping Harp trapping Hair Tubes Elliott traps Pitfall trapping | | 4 nights (6 units) 4 nights (1 unit) 10 nights (40 units) 4 nights (75 units) 4 nights (18 pits) | |
| 2012 | 4-6 Jan | Spotlighting | Long Bow Point | 5 hrs | SLR Consulting |
| | 4 Jan | Amphibian | | 1 hr | |
| | 5-6 Jan | Call Playback (Owls & Gliders) | | 2 hrs | |
| | 5 Jan | Avifauna | | 2 hrs | |
| | 5-15 Jan | Hair Tubes | | 10 nights (49 units) | |
| | 14-18 Jan | Glider Tubes | | 4 nights (5 units) | |
| | 15 Jan | Avifauna | | 2 hrs | |
| | 15 Jan | Amphibian | | 1 hr | |
| | 15-19 Jan | Anabat Infrared Tree Elliots Ground Elliots Cage Trapping | | 4 nights (2 units) 4 nights (2 units) 4 nights (10 units) 4 nights (100 units) 4 nights (17 units) | |
| | 16-19 Jan | Spotlighting | | 10 hrs | |
| | 16-19 Jan | Call Playback | | 4 hrs | |
| | 18 Jan | Avifauna | | 1 hr | |
| | 18 Jan- | Hair Tubes | | 29 nights (49 units) | |
| | 16 Feb | Amphibian | | 1 hr | |
| | 15-17 Feb | Harp Trapping | | 2 nights (2 units) | |
| | 15-17 Feb | Anabat | | 2 nights (2 units) | |
| | 15-17 Feb | Spotlighting | | 5 hrs | |
| | 17 Feb | Avifauna | | 2 hrs | |
| | 7-11 May | Spotlighting Call Playback Anabat Infrared | Subject Land | 8 hrs 2 hrs 4 nights (2 units) 4 nights (2 units) | |
| | 8-11 May 8 May – 29 May 9-11 May 10 May 27-28 Aug | Harp Trapping Hair Tubes Glider Tubes Avifauna Spotlighting Stagwatching Call Playback Avifauna Anabat | Long Bow Point | 3 nights (2 units) 21 nights (40 units) 2 nights (6 units) 6 hrs 13 hrs 3.5 hrs 2 hrs 14 hrs 2 nights (2 units) | SLR Consulting |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

| Year | Dates | Technique | Location | Effort | Reference |
|------|-----------------|---|----------------|--|-----------|
| | | Infrared Amphibian | | 2 nights (2 units) 1 hr | |
| | 28 Aug-17 Sep | Hair Tubes | Subject Land | 19 nights (40 units) | |
| | 29-31 Aug | Spotlighting | | 7 hrs | |
| | 29-31 Aug | Stagwatch | | 1 hr | |
| | 29-31 Aug | Anabat | | 2 nights (2 units) | |
| | 29-31 Aug | Infrared | | 2 nights (2 units) | |
| | 30-31 Aug | Avifauna | | 7 hrs | |
| | 30 Aug | Call Playback | | 1 hr | |
| | 30 Aug | Reptile surveys | | 2 hrs | |
| | 17-19 Sep | Spotlighting Stagwatching Call playback Avifauna Anabat Infrared | Long Bow Point | 4.5 hrs 2 hrs 1.5hrs 9.75 hrs 24 hrs (2 Units) 37 hrs (2 units) | |
| | 18-21 Sep | Avifauna | Subject Land | 8.5 hrs | |
| | 19-20 Sep | Spotlighting | | 5.5 hrs | |
| | 19-20 Sep | Stagwatching | | 1.5 | |
| | 19-21 Sep | Anabat | | 24 hrs (2 units) | |
| | 19-21 Sep | Infrared | | 36 hrs (2 units) | |
| | 19-20 Sep | Call Playback | | 1 hr | |
| | 18 Sep – 06 Oct | Hair Tubes | | 18 nights (40 units) | |
| | 16-18 Oct | Infrared | Long Bow Point | 38 hrs (2 units) | |
| | 17-18 Oct | Avifauna | | 5.5 hrs | |
| | 17-18 Oct | Reptile surveys | | 1.5 | |
| | 7-9 Nov | Avifauna | | 7 hrs | |
| | 7-9 Nov | Infrared | | 38 hrs (2 units) | |
| | 7-9 Nov | Anabat | | 24 hrs (2 units) | |

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| Year | Dates | Technique | Location | Effort | Reference |
|------|-----------|--|----------------|--|----------------|
| 2013 | 14-19 Jan | Spotlighting Stagwatching Call playback Anabat Infrared Reptile surveys | Long Bow Point | 10 hrs 5 hrs 4 hrs 5 nights (x 2 units) 5 nights (x 2 units) 8 hrs | SLR Consulting |
| | 13-17 Mar | Avifauna Pitfall trapping Glider traps Infrared | Subject Land | 16 hrs 48 TN 100 TN 4 nights (4 units) | SLR Consulting |
| | 18-20 Mar | Avifauna Infrared Avifauna Glider traps Anabat Reptile surveys Spotlighting Call Playback | Subject Land | 2 hours 3 nights (4 units) 9 hrs 20 TN 1 night (3 units) 3 hrs 4 hrs 1 hr | |

| | |
|----------------|---|
| Study Area | All lands surveyed |
| Subject Land | Urban Expansion Area north of Culburra Road (UEA north) |
| Long Bow Point | Site of Culburra Golf Course within Study Area (south of Culburra Rd) |
| STP | Sewage Treatment Plant |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

2 SPOTLIGHTING SURVEYS

Spotlighting surveys were conducted throughout the Subject Land, to target nocturnal mammals, owls, amphibians and other nocturnal fauna. All vegetation types were surveyed and special attention was given to areas of higher habitat value. Fauna species were detected both visually and aurally (Tables A1 and A2).

Table A2 Spotlighting surveys

| Date | Survey Effort (person-hours) | Area Surveyed | Surveyor |
|--------------------------|---|---|----------------------------|
| 1993 & 1996 | 11.5 hrs | Subject land, specifically Long Bow Point | Daly & Leonard 1994 & 1996 |
| 16-21/7/97 11-15/8/97 | 62.5 hrs | Subject land | Gunninah 1999 |
| 1/3–12/3/01 | 22 hrs 40 mins | Subject land, specifically Long Bow Point | Gunninah 2001 |
| 16-17/12/02 | 4 hrs | UEA north, specifically south of Sewerage Treatment Plant | Gunninah 2003. |
| 15/10- 19/10/07 | 11 hrs (3hrs from car, 8hrs on foot) | UEA north | Environmental InSites 2007 |
| 13-17/12/10 | 12 hrs | Subject land | LesryK Consulting |
| 4-6/01/12 | 5 hrs | Long Bow Point | SLR Consulting |
| 16-19/01/12 | 10 hrs | Long Bow Point | SLR Consulting |
| 15-17/02/12 | 5 hrs | Long Bow Point | SLR Consulting |
| 7-11/05/12 | 8 hrs | Subject Land | SLR Consulting |
| 27-28/08/12 | 13 hrs | Long Bow Point | SLR Consulting |
| 29-31/08/12 | 7 hrs | Subject Land | SLR Consulting |
| 17-19/09/12 | 4.5 hrs | Long Bow Point | SLR Consulting |
| 19-20/09/12 | 5.5 hrs | Subject Land | SLR Consulting |
| 14-19/1/13 | 10 hrs | Long Bow Point | SLR Consulting |
| 18-20/3/13 | 4 hrs | Subject Land | SLR Consulting |
| TOTAL | 195 hrs 40 mins | | |

3 CALL PLAYBACK SURVEYS

Pre-recorded calls of the Koala, Squirrel Glider, Yellow-bellied Glider, Masked Owl, Powerful Owl and Barking Owl were broadcast on numerous locations during the 1997 – 2012 field surveys. Surveys commenced after dusk with each call being broadcast for 5 minutes followed by a two minute listening period. Ten minutes were spent listening for calls prior to and after playback. In addition to the nocturnal surveys, diurnal call playback was conducted for the Black Bittern (Table A3).

Table A3 Call playback surveys

| Calls Broadcasted | Date | Survey Effort (person-hours) | Survey Area | Surveyor |
|--|--------------------------|---|--|-----------------------------------|
| Masked Owl, Barking Owl, Squirrel Glider, Yellow-bellied Glider, Koala | 1/3/01 | 1 hr 55 mins | Study Area | Gunninah 2001 |
| | 5/3/01 | 2 hrs 53 mins | Study Area | Gunninah 2001 |
| | 2/3/01 | 1hr | Study Area | Gunninah 2001 |
| | 6/3/01 | 1hr 50 mins | Study Area | Gunninah 2001 |
| | 3/3/01 | 1hr | Study Area | Gunninah 2001 |
| | 9/3/01 | 52 mins | Study Area | Gunninah 2001 |
| | 10/3/01 | 1hr | Study Area | Gunninah 2001 |
| Masked Owl, Barking Owl, Squirrel Glider, Koala | 4/3/01 | 45 mins | Study Area | Gunninah 2001 |
| Black Bittern | 7/3/01 | 10 mins | Study Area | Gunninah 2001 |
| Black Bittern | 12/3/01 | 15 mins | Study Area | Gunninah 2001 |
| Owl calls | 16-21/7/97 11-15/8/97 | 1.5 hrs | Long Bow Point | Gunninah 1999 |
| Powerful Owl, Masked Owl, Barking Owl, Sooty Owl, Koala | 16- 17/12/2002 | 3 hrs | Subject Land , specifically south of the Sewerage Treatment Plant | Gunninah 2003 |
| Masked Owl, Barking Owl, Powerful Owl, Yellow-bellied Glider | 16 & 17/10/2007 | 1 hr | Subject Land | Environment al InSites 2007 |
| Owls and Gliders | 13- 17/12/2010 | 3 hrs | Subject Land | LesryK Consulting |
| Powerful Owl, Barking Owl, Masked Owl, Sooty Owl | 4-6/01/2012 | 2 hrs | Long Bow Point | SLR Consulting |
| Powerful Owl, Barking Owl, Masked Owl, Sooty Owl Yellow-bellied Glider, Squirrel Glider | 16- 19/01/2012 | 4 hrs | Long Bow Point | SLR Consulting |
| Powerful Owl, Barking Owl, Masked Owl, Sooty Owl Yellow-bellied Glider, Squirrel Glider | 7-11/05/12 | 2 hrs | Subject Land | SLR Consulting |
| Powerful Owl, Barking Owl, Masked Owl, Sooty Owl Yellow-bellied Glider, Squirrel Glider | 27- 29/08/2012 | 2 hrs | Long Bow Point | SLR Consulting |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

| | | | | |
|---|-------------|-------------------------|-------------------|-------------------|
| Powerful Owl, Barking Owl, Masked Owl | 30/08/12 | 1 hr | Subject Land | SLR Consulting |
| Powerful Owl, Barking Owl, Yellow-bellied Glider, Squirrel Glider | 17-19/09/12 | 1.5hrs | Long Bow Point | |
| Powerful Owl, Barking Owl, Yellow-bellied Glider, Squirrel Glider | 19-20/09/12 | 1 hr | Subject Land | |
| Powerful Owl, Masked Owl, Barking Owl, Yellow-bellied Glider, Squirrel Glider | 14-19/1/13 | 4 hrs | Long Bow Point | |
| Powerful Owl, Masked Owl, Yellow-bellied Glider, Squirrel Glider | 18-20/3/13 | 1 hr | Subject Land | |
| TOTAL | | 37hrs 40mins | | |

4 MICROCHIROPTERAN BAT SURVEYS

Harp Traps and Anabat II recorders were employed to detect microchiropteran bats. Harp Traps were placed in appropriate areas for bat detection including coastal woodland and dry sclerophyll forest. Traps were left for a minimum of two nights. Anabat II recorders are useful in detecting high flying microchiropteran bats that are often under sampled by bat (harp) trapping. Anabat surveys were conducted during the spotlight Traverse and from dusk till dawn using the delay system. In addition, a single stationary anabat location was surveyed. Harp Traps were placed in appropriate areas for bat detection including coastal woodland and dry sclerophyll forest.

Table A4 Microchiropteran bat surveys.

| Survey Type | Date | Survey Effort | Area Surveyed | Surveyor |
|-------------------------|----------------|----------------------|---|----------------------------|
| Anabat II bat detectors | 16-21/7/97 | 18 nights | Subject land | Gunninah 2001 |
| | 11-15/8/97 | 12 hrs/night | | |
| | 19/1-21/1/01 | 5 nights | Study Area | Gunninah 2001 |
| | 28/2/01 | 1 night | Study Area | Gunninah 2001 |
| | 1/3 – 6/3/01 | 6 nights | Study Area | Gunninah 2001 |
| | 9 & 10/3/01 | 2 nights | Study Area | Gunninah 2001 |
| | 10/3/01 | 1 night | Study Area | Gunninah 2001 |
| | 20/10-24/10/96 | 4 nights | Subject land, specifically Low Bow Point | Hoye 1996 |
| | 16/12-17/12/02 | 2 nights | UEA north, specifically south of the Sewerage Treatment Works | Gunninah 2003 |
| | 15-19/10/07 | 4 nights | Study Area | Environmental InSites 2007 |
| | 13-17/12/2010 | 4 nights | Subject Land | LesryK Consulting |
| | 15-19/01/2012 | 4 nights (2 units) | Long Bow Point | SLR Consulting |
| | 15-17/02/2012 | 2 nights (2 units) | Long Bow Point | SLR Consulting |
| | 7-11/05/2012 | 4 nights (2 units) | Subject Land | SLR Consulting |
| | 29-31/08/2012 | 2 nights (2 units) | Subject Land | SLR Consulting |
| | 17-19 Sep | 2 nights (2 Units) | Long Bow Point | SLR Consulting |
| | 19-21 Sep | 2 nights (2 units) | Subject Land | SLR Consulting |
| | 7-9/11/2012 | 2 nights (2 units) | Long Bow Point | SLR Consulting |
| | 14-19/1/13 | 5 nights (x 2 units) | Long Bow Point | SLR Consulting |
| | 18-20/1/13 | 1 night (3 units) | Subject Land | SLR Consulting |
| TOTAL | | 75 nights | | |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

| | | | | |
|--|----------------------------|-----------------------------------|----------------|-------------------|
| Spotlight Transects – Microchiropteran Bats | 3/3 -6/3/01 | 4 hours 50 minutes | Study Area | Gunninah 2001 |
| | 9 & 10/3/01 | 2 hours 50 minutes | Study Area | Gunninah 2001 |
| | 10/3/01 | 1 hour 50 minutes | Study Area | Gunninah 2001 |
| | 12/3/01 | 40 minutes | Study Area | Gunninah 2001 |
| | 20/10-24/10/96 | 4 nights (2hrs per night- approx) | Subject land | Hoye 1996 |
| | 15-19/01/07 | 4 nights (1/2 hr each night) | Subject Land | SLR Consulting |
| | 15-19/02/2012 | 2 nights(1/2 hr each night) | Subject Land | SLR Consulting |
| | 29-30/08/2012 | 2 nights(1/2 hr each night) | Subject Land | SLR Consulting |
| | TOTAL | 22hrs 10 minutes | | |
| Harp Trap – Microchiropteran Bats | 20/1 -22/1/01 | 5 TN | Study Area | Gunninah 2001 |
| | 2/3 –11/3/01 | 20 TN | Study Area | Gunninah 2001 |
| | 16/7-21/7/97 –11/8-15/8/97 | 7 nights 21 TN | Long Bow Point | Gunninah 1999 |
| | 20/10-24/10/96 | 4 nights 16 TN | Long Bow Point | Hoye 1996 |
| | 13-17/12/2010 | 4TN | Subject Land | LesryK Consulting |
| | 15 –17/02/2012 | 2 nights (2 units) 4 TN | Long Bow Point | SLR Consulting |
| | 8-11/05/2012 | 3 nights (2 units) 6 TN | Subject Land | SLR Consulting |
| | TOTAL | 76 TN | | |

5 DEDICATED DIURNAL BIRD SURVEYS

Diurnal bird surveys involved visual observation of species as well as identification of calls. Terrestrial bird surveys were conducted at dawn while aquatic bird surveys were conducted at random times of day. In addition, bird species were also recorded on an opportunistic basis throughout all surveys (see effort in Table A1). Targeted searches were undertaken for the Black Bittern (Table A5).

Table A5 Avifauna surveys

| Date | Survey Effort (person-hours) | Surveyed Area | Surveyor |
|---------------|---|----------------------|----------------------------|
| 4/3/01 | 1 hr 30 mins | Study Area | Gunninah 2001 |
| 5/3/01 | 1 hr 15 mins | Study Area | Gunninah 2001 |
| 6/3/01 | 15 minutes | Study Area | Gunninah 2001 |
| 7/3/01 | 1 hr | Study Area | Gunninah 2001 |
| 16/1/01 | 30 minutes | Study Area | Gunninah 2001 |
| 22/1/01 | 15 minutes | Study Area | Gunninah 2001 |
| 21/1/01 | 15 minutes | Study Area | Gunninah 2001 |
| 16-17/12/02 | 12 hrs | Subject Land | Gunninah 2003 |
| 15-19/10/07 | 4hrs | Subject Land | Environmental InSites 2007 |
| 13-17/12/2010 | 5 hrs | Subject Land | LesryK Consulting |
| 5/01/2012 | 2hrs | Subject Land | SLR Consulting |
| 15/01/2012 | 2hrs | Subject Land | SLR Consulting |
| 18/01/2012 | 1hr | Subject Land | SLR Consulting |
| 17/02/2012 | 2hrs | Subject Land | SLR Consulting |
| 10/05/2012 | 6 hrs | Subject Land | SLR Consulting |
| 27-29/8/2012 | 12hrs | Long Bow Point | SLR Consulting |
| 30-31/08/2012 | 7 hrs | Subject Land | SLR Consulting |
| 31/8/2012 | 2hrs | Long Bow Point | SLR Consulting |
| 17-21 Sep | 9.75 hrs | Long Bow Point | SLR Consulting |
| 18-21 Sep | 8.5 hrs | Subject Land | SLR Consulting |
| 17 Oct | 2.5 hrs | Subject Land | SLR Consulting |
| 18 Oct | 3 hrs | Long Bow Point | SLR Consulting |
| 7-9/11/2012 | 7 hrs | Long Bow Point | SLR Consulting |
| 14-19/1/2013 | 16 hrs | Long Bow Point | SLR Consulting |
| 13-14/1/2013 | 2 hrs | Subject Land | SLR Consulting |
| 18-20/3/13 | 9 hrs | Subject Land | SLR Consulting |
| TOTAL | 116.75 hrs | | |

Note These do NOT include the thousands of person-hours of opportunistic diurnal surveys in the study area over the two decades of surveys

6 SCAT & TRACK SURVEYS

During SLR's 2013, 2012 and 2011 studies, scat and track surveys were conducted in all areas and habitat types of the subject land, on an opportunistic basis. A total of 6.7km was surveyed during the investigation during 2001 surveys. Hair, scat and owl pellets were collected during the Daly & Leonard surveys (1994 and 1996).

7 HABITAT SEARCHES

During the 2013 and 2012 surveys, the subject site was thoroughly examined for the occurrence of habitat features including hollow-bearing trees, dead stags, ground logs and debris as well as suitable vegetation types. Any favourable features observed were documented and mapped in correspondence with the proposed clearing.

During the 1997 surveys, 65 specific survey sites were chosen randomly and the vegetation structure and species were recorded. Allocasuarina density was recorded along with the presence of dead stags and hollow-bearing Trees. Opportunistic log and debris searches, scats and bones identified, animals sighted, bird searches (aural and visual).

17 Transects were driven and information regarding the frequency and number of hollow-bearing trees which occur, the apparent number of hollows borne by each tree and the number of dead stags which occur.

8 HERPETOFAUNA SURVEYS

Herpetofauna surveys were conducted for both reptiles and amphibians. Reptiles were surveyed on an opportunistic basis throughout the 2012/13 survey periods, particularly during the fauna habitat surveys. Specific attention was given to the Heath Monitor.

Amphibian investigations were undertaken on an opportunistic basis throughout the survey in areas of suitable habitat particularly during spotlighting and the fauna habitat surveys. Targeted diurnal and nocturnal searches were conducted for the Green & Golden Bell Frog including call imitation, dip netting and spotlighting (Table A6; Figure 3).

Table A6 Herpetofauna surveys

| Technique | Nocturnal/ Diurnal | Date | Survey Effort (person hours) | Surveyed Area | Surveyor |
|----------------------|-----------------------|---------------------|---|---|----------------------|
| Amphibian surveys | Nocturnal | 16/7/97- 15/8/97 | 62 hrs 30 minutes (opportunistic during spotlighting) | Subject land, specifically Long Bow Point | Gunninah 1999 |
| | Diurnal | 15/1/01 | 1 hour | Study Area | Gunninah 2001 |
| | Nocturnal | 28/2/01 | 3 hrs 20 mins | Study Area | Gunninah 2001 |
| | Nocturnal | 1/3/01 | 1 hour | Study Area | Gunninah 2001 |
| | Diurnal | 2/3/01 | 2 hours | Study Area | Gunninah 2001 |
| | Nocturnal | 7/3/01 | 3 hrs 20 mins | Study Area | Gunninah 2001 |
| | Diurnal | 8/3/01 | 1 hr 40 mins | Study Area | Gunninah 2001 |
| | Diurnal | 10/3/01 | 1 hour 30 mins | Study Area | Gunninah 2001 |
| | Nocturnal | 10/3/01 | 1 hr 20 mins | Study Area | Gunninah 2001 |
| | Diurnal | 11/3/01 | 40 minutes | Study Area | Gunninah 2001 |
| | Diurnal | 12/3/01 | 30 minutes | Study Area | Gunninah 2001 |
| | Diurnal | 16- 17/12/02 | 6hrs | Study Area, specifically area south of Sewage Treatment Plant | Gunninah 2003 |
| | Nocturnal | 4/1/2012 | 1hr | Subject Land | SLR Consulting |
| | Nocturnal | 15/1/2012 | 1hr | Subject Land | SLR Consulting |
| | Nocturnal | 16/2/2012 | 1hr | Subject Land | SLR Consulting |
| TOTAL | | | 86hrs 50mins | | |
| Reptile surveys | 16-17/12/2002 | | 6hrs | Subject Land | Gunninah 2003 |
| | 15-17/12/2010 | | 3 hrs | Subject Land | LesryK Consulting |
| | 4-6/01/2012 | | # Opp | Long Bow Point | SLR Consulting |
| | 15-19/01/2012 | | # Opp | Long Bow Point | SLR Consulting |
| | 30/08/2012 | | 2 hrs | Subject Land | SLR Consulting |

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| | | | |
|--------------|-----------------|----------------|----------------|
| 17/10/2012 | 0.5 hrs | Subject Land | SLR Consulting |
| 18/10/2012 | 1 hr | Long Bow Point | SLR Consulting |
| 14-19/1/2013 | 8 | Long Bow Point | SLR Consulting |
| 18-20/3/2013 | 3 | Subject Land | SLR Consulting |
| TOTAL | 23.5 hrs | | |

Opp = Opportunistic surveys during whole survey period.

9 HAIR-TUBE SURVEYS

Hair-tubes were distributed throughout the subject land in areas of high habitat value for small mammals to target threatened species including the Spotted-tailed Quoll, Brush-tailed Phascogale, White-footed Dunnart and the Southern Brown Bandicoot. Hair tubes were baited with a mixture of peanut butter, honey, oats and vanilla essence.

Table A7 Hair-tube surveys

| Date | Effort | M bait | St bait | V bait | Survey location | Surveyor |
|-----------------------|--------------------------|--------|---------|--------|---|------------------------------|
| 18/9/12-06/10/12 | 40 hairtubes 720 TN | | X | | Subject Land | SLR Consulting |
| 28/8/2012 - 17/9/2012 | 40 hairtubes 760 TN | | X | | Long Bow Point | SLR Consulting |
| 8–29/5/2012 | 40 hairtubes 840 TN | | X | | Subject Land | SLR Consulting |
| 18/1-16/2/2012 | 49 hair tubes 1421 TN | | X | | Long Bow Point | SLR Consulting |
| 5-15/1/2012 | 49 hair tubes 490 TN | | X | | Long Bow Point | SLR Consulting |
| 13-23/12/2010 | 40 hair tubes 400 TN | | X | | Subject Land | LesryK Consulting |
| 22/1-7/3/01 | 25 hair tubes 1100 TN | X | X | | Study Area | Gunninah 2001 |
| 4/3-14/3/01 | 60 hair tubes 600 TN | X | X | | Study Area | Gunninah 2001 |
| 21/7-14/8/97 | 17 hair tubes 425 TN | | | X | Subject Area, specifically Long Bow Point | Gunninah 2001 |
| 4/9-19/9/96 | 16 hair tubes 240 TN | X* | X | | Subject Area, specifically Long Bow Point | Daly & Leonard (1994 & 1996) |
| 23/11-13/12/96 | 10 hair tubes 140 TN | X* | X | | Subject Area, specifically Long Bow Point | Daly & Leonard (1994 & 1996) |
| TOTAL | 6736TN | | | | | |

Key

- M Number of tubes baited with meat
- St Number of tubes baited with honey and peanut butter
- V Mushrooms, carrots, bananas
- * Chicken was used to target Southern Brown Bandicoot

10 TRAPPING SURVEYS

Elliott ground traps were placed along 4 transects within areas of assessed higher habitat value. Each Transect consisted of 25 traps spaced approximately 10m apart.

Cage traps were placed randomly throughout the subject land. In addition, areas of suitable habitat for the Southern Brown Bandicoot (thick undergrowth and sedges) were focused upon.

Tree Elliot traps were installed in various locations around the subject land, at 1.8m above ground on platforms. Preference was given to those trees exhibiting hollow-bearing features suitable as potential roost/den sites for arboreal mammals. Tree trunks were sprayed with a diluted honey and water solution.

Glider Tube traps were attached to various suitable trees on site, particularly those that were flowering at the time of the survey.

All traps were baited with a mix of peanut butter, honey, oats and vanilla essence.

Table A8 Trapping surveys.

| Date | Elliott Traps (ground-based) | Elliott Traps (tree-mounted) | Cage Traps | Pitfall Traps | Glider Tube Traps | Surveyor |
|--|---------------------------------|---------------------------------|---------------|------------------|-------------------------|-------------------------------|
| 18-20/1/13 | | | | | 10 | SLR Consulting |
| 14-19/1/13 | | | | 2 | 15 | SLR Consulting |
| | | | | | | SLR Consulting |
| 9-11/5/2012 | | | | | 6 | SLR Consulting |
| 15-19/1/2012 | 100 | 10 | 17 | | 5 | SLR Consulting |
| 13- 17/12/2010 | 65 | 10 | 6 | 18 | | LesryK Consulting |
| 28/2/01 - 5/3/01 | 80 | - | 6 | 15 | | Gunninah 2001 |
| 15-21/1/01 | 40 | - | 5 | 5 | | Gunninah 2001 |
| 1-7/3/01 | 20 | - | 1 | - | | Gunninah 2001 |
| 1-6/3/01 | 20 | 20 | - | 5 | | Gunninah 2001 |
| 6-11/3/01 | 40 | 10 | 4 | 5 | | Gunninah 2001 |
| 7-12/3/01 | - | 10 | - | - | | Gunninah 2001 |
| 21/7-14/8/97 | | | | | | Gunninah 2001 |
| 4/9-15/9/96 | 50 | | | | | Daly & Leonard 1994 & 1996 |
| 13/12- 16/12/93 | - | 25 | - | - | | Daly & Leonard 1994 & 1996 |
| 23/11- 30/11/93 13/12- 17/12/93 | - | - | - | 10 | | Daly & Leonard 1994 & 1996 |
| TOTAL | 2140 TN | 355 TN | 184 TN | 332 TD | 127TN | |

APPENDIX D Details of flora and fauna field surveys conducted at Culburra

11 INFRARED CAMERAS

Infrared cameras were set up in various locations around the site to assist with nocturnal and diurnal mammal surveying. Each camera was set up adjacent to bait tubes, which were soaked in truffle oil, or baited with meat and/or fruit and placed in areas with evidence of mammal activity (scratchings, diggings and scats) or favourable habitat features.

Table A9

| Date | Effort | Units | Surveyor | Location |
|---------------|-----------------|--------------|-------------------|-----------------|
| 13-17/12/2010 | 80 hrs | 2 | LesryK Consulting | Subject Land |
| 15-18/01/2012 | 44hrs | 2 | SLR Consulting | Long Bow Point |
| 7-11/05/2012 | 84hrs | 2 | SLR Consulting | Subject Land |
| 27-28/08/2012 | 38hrs | 2 | SLR Consulting | Long Bow Point |
| 29-31/08/2012 | 38hrs | 2 | SLR Consulting | Subject Land |
| 17-19/09/12 | 24 hrs | 2 | SLR Consulting | Long Bow Point |
| 19-21/09/12 | 36 hrs | 2 | SLR Consulting | Subject Land |
| 16-17/10/12 | 20 hrs | 2 | SLR Consulting | Subject Land |
| 17-18/10/12 | 18 hrs | 2 | SLR Consulting | Long Bow Point |
| 7-9/11/12 | 38 hrs | 2 | SLR Consulting | Long Bow Point |
| 14-19/1/13 | 116 hrs | 2 | SLR Consulting | Long Bow Point |
| 13-17/1/13 | 106 hrs | 4 | SLR Consulting | Subject Land |
| 18-20/3/13 | 92 hrs | 4 | SLR Consulting | Subject Land |
| Total | 1116 hrs | | | |

12 FLORA SURVEYS

There have been a substantial number of flora surveys, undertaken by walked transects, random meanders and dedicated meanders, throughout the subject land and the study area over a very long period. Many of the investigations undertaken in the 1990s and early 2000s have not been well documented in terms of specific quadrats, transects or other metrics of investigation, or those data have been lost through old technology or the misplacement of old files.

However, it is clear that there have been very substantial and extensive flora surveys throughout the subject land, Long Bow Point and other parts of the study area, over the nearly two decades of intensive investigations in this general locality. In particular, detailed investigations in 2001 and 2002 (undertaken by Gunninah Environmental Consultants) involved several weeks of field investigations, which included:

- extensive walked surveys by dedicated botanists;
- the collection of detailed floristic information regarding various vegetation types in the study area; and
- dedicated searches for threatened plant species.

Subsequent investigation undertaken by SLR Ecology and previously Environmental InSites, have involved very extensive walked and driven surveys of the subject site, the subject land and Long Bow Point, including:

- dedicated searches within appropriate vegetation types for threatened orchids known to occur in the vicinity or locality;
- very extensive walked surveys to 'ground-truth', review and map vegetation community boundaries;
- walked transects along seven cross-sections from the Crookhaven River foreshore up into the subject site (Appendices D and J) - to identify the locations of various vegetation types and communities, and to search for threatened species of potential relevance; and
- through the latter half of 2012 and the early part of 2013, the SLR Ecology Team has conducted a very substantial regime of flora investigations of the subject land and Long Bow Point for the purposes of this ERIAR for the Culburra West Project, and for the *Species Impact Statement* (SIS) being prepared for the Culburra Golf Course Project on Long Bow Point.

Those investigations have involved:

- 10 dedicated surveys for threatened orchids within the Culburra West Project site and Culburra Golf Course site;
- at least 30 person-days of flora surveys by dedicated meanders, random meanders and walked inspections of cross-sections from the Crookhaven River onto the subject site; and
- dedicated surveys for threatened plant species and hollow-bearing trees throughout the subject site, subject land and Culburra Golf Course site.

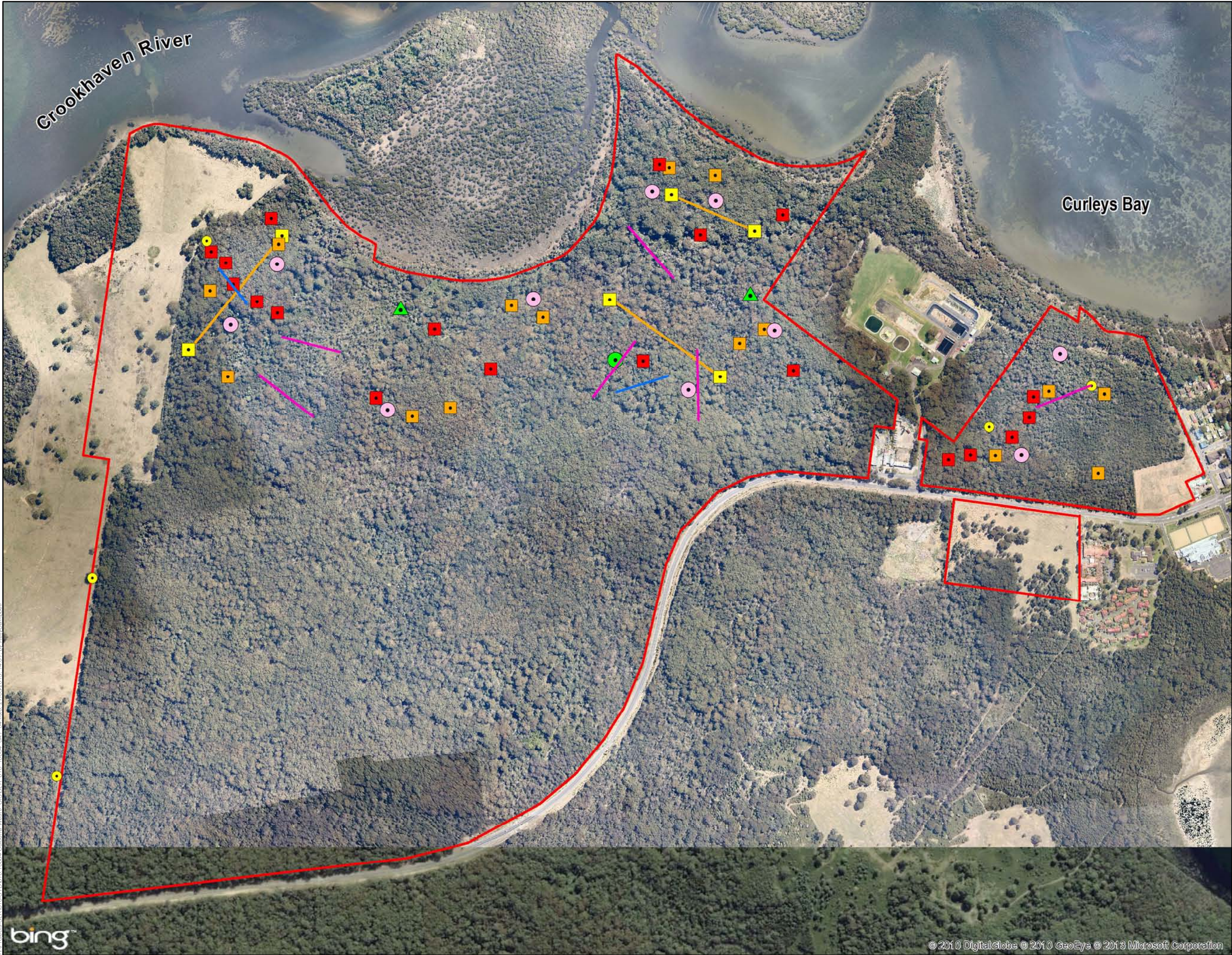
13 KOALA SPOT ASSESSMENTS

Koala surveys were conducted using the methods outlined in Phillips & Callaghan (1995). Suitable Trees were assessed for Koala evidence (scats and scratches). Preference was given to searching Trees identified as Koala feed Trees pursuant to *State Environmental Planning Policy No.44* (Table A10).

Table A10 Koala spot assessments (Gunninah 2001). DBH = Diameter at Breast Height. N/A = not applicable.

| Site | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | |
|--|-----------------------------------|--------|---|--------|--|--------|--|--------|---|-------|--|--------|
| | E: 293200 N: 6130700 | | E: 292400 N: 6130575 | | E: 294175 N: 6131725 | | E: 294525 N: 6131000 | | E: 292650 N: 6131900 | | E: 293300 N: 6132250 | |
| | DBH | Strike | DBH | Strike | DBH | Strike | DBH | Strike | DBH | Stike | DBH | Strike |
| Red Bloodwood (<i>Eucalyptus gummifera</i>) | 98, 25, 22, 100, 22, 45, 55 | 0 | 30, 50 | 0 | 60 | 0 | 25, 30, 40, 45 | 0 | - | - | - | - |
| Coastal Blackbutt (<i>E. pilularis</i>) | 50, 55, 55, 30, 60 | 0 | 45, 45, 55, 45, 45, 45, 50, 50, 40, 50, 40, 50, 50, 45, 55 | 0 | 50, 55, 65, 45, 55, 50, 55, 45, 25, 33, 45, 40 | 0 | 50, 70, 50, 70, 70, 40, 40, 45, 50, 65 | - | 50 | 0 | 75, 30, 45, 35, 50, 30, 45, 40, 45, 80, 50 | 0 |
| Scribbly Gum (<i>E. racemosa</i>) | - | - | 65, 30 | - | - | - | - | - | 50, 90, 25, 25 | 0 | 45, 40, 40, 55, 25, 30, 25 | 0 |
| Swamp Mahogany (<i>E. robusta</i>) | - | - | - | - | - | - | - | - | 20, 30, 40, 30, 65, 40, 55, 40, 40, 35, 40, 42, 65, 45, 45 | 0 | - | - |
| Large-fruited Grey Gum (<i>E. punctata</i>) | 30, 65, 45, 25, 90, 95 | 0 | - | - | 50, 50, 35 | 0 | 50, 45, 30, 50, 45, 70 | 0 | - | - | - | - |
| Stringybark Species | 50, 45 | 0 | 60 | 0 | - | - | 70 | 0 | - | - | - | - |
| Swamp Box (<i>Lophostemon</i> sp.) | - | - | - | - | 70, 90, 45, 50 | 0 | - | - | - | - | - | - |
| % Koala Activity | | 0 % | | 0 % | | 0 % | | 0% | | 0% | | 0% |

Figure A1 2012 and 2013 fauna survey efforts (dedicated techniques only) at Culburra West



LEGEND

- Subject Land
- Anabat detectors
- Glider tube traps
- Replicated hair funnels
- Harp traps
- Infrared cameras
- Glossy Black Cockatoo feed tree
- Glossy Black Cockatoo - Search Stations
- Glossy Black Cockatoo - Habitat Search Transects
- Pitfall traps (LesryK 2010)

NOTES

- Digital cadastral database (DCDB) © 2012 NSW Dept of lands.
- Subject land boundaries based on DCDB 2012
- Aerial imagery courtesy of Esri, BingMapAerial & Nearmap, 14/09/2011
- All features are approximate only and subject to detailed survey



2 Lincoln Street
Lane Cove
NSW 2066
Australia
T: +61 2 6287 0800
F: +61 2 6287 0801
www.slrconsulting.com

Project Name: Culburra West

Prepared for: Realty Realizations Pty Ltd

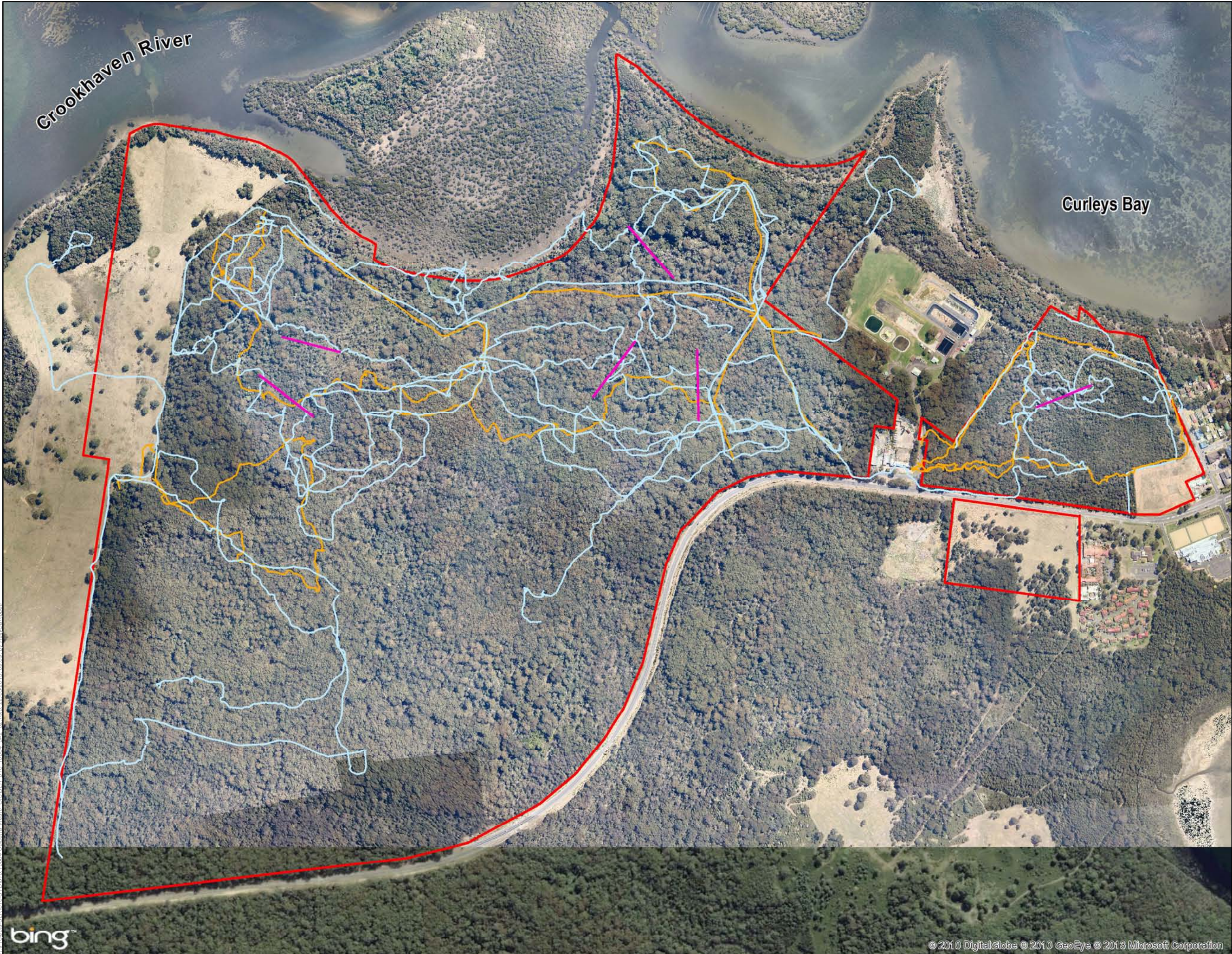
Project No: 610.10684

| | | | | | |
|---------|----------------|---|----|----------|-----------------|
| Scale | 1:8,000 | @ | A3 | Date | 27/03/2013 |
| Drafted | Kelly Campbell | | | Approved | Dominic Fanning |

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Figure A2

Some recent SLR walked surveys at Culburra West (August to March 2013)



LEGEND

- ▬ Subject Land
- ▬ Nocturnal Survey
- ▬ Diurnal Survey
- ▬ Glossy Black Cockatoo - Habitat Search Transects

0 50 100 200 300
Metres

N

- NOTES**
1. Digital cadastral database (DCDB) © 2012 NSW Dept of lands.
 2. Subject land boundaries based on DCDB 2012
 3. Aerial imagery courtesy of Esri, BingMapAerial & Nearmap, 14/09/2011
 4. All features are approximate only and subject to detailed survey



2 Lincoln Street
Lane Cove
NSW 2066
Australia
T: +61 2 6287 0800
F: +61 2 6287 0801
www.slrconsulting.com

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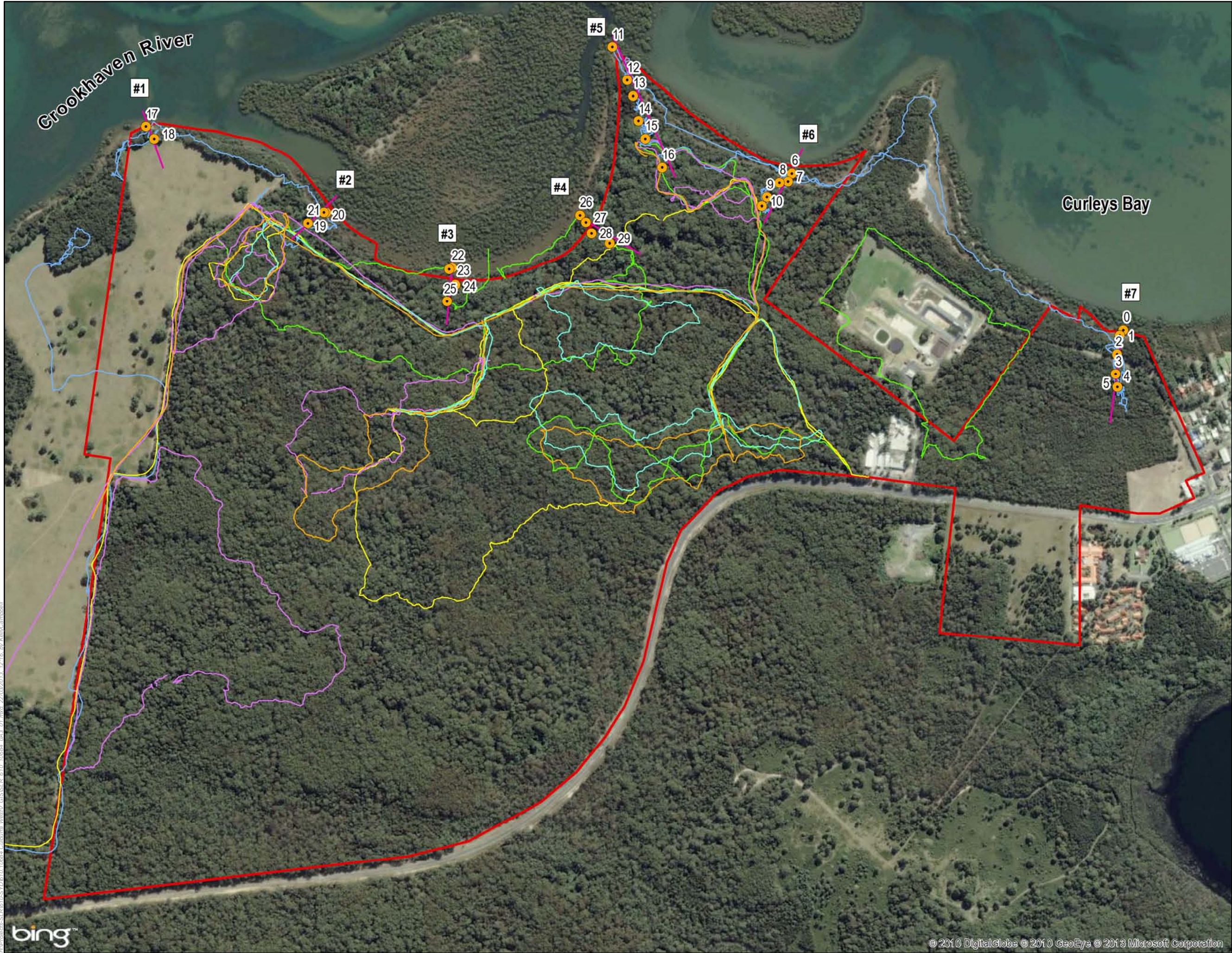
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|---------|----------------|----------|-----------------|------|------------|
| Scale | 1:8,000 | @ | A3 | Date | 22/03/2013 |
| Drafted | Kelly Campbell | Approved | Dominic Fanning | | |

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Figure A3

Some recent SLR vegetation surveys and seaches for "threatened flora"



LEGEND

Subject Land

— 17 Oct 2012 - 7 hours search for Illawarra Greenhood and Pretty Beard Orchid

— 19 Dec 2012 - 3 hours search for Leafless Tongue Orchid, Eastern Lynne Midge Orchid, Bauer's Midge Orchid and Tangled Bedstraw

— 21 Feb 2013 - 2 hours search for Leafless Tongue Orchid, Bauer's Midge Orchid and *Pterostylis ventricosa*

— 06 Mar 2013 - 2 hours search for Leafless Tongue Orchid, Bauer's Midge Orchid and *Pterostylis ventricosa*

— 13 & 14 Mar 2013 - 6 hours foreshore vegetation mapping check

— 19 Mar 2013 - 2 hours search for Leafless Tongue Orchid, Bauer's Midge Orchid and *Pterostylis ventricosa*

● Foreshore X-section points

#1 Foreshore X-sections

— Foreshore X-sections

0 50 100 200 300
Metres

N


NOTES

1. Digital cadastral database (DCDB) © 2012 NSW Dept of lands.

2. Subject land boundaries based on DCDB 2012

3. Aerial imagery courtesy of Esri, BingMapAerial & Nearmap, 14/09/2011

4. All features are approximate only and subject to detailed survey



2 Lincoln Street
Lane Cove
NSW 2066
Australia
T: +61 2 6287 0800
F: +61 2 6287 0801
www.slrconsulting.com

Project Name:
Culburra West

Prepared for:
Realty Realizations Pty Ltd

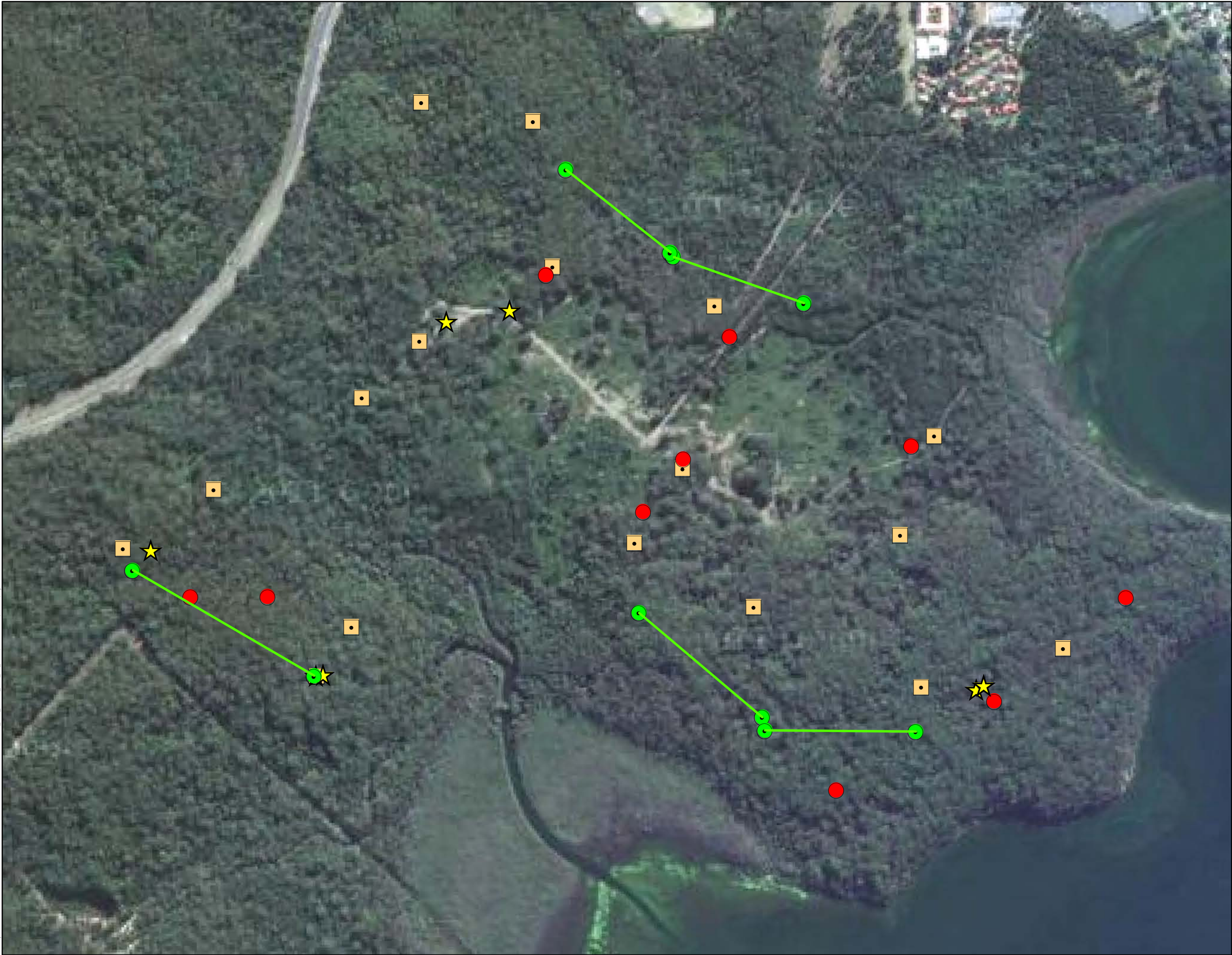
Project No:
610.10684

Scale 1:8,000 @ A3 Date 22/03/2013


Drafted Kelly Campbell Approved Dominic Fanning

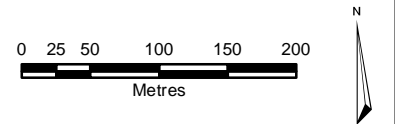
Figure 3

2011/2012 fauna survey locations



LEGEND

-  Elliott Lines
-  Glider Tubes
-  Tree Elliots
-  Cage Traps



NOTES

1. Aerial imagery courtesy of Google map
2. All features are approximate only and subject to detailed survey



2 Lincoln Street
Lane Cove
NSW 2066
Australia
T: +61 2 6287 0800
F: +61 2 6287 0801
www.slrconsulting.com

| | |
|-----------------------------|-------------------------|
| Project Name: | |
| Culburra Golf Course | |
| Prepared for: | |
| Realty Realizations Pty Ltd | |
| Project No: | |
| 610.10763 | |
| Scale 1:5,500 @ A3 | Date 15-Mar-2012 |
| Drafted Sara Haddady | Approved Sepehr Sobhani |

Figure 4

2011/2012 fauna survey locations



LEGEND

- Hair Funnels
- Harp Traps
- Anabat Stations
- Infrared Camera locations

0 25 50 100 150 200
Metres

N

NOTES

1. Aerial imagery courtesy of Google map
2. All features are approximate only and subject to detailed survey



2 Lincoln Street
Lane Cove
NSW 2066
Australia
T: +61 2 6287 0800
F: +61 2 6287 0801
www.slrconsulting.com

Project Name:
Culburra Golf Course

Prepared for:
Realty Realizations Pty Ltd

Project No: **610.10768**

| | | | | | |
|---------|--------------|---|----|----------|----------------|
| Scale | 1:5,500 | @ | A3 | Date | 09-Jan-2013 |
| Drafted | Sara Haddady | | | Approved | Sepehr Sobhani |

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